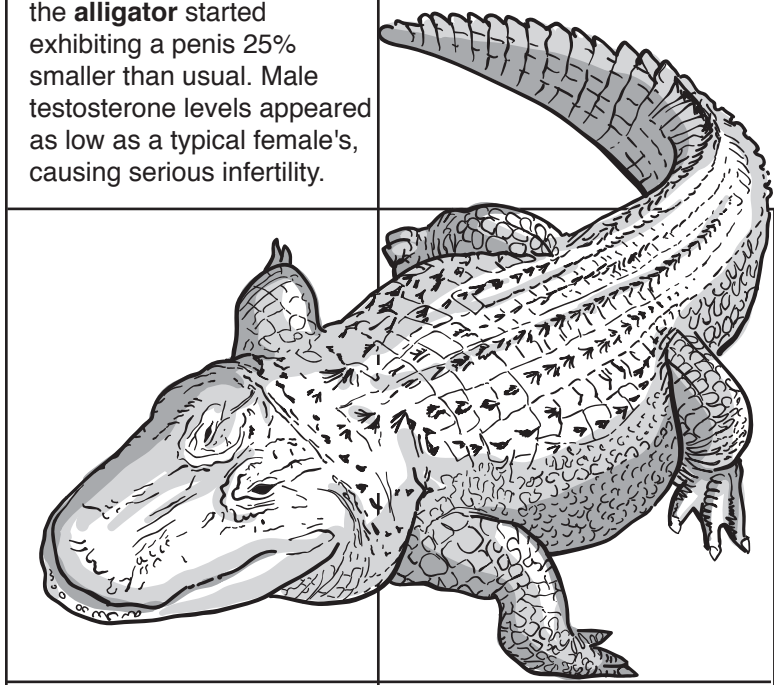


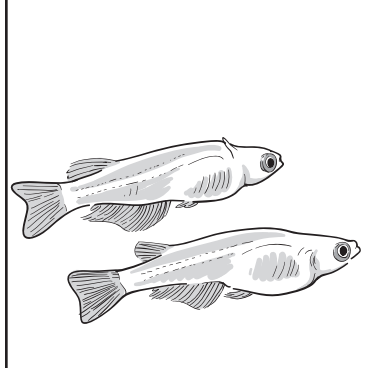
# Our Chemically Modified Organisms (CMOs)

**A**

After Tower Chemical spilled large quantities of dicofol, a pesticide closely related to DDT, into Florida's Lake Apopka in the early 1980s, the **alligator** started exhibiting a penis 25% smaller than usual. Male testosterone levels appeared as low as a typical female's, causing serious infertility.

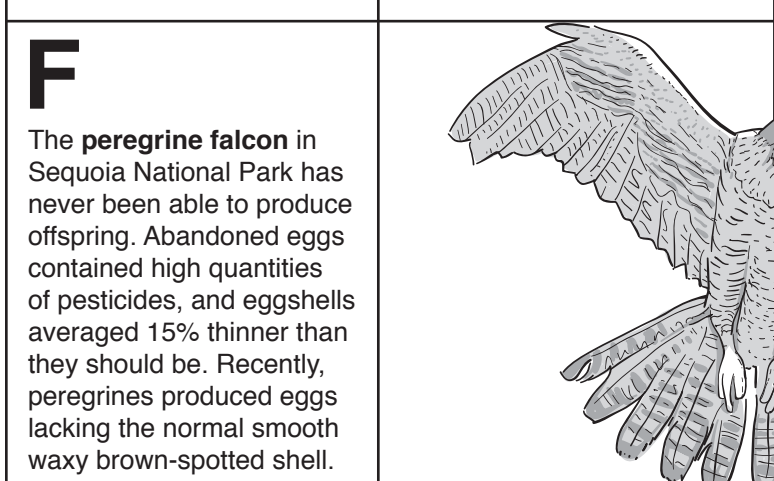


**M**  
A single exposure to the pesticide, DDT, can lead to a complete, permanent and functional sex reversal in the embryonic **medaka oryzias latipes fish**. Fish that would have matured as males instead matured as females.



