# Marine Science Review – 163
## Pollution

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In this review:

A. Recent articles – no abstract available
B. Recent articles with abstracts

## A. Recent articles – no abstract available

Shiomoto, A. and Kameda, T. **Distribution of manufactured floating marine debris in near-shore areas around Japan.** *Marine Pollution Bulletin* 50(11): 1430-1432, 2005.

## B. Recent articles with abstracts

Zheng, Y., Yanful, E.K., and Bassi, A.S. **A review of plastic waste biodegradation.** *Critical Reviews in Biotechnology* 25(4): 243-250, 2005.

**Notes**: With more and more plastics being employed in human lives and increasing pressure being placed on capacities available for plastic waste disposal, the need for biodegradable plastics and biodegradation of plastic wastes has assumed increasing importance in the last few years. This review looks at the technological advancement made in the development of more easily biodegradable plastics and the biodegradation of conventional plastics by microorganisms. Additives, such as pro-oxidants and starch, are applied in synthetic materials to modify and make plastics biodegradable. Recent research has shown that thermoplastics derived from polyolefins, traditionally considered resistant to biodegradation in ambient environment, are biodegraded following photo-degradation and chemical degradation. Thermoset plastics, such as aliphatic polyester and polyester polyurethane, are easily attacked by microorganisms directly because of the potential hydrolytic cleavage of ester or urethane bonds in their structures. Some microorganisms have been isolated to utilize polyurethane as a sole source of carbon and nitrogen source. Aliphatic-aromatic copolyesters have active commercial applications because of their good mechanical properties and biodegradability. Reviewing published and ongoing studies on plastic biodegradation, this paper attempts to make conclusions on potentially viable methods to reduce impacts of plastic waste on the environment.

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Trasande, L., Schechter, C.B., Haynes, K.A., and Landrigan, P.J. **Mental retardation and prenatal methylmercury toxicity.** *American Journal of Industrial Medicine* 49(3): 153-158, 2006.

**Notes**: ***Background*** Methylmercury (MeHg) is a developmental neurotoxicant; exposure results principally from consumption of seafood contaminated by mercury (Hg). In this analysis, the burden of mental retardation (MR) associated with methylmercury exposure in the 2000 U.S. birth cohort is estimated, and the portion of this burden attributable to mercury (Hg) emissions from coal-fired power plants is identified. ***Methods*** The aggregate loss in cognition associated withMeHg exposure in the 2000 U.S. birth cohort was estimated using two previously published dose-response models that relate increases in cord blood Hg concentrations with decrements in IQ. MeHg exposure was assumed not to be correlated with native cognitive ability. Previously published estimates were used to estimate economic costs of MR caused by MeHg. ***Results*** Downward shifts in IQ resulting from prenatal exposure to MeHg of anthropogenic origin are associated with 1,566 excess cases of MR annually (range: 376-14,293). This represents 3.2% of MR cases in the US (range: 0.8%-29.2%). The MR costs associated with decreases in IQ in these children amount to $2.0 billion/year (range: $0.5-17.9 billion). Hg from American power plants accounts for 231 of the excess MR cases/year (range: 28-2,109), or 0.5% (range: 0.06%-4.3%) of all

MR. These cases cost $289 million (range: $35 million-2.6 billion). ***Conclusions*** Toxic injury to the fetal brain caused by Hg emitted from coal-fired power plants exacts a significant human and economic toll on American children.

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Jewett, E.B., Hines, A.H., and Ruiz, G.M. **Epifaunal disturbance by periodic low levels of dissolved oxygen: native vs. invasive species response.** *Marine Ecology Progress Series* 304: 31-44, 2005.

**Notes**: Hypoxia is increasing in marine and estuarine systems worldwide, primarily due to anthropogenic causes. Periodic hypoxia represents a pulse disturbance, with the potential to restructure estuarine biotic communities. We chose the shallow, epifaunal community in the lower Chesapeake Bay, Virginia, USA, to test the hypothesis that low dissolved oxygen (DO) (< 4 mg l(-1)) affects community dynamics by reducing the cover of spatial dominants, creating space both for less dominant native species and for invasive species. Settling panels were deployed at shallow depths in spring 2000 and 2001 at Gloucester Point, Virginia, and were manipulated every 2 wk from late June to mid-August. Manipulation involved exposing epifaunal communities to varying levels of DO for up to 24 h followed by redeployment in the York River. Exposure to low DO affected both species composition (presence or absence) and the abundance of the organisms present. Community dominance shifted away from barnacles as level of hypoxia increased. Barnacles were important spatial dominants which reduced species diversity when locally abundant. The cover of *Hydroides dianthus*, a native serpulid polychaete, doubled when exposed to periodic hypoxia. Increased *H. dianthus* cover may indicate whether a local region has experienced periodic, local DO depletion and thus provide an indicator of poor water-quality conditions. In 2001, the combined cover of the invasive and cryptogenic species in this community, *Botryllus schlosseri* (tunicate), *Molgula manhattensis* (tunicate), *Ficopomatus enigmaticus* (polychaete) and *Diadumene lineata* (anemone), was highest on the plates exposed to moderately low DO (2 mg l(-1) < DO < 4 mg l(-1)). All 4 of these species are now found worldwide and exhibit life histories well adapted for establishment in foreign habitats. Low DO events may enhance success of invasive species, which further stress marine and estuarine ecosystems.

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Laufer, H., Pan, X.J., Biggers, W.J., Capulong, C.P., Stuart, J.D., Demir, N., and Koehn, U. **Lessons learned from inshore and deep-sea lobsters concerning alkylphenols.** *Invertebrate Reproduction and Development* 48(1-3): 109-117, 2005.

