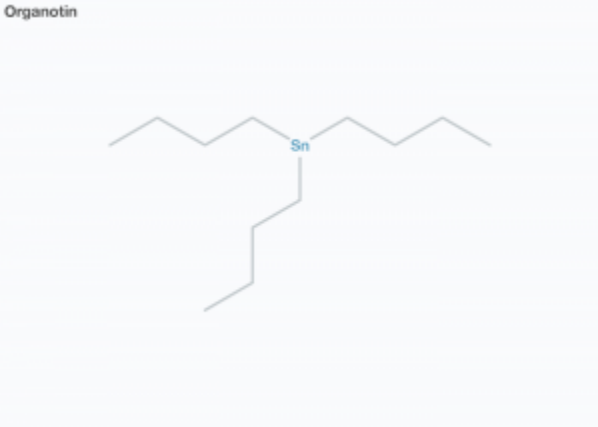
PollutionTracker Fact Sheet

Organotins

What are they?

Organotins are synthetic organometallic compounds that are used primarily as pesticides and stabilizers for polyvinyl chloride (PVC) plastic products.[5] In the marine environment, organotins are used in antifouling solutions and paints, which are used to prevent the accumulation of barnacles and other fouling organisms on boat hulls, fishing nets, lobster pots, and on the net pens of fish farms. Tributyltin (TBT) and triphenyltin (TPT) are the most toxic organotin compounds.[1]



How do they get into the ocean?

In British Columbia, TBT-based paints used on ships have likely been the largest source of butyltin compounds in the marine environment, and until recently, new inputs from ships and shipyards have occurred. Historically, salmon farms operating in British Columbia also used nets treated with TBT-based antifoulants, but this use was banned in the late 1980s.[2] Current sources of organotins include waste water, industrial wastes, and landfill leachate.

Organotins can dissolve in water or stick to organic materials such as bacteria and algae or to sediments, where they can persist for months to years.[2,3] TBT can move back and forth between sediment and water[3]; therefore, TBT-contaminated sediments can act as an ongoing exposure route for aquatic organisms. Marine organisms are known to bioaccumulate TBT, and it biomagnifies (increases in concentration) in marine food chains.[2]

Are they a problem?

TBT has toxic effects at all trophic levels. It is a known endocrine disrupter in invertebrates, affecting energy production, survival, growth, metabolism, and reproduction. Molluscs are particularly vulnerable to TBT because it can bioaccumulate in their tissues to levels sufficient to cause endocrine disruption in the form of elevated testosterone levels. This elevation results in a phenomenon known as imposex, which is when females exhibit male sex characteristics. Imposex has affected mollusc populations globally [3], and has been reported throughout the Straits of Georgia and Juan de Fuca in British Columbia.[2]

In fish, triphenyltin (TPT) has caused skeletal malformations, eye deformities, and impaired swimming ability[4], as well as changes in behaviour and reduced growth.[5]

FACT: The first record of the harmful effects of tributyltin came from the French Atlantic coast. During the 1970s and 1980s, production at many oyster farms was affected when oysters exhibited severe growth problems, lack of reproduction, and issues with shell calcification.[10]

TBT exposure can affect the immune and hormone systems of marine mammals [6,7], and has been shown to affect the reproductive system in rodents.[1] Liver concentrations measured in sea otters that died due to infectious disease were found to be near or above the threshold levels for immune and liver toxicity in other species, potentially contributing to their susceptibility to infectious disease.[8] It has also been hypothesized that TBT may cause hearing impairment in whales and other mammals by affecting the ability of the inner ear's outer hair cells (which amplify incoming sound) to regulate chloride levels.[9] Because many marine mammals rely on echolocation or sonar, the researchers hypothesized that this hearing impairment may contribute to marine mammals being struck by ships and beaching themselves.[9]

What is being done?

While some organotins are still used in Canada, the use of TBT-based antifouling paints was banned for small vessels (under 25 m length) in 1989, and terminated completely in Canada in 2002.[7] The use of TBT-based paints on ships was banned globally in 2008 by the International Maritime Organization; however, countries that are not signatories to this convention may continue to use antifouling paints containing TBT.[1]

The interim marine Canadian Water Quality Guideline for TBT is 0.001 µg/L. This guideline is intended to be protective of aquatic life.[5] There is no guideline for TBT in sediment.

What can we do?

As individuals and organizations, we can:

- Learn more about organotins using the resource links below
- Recycle and dispose of waste responsibly and according to local guidelines

More information?

[1] Graceli JB, Sena GC, Lopes PFI, Zamprogno GC, da Costa MB, Godoi AFL, dos Santos DM, de Marchi MR, Fernandez MAS. 2013. Organotins: A review of their reproductive toxicity, biochemistry, and environmental fate. *Reproductive Toxicology* 36: 40-52.

[2] Garrett C. 2004. Priority Substances of Interest in the Georgia Basin. Profiles and background information on current toxics issues. Technical Supporting Document of the Canadian Toxics Work Group. Puget Sound/Georgia Basin International Task Force. GBAP Publication No. EC/GB/04/79.

[3] Antizar-Ladislao B. 2008. Environmental levels, toxicity and human exposure to tributyltin (TBT)-contaminated marine environment – A review. *Environment International* 34: 292-308.

[4] Wu L, Chen Z, Zhu J, Hu L, Huang X, Shi H. 2014. Developmental toxicity of organotin compounds in animals. *Frontiers in Marine Science* 1.

[5] CCME 1999. Canadian water quality guidelines for the protection of aquatic life: Organotins – Tributyltin, triphenyltin, and tricyclohexyltin. In: Canadian environmental quality guidelines, 1999. Canadian Council of Ministers of the Environment, Winnipeg, MB.

[6] Nakata H, Sakakibara A, Kanoh M, Kudo S, Watanabe H, Nagai N, Miyazaki N, Asano Y, Tanabe S. 2002. Evaluation of mitogen-induced responses in marine mammal and human lymphocytes by *in vitro* exposure of butyltins and non-ortho coplanar PCBs. *Environmental Pollution* 120: 245–253.

[7] Garrett C, Ross PS. 2010. Recovering resident killer whales: a guide to contaminant sources, mitigation, and regulations in British Columbia. *Canadian Technical Report of Fisheries and Aquatic Sciences* 2894: xiii+.

[8] Murata S, Takahashi S, Agusa T, Thomas NJ, Kannan K, Tanabe S. 2008. Contamination status and accumulation profiles of organotins in sea otters (*Enhydra lutris*) found dead along the coasts of California, Washington, Alaska (USA), and Kamchatka (Russia). *Marine Pollution Bulletin* 56: 641-649.

[9] Song L, Seeger A, Santos-Sacchi J. 2005. On membrane motor activity and chloride flux in the outer hair cell: Lessons learned from the environmental toxin tributyltin. *Biophysical Journal* 88: 2350-2362.

[10] Sousa ACA, Pastorinho MR, Takahashi S, Tanabe S. 2014. History on organotin compounds, from snails to humans. *Environmental Chemistry Letters* 12: 117-137.