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Fact Sheet

Surface Water Samples Test Free of Strong EEDC Activity

Monitoring results suggest no strong endocrine-disrupting chemical activity in Central Valley and North Coast surface water samples

Study Overview

California's Central Valley and North Coast Regions together cover more than 50 percent of the state's land area and account for more than 85 percent of the state's freshwater runoff. Both regions' waters support critical habitat for fish, birds and other wildlife. Both regions also support viable urban areas and agricultural industries that are important to California's economy. The Central Valley Region contains over 77 percent of the state's irrigated agriculture.

The University of California, Davis, in collaboration with the U.S. Environmental Protection Agency, conducted a preliminary screening of surface waters in the Central Valley and North Coast Regions for estrogenic endocrine disrupting chemical (EEDC) activity.¹ Surface water sites were chosen in these regions to determine whether chemicals associated with agricultural and urban land uses, such as industrial and municipal treated effluents (synthetic and natural hormones and estrogen mimics), could be potential sources of EEDC activity.

The indicator used for this assessment was a juvenile rainbow trout liver vitellogenin (Vtg) gene expression assay. Vtg is the liver-synthesized egg yolk protein precursor and is usually silent or not expressed in male fish. Exposure of

fish to estrogenic chemicals can result in Vtg production. Vtg gene expression in fish is widely employed as an indicator of exposure to estrogenic compounds.



A SWAMP staff member collects from agriculturally dominated surface water in the North Coast region to test for EEDC activity.



1. Screening California Surface Waters for Estrogenic Endocrine Disrupting Chemicals (EEDC) with a Juvenile Rainbow Trout Liver Vitellogenin mRNA Procedure. Surface Water Ambient Monitoring Program peer reviewed technical report. State Water Resources Control Board, 2006.



Findings

Analysis of 113 ambient water samples collected from agricultural and urban waterways in the Central Valley and North Coast Regions indicated no strong estrogenic activity equivalent to assay positive control. Only six (5 percent) of the 113 samples induced marginal, but statistically significant, estrogenic activity in the screening procedure. EEDC concentrations in these six samples were low (at or near procedure threshold) and may have included false positives.

EEDC Facts

Significance of Estrogenic Endocrine Disrupting Chemicals

Hormones are chemical messengers that control a wide range of organism functions. For example, insulin is a hormone that is critical for metabolism of foods. Endocrine disrupting chemicals (EDCs) interfere with the normal function of hormones produced by endocrine organs (such as pituitary, thyroid, adrenals and pancreas) that regulate many physiological functions. Endocrine disruption is not necessarily the occurrence of adverse health effects, but it is considered to be a change that may lead to harmful effects. The current study did not screen surface water samples for all endocrine disrupting chemicals; rather, it screened only for estrogenic endocrine disrupting chemicals—those that mimic or interfere with the actions of estrogen, an important female sex hormone.

Assessment Threshold to Evaluate Estrogenic Activity in Surface Waters

To assess exposure to potential EEDCs, fish in surface water samples were statistically compared to fish in laboratory control water. To evaluate degree of response and thus the level of EEDCs in a sample, the response of fish exposed to surface water samples was compared to fish

exposed to positive controls containing an estrogenic chemical. Statistically significant induction of liver Vtg messenger RNA (mRNA) was observed at 5 nanograms per liter (5 ng/L) of 17-alpha ethinyl estradiol (EE2). Thus, the detection limit for EE2 in 24-hour exposures was 5 ng/L or less. Data collected in this study also revealed that response in 8-day exposures is greater than in the 24-hour exposures and, thus, indicate that the procedure detection limit in 8-day exposures is lower.

The threshold for induction of the Vtg gene should not be equated with the threshold concentration for adverse effects on sexual development or reproductive function. Best professional judgment suggests that the sensitivity (detection limit) of the procedure used was sufficient to detect EEDC adverse effect concentrations. While the screening procedure used in this study is effective for detecting significant concentrations of rapidly acting estrogenic chemicals, longer term exposures may be necessary to detect EEDCs that bioaccumulate (for example, alkylphenols).



A SWAMP staff member prepares to collect a surface water sample from the Russian River to test for EEDC activity.

Limitations of Screening to Identify Population Level Effects on Resident Fish

The screening procedure is a short-term assay that is used only to identify whether fish in surface waters are being



UCD staff captures fish exposed to surface water samples for analysis of EEDC activity.

exposed to estrogenic chemical activity. Estrogenic activity is quantified by examination of Vtg gene expression as Vtg mRNA in fish used in the laboratory assay (see Figure 1). The relationship of Vtg gene expression with fish normal sexual development and reproductive success is, however, variable. That is, the induction of the Vtg gene should not be equated with adverse effects on sexual development or reproductive function in resident fish populations. Moreover, threshold concentration and duration of exposure can be different for induction of the Vtg gene and for actual developmental and/or reproductive adverse effects.

Surface Water Assessment for Estrogenic Chemical Activity in the U.S. and Europe

Screening fresh surface waters for estrogenic activity has been much less common in the U.S. compared to Europe and particularly the United Kingdom. Different types of screening are possible:

- Chemical analysis of surface water samples for various (potential) EEDCs.
- Screening surface water samples in the laboratory with fish to assess induction of Vtg gene expression.
- Induction of Vtg gene expression in resident fish or caged fish deployed into surface waters.

Caged fish have been deployed in U.S. streams below wastewater treatment facilities to screen for EEDC exposure in very few studies. Vtg gene induction was noted in some, but not all, of the studies. In the few investigations that measured concentrations of some potential EEDCs in U.S. surface waters, the frequency of detections have been relatively low and the median, mean, and frequently the maximum concentrations have most often been below documented adverse effect concentrations. The data from the current surface water assessment in California's Central Valley and North Coast are consistent with these investigations.

Illustration of Vtg Transcription and Translation