**Notes**: In earlier studies it was found that metamorphosis-inducing activity brings about the settlement of swimming trochophore larvae of the marine worm *Capitella capitata*. Such activity was attributable to alkylphenols, which are present in marine sediments as well as in hemolymph and embryos of the lobster *Homarus americanus*. These samples were taken from Long Island Sound and Vineyard Sound. Little or none of this activity was found in offshore lobsters taken from the edge of the continental shelf far from human influence. A comprehensive analytical method based on organic solvent microwave-assisted extraction, followed by solid phase extraction and gas chromatography-mass spectrometry was developed for the simultaneous identification and quantification of bioactive compounds. These compounds include the following four alkylphenols: #1: 2-t-butyl4-(diniediylberizyl)phenol; #2: 2,6-bis-(t-butyl)-4-(dimethylbenzyl)phenol; #3: 2,4-bis-(dimethylbenzyl)phenol; and #4: 2,4-bis-(diniethlybenzyl)-6-t-butylphenol. It is reported that 95 (36%) of 262 inshore lobsters contained one or more alkylphenols with average values as follows: compound #1, 11.2 +/- 55.9 ng/mL; #2, 23.3 +/- 355.9 ng/mL; #3, 116.6 +/- 434.2 ng/mL; and #4, 107.1 +/- 1167.9 ng/mL, respectively. Only one of 15 offshore lobsters (6.7%), had detectable alkylphenols. Three of five (60%) deep-sea lobsters had embryos that were carrying higher levels of alkylphenols. These results suggest that inshore lobsters at higher water temperatures are exposed to alkylphenol contamination. Offshore lobsters at lower temperatures appear to be remediated and have lower alkylphenol levels in their blood by having remained offshore, presumably in less contaminated waters. The embryos were most likely formed during inshore reproductive maturation because offshore temperatures are too low for ovarian and egg maturation. These embryos remained contaminated because of their isolation within a relatively impervious shell.

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Spurgeon, A. **Prenatal methylmercury exposure and developmental outcomes: Review of the evidence and discussion of future directions.** *Environmental Health Perspectives* 114(2): 307-312, 2006.

**Notes**: I conducted a review of the published literature to assess the strength of the evidence for an association between prenatal exposure to methylmercury (MeHg) and subsequent child development. I identified 12 studies on this subject published since 1980. Of these, 3 were longitudinal studies -- 2 conducted in the Seychelle Islands, and 1 in the Faroe Islands. Nine were cross-sectional studies conducted in different countries where seafood, a source of MeHg, constituted a major part

of the diet. The ages of the children studied ranged from 2 weeks to 12 years. The results of the longitudinal studies were contradictory. Researchers in the Faroe Islands identified an association between MeHg exposure and developmental effects, whereas those in the Seychelle Islands identified no such association. This inconsistency was mirrored in the results of the cross-sectional studies where there were some positive and some negative findings. It was concluded that it was not possible from currently available data to determine whether there is an association between prenatal MeHg exposure and adverse developmental effects in children. In advance of future research, consideration should be given to resolving the uncertainties surrounding exposure assessment and outcome measurement, as both elements varied between studies. It was suggested that questions of exposure assessment would benefit from the application of an expert review process. Outcome assessment would benefit from the development of theoretically based measures of specific aspects of cognitive functioning to replace the relatively crude measures of attainment and IQ currently employed in most studies. This would assist in the development of classic longitudinal studies by allowing repeated assessment over the full age range and providing data that are more readily interpretable and comparable between studies.

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Jjemba, P.K. **Excretion and ecotoxicity of pharmaceutical and personal care products in the environment.** *Ecotoxicology and Environmental Safety* 63(1): 113-130, 2006.

**Notes**: The presence and fate of pharmaceutical and personal care products (PPCPs) in the environment is undergoing increasing scrutiny. The existing clinical pharmacokinetics and pharmacodynamics data for 81 common compounds were examined for cues of ecotoxicity. Of these the proportions excreted were available for 60 compounds (i.e., 74%). The compounds had a low (<= 0.5%), a moderately low (6-39%), a relatively high (40-69%), or a high (>= 70%) proportion of the parent compound excreted. More than half of the compounds evaluated have low or moderately low proportions of the parent compound excreted. However, the proportions excreted were negatively but moderately correlated ($r = -0.50$; $n = 13$; $P = 0.08$) with the concentrations of the compounds in the aquatic environment, suggesting that the compounds that have low proportions excreted may also have inherently low degradability in the environment. Solubility, log K-ow, and pK(a), work well in predicting the behavior of PPCPs under clinical conditions and have been used in the environmental assessment of PPCPs prior to approval. However, these parameters did not correlate with the proportion of PPCPs excreted in the environment or their concentration in the environment, underscoring the need for research into the behavior of PPCPs in the environment. PPCPs occur in low concentrations in the environment and are unlikely to elicit acute toxicity. An ecotoxicity potential that is based on chronic toxicity, bioavailability, and duration of exposure to nontarget organisms is described as a guide in assessing the potency of these compounds in the environment.

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Weltje, L., vom Saal, F.S., and Oehlmann, J. **Reproductive stimulation by low doses of xenoestrogens contrasts with the view of hormesis as an adaptive response.** *Human and Experimental Toxicology* 24: 431-437, 2005.

**Notes**: We discuss the similarities and differences of two types of effects that occur at low but not high doses of chemicals: hormesis and stimulation by oestrogenic endocrine-disrupting chemicals or xenoestrogens. While hormesis is a general phenomenon evoked by many compounds, oestrogenic stimulation occurs for specific chemicals that disrupt actions of endogenous oestrogen. Both types of phenomena can induce an inverted-U dose-response curve, resulting from low-dose stimulation of response, and thus challenge current methods of risk assessment. Hormesis is generally thought to be caused by an over-reaction of detoxification mechanisms, which is considered an adaptive response that should protect an organism from subsequent stress. One view of the hormetic low-dose stimulatory response, i.e., increased performance, is that it is beneficial. In contrast, we propose that for manmade xenoestrogens this is never the case. This is demonstrated with examples for low doses of the oestrogenic environmental chemicals bisphenol A and octylphenol, and the oestrogenic drug diethylstilbestrol. Adverse low-dose effects include oviduct rupture, an enlarged prostate, feminization of males and reduced sperm quality. These adverse stimulatory effects divert energy needed for other processes, resulting in reduced fitness. In conclusion, while there are similarities (inverted-U dose-response), there are also differences, adaptive response for hormesis versus adverse stimulatory response for low doses of manmade xenoestrogens, that have been almost totally ignored in discussions of hormesis. We propose that the risk posed by low doses of manmade xenoestrogens that show inverted-U dose-response curves is underestimated by the current threshold model used in risk assessment, and this is likely to apply to other endocrine-disrupting chemicals.

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Ward, A.J. W., Duff, A.J., and Currie, S. **The effects of the endocrine disrupter 4-nonylphenol on the behaviour of juvenile rainbow trout (*Oncorhynchus mykiss*).** *Canadian Journal of Fisheries and Aquatic Sciences* 63(2): 377-382, 2006.

