science summary

Environment Agency

www.environment-agency.gov.uk

SCHO0907BNGV-E-P

Biological effect measures in fish – application to treated sewage effluent

Science summary: SC030278

A new report from the Environment Agency describes a method that means we can directly measure the effect of exposure to sewage effluent on fish reproduction. We have known for some years that effluents from sewage treatment works contain chemicals that can affect the reproductive systems of many species of fish. These endocrine disrupting chemicals can act as oestrogens (female sex hormones) in the fish, leading to male fish developing eggs in the testes and impairing their ability to reproduce. This report describes new methods for measuring how much a particular effluent affects reproduction in fish by looking at the numbers of eggs the fish produce both before and after being exposed to the effluent. The researchers also measured levels of certain proteins in the fish, as well as changes in secondary sex characters, such as relative size of testes. This new method will be very important not only for developing new ways of treating sewage but also for understanding more about the potential health effects that these effluents might pose to wild fish populations.

Three effluents from sewage treatment works were chosen for this study. Their oestrogenic activity was assessed using a recombinant Yeast Oestrogen Screen and by measuring the concentrations of two natural steroidal oestrogens, 17β-oestradiol and oestrone. The oestrogenic activity of effluent I was previously determined to be high, whilst effluent II was intermediate and effluent III was of low activity. The activity of the effluents was shown to be stable during storage at 8 ºC for 8 days. Fathead minnow (*Pimephales promelas*) were exposed to the different effluents in a flow-through system, both as non-spawning individuals and as breeding pairs. The fathead minnow is a member of the carp family, so it is representative of a large component of the UK freshwater fisheries. It also has a relatively fast reproductive cycle, which makes it possible to measure potentially detrimental reproductive effects within reasonable timescales.

The researchers looked at the concentrations of a protein called vitellogenin that is a precursor for egg yolk production as well as measuring secondary sex characteristics. These biomarkers are dependent on oestrogen and androgen levels and depending on the stage of sexual development and sex of the fish ,can be used as a measure of exposure to oestrogens, anti-oestrogens, androgens and anti-androgens. Vitellogenin concentrations in the fish exposed to the three effluents reflected the oestrogenic loads of the effluent. Exposure to the effluents tended to increase the relative weight of the male gonads but there was no similar affect in females. There were no clear concentration-related effects of the effluent on male SSCs.

In the pair-breeding experiments, effluent I reduced total egg production at concentrations of 50% and 100%, while effluent III ('low' oestrogenic activity) reduced egg production at the 100% concentration only. In contrast, effluent II (the 'intermediate' oestrogenic effluent) did not affect egg production over the period of exposure (21 days). Control experiments using an oestrogen (17a-ethinyloestradiol), consistently induced higher concentrations of vitellogenin than any of the effluents tested, but did not affect reproduction. This suggests that the effects of the effluents on reproduction may be a consequence of exposure to a complex mixture of chemicals within the effluent, which act via multiple mechanisms. This also demonstrates why it is so important to use a pair-breeding test for assessing the effects of effluents, as well as measuring the levels of chemicals present and the biomarkers in non-spawning individuals.

The results from these experiments demonstrate that it is possible to measure the impact of exposure to sewage effluents on reproduction in fish. This, in turn, provides an important step to furthering our understanding of the potential health effects that such effluents might pose to wild fish populations.

This summary relates to information from Science Project SC030278 reported in detail in the following output(s):

Science Report: SC030278/SR
Title: Biological Effect Measures in Fish – Application to Treated Sewage Effluent.

ISBN: 978-1-84432-824-6 **November 2007**
Report Product Code: SCHO0907BNGU-E-P

Internal Status: Released to all regions
External Status: Publicly available

Project manager: Rachael Benstead, Science

Research Collaborator: AstraZeneca

Research Contractor: University of Exeter

This project was funded by the Environment Agency's Science Department, which provides scientific knowledge, tools and techniques to enable us to protect and manage the environment as effectively as possible.

Further copies of this summary and related report(s) are available from our publications catalogue on or our National Customer Contact Centre T: 08708 506506 or E: enquiries@environment-agency.gov.uk.

.