TOXIC CHEMICALS THAT DISRUPT HORMONES: IMPACTS ON FISH AND PEOPLE

Dr. Fran Solomon

fran@enviroteach.com

August 24, 2011

TOPICS TO BE COVERED

- Properties and sources of endocrine disruptor chemicals (EDCs)
- Exposure pathways in Arctic region
- Why young are more vulnerable
- Impacts of phthalates and perfluorinated compounds (PFCs)
- Regulatory reform
- How to reduce exposure

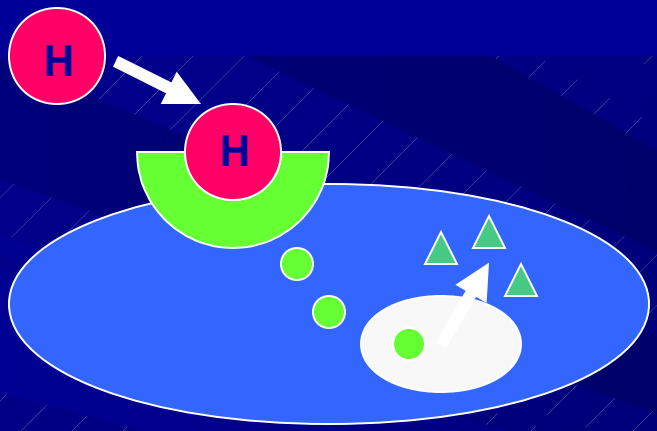
TOXIC CHEMICALS

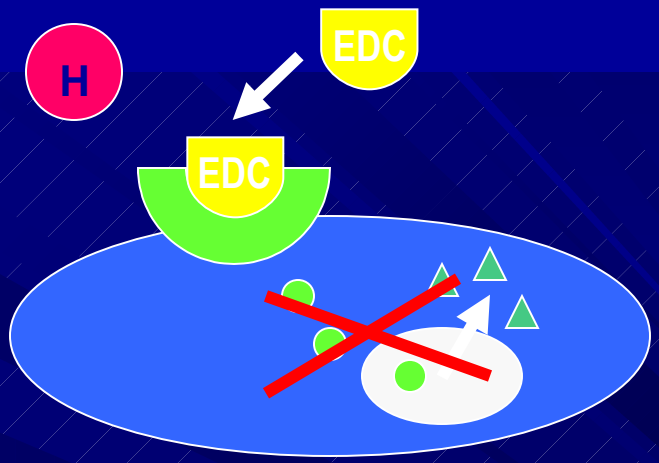
- Chemicals that harm the survival or health of people, other animals, and plants
- Include over 200,000 human-made organic chemicals (contain carbon)
- Some toxic chemicals are endocrine disruptor chemicals (EDCs).

ENDOCRINE DISRUPTION

- Endocrine disruptor chemical (EDC) is "any chemical with the potential to alter hormonally mediated signals in plants or animals." (National Research Council)
- Endocrine glands produce hormones.
- Examples of hormones – thyroxin, insulin, estrogen, testosterone