**Notes**: Endocrine-disrupting chemicals pose a serious threat to the health of animals, particularly those in aquatic ecosystems. One such chemical, the alkylphenolic compound 4-nonylphenol (4-NP), is used extensively as a surfactant in industrial and sewage-treatment processes and is thus extremely widespread in the aquatic environment. The impact of pollutants on organisms can be measured using a number of toxicological assays. The use of behavioural studies is one such tool, allowing a noninvasive, proximate assessment of the effects of exposure. In this study, we examined the effects of short-term exposure to 4-NP on the behaviour of juvenile female rainbow trout (*Oncorhynchus mykiss*). Fish that had been exposed to 4-NP over a 5-day period showed a decreased shoaling tendency, were more likely to be attacked by other fish, and were less successful when competing for food resources than control fish. Focal fish that had been exposed to 4-NP showed no decrease in swimming speed or response to a simulated predator strike compared with control fish. We discuss possible reasons for these changes in social behaviour.

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Boyer, E.W., Howarth, R.W., Galloway, J.N., Dentener, F.J., Green, P.A., and Vörösmarty, C.J. **Riverine nitrogen export from the continents to the coasts.** *Global Biogeochemical Cycles* 20(1): art. GB1S91, 2006.

**Notes**: We present an overview of riverine nitrogen flux calculations that were prepared for the International Nitrogen Initiative's current global assessment of nitrogen cycles: past, present, and future (Galloway et al., 2004). We quantified anthropogenic and natural inputs of reactive nitrogen (N) to terrestrial landscapes and the associated riverine N fluxes. Anthropogenic inputs include fossil-fuel derived atmospheric deposition, fixation in cultivated croplands, fertilizer use, and the net import in human food and animal feedstuffs. Natural inputs include natural biological N fixation in forests and other noncultivated vegetated lands, and fixation by lightning. We use an empirical model relating total N inputs per landscape area to the total flux of N discharged in rivers based on watershed data from contrasting ecosystems spanning multiple spatial scales. With this approach, we simulate riverine N loads to the coastal zone and to inland waters from the continents. Globally, rivers exported about 59 Tg N yr-1, with 11 Tg N yr-1 transported to dry lands and inland receiving waters, and 48 Tg N yr-1 transported to the coastal zone. Rates of riverine N loss vary greatly among the continents, reflecting the regional differences in population and the associated anthropogenic N inputs. We compare our estimates to other approaches that have been reported in the literature. Our work provides an understanding of the sources of N to landscapes and the associated N fluxes in rivers, and highlights how anthropogenic activities impact N cycling around the world.

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Fent, K., Weston, A.A., and Caminada, D. **Ecotoxicology of human pharmaceuticals.** *Aquatic Toxicology* 76(2): 122-159, 2006.

**Notes**: Low levels of human medicines (pharmaceuticals) have been detected in many countries in sewage treatment plant (STP) effluents, surface waters, seawaters, groundwater and some drinking waters. For some pharmaceuticals effects on aquatic organisms have been investigated in acute toxicity assays. The chronic toxicity and potential subtle effects are only marginally known, however. Here, we critically review the current knowledge about human pharmaceuticals in the environment and address several key questions. What kind of pharmaceuticals and what concentrations occur in the aquatic environment? What is the fate in surface water and in STP? What are the modes of action of these compounds in humans and are there similar targets in lower animals? What acute and chronic ecotoxicological effects may be elicited by pharmaceuticals and by mixtures? What are the effect concentrations and how do they relate to environmental levels? Our review shows that only very little is known about long-term effects of pharmaceuticals to aquatic organisms, in particular with respect to biological targets. For most human medicines analyzed, acute effects to aquatic organisms are unlikely, except for spills. For investigated pharmaceuticals chronic lowest observed effect concentrations (LOEC) in standard laboratory organisms are about two orders of magnitude higher than maximal concentrations in STP effluents. For diclofenac, the LOEC for fish toxicity was in the range of wastewater concentrations, whereas the LOEC of propranolol and fluoxetine for zooplankton and benthic organisms were near to maximal measured STP effluent concentrations. In surface water, concentrations are lower and so are the environmental risks. However, targeted ecotoxicological studies are lacking almost entirely and such investigations are needed focusing on subtle environmental effects. This will allow better and comprehensive risk assessments of pharmaceuticals in the future.

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Corsolini, S., Covaci, A., Ademollo, N., Focardi, S., and Schepens, P. **Occurrence of organochlorine pesticides (OCPs) and their enantiomeric signatures, and concentrations of polybrominated diphenyl ethers (PBDEs) in the Adelie penguin food web, Antarctica.** *Environmental Pollution* 140(2): 371-382, 2006.

**Notes**: Concentrations and enantiomeric signatures of organochlorine pesticides were determined in Antarctic krill, emerald rockcod and Adelie penguin from the Ross Sea, Antarctica. HCB and DDTs were prevalent contaminants in penguin eggs. The highest concentrations of SHCHs (1.35 +/- 0.72 ng/g) were found in the rockcod muscle, where g-HCH (1.23 +/- 0.67 ng/g) was the principal isomer. The ratio g-HCH/a-HCH was evaluated. Enantioselective gas chromatography was used for the evaluation of enantiomeric fractions (EFs) for a-HCH and oxychlordane. An increase of 14% in the (+)a-HCH enantiomer was found from krill through penguin, suggesting the enantioselective biotrasforrnation increased proportionately with trophic level. Polybrominated diphenyl ethers (PBDEs) were measured and their concentrations were 5.6 +/- 1.12, 5.81 +/- 2.32, 4.57 +/- 0.17 and 3.06 +/- 3.27 ng/g lipids in krill, rockcod muscle, rockcod homogenate and penguin eggs, respectively. The detection of BDE28, BDE47, BDE99 and BDE100 in Antarctic organisms confirmed their global transport and distribution; the detection of lower brominated congeners suggested a potential long-range transport.

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Bustnes, J.O. **Pinpointing potential causative agents in mixtures of persistent organic pollutants in observational field studies: A review of glaucous gull studies.** *Journal of Toxicology and Environmental Health Part A* 69(1-2): 97-108, 2006.

**Notes**: Since different organochlorine contaminants (OCs) are often highly correlated in biota, a major challenge in observational field studies is to establish whether some OCs are potentially important causative agents of adverse effects. A possible solution to this problem is to compare the strength of the effects of different OCs on a number of outcome parameters, and then examine if some compounds are more consistently reliable predictors of adverse effects. In this analysis the four most common OCs (hexachlorobenzene [HCB], oxychlordane, p,p'-dichlorodiphenyldichloroethylene[ DDE], and polychlorinated biphenyls [PCBs]) in arctic glaucous gulls (*Larus hyperboreus*) were ranked in relation to 19 different outcome parameters, for which at least 1 of the 4 OCs were significantly related. PCBs, made up close to 75% of the measured SOCs, DDE 17 - 18%, and HCB and oxychlordane 3 - 4%, respectively. Despite relatively low levels of oxychlordane and HCB, these compounds tended to be more reliable predictors of adverse effects and were ranked highest for 11 and 10 of the 19 outcome parameters, respectively. PCBs and DDE were only ranked highest for seven of the outcome parameters. Oxychlordane, HCB, DDE, and PCB were "not significant" two, six, six, and eight times, respectively. Oxychlordane was significantly more likely to be related to adverse effects than DDE. Even if effects of OCs may depend on a complex interaction between different compounds, this analysis indicates that adverse effects are more likely to occur in glaucous gulls with relatively high concentrations of oxychlordane and HCB.