**F**

The **peregrine falcon** in Sequoia National Park has never been able to produce offspring. Abandoned eggs contained high quantities of pesticides, and eggshells averaged 15% thinner than they should be. Recently, peregrines produced eggs lacking the normal smooth waxy brown-spotted shell.



**Industrial chemistry** is a 20th century phenomenon. During World War I, military demand for war gas was a great boon for the burgeoning industry. But, in 1925, with the signing of the Geneva Protocol that banned chemical warfare, industry had to look for other markets. The production of nerve gas (a phosphorus-containing chemical) gave way to a new line of insecticides and the chlorine used in weapons such as phosgene and mustard gas became feedstock for newly designed solvents, PCBs and, eventually, plastics.

The chemical industry really took off after World War II. In the United States, synthetic organic chemical production has grown more than thirty-fold since 1940. Today industry produces billions of tons of chemicals per year of approximately **90,000 substances**. These man-made chemicals are the foundation of our built environment. They form our plastics, cosmetics, household cleaners, pharmaceuticals, resins, pesticides, food packaging, paper, clothing, flame-retardants, electronics, solvents, paint,

automobile parts, mattresses, lumber, pigments, refrigeration, detergents, PVC, silicone, dry cleaning, disinfectants, lubricants – the list is truly endless.

Many of these chemicals and the byproducts produced during their life cycle are stable and **persist** in the environment. These chemicals also **bio-accumulate**, meaning they increase in concentration as they move up the food chain. Chemicals can travel great distances on currents of wind and water, making remote regions like the Arctic just as susceptible to degradation.

New research demonstrates that some of these pollutants, even at very **low doses**, can cause serious health problems. Previously it was thought that decreasing the concentration of a substance would mitigate its impact. Dilution is no longer seen as the pollution solution. Timing of exposure is crucial and sensitivity is particularly high when exposure occurs in utero or early development.

For many years, cancer was the primary health concern. Today, laboratory studies and wildlife observations demonstrate that **chemical dangers are extensive**. Chemical exposures disrupt endocrine, reproductive, immune and nervous systems as well as contribute to cancer and other diseases.

In its first scientific statement published in 2009, The Endocrine Society – an international body with 14,000 members founded in 1916 – stated: "Results from animal models, human clinical observations, and epidemiological studies converge to implicate EDCs [**endocrine-disrupting chemicals**] as a significant concern to public health."

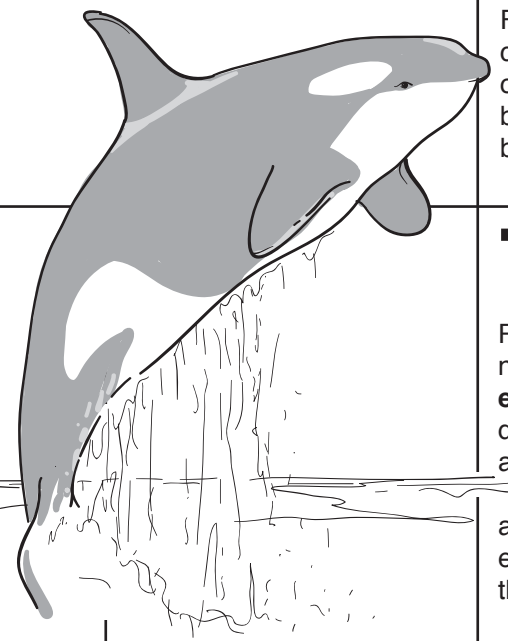
The United States government does not require manufacturers to prove a chemical is safe before use and companies generally do not voluntarily do so. The U.S. Environmental Protection Agency (EPA) has only required testing for some 200 of the 90,000 chemicals already in circulation. In response, many groups

and concerned citizens are promoting the **precautionary principle**, which states that the manufacture of certain products should cease even when there are only hypothetical and untested risks. This places the burden of proof on the industry to show that a substance is safe rather than on society to demonstrate there is a specific risk.