ENDOCRINE DISRUPTION





- **Hormones** bind to cell receptors and induce a response

EDCs bind to receptors and

MIMIC a hormone

BLOCK hormone binding

INTERFERE with hormone synthesis, transport or degradation

EXAMPLES OF EDCS

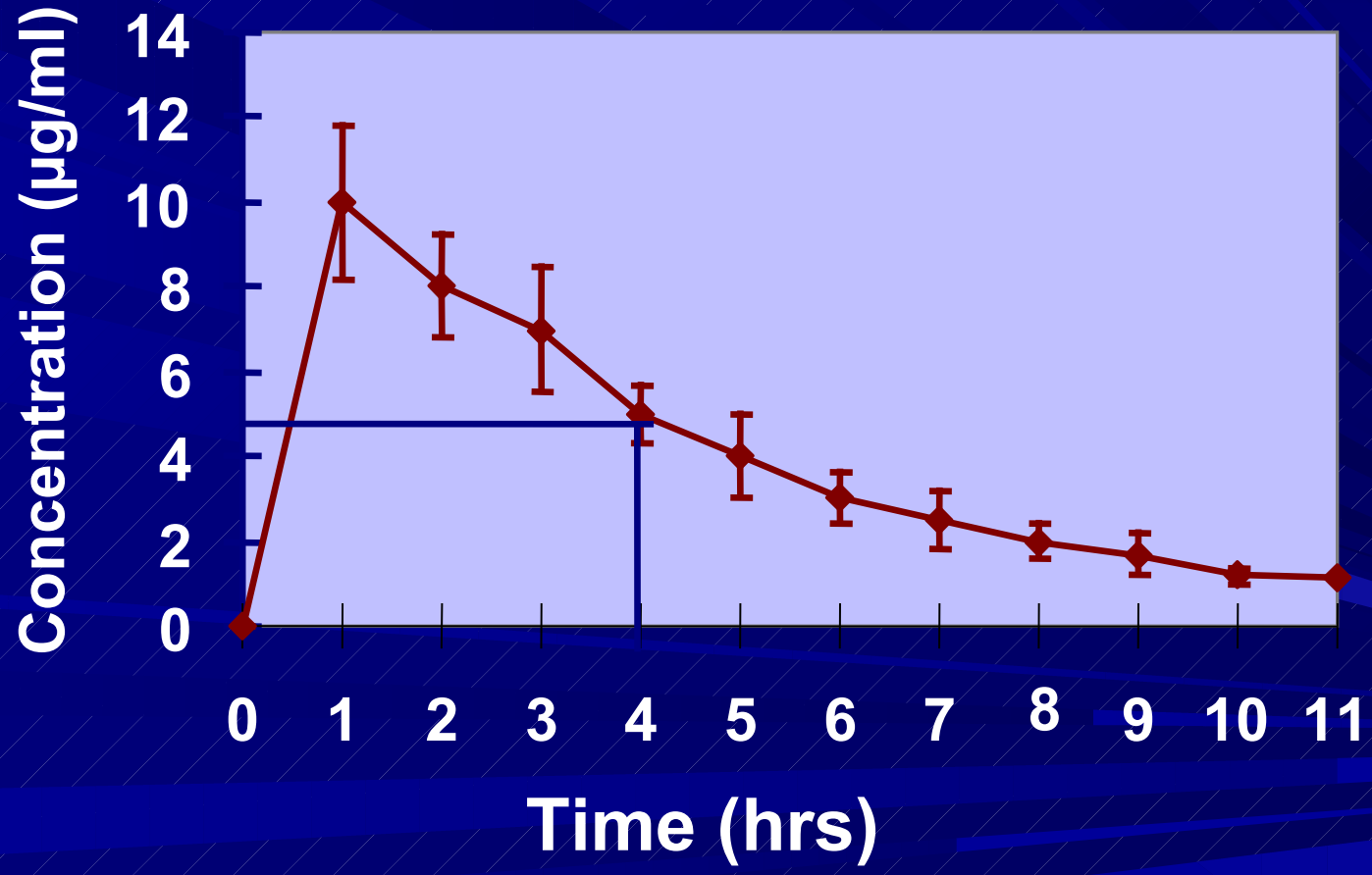
- Pesticides
- Polybrominated diphenyl ethers (PBDEs)
- Bisphenol-A (BPA)
- Phthalates
- Perfluorinated compounds (PFCs)