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Goksoyr, A. **Endocrine disruptors in the marine environment: Mechanisms of toxicity and their influence on reproductive processes in fish.** *Journal of Toxicology and Environmental Health Part A* 69(1-2): 175-184, 2006.

**Notes**: Recent research demonstrated how endocrine-disrupting chemicals (EDCs) may disturb wildlife populations and possibly also represent a human health risk. Much of the focus has been on (anti-) estrogenic and ( anti-) androgenic effects, and these effects are thought to be mediated through the estrogen (ER) and androgen (AR) receptors, respectively. The seriousness of the problem has led international bodies such as the Organization for Economic Cooperation and Development (OECD) and the European Union (EU) to initiate large research programs and developments toward new guidelines and regulations. EDCs have both synthetic and natural sources. The mechanisms of action of EDCs can be divided into: (1) agonistic/antagonistic effect ("hormone mimics"), (2) disruption of production, transport, metabolism, or secretion of natural hormones, and (3) disruption of production and/or function of hormone receptors. However, the number of nuclear hormone receptors being potential targets for EDCs has increased dramatically the last decade, opening up new avenues for possible endocrine disruptor effects. In studies with Atlantic salmon, data showed that 4-nonylphenol, a model xenoestrogen previously used in large volumes, for example, in paints and detergents, acts as an estrogen mimic, as a steroid metabolism disruptor, and by modulating estrogen receptor (ER) levels, indicating that one single compound exerts all of these three mechanisms, depending on the dose given to the organism. A hypothesis explaining this observation is that the nature of the effect of an EDC is determined by dose-dependent routing and cross-talk between different classes of nuclear receptors.

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Smalling, K.L. and Aelion, C.M. **Biological and chemical transformation of atrazine in coastal aquatic sediments.** *Chemosphere* 62(2): 188-196, 2006.

**Notes**: The degradation and distribution potential of atrazine, a persistent triazine herbicide, into three chemical fractions were measured in coastal aquatic sediments in the laboratory over time. Sediments with varying organic carbon contents were extracted with an organic solvent followed by an alkali hydrolysis reaction, and atrazine, deethylatrazine (DEA) and deisopropylatrazine (DIA) were quantified in the aqueous, solvent, and basic fractions using gas chromatography-mass spectrometry. The total amount of atrazine and its metabolites recovered after 95 days varied by site and ranged from 5% to 30% in which 95% was atrazine found primarily in the solvent fraction. Sediment organic carbon was positively correlated with the distribution of atrazine into the basic fraction and the decline in the total amount recovered. No DIA was detected in laboratory spiked sediments and transformation to DEA was limited in all sediments and made up less than 1% of the mass balance. The production and persistence of DEA were inversely correlated to organic carbon; sediments with less carbon and limited binding sites had increased formation and persistence of DEA. A secondary metabolite, methylated atrazine (M-ATR) not previously documented to be derived from atrazine, was chemically produced, detected in all sediments and time points, and concentrations were an order of magnitude higher than DEA. Based on results from spiked estuarine sediments, atrazine and M-ATR may have the potential to persist in the environment while DEA and DIA may not be an ecological threat due to their limited formation.

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Nunes, B., Carvalho, F., and Guilhermino, L. **Effects of widely used pharmaceuticals and a detergent on oxidative stress biomarkers of the crustacean *Artemia parthenogenetic*a.** *Chemosphere* 62(4): 581-594, 2006.

**Notes**: Pharmaceuticals are continuously dispersed into the environment as a result of human and veterinary use, posing relevant environmental concerns. The present paper reports the acute toxic effects of three therapeutic agents (diazepam, clofibrate and clofibric acid) and a detergent, sodium dodecylsulphate (SDS), to the hypersaline crustacean *Artemia parthenogenetica*. This study specially focused on oxidative stress parameters, namely (1) total and selenium-dependent glutathione-peroxidase (GPx), (2) glutathione reductase (GRed), (3) total superoxide dismutase (SOD), and (4) glutathione-S-traiisferases (GSTs). The effects of tested substances on lipid peroxidation (thiobarbituric acid reactive substances, TBARS), and soluble cholinesterases (ChE) were also investigated. Diazepam caused a significant inhibition of ChE (LOEC = 7.04 mg/l) and total GPx activities. SDS was responsible for a decrease in the activity of both ChE (LOEC = 8.46 mg/l) and GRed (LOEC = 4.08 mg/l). Both fibrates (clofibrate and clofibric acid) were responsible for significant decreases in Se-dependent GPx, with LOEC values of 176.34 and 3.09 mg/l, respectively. Clofibrate also caused a slight increase of TBARS content of *A. parthenogenetica* homogenates. These results indicate that the exposure to all the tested compounds induced alterations on the cellular redox status in *A. parthenogenetica*. In addition, diazepam was shown to have the capability of interfering with *A. parthenogenetica* neurotransmission, through the inhibition of ChE.

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Domingo, J.L. **Polychlorinated diphenyl ethers (PCDEs): Environmental levels, toxicity and human exposure - A review of the published literature.** *Environment International* 32(1): 121-127, 2006.

**Notes**: This paper reviews the state of the science regarding polychlorinated diphenyl ethers (PCDEs), a group of halogenated aromatic compounds, which are structurally related to polychlorinated biphenyls (PCBs) and polychlorinated dibenzofurans (PCDFs). Special attention is paid to the environmental levels, toxicity, and human exposure. PCDEs have been detected in a number of environmental samples, and their widespread occurrence in the environment is mainly the result of their presence as impurities in chlorophenol preparations. In humans, PCDE congeners have been detected in adipose tissue. As for other persistent organic pollutants (POPs), dietary intake is very probably the main route of exposure to PCDEs for the general population. However, data concerning PCDE levels in foodstuffs are very limited. It is concluded that investigations on experimental toxicity, dietary intake, and potential human health effects of PCDEs are clearly necessary.

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Zoller, U. **Estuarine and coastal zone marine pollution by the nonionic alkylphenol ethoxylates endocrine disrupters: Is there a potential ecotoxicological problem?** *Environment International* 32(2): 269-272, 2006.

