Recent Incidents of Toxicity in the Delta

Bruce Thompson

The potential for toxic effects of contamination on the aquatic resources of the delta is receiving renewed emphasis in the Interagency Program, which reflects the broadened scope of the program to consider all potential effects on the biota. Toxic effects of contaminants may be one of the most contentious of these factors, mainly because of the lack of adequate data. Further, many of the studies that have been conducted reside in the "gray" literature.

The purpose of this article is to report and document two recent incidents of apparent toxicity. Although each incident may seem inconsequential, considered together such incidents may eventually show a pattern or lead to questions that require more in-depth study.

Toxicity to Mysids at the Sacramento-San Joaquin Confluence

Since 1993, the San Francisco Estuary Regional Monitoring Program has been conducting laboratory bioassays using ambient estuary water at about a dozen stations in the lower estuary. Testing occurs on a regular basis at RMP stations (usually in February and August) along with collection of information on ambient water quality and contaminant concentrations.

Using standard protocols, two bioassays are conducted: *Mysidopsis bahia* is used in a 7-day survival and growth test, and larval mussels or oysters are used in a 48-hour development test. Toxicity is indicated if the endpoint (*eg*, survival or development) is significantly less than a laboratory control.

In 1993, no toxicity was observed at any of the stations sampled. In February 1994, mysid survival was significantly reduced in water samples from the Napa River and Red Rock (in Central Bay south of Richmond-San Rafael Bridge). In February 1995, mysid survival was significantly reduced in the water sample from the mouth of the San Joaquin River. Results of the 1994 Napa River and 1995 San Joaquin River samples appear to be related to elevated levels of pesticides in the water.

In 1996, samples collected from the confluence of the Sacramento and San Joaquin rivers, Grizzly Bay, and the Napa River on February 13 and 14 all caused significant mortality of the mysids. At the Sacramento River station, there was no survival in 6 of the 8 replicates tested (mean survival = 7.5%). At the San Joaquin River station, there was no survival in any of the replicates. At Grizzly Bay, mean survival was 60%, significantly reduced from control survival, and at Napa River, there was no survival in 7 of 8 replicates (mean survival = 2.5%).

The cause of the mysid mortalities is not known. Pacific EcoRisk Laboratories in Martinez, where the tests were conducted, attempted a toxicity identification evaluation, but the water sample holding times were exceeded. Concentrations of the pesticide diazinon ranged between 16 ng/L at the Sacramento River and 367 ng/L at Grizzly Bay, well below the acute LC50 for *Mysidopsis* of 4200 ng/L. Analyses for other contaminants in the ambient water samples are not yet complete. One possibility is that the mortalities were caused by the additive effects of several pesticides known to occur in the rivers in February.

The ecological consequences of these test results are also unknown. *Mysidopsis* is not a resident of the estuary, but other related genera are. In particular, *Neomysis*, an important food for many fish, exhibits comparable sensitivity to organophosphate pesticides. How episodic toxicity to important estuarine species may affect fish has not been well studied.

Unexplained Fish Mortality at the Tracy Fish Collection Facility

As a result of reading an article on organophosphate insecticides in *Regional Monitoring News*, Lloyd Hess (USBR) called SFEI to report a recurring phenomenon at the Tracy Fish Collection Facility. He subsequently sent a brief report, excerpted below:

> On April 9-10th, 1996, I noted a fish kill taking place in front of the Tracy Fish Collection Facility. On that date, I found three stressed white sturgeon (lengths of about 3.5 ft, 5 ft, 5.5 ft) on the trash rack. I took one of these fish off the rack that was still alive and put it in the quiet bay on the other side of the fish facility. After two hours it swam away. The smaller sturgeon was still alive when pulled from the water, but it was in poor condition. I did not try to save it. The largest sturgeon was found in the trash truck, 5 hours after the rack was cleaned. Its condition at the time of entry into the truck is not known. It appeared to be in good condition. It was frozen to use as a "show and tell fish", or to use for pesticide analysis.
>
> In addition, 25 dead striped bass were noted. They were from 5 to 30 lbs in size, again on the trash rack. All fish appeared to be in extremely good condition. I saved the largest fish for pesticide analysis (figuring that if metal analysis was a cause of the mortality, it would likely be highest in the largest, oldest fish). All smaller (pre-spawning) fish in the holding tanks were in good condition, and showed no signs of stress.
>
> The fish kill continued with fresh fish washing up on the rack Thursday and Friday. By Saturday, the numbers of dead fish decreased dramatically. No other sturgeon were observed, with the majority of fish being larger-sized pre-spawning striped bass. A few dead carp/goldfish were also noted.
>
> On Thursday, I contacted Fred Nibbling of the Denver staff. He was going to talk to Dr. Charles Liston, and maybe talk to some of his contacts on possible causes of this fish kill.
>
> In the past I have collected dead and dying striped bass at the TFCF during this time of the year. In fact, it is almost a yearly event and usually lasts about one week. Previously, I have taken these fish into the DFG toxicity unit and had a pesticide (contaminant) analysis and fish health (disease) analysis done. The dead fish were in extremely healthy condition, except for "high levels" of diazinon. However, the levels present were far below the toxic levels, and the DFG pesticides people believed this could not be the cause of death....

