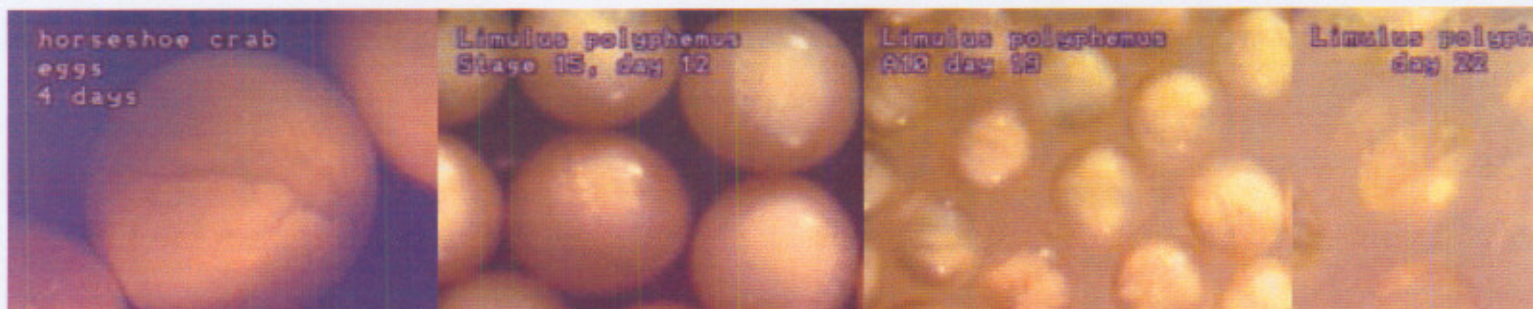


Protecting Horseshoe Crab and Health

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Early research shows that mosquito insecticides may not affect developing horseshoe crab eggs and larvae, which lay prey for weeks as they mature.

The Delaware Bay is rich in natural resources, including a wide diversity of flora and fauna. From a strictly human perspective, these organisms exist along a continuum of sorts, ranging from positive benefits to negative outcomes.

For example, some species are commercially valuable (e.g., oysters, blue crabs and shad); others perform important ecological services (e.g., fiddler crabs build burrows that oxygenate sediments, increasing marsh productivity); some, like the many egrets, heron and other fowl, have aesthetic value; some are nuisances (e.g., barnacles and algae that foul boat hulls); and some pose threats to human health (e.g., *Vibrio* bacteria that can cause a variety of illnesses).

The location of a species along this scale helps to define management objectives in working to minimize negative impacts or maximize positive benefits. Sometimes managing one species can affect another, so it is important to understand these relationships.

Benefit and Bane

Two species that fall along opposite sides of this continuum are horseshoe crabs and mosquitoes. Horseshoe crabs are commercially important to the medical industry, and they constitute an important bait fishery. In addition, they support a variety of other species by providing a rich source of protein and nutrients in the form of eggs produced when they mate each spring along the shores of the Delaware Bay.

Mosquitoes, on the other

hand, are a nuisance during the warmer months of the year and can spread a variety of human diseases, the most recent concern being West Nile virus. As a result, managers try to maximize horseshoe crab populations to enhance the benefits they provide, while, at the same time, minimizing or eliminating populations of mosquitoes to reduce risks to human health. Mosquito management involves spraying a pesticide in stagnant marsh waters behind beaches where horseshoe crabs spawn. This begs the question: Do mosquito pesticides affect the development of newly laid horseshoe crab eggs? This is the question I am working to answer along with Brian Marsh of the U.S. Fish and Wildlife Service and Pete VanVeld of the Virginia Institute of Marine Science.

Signature Species of the Delaware Bay

The Atlantic horseshoe crab *Limulus polyphemus* has been called the "signature species" of the Delaware Bay. This water body represents the center of the crab's population, and Delaware Bay beaches comprise the largest horseshoe crab spawning grounds in the world. For centuries, thousands of horseshoe crabs have migrated to spawn on these shores each spring between April and June. Their blue-green eggs, the size of small ball bearings, are a rich source of food for the wide diversity of fauna that follow the spawning crabs to gorge on the bountiful supply of eggs they leave behind.

The size of the crab population is poorly understood and estimates are based on incom-

Human

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plete and disjunct data (Atlantic States Marine Fisheries Commission, 1998). Regardless, most estimates clearly document a declining population throughout Delaware Bay, including beaches at Cape May, and at Prime Hook and Bombay Hook National Wildlife Refuges.

Stranded crab surveys performed between 1985 and 1995, by researchers Mark Botton of Fordham College and Robert Loveland of Rutgers, have indicated that natural strandings have decreased by 90 percent on beaches in New Jersey. Mark Botton's egg surveys also indicate a 90 percent decline in the number of eggs deposited on New Jersey beaches between 1990 and 1997.

A Critical Species In Decline

The Atlantic States Marine Fisheries Commission reports that trawling data in and outside of Delaware Bay suggest a decline in crabs. Spawning surveys have been conducted on the Delaware and New Jersey sides of the Delaware Bay since 1990. While the methodology used for these surveys has varied and statistical validity was not established until 1999 (Smith et al., 2002), the data does suggest a declining adult population of almost 90 percent.

Horseshoe crab spawning coincides with the initiation of seasonal spraying of pesticides to control mosquitoes. Waterways lined with marshes and other wetlands are ideal breeding grounds for mosquitoes, and the Delaware Bay

and its tributaries are no exception. Spend a warm summer evening enjoying the beauty of a Delaware Bay marsh and you will soon see why. It will not take long before you begin to swat mosquitoes, reach for a long-sleeved shirt and spray yourself with bug repellent from head to toe.

In addition to being a nuisance, mosquito bites can also spread deadly diseases like West Nile virus. As a result, marshes around the bay are routinely sprayed with pesticides to kill mosquitoes that may danger human health. Unfortunately, like any other pesticide, it is virtually impossible to find one that targets and harms only a single species or type of organism. So could there be a link between mosquito spraying, horseshoe crab spawning and population decline?

Impact of Mosquito Control

The presence of all life stages of *Limulus polyphemus* in intertidal and nearshore areas makes them vulnerable to the contaminants associated with those areas (Weis and Ma, 1987). The role of contaminant exposure in the decline of this species is one of the least studied factors in their mortality, but potentially one of the greatest contributors. One contaminant of concern is the mosquito larvicide known as methoprene. Methoprene prevents mosquito larvae from

molting by disrupting the hormones that control this complex biological process.

Mosquitoes and horseshoe crabs are both arthropods, so both go through several molts. To determine if methoprene affects the development and survival of horseshoe crabs, we exposed developing and newly hatched larvae to environmentally relevant levels of methoprene. After following development and survival through the first larval molt, we were unable to detect any macroscopic effects. That is, all eggs and larvae appeared to develop normally, even at levels well above those applied to control mosquitoes along the Delaware Bay. We are continuing to look for sub-lethal effects on biochemical activities within developing embryos, but none have been detected to date.

The bad news is that we still lack a good understanding of the causes related to the declining number of horseshoe crabs in the Delaware Bay Fishery restrictions are increasing, along with restrictions on coastal development and the use of spawning beaches during breeding periods, but additional research into the effects of contaminants and habitat degradation in general is needed.

For more information on this and other research pertinent to species in the Delaware Estuary, please visit www.HSRL.Rutgers.edu. ■