**Notes**: The nonionic biodegradation-resistant ("hard") alkylphenol ethoxylate (APEO) surfactants and their degradation products are known endocrine disrupting chemicals (EDCs). We report here the findings concerning the APEOs concentrations and homologic distribution profiles in Israel's estuarine and coastal zone seawater to serve as a case study. The concentrations in sewage-containing rivers, estuaries and 50-60-m offshore sea (Mediterranean) water were found to be 12.5-75.1, 4.2-25.0 and 0.9-2.6 mu g/L, respectively. The corresponding homologic distribution profiles were found to be within the range of 1-10% each, somewhat skewing, as expected, towards the more toxic shorter-chain ethoxylates. Egg production by zebrafish, exposed to 75, 25 and 10 mu g/L of a typical industrial APEOs was reduced up to 89.6%, 84.7% and 76.9%, respectively, between the 8th and 28th days of exposure. Apparently, there is a potential APEOs-related ecotoxicological health risk problem.

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Prevedouros, K., Cousins, I.T., Buck, R.C., and Korzeniowski, S.H. **Sources, fate and transport of perfluorocarboxylates.** *Environmental Science and Technology* 40(1): 32-44, 2006.

**Notes**: This review describes the sources, fate, and transport of perfluorocarboxylates (PFCAs) in the environment, with a specific focus on perfluorooctanoate (PFO). The global historical industry-wide emissions of total PFCAs from direct (manufacture, use, consumer products) and indirect (PFCA impurities and/or precursors) sources were estimated to be 3200-7300 tonnes. It was estimated that the majority (~ 80%) of PFCAs have been released to the environment from fluoropolymer manufacture and use. Although indirect sources were estimated to be much less important than direct sources,there were larger uncertainties associated with the calculations for indirect sources. The physical-chemical properties of PFO (negligible vapor pressure, high solubility in water, and moderate sorption to solids) suggested that PFO would accumulate in surface waters. Estimated mass inventories of PFO in various environmental compartments confirmed that surface waters, especially oceans, contain the majority of PFO. The only environmental sinks for PFO were identified to be sediment burial and transport to the deep oceans, implying a long environmental residence time. Transport pathways for PFCAs in the environment were reviewed, and it was concluded that, in addition to atmospheric transport/degradation of precursors, atmospheric and ocean water transport of the PFCAs themselves could significantly contribute to their long-range transport. It was estimated that 2-12 tonnes/year of PFO are transported to the Artic by oceanic transport, which is greater than the amount estimated to result from atmospheric transport/degradation of precursors.

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Falandysz, J., Taniyasu, S., Gulkowska, A., Yamashita, N., and Schulte-Oehlmann, U. **Is fish a major source of fluorinated surfactants and repellents in humans living on the Baltic coast?** *Environmental Science and Technology* 40(3): 748-751, 2006.

**Notes**: Concentrations of 19 perfluorochemicals have been quantified in human blood and in some marine food resources from the region of the Gulf of Gdansk at the Baltic Sea south coast in Poland. We indicate that in addition to PFOS and PFOA, a further 8 perfluorochemicals bioaccumulate in the human body. Food chain is an important route of exposure for all 10 perfluoroalkyl compounds detected in nonoccupationally exposed humans. Individuals who declared to have a high fish intake in their diet (mainly Baltic fish) on average contained the highest load of all 10 fluorochemicals when compared with the other human subpopulations. Baltic seafood has been found to highly influence human body burden of PFHxS, PFOS, PFOSA, PFHxA, PFHpA, PFNA, PFDA, PFUnDA, and PFDoDA, and to a lesser extent PFOA.

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Ward-Paige, C.A., Risk, M.J., Sherwood, O.A., and Jaap, W.C. **Clionid sponge surveys on the Florida Reef Tract suggest land-based nutrient inputs.** *Marine Pollution Bulletin* 51(5-7): 570-579, 2005.

**Notes**: Bioerosion by *Cliona delitrix* and *Cliona lampa* was assessed at 43 sites along the Florida Reef Tract, USA, in the summer of 2001. Sponge abundances were estimated using rapid visual assessment. Tissue samples of sponges were taken for analysis of d(15)N. Comparison samples were taken from Belize. Annual trends in sponge abundance were estimated from archived videos covering the period from 1996 to 2001. Sites with the greatest boring sponge size and cover were in the Backcountry and Lower Keys, where total nitrogen, ammonium, and d(15)N levels were highest. The sites with the largest relative increase of *C. delitrix* and *C. lampa* over the 5 year period were in the Upper Keys, where the greatest relative decline in stony coral cover has occurred. Florida sponge d(15)N values were 5.2(+/- 0.1)%, suggesting the influence of human waste; in comparison, offshore Belize samples were 2.1(+/- 0.1)%. These results suggest sewage contamination of the Florida Reef Tract, shifting the carbonate balance from construction to destruction.

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Jones, R. **The ecotoxicological effects of Photosystem II herbicides on corals.** *Marine Pollution Bulletin* 51(5-7): 495-506, 2005.

**Notes**: The recent discovery of contamination of the tropical marine environment by Photosystem II (PSII) herbicides used in agriculture and antifouling paints has led to concerns regarding the effects on corals and their symbiotic dinoflagellate algae. In reviewing the ecotoxicological studies conducted so far, PSII herbicides appear able to readily penetrate the coral tissues and rapidly (within minutes) reduce the photochemical efficiency of the intracellular algal symbionts. The dinoflagellates appear at least as sensitive to PSII herbicides as other phototrophs tested so far, with photosynthesis being affected at exceptionally low concentrations (i.e. in the ng l(-1) range). At these levels and over short exposure periods, the effects can be fully reversible (i.e. when corals are returned to clean seawater) and vary according to type of herbicide; however, when exposed to higher concentrations in the light or over longer exposure periods, it results in a long-term sustained reduction of the photochemical efficiency of the algae (symptomatic of chronic photoinhibition). This can result in the dissociation of the symbiosis (bleaching) which is a common but nevertheless significant sublethal stress response requiring many months to recover from. It is argued that the reliance of corals on an endosymbiotic photo-autotrophic energy source, together with predilection for the symbiosis to dissociate when photosynthesis of the algae is affected, renders coral particularly susceptible to changes in environmental conditions -- and especially phytotoxins such as PSII herbicides.

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Yamashita, N., Kannan, K., Taniyasu, S., Horii, Y., Petrick, G., and Gamo, T. **A global survey of perfluorinated acids in oceans.** *Marine Pollution Bulletin* 51(8-12): 658-668, 2005.