Some scientists are creating new frameworks, citing the failure of the scientific method alone to sufficiently protect human health and ecological effects. Funtovicz and Ravetz, for example, have introduced **postnormal science**, which is useful when facts are uncertain, the stakes are high and decisions are urgent. These scientists encourage dialogue and participation with a full range of stakeholders since scientific objectivity cannot provide all that is needed for decision-making on high, risk issues.

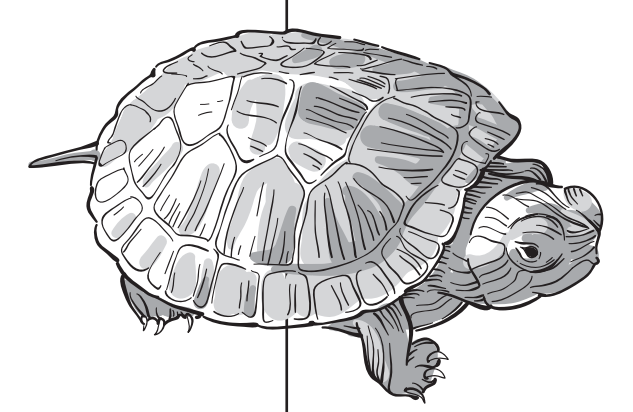
**W**

A **male killer whale** in the Pacific Northwest carries almost 150 parts per million of PCBs, the highest concentration recorded in a wild animal. Females tend to have lower concentrations because they offload them to their young, both in the womb and through breast milk.



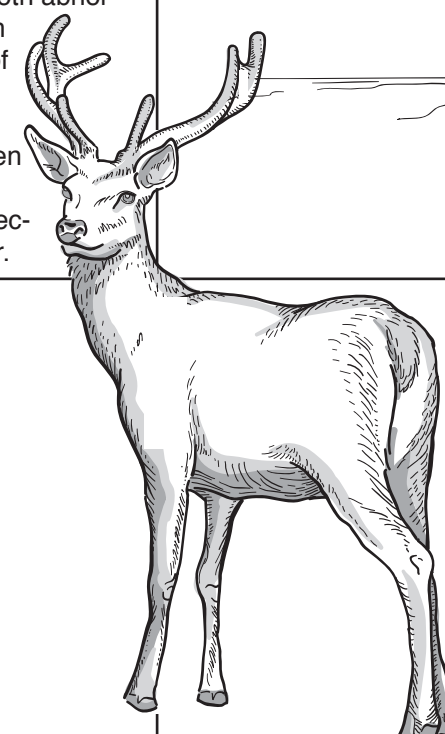
**T**

PCBs and pesticides are negatively impacting the **red ear slider turtle** during fetal development. The chemicals alter sex ratios and other effects continue into turtle adulthood even though the exposure took place only in the egg.



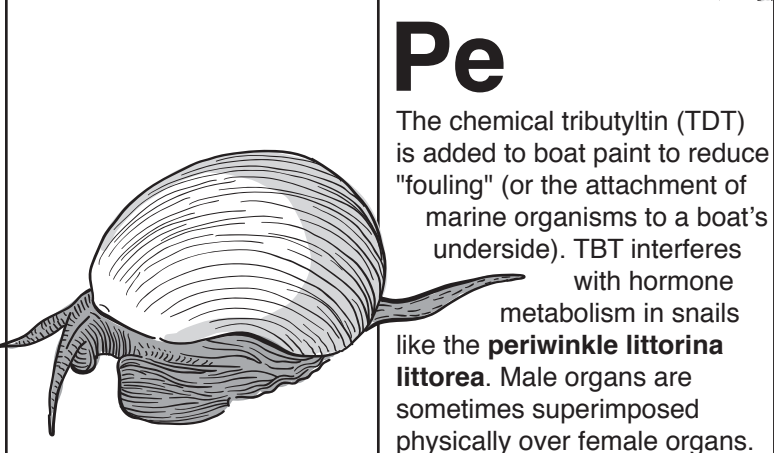
**D**

**Red deer** examined near aluminum smelters were found to have tooth abnormalities and high concentrations of fluoride in their bones. Severe fluorosis has been correlated with reduced life expectancy in red deer.



