Dye Helps Predict Potential Dispersal of Non-native Oyster Larvae

Swimmers and boaters may have seen what appeared to be a "red tide" in several areas of Chesapeake Bay this summer and fall. But instead of a potential menace to the waterway, the red patches were part of a study designed to further enhance biosecurity of non-native oyster trials.

"Each of the red patches resulted from the release of about 30 gallons of rhodamine dye into the water," says project leader Dr. Roger Mann.

Mann, Dr. Kenneth Moore, and other VIMS researchers tracked the dye patches to help predict where tidal currents would carry larval oysters in the unlikely event that any of the non-native oysters now deployed in seafood industry trials successfully reproduce.

Karen Hudson and Missy Southworth transfer rhodamine dye onto a VIMS research vessel in preparation for a dye release experiment on the York River. The dye will help show how tidal currents might disperse oyster larvae.

The first release took place in July near Crossroads Aquafarms & Chessie Seafood and Aquafarms on the York River at Yorktown. Additional dye studies took place at three other sites selected to provide a broad range of tidal conditions and salinity: Seafarms Inc., at Milford Haven in Mathews County in September, Shores & Ruark Seafood Inc., on the Rappahannock River near Urbanna in October, and near Kinsale on the Yeocomico River in mid-November.

The dye study is one requirement of a July decision by the Army Corps of Engineers to extend the Virginia Seafood Council's on-going trial of the non-native oyster *Crassostrea ariakensis*. NOAA, EPA, and the US Fish and Wildlife Service also contributed to the decision.

The Virginia Seafood Council (VSC) trials began in September 2003 when commercial growers deployed 100,000 sterile oysters at each of 8 sites in the Virginia waters of Chesapeake Bay. The Virginia Marine Resources Commission granted a state permit for the trial through May 2005. The Army Corps of Engineers granted a federal permit through June 2004. Both dates were based on a planned starting date of August 2003. But a two-month delay in the initial deployment of the oysters led the growers to request an extension of the federal permit until April 2005 so that their animals can grow to market size.

The main concern with the VSC request was that the extension would allow the non-native oysters to remain in the water during their summer spawning season. The deployed oysters are the offspring of adult oysters that were genetically manipulated to produce progeny with three sets of chromosomes, rather than the pair of chromosomes carried by normal "diploid" oysters. These "triploid" offspring are effectively sterile. However, this process is not foolproof, and the original VSC permit allowed a maximum of 1 diploid oyster per 1,000 non-native oysters deployed.

The federal agreement to extend the VSC permit contained two key provisions to minimize the risk that any of the deployed diploid oysters might successfully spawn and produce larvae that could establish a feral population.

First, the extension permit required that the growers further thin out their oysters, either by distributing them amongst a larger number of containment bags, or selling those of market size. The growers also had to move the structures that contain the bags farther apart. Oysters are "broadcast spawners" that release eggs and sperm freely into the water. Increasing the distance

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Researchers Release Juvenile Blue Crabs

Hatchery-reared animals may help restore the Chesapeake's ailing crab fishery

VIMS researchers continue to release hatchery-reared blue crabs into the York River in a collaborative effort to determine whether such efforts could be used to enhance Chesapeake Bay's historically low blue crab stocks.

The population of female blue crabs in Chesapeake Bay has declined more than 80% during the last ten years.

The VIMS research team, led by Drs. Rom Lipcius and Rochelle Seitz and Mr. Jacques van Montfrans, released 11,540 juvenile crabs into shallow York River coves in June. Maryland scientists released a similar number of juvenile crabs into the Rhode River, which empties into Chesapeake Bay near Annapolis. Together, the 23,000 crabs represent the largest single experimental release of juvenile blue crabs ever attempted to test the feasibility of stock enhancement for the species.

The release program is a collaborative effort between VIMS, the University of Maryland's Center of Marine Biotechnology (COMB) in Baltimore, and the Smithsonian Environmental Research Center (SERC) in Edgewater, Maryland. It complements efforts to reduce the harvest of adult crabs through the establishment of blue crab sanctuaries.