PROPERTIES OF EDCs

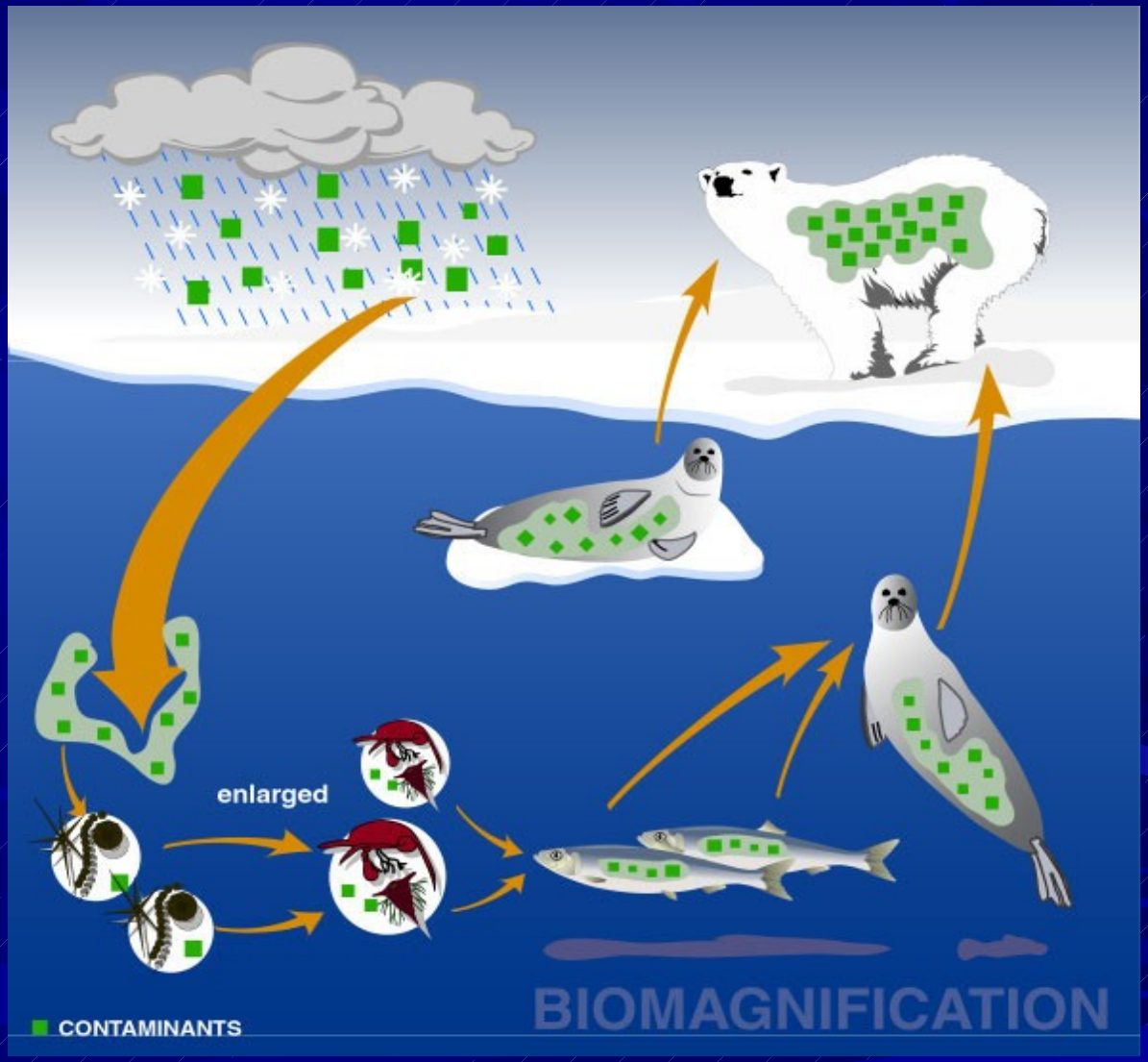
- Dissolve in fats (lipophilic)
- Bioconcentration – higher level (concentration) of an EDC in a plant or animal compared to its concentration in water or sediments
- Persistent