**Notes**: Perfluorinated acids and their salts have emerged as an important class of global environmental contaminants. Biological monitoring surveys conducted using tissues of marine organisms reported the occurrence of perfluorooctanesulfonate (PFOS) and related perfluorinated compounds in biota from various seas and oceans, including the Arctic and the Antarctic Oceans. Occurrence of perfluorinated compounds in remote marine locations is of concern and indicates the need for studies to trace sources and pathways of these compounds to the oceans. Determination of sub-parts-per- trillion (ng/L) or parts-per-quadrillion (pg/L) concentrations of aqueous media has been impeded by relatively high background levels arising from procedural or instrumental blanks. Our research group has developed a reliable and highly sensitive analytical method by which to monitor perfluorinated compounds in oceanic waters. The method developed is capable of detecting PFOS, perfluorohexanesulfonate (PFHS), perfluorobutanesulfonate (PFBS), perfluorooctanoate (PFOA), perfluorononanoate (PFNA), and perfluorooctanesulfonamide (PFOSA) at a few pg/L in oceanic waters. The method was applied to seawater samples collected during several international research cruises undertaken during 2002-2004 in the central to eastern Pacific Ocean (19 locations), South China Sea and Sulu Seas (five), north and mid Atlantic Ocean (12), and the Labrador Sea (20). An additional 50 samples of coastal seawater from several Asian countries (Japan, China, Korea) were analyzed. PFOA was found at levels ranging from several thousands of pg/L in water samples collected from coastal areas in Japan to a few tens of pg/L in the central Pacific Ocean. PFOA was the major contaminant detected in oceanic waters, followed by PFOS. Further studies are being conducted to elucidate the distribution and fate of perfluorinated acids in oceans.

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Addison, R.F., Ikonomou, M.G., Fernandez, M.P., and Smith, T.G. **PCDD/F and PCB concentrations in Arctic ringed seals (*Phoca hispida*) have not changed between 1981 and 2000.** *The Science of the Total Environment* 351: 301-311, 2005.

**Notes**: Concentrations of polychlorinated dibenzo-p-dioxins (PCDD) and dibenzofurans (PCDF) and of non-ortho-, mono-ortho- and di-ortho-substituted polychlorinated biphenyls (NO-CB, MO-CB and DO-CB) were measured in blubber of ringed seals sampled at Holman, NWT, in 1981, 1991, 1996 and 2000. Total PCDD and PCDF concentrations were usually below approx. 10 and 5 pg/g wet wt., respectively, and did not change significantly between 1981 and 2000, although there were sporadic temporal differences in some congeners. Total NO-CB, MO-CB and DO-CB concentrations were below approx. 1 ng/g, 250 ng/g and 1 mg/g wet wt. respectively; none of the total PCB concentrations changed significantly over the sampling period. Neither PCDD nor PCDF concentrations differed between males and females, nor did they increase with age in male samples. MO-CB and DO-CB concentrations increased with age in males, but not in females, and concentrations of total MO-CB and DO-CB were usually lower in females than in males. Changes in the distribution of PCB congeners between the 1980s

and the 1990s are consistent with atmospheric transport processes becoming increasingly important in the introduction of PCBs to the Arctic in recent years.

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Verreault, J., Muir, D.C.G., Norstrom, R.J., Stirling, I., Fisk, A.T., Gabrielsen, G.W., Derocher, A.E., Evans, T.J., Dietz, R., Sonne, C., Sandala, G.M., Gebbink, W., Riget, F.F., Born, E.W., Taylor, M.K., Nagy, J., and Letcher, R.J. **Chlorinated hydrocarbon contaminants and metabolites in polar bears (*Ursus maritimus*) from Alaska, Canada, East Greenland, and Svalbard: 1996-2002.** *The Science of the Total Environment* 351: 369-390, 2005.

**Notes**: A suite of chlorinated hydrocarbon contaminants (CHCs) including organochlorine pesticides (OCPs) and by-products, polychlorinated biphenyls (PCBs), and methyl sulfone (MeSO2) PCB and p,p'- dichlorodiphenyldichloroethylene (p,p'-DDE) metabolites were determined in adipose tissue of 107 adult and sub-adult polar bears, almost exclusively females, sampled between 1996 and 2002 from populations spanning Arctic and Subarctic regions of Alaska, Canada, East Greenland, and Svalbard. The East Greenland and Svalbard populations of polar bears were distinguished by higher proportions of dichlorodiphenyldichloroethane (DDT)-related compounds, nonachlors, oxychlordane, and higher-chlorinated and persistent PCB congeners (hepta- to nona-chlorinated). Conversely, Alaska, the westernmost population of the North American Arctic, was characterized by higher proportions of relatively volatile compounds such as hexachlorocyclohexanes (HCHs) and pentachlorobenzene (PnCBz), lower-chlorinated PCB congeners (tri- to penta-chlorinated), and lower proportions of oxychlordane. Geometric mean (GM) with 95% confidence limits (CL) SHCH concentrations were highest in Alaska male polar bear fat samples (GM 593; CL 363-909 ng g(-1) lipid weight), SDDT concentration were highest in East Greenland female samples (GM 309; CL 249-490 ng g(-1) l.w.), and S (42)PCB (GM 5972; CL 4637-9129 ng g(-1) l.w.) and SMeSO2-PCB (GM 198; CL 162- 279 ng g(-1) l.w.) concentrations were highest in female samples collected from Svalbard. The distribution of S-chlordane-related compounds (SCHL), SCBz, mirex, and dieldrin was relatively uniform among the populations of polar bears investigated. The present 1996-2002 data of female polar bear fat samples was compared to spatial assessments of female polar bear fat samples collected between 1989 and 1993 from comparable populations. The two-point temporal comparisons showed a general decrease for age-adjusted mean concentrations of SCHL, p,p'-DDE, 142PCB, SMeSO2-PCB and 3-MeSO2-p,p'-DDE over a period of approximately 10 years. However, concentrations of dieldrin were comparatively unchanged. Comparisons of present 2001-2002 concentrations in fat of female polar bears from Western Hudson Bay showed great consistency with temporal trends (1991-1999) previously reported for the same region, i.e. the apparent non-decreasing trend of SCHL, beta-HCH, SHCH and dieldrin, and the apparent declining trend for SPCB. However, present concentrations of alpha-HCH and SCBz were elevated, and SDDT was notably lower in Western Hudson Bay samples compared to the last measurements in fat samples collected in 1999, which was not in accord with reported temporal trends for this region. As a result of their relatively high degree of contamination, East Greenland and Svalbard polar bears are at higher health risk of contaminant exposure among Arctic and Subarctic populations. In addition to continued biomonitoring, further research on health and population status is needed to evaluate the impact from chronic exposure of polar bear populations to CHCs and their metabolites.