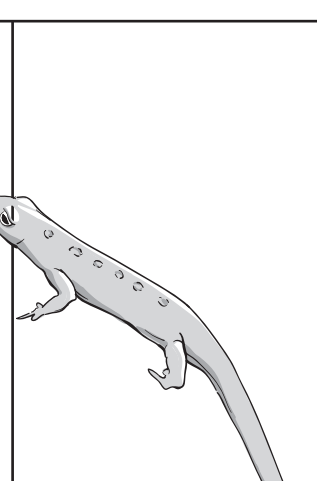
**Pe**

The chemical tributyltin (TBT) is added to boat paint to reduce "fouling" (or the attachment of marine organisms to a boat's underside). TBT interferes with hormone metabolism in snails like the **periwinkle littorina littorea**. Male organs are sometimes superimposed physically over female organs.



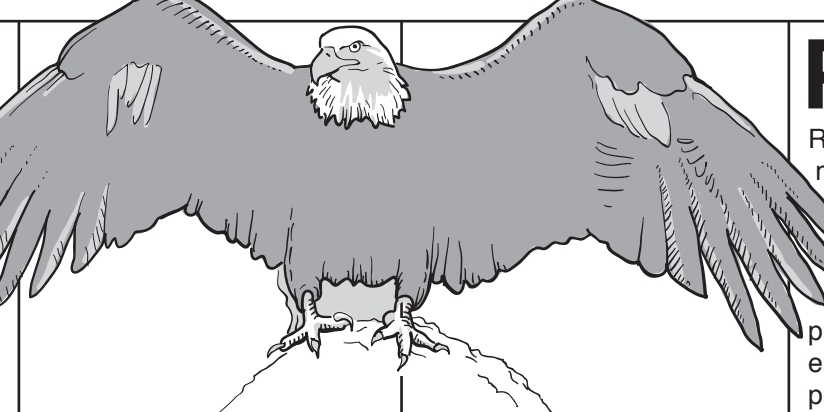
**N**

Exposure to extremely low levels of a commonly-used pesticide, endosulfan, interferes with reproduction in the **red-spotted newt** by disrupting the development of glands that synthesize a pheromone used in female-male communication. This disruption lowers a newt's mating success.



**E**

For many years the **bald eagle** was close to extinction. The pesticide, DDT, was one factor. It caused eggshells to thin to the point that they would break during incubation, radically decreasing eagle population.



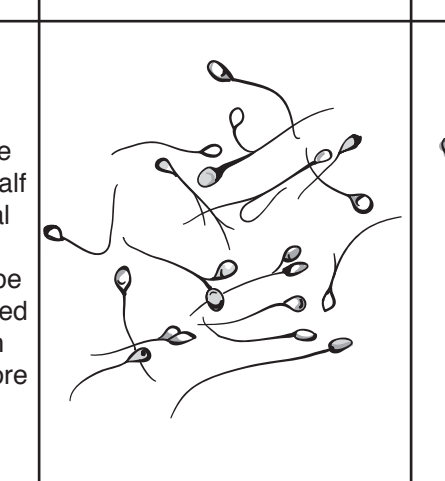
**Pa**

Research suggests that the male Florida **panther** may have been demasculinized and feminized due to prenatal or postnatal exposure to mercury, p,p'-DDE and PCBs. The endangered panther suffers physiological, reproductive, endocrine, and immune system defects.