HALF-LIFE

How Long It Takes To Go



BIOMAGNIFICATION



SOURCES OF EDCs

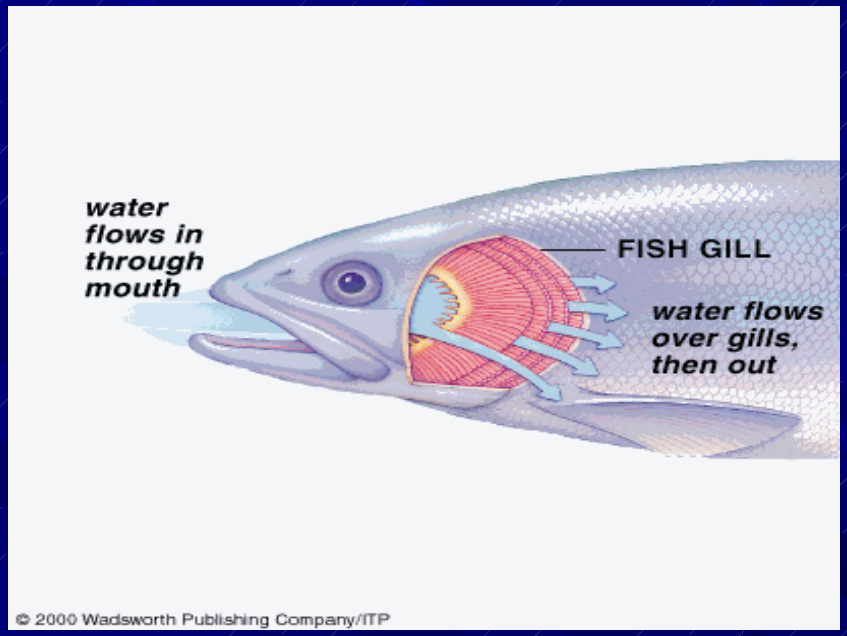
- Sewage
- Industrial waste
- Stormwater
- Atmospheric deposition
- Oil spills
- Household items

EDCs CAN TRAVEL LONG DISTANCES!

- Wind concentrates EDCs in Arctic.
- EDCs enter food chain from snow.
- Inuit of Baffin Island have highest worldwide levels of some EDCs.

