FACT SHEET
HUDSON RIVER
Predicting Future Levels of PCBs in Lower Hudson River Fish

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The Hudson River Natural Resource Trustees – the National Oceanic and Atmospheric Administration (NOAA), the U.S. Department of the Interior, and New York State (collectively the Trustees) – continue to determine how polychlorinated biphenyls (PCBs) from the General Electric Company (GE) plants at Fort Edward and Hudson Falls, NY harm the Hudson River's natural resources.

In support of this effort, NOAA recently published a paper that provides updated projections of when Lower Hudson River (LHR) fish will likely achieve EPA thresholds meant to be protective of humans consuming Hudson River fish. The findings in the paper were presented in 2015 at scientific conferences and elsewhere. As trustees, knowing when fish are no longer contaminated above health thresholds is crucial to our understanding of how long injury to fish will last into the future. The study "Re-visiting Projections of PCBs in Lower Hudson River Fish Using Model Emulation" was recently published in the peer-reviewed journal, Science of The Total Environment (Vol 557-558, pp 489-501). It is available online here: http://authors.elsevier.com/a/1SmFlB8ccYuFa.

The decision making process leading to the 2002 Record of Decision (ROD) for the Hudson River PCBs Superfund Site relied on complex mechanistic mathematical models to forecast future concentrations of PCBs in Upper Hudson River (UHR) and LHR fish in order to compare among remedial alternatives. Studies conducted after the remedy was selected found: 1) surface sediments were much more contaminated with PCBs and 2) NOAA estimated that natural recovery was much slower than was used in the modeling to support remedy selection. Re-running the original models to incorporate these new findings was time and cost prohibitive. Therefore, NOAA applied a *model emulation* approach to evaluate how these new findings affect the time to reach human health thresholds (PCB concentrations in fish tissues) in LHR fish under Monitored Natural Attenuation (MNA) and the selected and implemented dredging remedy (REM).

Findings from the paper include:

- After remedy selection in 2002, extensive sampling to design the remedy revealed that PCB concentrations in surface sediment were 2-3 times higher than the concentrations used in the original modeling, and NOAA estimated that the rate of natural recovery (the PCB decay rate) was 3% or less, slower than the 8% decay rate predicted by the mechanistic models.
- NOAA's emulated model reproduced the mechanistic model's projections of concentrations of PCBs in UHR sediment and water and LHR fish under MNA and REM.
- The emulated model predicted that reaching human health thresholds in LHR fish will take decades longer than the original mechanistic model projected**.** The analysis shows the measured concentrations of PCBs in fish (e.g., white perch and black bass) in the Lower Hudson (Albany/ Troy) from 1997 to 2014 are higher than the original model forecasts that were relied upon for remedy selection, and more closely match NOAA's updated predictions.
- The study acknowledges that due to data limitations the exact decay rate is highly uncertain and demonstrates that modest changes in the decay rate translate into a wide range of estimated times to recovery. However, the model emulation predictions provide our current best estimates of times to reach human health thresholds.

Background on the model emulation approach:

- Model emulation condenses complex integrated models into an easy-to-use model. It maintains the underlying relationships among the original models, enables use of updated data and evaluation of alternative scenarios, and has been used effectively for large numerical ocean and climate change models.
- The research approach was to develop statistical models to reproduce mechanistic model projections for PCBs in UHR surface sediment and water and LHR fish for MNA and REM.
- NOAA used the model emulation to apply updated surface sediment PCB data and decay rates to assess the impact of the post-2002 ROD findings on predictions of LHR fish PCBs.

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Background (continued)

The analysis is based upon data from over 8,000 sediment cores collected between 2002 and 2005 and analyzed as part of a systematic remedial design sampling program. NOAA's analyses relied on these data to provide both the basis for updated estimates of pre- and post-remediation PCB concentrations in surface sediment and an empirical estimate of the decay rate. Annual monitoring data for white perch and black bass from the Albany/Troy LHR sampling location between 1997 and 2014 were used to evaluate the emulated model predictions. Due to a change in fish processing protocol (at some point after 2003 fish sample preparation changed from a "rib-in" method to a "rib-out" procedure), these data should be considered biased low for some or all of the period between 2004 and 2013.

The authors evaluated how the updated sediment concentrations and decay rates impact the projected time to reach human health risk-based target PCB thresholds (0.05, 0.2, 0.4 ppm PCBs) in 4 fish species (white perch, largemouth bass, brown bullhead, yellow perch) in the Lower Hudson under MNA, REM, and an alternative scenario that involved additional removal of ~170 acres of PCB-contaminated sediments in River Sections (RS) 2 and 3 (i.e., applying RS1 criteria to RS2 and RS3). Uncertainty analyses were also conducted using a 2% to 5% range of decay rates to assess the importance of changes in the decay rate on estimated times to recovery.

CONCLUSIONS

- NOAA's analysis shows that, absent further removal of PCBs, achievement of LHR fish PCB threshold concentrations protective of human health may be delayed for up to several decades. These results are sensitive to the decay rate used and conducting a robust post-remedy monitoring program is critical to further refining estimates of recovery.

RECOMMENDATIONS

- To provide a strong foundation for future estimates of decay rate and predictions of time to recovery, post-remedial sediment monitoring should include a probability-based statistical design for selection of sample locations within dredged and undredged areas for each individual reach, with PCBs measured in both the top 2 and 12 inches.

- A special study should be performed to assess the wet weight and lipid PCB concentrations in "rib–in" vs "rib-out" samples for striped bass, white perch, yellow perch, channel catfish and brown bullhead to correct the data record of fish tissue PCBs between 2004 and 2013 for long-term trend analysis.

IMPLICATIONS FOR THE NRDA

This analysis is important to the Hudson River Trustees. The longer it takes for fish PCB concentrations to decline, the more significant the injury to Trustee resources and the longer the public's use of their resources will be impaired. These results will be incorporated into the NRDA to ensure the public is appropriately compensated.

For more information:

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