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A Comprehensive Oyster Disease Survey in California

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Background

Although California produces some oyster seed for local growers, its shellfish farms rely heavily on seed from the state of Washington. This has been a good business arrangement for both growers and hatcheries, but their future was threatened in 2002 when two wild Pacific oysters from Washington's Dungeness Bay were found to be infected with the pathogen *Mikrocytos mackini*, the causative agent of Denman Island disease. The disease poses no human health risk, but in oysters it can cause unsightly green or yellow pustules, rendering the animals commercially worthless.

Since literally millions of seed from Washington have been brought into California in the past decade, the discovery of the disease immediately raised concerns about its status in California and whether the continued importation of Washington seed was a wise idea. California oyster growers produced about $6.7-million worth of product in 2003. Diseases are one of the main threats to the industry's viability; and by law, any occurrence of certain pathogens must be reported.

The European Union was also worried about introducing disease and proposed banning the importation of all U.S. oyster seed until more was learned about its distribution and virulence. Although the ban was eventually canceled, it did have some historical rationale. The oyster disease known as Bonamia, for example, was introduced to France via infected seed from the U.S. and spread quickly throughout Europe. The U.S. has also been the recipient of pests introduced via seed, the Japanese oyster drill being a prime example. California today gets all its oyster seed from approved facilities in Washington, Oregon and Hawaii.

Pacific oysters (*Crassostrea gigas*) in hanging bags in Drake's Estero, Point Reyes. Spat are settled onto cultch (old oyster shells that provide a substrate) and the cultch is placed in bags. These oysters are typically shucked and sold in pint jars.

Project

California Sea Grant funded James Moore, a shellfish pathologist who holds a joint position at UC Davis and the California Department of Fish and Game, to conduct a comprehensive survey of oyster disease in California. The goals of the project were two-fold: one, to search for evidence of the presence of *M. mackini* and two, to establish a baseline of disease status in California oysters. To do this, he and colleagues collected more than 2,150 oysters from farms and wild beds in Santa Barbara, Morro Bay, Elkhorn Slough, Drake's Estero, and San Francisco, Tomales and Humboldt Bays.

Four different species of oysters were represented in the survey: Pacific (*Crassostrea gigas*), Kumamoto (*C. sikamea*), Atlantic (*C. virginica*) as well as the native oyster (*Ostreola conchaphila*). The first three of these species are cultured for commercial sale, the most lucrative product being single oysters for the half-shell market. The native oyster is too small and too fragile for culture, but was nonetheless sampled to assess its health status.

The first phase of this research project was to visually examine specimens for evidence of pustules indicative of advanced infection. None of the oysters were observed to have any outward signs of disease.

These *C. gigas* oysters are at least 7 years old. Older oysters are examined because they have been exposed to more disease. Photos this story courtesy James Moore

Because oysters may harbor pathogens without showing symptoms, the second step was to micro-

Native oysters (*Ostreola conchaphila)* growing on a cement pipe in Elkhorn Slough.

Shellfish pathologist, James Moore.

scopically look at hematoxylin and eosin-stained, 5-micron-thick tissue samples (taken from the heart, kidney, adductor muscle, digestive gland, stomach, intestine, mantle and gills) for bacteria, viruses and protozoa. Oysters often contain a small number of nonworrisome symbionts. However, none of the several hundreds of tissue slides examined so far showed signs of any pathogen of concern.

Despite the clean bill of health, Moore anticipates finding areas where disease is an issue. "Past studies have shown the occurrence of certain pathogens in certain locations," he said. *Haplosporidium nelsoni*, the causative agent of Delaware Bay disease, for example, has been found in Drake's Estero at Point Reyes in the past. "I am pretty sure there are certain pathogens we will find," he said. "I have not yet examined slides from every location."

Because histology is somewhat limited in the detail it can provide, Moore and colleagues created an archive of samples of labial palp tissue, preserved in ethanol. (Labial palps are structures that help deliver food to an oyster's mouth.) These samples, which are being kept at Bodega Marine Laboratory, will make it possible for researchers to further characterize pathogens observed microscopically.

"If in the future, we find something by histology that looks like a potential disease agent, we can go back to the archives and probe them with various diagnostic technologies to determine whether specific pathogens are present," Moore said.

The slides and the archive create a "snapshot" of what diseases are absent or present. "When there is an outbreak in the future, we can look back at the samples and say 'no, that was not there before' or 'yes, this was already there,'" Moore said. "This is critical for future investigations in which scientists are trying to understand the epidemiology of a disease, in other words how the disease was introduced and spread.

Implications

California's native oyster has historically played an important role in maintaining the ecology of coastal waterways. As part of a larger effort to restore coastal habitats, there is an intense interest in rebuilding native oyster populations in places such as San Francisco Bay. This research has helped to assess the status of disease in areas now being considered for restoration.

Understanding the status of oyster disease in California is fundamental to establishing appropriate science-based trade policies regarding the importation and exportation of oyster and oyster seed. In this way, this research furthers state and federal efforts to protect U.S. shellfish industries and marine ecosystems.

Collaborations

California Department of Fish and Game
NOAA's Elkhorn Slough National Estuarine Research Reserve

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