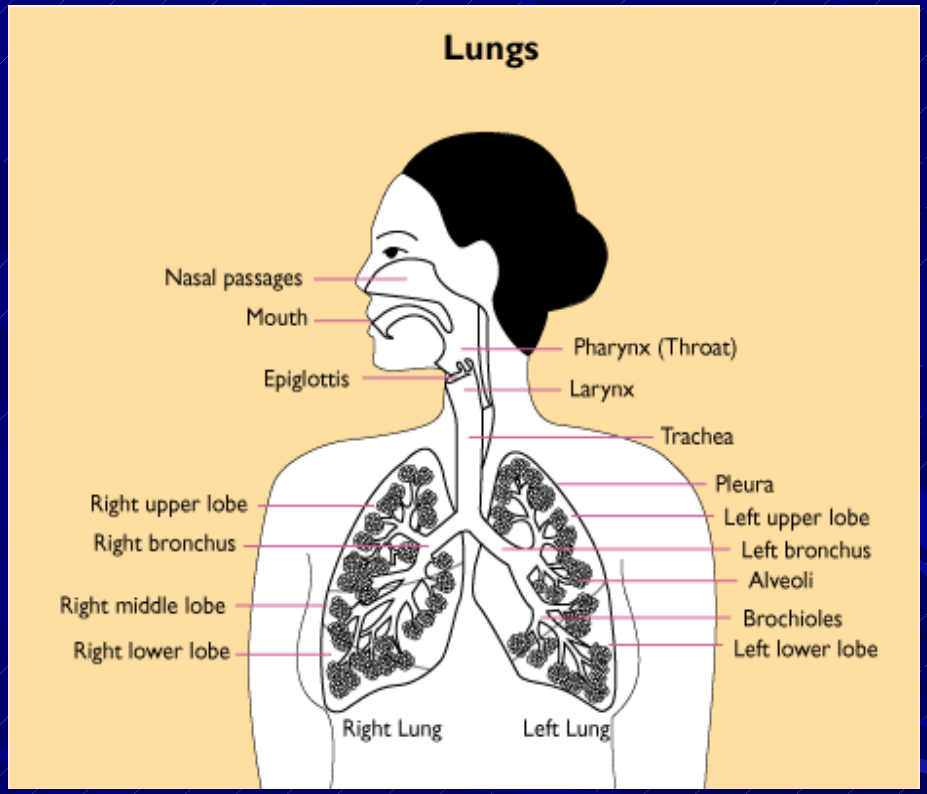
FISH EXPOSURE PATHWAYS

- Gills
- Skin
- Drinking polluted water
- Sediments
- Food chain



HUMAN EXPOSURE PATHWAYS

- Lungs
- Skin
- Drinking polluted water
- Food chain
- Placenta



TOXICITY AND AGE/BODY SIZE

Developmental and young life stages of all species are especially sensitive to EDCs.

- Given concentration of an EDC is larger percentage of body weight or volume.
- Higher breathing and metabolic rates lead to faster and greater uptake of toxic chemicals.
- Young animals and humans lack completely developed detoxification systems.

PHTHALATES – USES AND OCCURRENCE

- Used as fragrances, nail polish hardeners, and plasticizers, but not chemically bound to plastics
- Dispersed via food, air, water, soil, and sediments
- Continuous exposure of aquatic organisms and humans, especially children and young women

EXAMPLES OF PHTHALATES

- dibutyl phthalate (DBP)
- butylbenzyl phthalate (BBP)
- diethyl phthalate (DEP)
- di-(2-ethylhexyl) phthalate (DEHP) = bis-ethylhexyl phthalate (BEHP)
- dimethyl phthalate (DMP)

"PUGET SOUND DOWN THE DRAIN" (www.watoxics.org)

- Washington Toxics Coalition and People for Puget Sound study
- How do phthalates from everyday products get into Puget Sound?

PHTHALATES IN PERSONAL CARE PRODUCTS

- Off-gas to air → dust → clothes → laundry water → sewage treatment plant effluent → Puget Sound
- Correlation between DEHP in dust and laundry water
- Phthalates from clothing contribute 17.5% of total phthalate load entering sewage treatment plants.

PHTHALATES AND AQUATIC ORGANISMS

- Impaired reproduction in mussels and sand fleas in Thea Foss Waterway (Tacoma, WA)
- Can affect entire ecosystem

PHTHALATES AND AQUATIC ORGANISMS

- Reduced survival of fathead minnow larvae exposed to DBP
- Reduced growth of rainbow trout exposed to DBP

PHTHALATES AND REPRODUCTIVE HEALTH

- Phthalates mimic estrogen and block testosterone.
- Abnormal reproductive system development in male fetuses
- Correlation between levels of phthalates in breast milk and decreased testosterone production in 3-month old boys

PHTHALATES AND REPRODUCTIVE HEALTH

- Correlation between reduced sperm quality and higher urinary levels of phthalate metabolites in adult men
- Correlation between low birth weight and higher levels of DEHP in blood of newborn infants

