Effects of Pesticides on Lobster Health: Simulating Realistic Concentrations

Sea Grant researchers measured the toxicity of pesticides that may have been implicated in the 1999 lobster die off in Long Island Sound. Techniques developed to measure the pesticides are now sought after nationwide.

A coordinated research effort addresses cause of lobster mortalities

The massive Long Island Sound lobster die off in 1999-2000 led to a lobster research initiative by NY and CT Sea Grant and other state and federal groups to determine the factors involved with the event. Many research projects were funded that looked at different aspects of lobster biology, physiology and the Long Island Sound environment at the time of the die off. Information was needed on the state of the environment and the lobster population and potential factors at play that could have led to such a sudden and economically damaging outcome. Many approaches were used by the research effort including modeling, laboratory experiments, and environmental sampling. Together the various research teams and approaches developed a picture of how and why the event happened. This was one project of the initiative that looked at one piece of the puzzle, the possible role that pesticides might have had in the lobster mortalities.

Analyzing pesticide toxicity on lobsters at likely concentrations

One of the projects that involved both laboratory experiments and environmental sampling was led by Dr. Anne McElroy and Dr. Bruce Brownawell at Stony Brook University Marine Sciences Research Center. The project addressed the controversial role pesticides might have played in the lobster die-off. Recent spraying for control of West Nile infected mosquitoes was believed by some to have played an important role in the lobster die-off. Those parties believed that through runoff from sprayed areas, pesticides entered the

Researcher Anne McElroy demonstrates the highly sensitive spectrometer used to measure minute quantities of pesticides.
Photo by Bob Strovink

Sound in concentrations high enough to be toxic to lobsters. This study analyzed the toxicity of commercially applied pesticides (i.e., active ingredients resmithrin, sumithrin, and methoprene) on stage I-II larval, and juvenile (1.5 to more than 2 year old) lobsters (which would have been prevalent around the time of the die-off), at concentrations realistically expected to be present in the water. The project also measured pesticide levels in receiving waters adjacent to areas sprayed.

Innovations in technique go far beyond measuring lobster sensitivity to pesticides

Results of the study show that Stages I-II larvae seem to be extremely sensitive to continuous exposure from resmithrin at low concentrations (0.26-0.95 µg per liter). Other pesticides used (malathion, methoprene) were much less toxic to lobster larvae. Juvenile (1.5 to more than 2 year old)

lobsters appeared to be less sensitive to resmethrin and malathion than larval lobsters, but more sensitive to elevated temperatures. The results of the environmental sampling indicated that the concentrations of the applied pesticides were at much lower levels than found to be acutely toxic to larval and juvenile lobsters in the laboratory tests except in some enclosed bays in the very western end of LIS.

In order to detect the levels of pesticides found in the environment at the levels that might be present, the project team needed to develop more highly sensitive methods of measurement. The methods developed in this study use liquid chromatography coupled to time of flight mass spectrometry (LC-TOF-MS) and are more sensitive and robust than available in other laboratories. Also, the use of alkali metal adducts to simultaneously ionize important classes of pesticides are a new and powerful innovation in pesticide residue analysis. This innovative method is simple and can be easily extended to a wide range of different instruments in current use. It also can be applied to the analysis of other polar contaminants. The key aspects of these methods are now being assessed by state-of-the art analytical laboratories such as those of the USGS. Hydroqual Inc. has used data from this project for its modeling work on pesticides in Long Island Sound.

Development of these methods has led to further funding from EPA and NIEHS, and has contributed to the building of a new environmental mass spectrometry facility at Marine Sciences Research Center that was turned into a University Service Center. That facility is bringing in approximately $70,000-$100,000 per year in support for running research level analyses of estrogens, pharmaceuticals, pesticides and other trace organic contaminants.

One of the first sets of analyses conducted by the facility was the determination of pharmaceuticals and estrogens in wastewaters treated by a reverse-osmosis pilot plant study conducted by Montgomery-Watson at the Sonoma County Wastewater Treatment Plant. Work was also conducted for Suffolk County Vector Control caging study.

This research provided an important piece to the lobster mortality puzzle being addressed by the lobster research initiative. This work showed that the pesticides used during spraying events at the time were unlikely to have caused the mortalities at the concentrations likely present in the environment.

Students

The one scholar for this project, Ann Zulkosky, is currently a Knauss Fellow with the Senate Committee on Commerce, Science & Transportation. She is scheduled to complete her PhD in the spring of 2010.

Publications

Focazio, P.C., and B.A. Branca. 2001. Lobster Mortalities and Shell Disease. *Coastlines* 30(2): 5&14.

Zulkosky, A.M., J.P. Ruggieri, S.A. Terracciano, B.J. Brownawell, and A.E. McElroy. 2005. Acute toxicity of resmethrin, malathion and methoprene to larval and juvenile American lobsters (*Homarus americanus*) and analysis of pesticide levels in surface waters after Scourge™, Anvil™ and Altosid™ application. *Journal of Shellfish Research* 24(3):795-804.