

## NOAA Endocrine Disruption in Fish: An Assessment of Recent Research and Results

### OVERVIEW

May 2001: Research cruise aboard NOAA's Albatross IV. Scientific crew washing zooplankton out of the nets and into buckets. The Center for Coastal Monitoring and Assessment, part of the U.S. Department of Commerce\National Oceanic Atmospheric Administration's National Centers for Coastal Ocean Science (NOAA/NCCOS), has completed an assessment of current research findings on endocrine disruption in fresh and saltwater fish species.

Conducted jointly by Anthony S. Pait, of NOAA and Judd O. Nelson, of the University of Maryland, the 55-page report (NOAA Technical Memorandum NOS NCCOS CCMA 149) reports that endocrine disruption in fish studied "does not appear to be a ubiquitous environmental phenomenon." Rather, endocrine disruption in fish tends to be concentrated near sewage treatment plants, pulp and paper mills, and in areas with high organic chemical contamination.

The study reports "no clear indication" that large populations of fish are being seriously affected by endocrine disruption, but it cautions that more work is needed to confirm this assessment.

### QUESTIONS AND ANSWERS

What is the purpose of this report?

The purpose of the report is to assess recent research and results from investigations of endocrine disruption in fresh and saltwater species of fish. The report begins with background, historical perspective, and an overview of the effects of various chemical compounds that have been implicated as endocrine disrupters. The report then summarizes research findings of fish studies that have been performed in the laboratory and in the environment.

What is meant by "endocrine disruption" in the context of this report?

In this report, compounds that either mimic or antagonize the action of naturally occurring hormones are termed endocrine disrupters or endocrine disrupting compounds (EDCs).

Why study this phenomenon now? Is there reason to believe it is increasing?

EDCs affect an organism's ability to develop and reproduce. Chemical disruption of the endocrine system is not a new phenomenon. DDT, banned since the early 1970s, was known to produce estrogenic responses in the reproductive tracts of rats and birds. As early as 1949, crop duster pilots handling DDT evidenced reduced sperm counts. Studies of Lake Michigan herring gulls in the mid 1960's suggested that environmental contaminants were affecting hatching success. The reason for increased concern now is that recently, the number of compounds confirmed or suspected of endocrine disruption has increased substantially. Experts disagree on the extent and environmental significance of endocrine disruption. Some argue that the damage to the environment is already widespread, while others point out that EDCs are far less potent than the bodies' own hormones, and in certain cases (e.g., environmental antiestrogens and estrogens) could balance each other out. Despite this debate, there is little disagreement over the need to better understand environmental impacts.

What are the causes of endocrine disruption found in the fresh and salt water fish studied?

Studies in the laboratory have shown that a number of synthetic and natural chemicals can interfere with the endocrine system in fish. These include certain chemicals used in industrial and manufacturing processes, classic contaminants such as polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), dioxins, certain pesticides, and a number of trace elements. In plants, naturally occurring compounds termed phytoestrogens are also known to have hormone-like properties. The potency of most of these chemicals, however, is typically hundreds to thousands of times less than that of hormones that organisms produce themselves.

Why focus this assessment exclusively on fish?

In the aquatic environment, fish are good study subjects because:

Their endocrine system is similar to those of higher vertebrates;  
Their susceptibility to EDCs has been validated by laboratory experiments;  
They are easy to work with; and  
There have been indications of endocrine disruption in fish in some areas  
What factors can influence the risks posed by endocrine disruption in fish?

A number of factors are involved. Among these: the potency and concentration of the compound or compounds involved, duration of exposure, life stage exposed, bioconcentration potential, season, and other environmental factors such as temperature and salinity.

Is there evidence of environmental endocrine disruption for fish? How are the fish affected?

Localized studies have found evidence of reproductive abnormalities in fish exposed to discharges from sewage treatment plants, paper mills, and other industrial or chemical pollution sources. Among these abnormalities are fish with depressed levels of naturally produced hormones (like estrogens and androgens), fish that exhibit both male and female characteristics (intersex fish) in normally separate sex species, degraded gonadal structure, and male fish that have elevated levels of a protein usually associated with egg laying in females. The various endocrine-disrupting compounds affect fish differently - some mimicking and others counteracting the action of naturally occurring hormones to create an assortment of reproductive abnormalities. Although effects on reproduction are typically the focus of endocrine disrupter studies, the authors noted that other important functions influenced by the endocrine system, such as metabolism or growth, could also be targets of endocrine disrupters, although more research is needed in these areas.

How pervasive are reproductive effects of EDCs on fish?

Overt reproductive endocrine disruption in fish does not appear to be a ubiquitous environmental phenomenon. Rather it appears to be associated with higher levels of contamination near pollution sources such as sewage treatment plants and industrial plants.

Some laboratory studies, however, suggest that subtler effects may be occurring at very low levels of contamination. There is no clear indication that geographically large populations of fish are being seriously affected by endocrine disruption. However, several research authors have noted that reproduction and population structure very likely is affected in localized areas where the greatest impacts on individual fish have been found, such as adjacent to certain sewage treatment plants. More research is needed to assess broader implications on the size, age structure and other characteristics of fish populations.

Where and under what circumstances have EDCs been associated with reproductive abnormalities in fish?

Endocrine disruption in fish appears more frequently associated with three types of land use: sewage treatment plants, pulp and paper mills, and areas of high industrial activity/chemical contamination.

Natural and synthetic estrogens are believed responsible for many of the estrogenic effects observed near sewage treatment plants - because these compounds are not entirely removed or broken down by sewage treatment processes. Effluents from pulp and paper mills, in some instances, have been associated with masculinization of female fish and decreased levels of reproductive hormones in both females and males. Various abnormalities have been observed near other sources of heavy industrial activity and chemical pollution, including reduced estrogen levels in female fish and inhibited development of gonads.

When detected, endocrine disruption is more likely to be associated with higher levels of contaminants occurring near sources of pollution, such as spills, and discharge effluents from factories and sewage treatment plants.

A PDF of the full report, NOAA Technical Memorandum NOS NCCOS CCMA 149, Endocrine Disruption in Fish: An Assessment of Recent Research and Results, is available at <http://www.nccos.noaa.gov/documents/techmemo149.pdf>

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