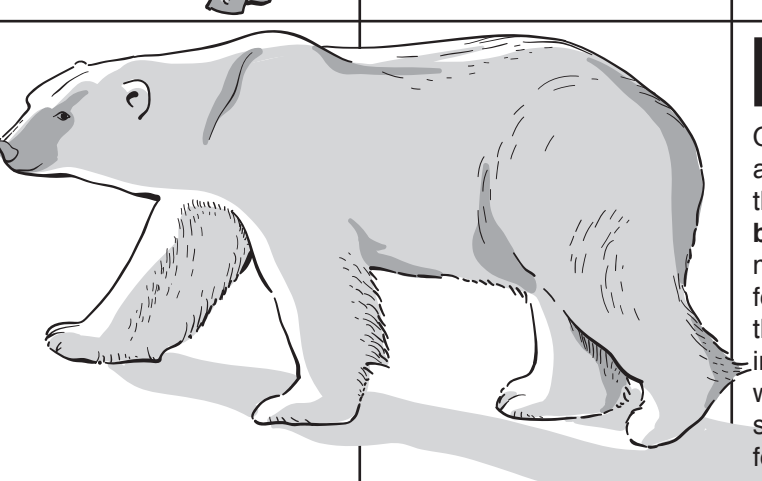
**Sp**

**Human sperm** counts have plummeted over the past half century worldwide. Prenatal exposure to hormone-mimicking chemicals may be at fault. Exposure to elevated estrogen levels before birth appears to make males more vulnerable to prostate enlargement later in life.



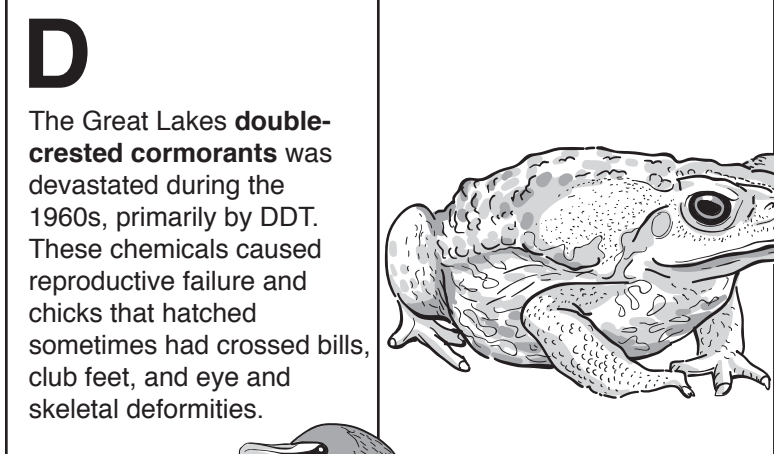
**Po**

Oil production, global warming and pesticide exposure all threaten the life of the **polar bear**. Pesticides are bio-magnified with each step in the food web, reaching some of their biggest concentrations in polar bears. Pesticides weaken the bear's immune system and increase the risk for infections.



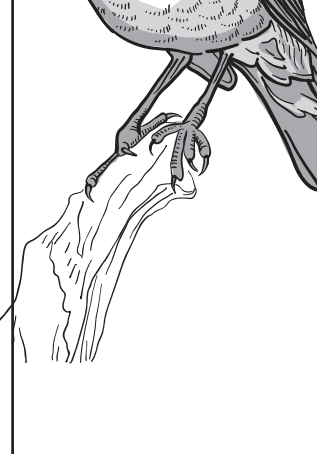
**D**

The Great Lakes **double-crested cormorants** was devastated during the 1960s, primarily by DDT. These chemicals caused reproductive failure and chicks that hatched sometimes had crossed bills, club feet, and eye and skeletal deformities.



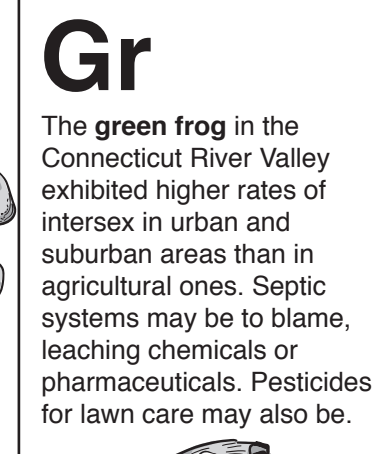
**C**

In Florida, **cane toads** in agricultural areas -- where glyphosate (active ingredient in Round Up herbicide) and atrazine (an herbicide) use is common -- have a higher rate of feminization.



**R**

DDT is known to cause **robin** mortality and reduced nest success. Rachel Carson in her famous book "Silent Spring" brought attention to this issue. She wrote: "We spray our elms and the following springs are silent of robin song."