PHTHALATES AND BREAST CANCER

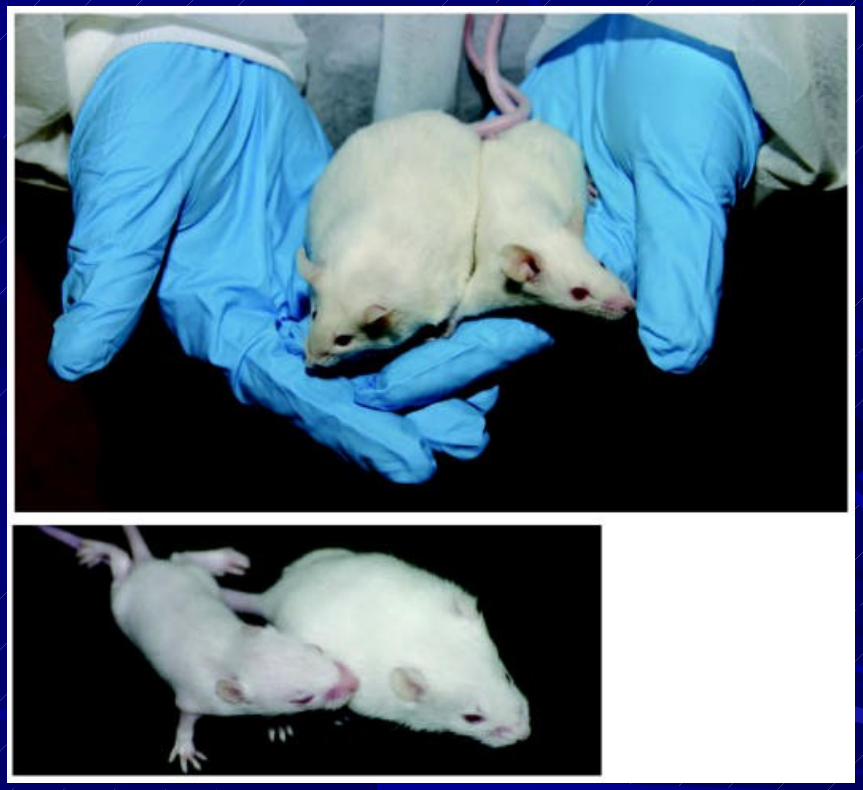
- Increased cell growth and cell division in human breast cancer tumors
- Exposure to phthalates may contribute to early puberty.
- DEP, DBP, and BBP found in 85 of 90 girls, ages 6-9 (2007 study)
- Early puberty is breast cancer risk factor.

PHTHALATES AND THYROID GLAND FUNCTION

- Correlation between reduced thyroid hormone levels and higher urinary levels of phthalate metabolites in adult men
- Correlation between reduced thyroid hormone levels and higher urinary levels of DBP in pregnant women

PHTHALATES AND OBESITY

- Offspring of exposed pregnant mice became fat as adults.
- Phthalate metabolite levels correlate with abdominal fat in men and in pre-adolescent girls.



PHTHALATES AND RESPIRATORY SYSTEM HEALTH

- Higher incidence of asthma and skin allergies in children in homes with higher levels of phthalates
- Correlation between exposure to phthalates and reduced lung capacity in adult men

PERFLUORINATED COMPOUNDS (PFCs) - USES

- Teflon (non-stick cookware)
- Stain-resistant materials (Scotchgard™)
- Repelling water and oil from clothing, carpeting, and food packaging
- Fire-fighting foams
- Hardwood floor protectant

PFCs - EXAMPLES

- Perfluorooctanoic acid (PFOA) – used in manufacture of Teflon products, half-life is 4 years
- Perfluorooctane sulfonate (PFOS) – used formerly to make Scotchgard™, half-life is 8 years
- Breakdown products of other PFCs
- Highly persistent and widespread

PFCs - OCCURRENCE

- Detected in Puget Sound and many rivers in Washington State
- Detected in Arctic air, ice, fish, and wildlife
- Levels in polar bears are 10 times higher than in 1970s.