The high level of diazinon referred to was 3 μg/L in one striped bass liver. Other samples of striped bass, carp, and catfish did not have detectable pesticide residues in their livers or gills. Organophosphate pesticides are readily metabolized by fish and, consequently, are seldom measured in fish tissue. As a result, it is difficult to interpret the significance of the concentration detected in the striped bass liver. Diazinon is acutely toxic to fish exposed to concentrations of 0.02–10.8 μg/L in water.

The timing of the fish kills does *not* coincide with diazinon applications in orchards, but it does correspond with alfalfa spraying. Although diazinon is no longer used on alfalfa, the following insecticides frequently are: chlorpyrifos, carbofuran, permethrin, malathion, methidathion, phosmet, and methomyl (Chris Foe, personal communication). Although fish barriers along Old River are thought to cause increased exposure of fish to pesticides, these barriers were not yet in place at the time of the fish kill. These barriers are usually installed 2-3 weeks after the fish kills.

The striped bass mortality described above is consistent with "die-offs" observed annually for many years. Differences in histology, blood chemistry, and physiology between moribund and healthy stripers has been documented (Young *et al* 1994). Separately, elevated chlorinated organic contamination was measured in striped bass tissues (Pereira *et al* 1994). However, firm linkages between contamination and mortality in striped bass have not been made.

In 1997, the Regional Monitoring Program will begin monitoring fish contamination in the estuary as a follow-on to the San Francisco Bay Regional Water Quality Control Board's 1993 pilot study. Committees are developing work plans for this new component.

Acknowledgments

Thanks to Lloyd Hess (USBR) for bringing this to our attention. Jay Davis and Rainer Hoenicke of SFEI helped write this article. If you would like to receive Regional Monitoring Program reports or newsletters, please contact SFEI at 510/231-9539 or check out our web site at www.sfei.org.

References

Pereira, W., F. Hostettler, J. Cashman, R. Nishioka. 1994. Occurrence and distribution of organochlorine compounds in sediment and livers of striped bass (*Morone saxitalis*) from the San Francisco Bay-Delta estuary. *Mar. Poll. Bull. 28* (7):434-441.

Young, G., C. Brown, R. Nishioka, L. Folmar, M. Andrews, J. Cashman, H. Bern. 1994. Histopathology, blood chemistry, and physiological status of normal and moribund striped bass (*Morone saxitalis*) involved in summer mortality (die-off) in the Sacramento-San Joaquin Delta of California. *Jour. Fish Biol.* 44(3):491-512.

Moving On to Bluer Waters

After more than 34 years of collecting and overseeing the collection, analysis, and dissemination of water quality data, Harlan Proctor is hanging up his Van Dorn bottle. He will retire this December, and he and his wife will move permanently to their home in Carmet, a few miles north of Bodega Bay. After he finds the right boat, Harlan plans to move his personal field sampling program a little higher up the food web to collect such critters as chinook salmon, California halibut, and Dungeness crab.

Under Harlan's direction, and with the help of staff from Water Resources and Interagency Program paricipants and stakeholders, the compliance water quality program has constantly evolved. Today, we have multiagency crews sampling algae, zooplankton, and water quality at the many Delta/Suisun Bay sites. Sampling on the boat has become more automated and data handling streamlined. Multiparameter fixed stations collect several water quality parameters every few minutes, and the information is transmitted to a central location via radio — a far cry from the days of the water bottle and Winkler field kit.

We join Harlan's staff, coworkers and friends in wishing him a long and enjoyable retirement. We will miss his ever-present smile, integrity, and knowledge of the bay and delta.