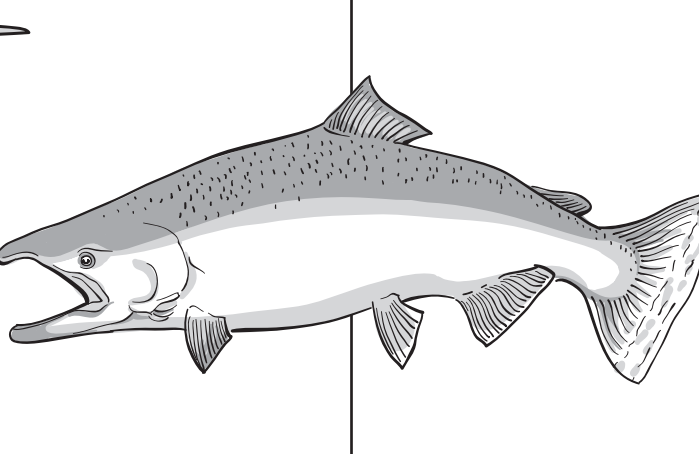
**Gr**

The **green frog** in the Connecticut River Valley exhibited higher rates of intersex in urban and suburban areas than in agricultural ones. Septic systems may be to blame, leaching chemicals or pharmaceuticals. Pesticides for lawn care may also be.



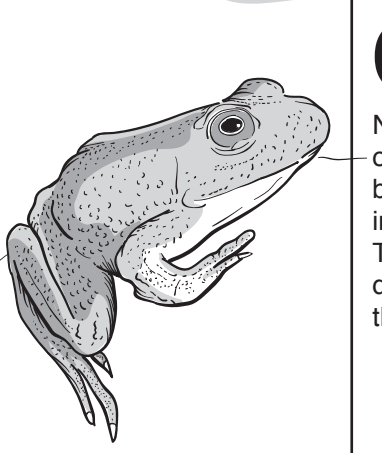
**Sa**

**Chinook salmon** in the in central Washington state are displaying feminization. Many of the males are fully fertile females. Environmental estrogens are a likely factor. These are chemicals in the form of detergents, plasticizers, and pesticides that result from human activity.



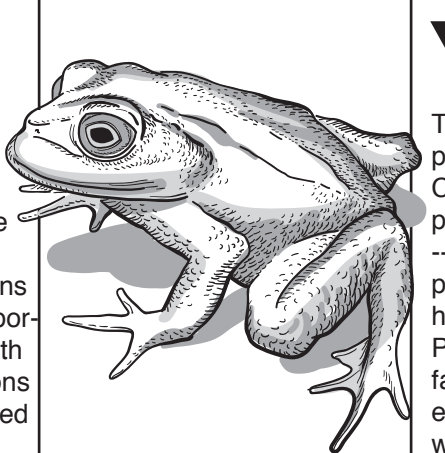
**Oy**

Nonylphenol can alter the sex of an **oyster**, cause some to become hermaphroditic, and impair survivorship of offspring. The effects are extremely deleterious to the survival of the oysters.



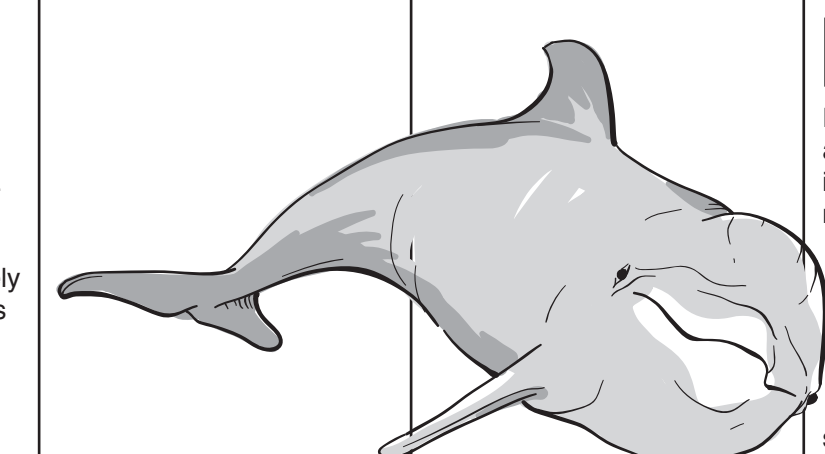
**Y**

The **yellow-legged frog** population is declining in California. As little as 0.3 parts per billion of endosulfan -- the active ingredient in many pesticides -- in water can kill half of the frogs living in it. Pesticides move out of the farm valley, into snow and eventually into the streams where frogs live and breed.