The ongoing trials are designed to determine the optimal time and place for releasing juvenile crabs. Because the ultimate success of the trials depends on factors such as crab size, food availability, predation, cannibalism, water temperature, and salinity, the researchers spent the summer months studying crab survival in relation to these parameters. They also studied whether hatchery crabs would survive as well as those collected from the wild.

The VIMS team released another 4,017 hatchery-reared crabs into York River coves in October and November. The fall release was designed to test whether high rates of predation and cannibalism observed during the summer might decrease in autumn as adult crabs and finfish such as Atlantic croaker leave the coves to migrate downstream.

Analysis of the recent experimental data indicates that fall releases are indeed more successful. "During the summer, tethered crabs survived only about a day on average," says Seitz. "Many of the crabs we released in November are surviving for as long as 10 days." In addition, hatchery crabs are surviving at rates equal to those of wild crabs of the same size.

Early results also suggest that crabs of the size used in the release studies (15-20 mm across the carapace) can and do survive in significant numbers when set loose in unvegetated sand and mud flats.

Kristie Erickson inserts a microwire tag into a juvenile blue crab during the summertime translocation experiments.

"That's somewhat unexpected given the traditional view of seagrass beds as the main crab nursery grounds," says Seitz. Data from ongoing studies suggest that grass beds are important for the youngest crabs, but that the slightly older and larger juvenile crabs used in the release studies may prefer the open flats because of their large populations of burrowing clams—animals the young crabs like to eat.

"Our recent field experiments also suggest that releasing slightly larger juvenile crabs of 20-25 mm carapace width produces higher survivorship," says Lipcius.

The hatchery crabs were reared at COMB by Drs. Yoni Zohar and Odi Smora, who have spent the last several years overcoming previous obstacles to raising blue crabs in captivity, including cannibalism. Drs. Anson Hines and Eric Johnson of SERC have directed the Maryland enhancement efforts and provided support for the VIMS component.

Before each release, Lipcius, Seitz, and their staff collect the crabs from SERC, where resident and VIMS scientists have already completed the laborious task of tagging each of the

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between spawning oysters decreases the already low risk that water currents will bring an egg and sperm cell together for fertilization.

The second provision required the completion of the dye study, to better understand where tidal currents are likely to carry any larvae that might result from successful reproduction between two diploid non-native oysters. If tidal currents scatter the larvae so that they settle over a broad area, they will be too far apart to reproduce as adults.

VIMS Assistant Professor Jian Shen is feeding the field data from the dye releases into a high-resolution computer model of lower Chesapeake Bay. Model output helped the researchers track and sample each dye patches in the week following its release (after which it became too dilute to measure). In turn, their field data helps the model predict the movement of the patch, and can be used to calibrate the model so that it can more accurately predict larval dispersal at other sites and under different conditions.

Researchers have used rhodamine dye in hundreds of studies since the 1960s to trace water movement through lakes, rivers, and estuaries. They use it because it dissolves readily in water, is harmless in low concentrations, and is strongly fluorescent and thus easy to detect. Mann and Moore traced the dye patch using a boat-mounted "Dataflow" sensor that can measure dye concentrations continuously while the vessel travels at speeds up to 20 knots.

"Our overall objective is to demonstrate and quantify dispersal of a larval surrogate—fluorescent dye—at four of the trial sites to provide quantitative input to the risk analysis," says Mann. "Release of fluorescent dye provides a tractable method to simulate passive dispersal of larval forms on a site-specific basis in real time. Site-specific data are required to provide critical values for risk assessment in the ongoing permit process."

Funding for the study comes from EPA and NOAA through the Chesapeake Bay Program, and from the Virginia Marine Resources Commission.

To see a video of the dye release, visit www.vims.edu/newsmedia/iv_bank/index.html