Aftermath of an Oil Spill: A Black Seven Years

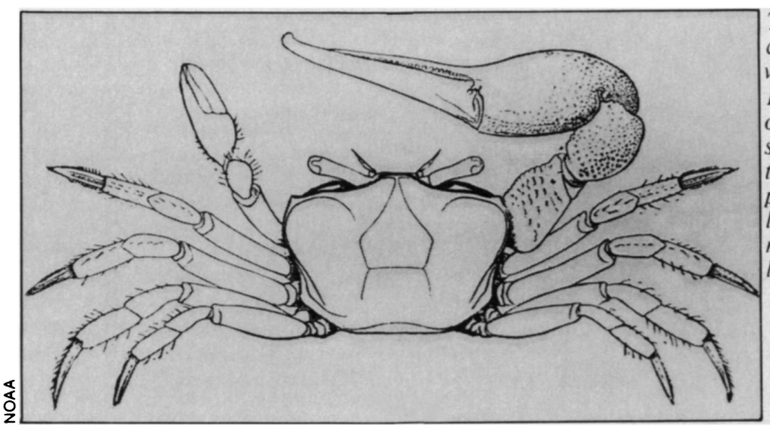
Oil spills—at their horrendous worst, they can clog large patches of ocean, coat miles of beaches and choke-off marine life with a stunning quickness that belies the slow, viscous nature of the oil itself. The devastating effects of oil on marine and estuarine organisms have been documented by numerous laboratory and field studies. However, much remains to be learned about the long-term effects of oil spills on marine life and about how long it takes for various organisms to recover and resume normal life patterns at pre-spill population levels.

But now come the results of a seven-year study of the Wild Harbor Marsh in West Falmouth, Mass., contaminated in 1969 by a spill of No. 2 oil in Buzzards Bay. Even though the spill was "relatively small," researchers report it did extensive and long-lasting damage—both physiologically and behaviorally—to the salt marsh's population of fiddler crabs (*Uca pugnax*). In an extensive long-term study of the effects of the oil spill, the researchers paint a picture of widespread death and disorientation among the *Uca* that still had not completely ended by 1976. Among the findings, they report that the spill:

- Reduced the density of fiddler crabs to the point where "recovery . . . is still incomplete after seven years."
- Triggered behavioral disorders, such as locomotor impairment and abnormal burrow construction.
- Depleted the juvenile settlement.
- Reduced the ratio of female to male crabs.
- Contributed to heavy winter mortality.
- Infiltrated the crabs' body tissues and remained there for at least four years.
- Substantially contaminated areas of sediment, some of which stayed extensively oil mixed through 1976, when the last measurements were taken.

Observations made immediately after the spill—which deposited up to 6,000 parts of oil per million parts (ppm) of wet mud in the area—showed numerous dead and moribund *Uca* throughout the heavily oiled marsh regions. Many surviving crabs had burrowed into the sandier sediments above the mean high-tide mark. Several field stations, including two control stations in low contamination areas, were established in 1972 by the researchers, Charles T. Krebs of St. Mary's College in Maryland and Kathryn A. Burns of the Marine Chemistry Unit in Melbourne, Australia. From that point through 1976, the scientists periodically estimated crab densities by measuring the numbers and diameters of open crab burrows. Juveniles, who often do not make their own burrows, were sampled separately by collection. Behavioral and physical examinations were performed during that period both in the field and laboratory.

Except for pockets where concentrations of petroleum hydrocarbons were below 100 ppm in the sediment, the *Uca* had still not fully recovered some seven years after the spill, the researchers report in the July 29 SCIENCE. The results also confirm that the greatest population reduction occurred in areas with the highest oil concentrations, and concentrations in 1976 remained as high as 1,283 ppm at one station and around 600 ppm at two others.



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The fiddler crab, primary victim of a 1969 oil spill off Cape Cod, still struggles to recoup population losses and regain normal lifestyle.

Behaviorally, the aberrations that struck the crabs immediately after the spill persisted throughout the years, and the repercussions were still being felt seven years later. Many adults increased molting and display of mating colors, although the time of year was inappropriate for such responses, report the researchers. Also, "the usually rapid escape response was very slow, and many crabs made no attempt to escape when frightened," they say. "Survivors were lethargic and displayed loss of equilibrium." Such locomotor impairment persisted for "at least four years." Laboratory experiments corroborated field observations—the escape times from a threatening situation more than doubled after test crabs ingested sediments mixed with 100 ppm of No. 2 oil.

Perhaps the most damaging change in behavior came in the burrowing behavior of crabs in moderately and heavily oiled areas. Not only did the abnormally shaped burrows seldom exceed 10 centimeters in depth, some actually became horizontal and even curved upward toward the surface. Normal burrows—as observed in control areas—are larger, steeply inclined to the vertical and as deep as 50 centimeters.

Such a mistake is disastrous because the burrow is essential to crab survival, especially as an underground escape from winter temperatures. The researchers attribute much of the high midwinter mortality rate to such poorly constructed, shallow burrows. Juveniles, which molt every 5 to 14 days, were much more sensitive and vulnerable to the toxic effects of the oil, as well as the cold winter temperatures, they note. In addition, the "greatly reduced percentage of females"—up to 23 percent fewer than in control areas—was attributed to a possible "differential immigration or differential mortality (or both) between males and females . . . as a result of the oil contamination."

Reduction of the fiddler crab populations by oil pollution is "ecologically significant," the scientists say, "since *Uca* are important in the energy flow both within salt marshes and between marshes and coastal waters." Female *Uca* normally release large numbers of larvae into coastal waters. And a greatly diminished female population would have substantial ecological implications.

Analyses of crab tissues showed that *Uca* had incorporated up to 280 ppm of hydrocarbons into their bodies at least through 1973, when the last tissue samples were taken. Previous studies have shown that ingestion of oil emulsions can lead to immobilization and death, depending on the concentration levels of the oil. "The long-term behavioral disorders displayed by crabs in the field year after year [in this study] may be the result of the accumulation of hydrocarbons in the central nervous system, resulting in interference with locomotor coordination," the researchers suggest.

"Although oil spilled in certain environments may have rather short-term effects on benthic organisms," they conclude, "oil stranded in marshlands contaminates the sediments and becomes incorporated in the tissues of marine organisms, affecting the survival and recovery of marine populations for many years." □