PFCs – IMPACTS ON FISH AND WILDLIFE

- PFOA caused tumors in trout exposed in lab.
- Higher levels of PFCs found in California river otters that died of infectious diseases

PFOA AND PFOS IMPACTS ON BIRTH WEIGHT

- Cross placenta – found in 291 of 293 newborns tested in 2004 and 2005
- Correlation between lower birth weight and higher PFOA and PFOS levels in newborns
- Correlation between lower birth weight in newborns and higher PFOA levels in mothers during pregnancy

PFOA AND PFOS - IMPACTS ON FERTILITY AND BODY WEIGHT

- Correlation between highest levels in blood of 105 young Danish men and lowest numbers of normal sperm
- Correlation between longer time to pregnancy and highest blood levels in 1240 Danish women
- Adult obesity in offspring of exposed pregnant mice

EDCs AND OBESITY POSSIBLE MECHANISMS

- Prenatal reprogramming of metabolism
- Promoting development and maturation of fat cells throughout life
- Altering behavior of specific genes involved in determining number of fat cells an individual will have as an adult

PRECAUTIONARY PRINCIPLE

- Endocrine Society warning: EDCs are "a significant concern to public health."
- "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

PHTHALATE RESTRICTIONS

- Banned in toys and cosmetics in Japan in 2002 and Europe in 2005
- Restricted in toys and other children's products in Washington State and nationwide in 2008
- The Consumer Guide to Toxic Chemicals in Toys (www.healthytoys.org)

TOXIC SUBSTANCES CONTROL ACT (TSCA) - NEED FOR REFORM

- 1976 federal law
- Toxicity testing based on one chemical at a time and on acute effects
- Required testing on only 200 chemicals out of 80,000 in use

SAFE CHEMICALS ACT (TSCA UPDATE)

- Introduced by Sen. Frank Lautenberg (D-NJ) on 4/14/11 (S. 847)
- Will require new health and safety information for all chemicals
- Health-based safety standards that protect vulnerable populations and consider effects of mixtures and cumulative exposures

SAFE COSMETICS ACT OF 2011

- Introduced by Reps. Jan Schakowsky (D-ILL), Ed Markey (D-MA), and Tammy Baldwin (D-WISC) on 6/24/11 (HR 2359)
- Will require manufacturers to test and disclose all ingredients, including those in fragrances
- Will require cosmetics to be free of toxic chemicals

REDUCING EXPOSURE TO EDCs INDIVIDUAL ACTIONS

- Remove shoes at the door.
- Reduce dust in your home.
- Choose products that are fragrance-free or that contain natural fragrance.
- Eat organically grown produce.
- Heed fish consumption advisories.

REDUCING EXPOSURE TO EDCs INDIVIDUAL ACTIONS

- Do not give plastic toys to babies.
- Choose phthalate-free plastics (recycle #4 or #5).
- Do not heat or microwave food in plastics.
- Keep stove at low or medium heat when using teflon cookware.

REDUCING EXPOSURE TO EDCs INDIVIDUAL ACTIONS

- Ask federal legislators to vote for regulatory reform (Capitol switchboard: 202-224-3121).
- Get involved in environmental nonprofit organizations that address EDCs issues.

FURTHER INFORMATION
WEBSITES

1. Alaska Community Action on Toxics (www.akaction.org)
2. Breast Cancer Fund (www.breastcancerfund.org)
3. Safer Chemicals, Healthy Families (www.saferchemicals.org)
4. Silent Spring Institute (www.silentspring.org)
5. The Collaborative on Health and the Environment (www.healthandenvironment.org)
6. Washington Toxics Coalition (www.watoxics.org)
7. Women's Voices for the Earth (www.womensvoices.org)

FURTHER INFORMATION BOOKS

- Colburn, Theo, Dianne Dumanoski, and John Peterson Myers (1997). *Our Stolen Future,* Penguin Books, New York, N.Y.
- Gilbert, Steven G. (2008). *A Small Dose of Toxicology: The Health Effects of Common Chemicals,* Informa Health Care, USA, Inc., New York, N.Y.
- Shabecoff, Philip and Alice Shabecoff (2008). *Poisoned Profits: the Toxic Assault on Our Children,* Random House, New York, N.Y.