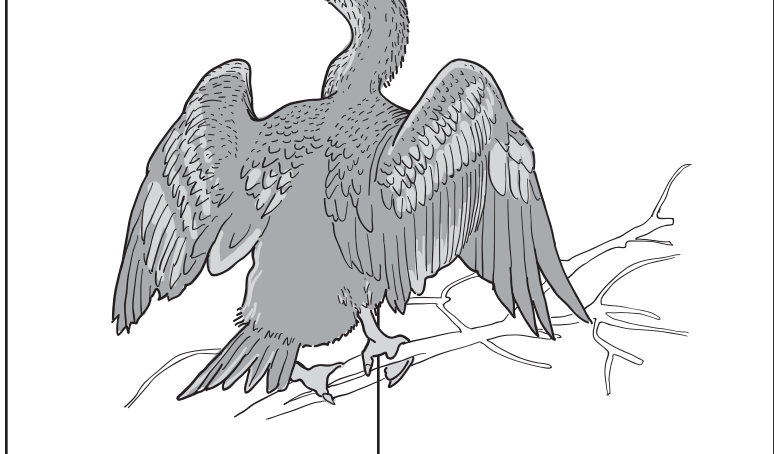
**Do**

For the first time, the popular antibacterial agent, triclosan, is found in the blood of a marine mammal: the **bottlenose dolphin**. Triclosan, an ingredient in common soaps and toothpastes, can transform into other toxic compounds and may interfere with hormone systems at very low levels.



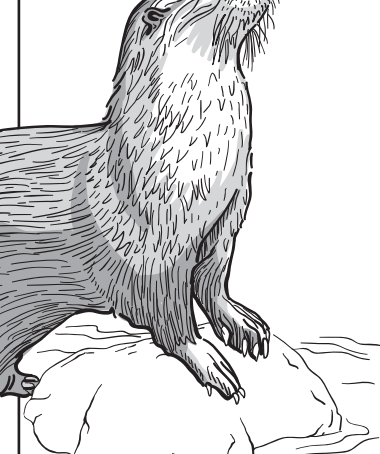
**Au**

The pesticide, endosulfan, and fungicide, carbendazim, have been implicated in the chronic deformities and deaths of thousands of **Australian bass**. Spray drift from macadamia nut plantations is the suspected cause of two-headed bass, which survive for only 48 hours after hatching.



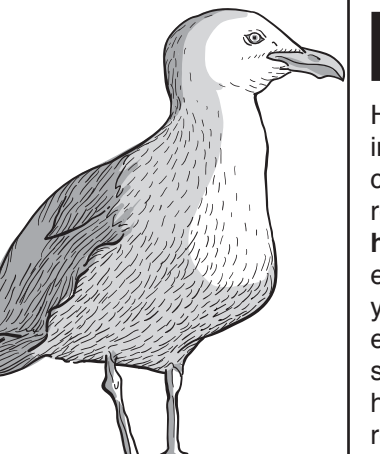
**O**

Male **river otters** in the lower Columbia River showed significantly smaller baculum (penis bone) size and weight, and much smaller testes than typical. Insecticides, PCBs, dioxins and furans are under investigation for cause.



**Hg**

High levels of toxic chemicals in the Great Lakes has coincided with poor health and reproduction problems in the **herring gull**. Deformities in embryos and the hatched young, biochemical changes, endocrine disruption and suppressed immune function have also been observed recently.



Created by **Brooke Singer**. For more information, please visit <http://www.undesigning.org>. Illustrations by John Kitses. This work is made possible with public funds from the New York State Council on the Arts, a State Agency.