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Lockhart, W.L., Stern, G.A., Wagemann, R., Hunt, R.V., Metner, D.A., DeLaronde, J., Dunn, B., Stewart, R.E.A., Hyatt, C.K., Harwood, L., and Mount, K. **Concentrations of mercury in tissues of beluga whales (*Delphinapterus leucas*) from several communities in the Canadian Arctic from 1981 to 2002.** *The Science of the Total Environment* 351: 391-412, 2005.

**Notes**: Beluga whales have been hunted for food by Native People in the Canadian Arctic since prehistoric time. Here we report the results of analyses of total mercury in samples of liver, kidney, muscle and muktuk from collections over the period 1981-2002. We compare these results with human consumption guidelines and examine temporal and geographic variation. Liver has been analyzed more frequently than other organs and it has been used as the indicator organ. Mercury accumulates in the liver of the whales over time so that the whale ages are usually linked statistically to their levels of mercury in liver. Virtually all the samples of 566 animals analyzed contained mercury in liver at concentrations higher than the Canadian consumption guideline of 0.5 mg g(-1) (wet weight) for fish. (There is no regulatory guideline for concentrations in marine mammals in Canada.) Samples from locations in the Mackenzie Delta in the western Canadian Arctic and from Pangnirtung in the eastern Canadian Arctic were obtained more often than from other location and these offered the best chances to determine whether levels have changed over time. Statistical outlier points were removed and the regressions of (ln) mercury in liver on age were used to calculate the level of mercury in whales of age 13.1 years in order to compare age-adjusted levels at different locations. These age-adjusted levels and also the slopes of regressions suggested that levels have increased in the Mackenzie Delta over the sampling period although not in a simple linear fashion. Other locations had fewer collections,

generally spread over fewer years. Some of them indicated differences between sampling times but we could not establish whether these differences were simply temporal variation or whether they were segments of a consistent trend. For example, the levels in whales from Arviat were considerably higher in 1999 than in 1984 but we have only two samples. Similarly, samples from Iqaluit in 1994 exceeded considerably those in 1993 and the interval seems too short to reflect any regional temporal trend and more likely represent an extreme case of year-to-year variation. Previous analyses of data from geographically distinct groups had suggested that whales in the western Canadian Arctic had higher levels of mercury than those from the eastern Canadian Arctic. The present analysis suggests that such regional differences have diminished and are no longer statistically significant. No site has indicated significant decreases in more recent samples. The levels of total mercury in the most analyzed organs fell in the order of liver (highest levels), kidney, muscle and muktuk (lowest level). While muktuk had the lowest level of the organs most frequently analyzed, it is the preferred food item from these whales and it still exceeded the consumption guideline in most instances.

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Muir, D.C.G., Shearer, R.G., Van Oostdam, J., Donaldson, S.G., and Furgal, C. **Contaminants in Canadian arctic biota and implications for human health: Conclusions and knowledge gaps.** *The Science of the Total Environment* 351: 539-546, 2005.

**Notes**: This paper summarizes the major findings of the special issue entitled "Contaminants in Canadian Arctic Biota and implications for Human Health." The individual papers and reviews in this special issue present a large amount of new information on contaminants in biota primarily from the Canadian arctic as well as from Alaska, Greenland and the European Arctic. Temporal and spatial trends are examined and potential biological effects on wildlife are assessed. The special issue also presents new and updated data on human exposure to and possible health effects of current levels of environmental contaminants in the Canadian Arctic. As part of the assessment of the human health implications, the unique structures and processes that have developed in the Canadian Arctic under the Northern Contaminants Program (NCP) of Indian and Northern Affairs Canada to build partnerships and manage and communicate the benefits and risks associated with contaminant exposure are discussed. Application of this information in international forums to reduce anthropogenic emissions of contaminants to the environment is also discussed.

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Braune, B.M., Outridge, P.M., Fisk, A.T., Muir, D.C.G., Helm, P.A., Hobbs, K., Hoekstra, P.F., Kuzyk, Z.A., Kwan, M., Letcher, R.J., Lockhart, W.L., Norstrom, R.J., Stern, G.A., and Stirling, I. **Persistent organic pollutants and mercury in marine biota of the Canadian Arctic: An overview of spatial and temporal trends.** *The Science of the Total Environment* 351: 4-56, 2005.

**Notes**: This review summarizes and synthesizes the significant amount of data which was generated on mercury (Hg) and persistent organic pollutants (POPs) in Canadian Arctic marine biota since the first Canadian Arctic Contaminants Assessment Report (CACAR) was published in 1997. This recent body of work has led to a better understanding of the current levels and spatial and temporal trends of contaminants in biota, including the marine food species that northern peoples traditionally consume. Compared to other circumpolar countries, concentrations of many organochlorines (OCs) in Canadian Arctic marine biota are generally lower than in the European Arctic and eastern Greenland but are higher than in Alaska, whereas Hg concentrations are substantially higher in Canada than elsewhere. Spatial coverage of OCs in ringed seals, beluga and seabirds remains a strength of the Arctic contaminant data set for Canada. Concentrations of OCs in marine mammals and seabirds remain fairly consistent across the Canadian Arctic although subtle differences from west to east and south to north are found in the proportions of various chemicals. The most significant development since 1997 is improvement in the temporal trend data sets, thanks to the use of archived tissue samples from the 1970s and 1980s, long-term studies using archeological material, as well as the continuation of sampling. These data cover a range of species and chemicals and also include retrospective studies on new chemicals such as polybrominated diphenyl ethers. There is solid evidence in a few species (beluga, polar bear, blue mussels) that Hg at some locations has significantly increased from pre-industrial times to the present; however, the temporal trends of Hg over the past 20-30 years are inconsistent. Some animal populations exhibited significant increases in Hg whereas others did not. Therefore, it is currently not possible to determine if anthropogenic Hg is generally increasing in Canadian Arctic biota. It is also not yet possible to evaluate whether the recent Hg increases observed in some biota may be due solely to increased anthropogenic inputs or are in part the product of environmental change, e.g., climate warming. Concentrations of most "legacy" OCs (PCBs, DDT, etc.) significantly declined in Canadian Arctic biota from the 1970s to the late 1990s, and today are generally less than half the levels of the 1970s, particularly in seabirds and ringed seals. Chlorobenzenes and endosulfan were among the few OCs to show increases during this period while THCH remained

relatively constant in most species. A suite of new-use chemicals previously unreported in Arctic biota (e.g., polybrominated diphenyl ethers (PBDEs), short chain chlorinated paraffins (SCCPs), polychlorinated naphthalenes (PCNs), perfluoro-octane sulfonic acid (PFOS) and perfluorocarboxylic acids (PFCAs)) has recently been found, but there is insufficient information to assess species differences, spatial patterns or food web dynamics for these compounds. Concentrations of these new chemicals are generally lower than legacy OCs, but there is concern because some are rapidly increasing in concentration (e.g., PBDEs), while others such as PFOS have unique toxicological properties, and some were not expected to be found in the Arctic because of their supposedly low potential for long-range transport. Continuing temporal monitoring of POPs and Hg in a variety of marine biota must be a priority.

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Fisk, A.T., de Wit, C.A., Wayland, M., Kuzyk, Z.Z., Burgess, N., Robert, R., Braune, B., Norstrom, R., Blum, S.P., Sandau, C., Lie, E., Larsen, H.J.S., Skaare, J.U., and Muir, D.C.G. **An assessment of the toxicological significance of anthropogenic contaminants in Canadian arctic wildlife.** *The Science of the Total Environment* 351: 57-93, 2005.

**Notes**: Anthropogenic contaminants have been a concern in the Canadian arctic for over 30 years due to relatively high concentrations of bioaccumulating and biomagnifying organochlorine contaminants (OCs) and toxic metals found in some arctic biota and humans. However, few studies have addressed the potential effects of these contaminants in Canadian arctic wildlife. Prior to 1997, biological effects data were minimal and insufficient at any level of biological organization. The present review summarizes recent studies on biological effects related to contaminant exposure, and compares new tissue concentration data to threshold effects levels. Weak relationships between cadmium, mercury and selenium burdens and health biomarkers in common eider ducks (*Somateria mollissima borealis*) in Nunavut were found but it was concluded that metals were not influencing the health of these birds. Black guillemots (*Cepplius grylle*) examined near PCB-contaminated Saglek Bay, Labrador, had enlarged livers, elevated EROD and liver lipid levels and reduced retinol (vitamin A) and retinyl palmitate levels, which correlated to PCB levels in the birds. Circulating levels of thyroid hormones in polar bears (*Ursus maritimus*) were correlated to PCB and HO-PCB plasma concentrations, but the impact at the population level is unknown. High PCB and organochlorine pesticide concentrations were found to be strongly associated with impaired humoral and cell-mediated immune responses in polar bears, implying an increased infection risk that could impact the population. In beluga whale (*Delphinapterus leucas*), cytochromes P450 (phase I) and conjugating (phase II) enzymes have been extensively profiled (immunochemically and catalytically) in liver, demonstrating the importance of contaminants in relation to enzyme induction, metabolism and potential contaminant bioactivation and fate. Concentrations of OCs and metals in arctic terrestrial wildlife, fish and seabirds are generally below effects thresholds, with the possible exception of PCBs in burbot (*Lota lota*) in some Yukon lakes, Greenland shark (*Soniniosus microcephalus*), glaucous and great black-backed gulls (*Larus hyperboreus* and *L. marinus*), and TEQs of dioxin-like chemicals in seabird eggs. PCB and DDT concentrations in several arctic marine mammal species exceed effects thresholds, although evidence of stress in these populations is lacking. There is little evidence that contaminants are having widespread effects on the health of Canadian arctic organisms, with the possible exception of polar bears. However, further research and better understanding of organohalogen exposure in arctic biota is needed considering factors such as tissue levels that exceed effects thresholds, exposure to "new" organohalogen contaminants of concern, contaminated regions, and climate change.

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Van Oostdam, J., Donaldson, S.G., Feeley, M., Arnold, D., Ayotte, P., Bondy, G., Chan, L., Dewaily, E., Furgal, C. M., Kuhnlein, H., Loring, E., Muckle, G., Myles, E., Receveur, O., Tracy, B., Gill, U., and Kalhok, S. **Human health implications of environmental contaminants in Arctic Canada: A review.** *The Science of the Total Environment* 351: 165-246, 2005.

**Notes**: The objectives of this paper are to: assess the impact of exposure to current levels of environmental contaminants in the Canadian Arctic on human health; identify the data and knowledge gaps that need to be filled by future human health research and monitoring; examine how these issues have changed since our first assessment [Van Oostdam, J., Gilman, A., Dewailly, L, Usher, P., Wheatley, B., Kuhnlein, H. Et al., 1999. Human health implications of environmental contaminants in Arctic Canada: a review. Sci Total Environ 230, 1-82]. The primary exposure pathway for contaminants for various organochlorines (OCs) and toxic metals is through the traditional northern diet. Exposures tend to be higher in the eastern than the western Canadian Arctic. In recent dietary surveys among five Inuit regions, mean intakes by 20- to 40-year-old adults in Baffin, Kivalliq and Inuvialuit communities exceeded the provisional tolerable daily intakes (pTDIs) for the OCs, chlordane and toxaphene. The most recent findings in NWT and Nunavut indicate that almost half of the blood samples from Inuit mothers exceeded the level of concern value of 5 mg/L for PCBs, but none exceeded the action level of 100 mg/L. For

Dene/Metis and Caucasians of the Northwest Territories exposure to OCs are mostly below this level of concern. Based on the exceedances of the pTDI and of various blood guidelines, mercury and to a lesser extent lead (from the use of lead shot in hunting game) are also concerns among Arctic peoples. The developing foetus is likely to be more sensitive to the effects of OCs and metals than adults, and is the age groups of greatest risk in the Arctic. Studies of infant development in Nunavik have linked deficits in immune function, an increase in childhood respiratory infections and birth weight to prenatal exposure to OCs. Balancing the risks and benefits of a diet of country foods is very difficult. The nutritional benefits of country food and its contribution to the total diet are substantial. Country food contributes significantly more protein, iron and zinc to the diets of consumers than southern/market foods. The increase in obesity, diabetes and cardiovascular disease has been linked to a shift away from a country food diet and a less active lifestyle. These foods are an integral component of good health among Aboriginal peoples. The social, cultural, spiritual, nutritional and economic benefits of these foods must be considered in concert with the risks of exposure to environmental contaminants through their exposure. Consequently, the contamination of country food raises problems which go far beyond the usual confines of public health and cannot be resolved simply by risk-based health advisories or food substitutions alone. All decisions should involve the community and consider many aspects of socio-cultural stability to arrive at a decision that will be the most protective and least detrimental to the communities.

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