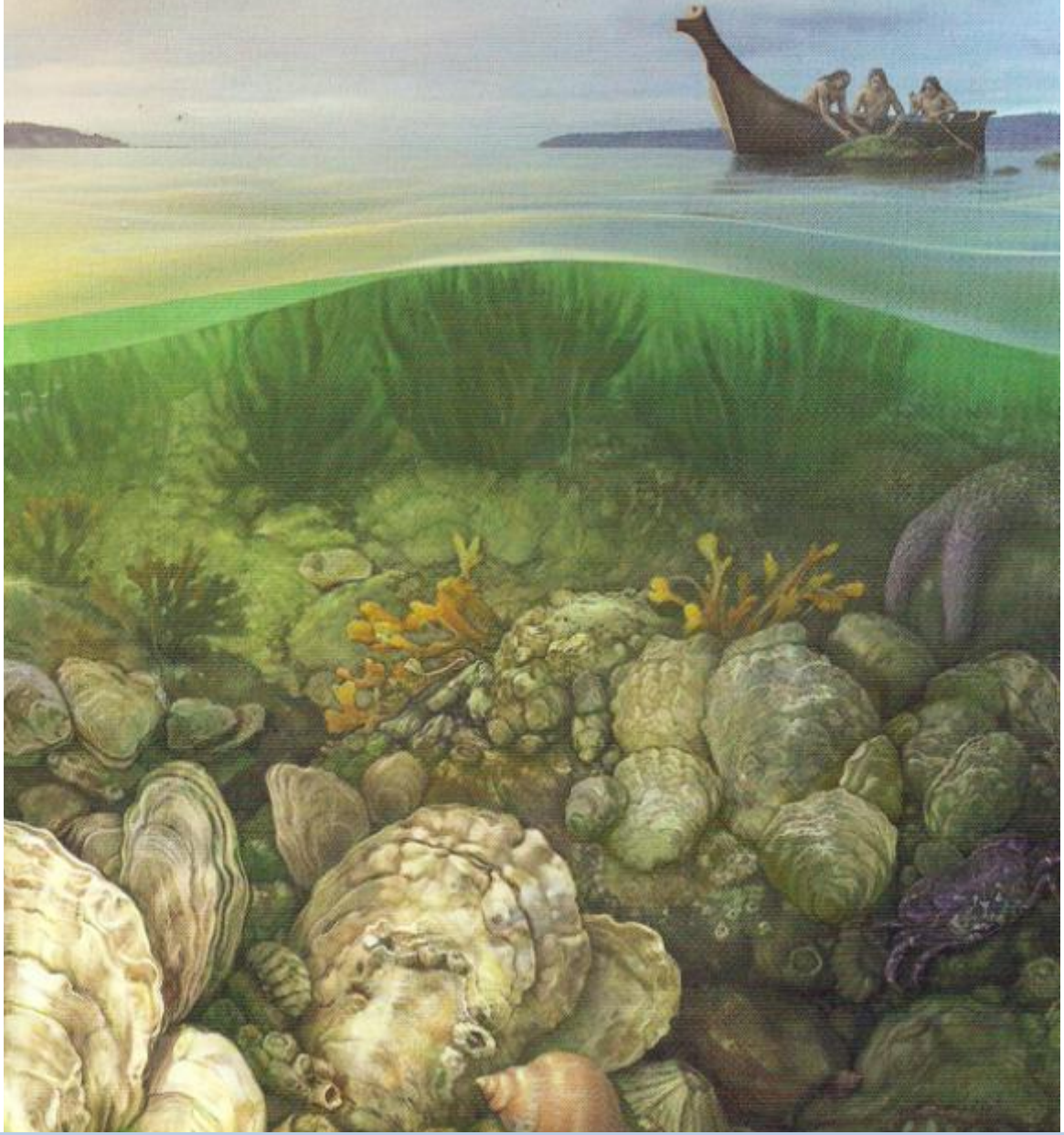
NATIVE OYSTER RESTORATION AT ELKHORN SLOUGH, CALIFORNIA

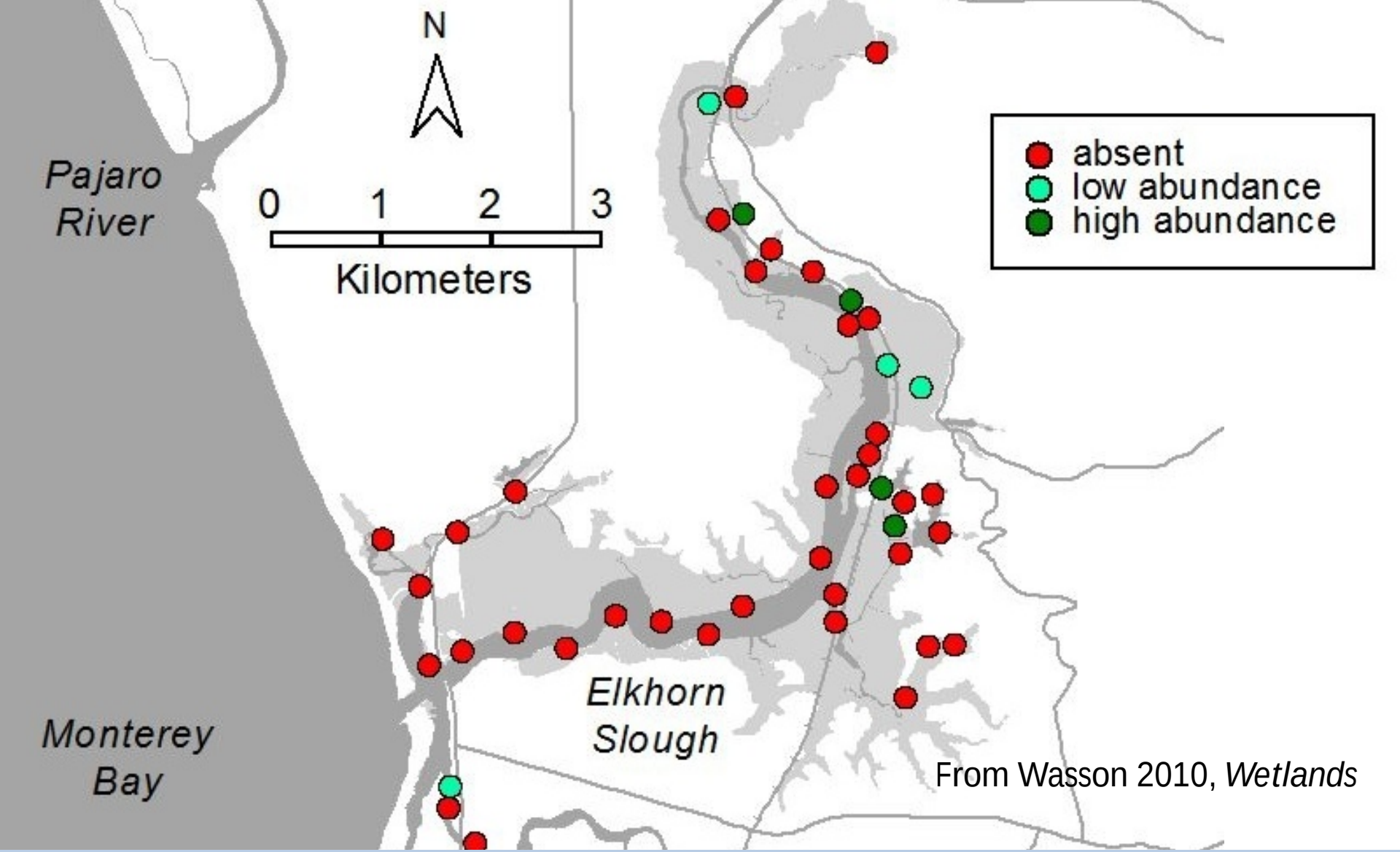
Photo by Erin Garcia



Painting by Cory and Catska Ench, 2003
From Journal of Shellfish Research
March 2009

Olympia oysters are an ancient part of healthy estuarine ecosystems on the Pacific coast

Oysters increase estuarine biodiversity
and improve water quality through filtering



At Elkhorn Slough, abundant oysters (sites with green dots) only occur in the upper estuary. We estimate only about 5000 oysters remain in the estuary.

Oysters at Elkhorn Slough face many threats, including burial in sediment and poor water quality from artificial tidal restriction. Restoring healthier estuarine conditions will help oysters, including efforts to...

decrease sedimentation

increase tidal exchange

decrease fertilizer run-off

One factor limiting oysters is lack of hard substrates large enough to avoid burial in mud

In muddy places, oysters are mostly found on artificial hard substrates

In 2009, the Elkhorn Slough Reserve began collecting clam shells in th lower estuary to use as natural substrates for oysters in the upper estuary

Large gaper clam shells (left over from sea otter foraging) make great habitat for native oysters

In 2012-2013, the Elkhorn Slough Reserve had a grant from CDFW's Environmental Enhancement Fund to to conduct oyster restoration with clam shell necklaces

164 clam shell necklaces were deployed, along with some concrete reef balls and wooden stakes

Oyster larvae are released from adults, spend some time feeding and swimming, and then settle permanently on hard substrates….including clam shell necklaces

oyster larvae being brooded

oyster larvae swimming in the water

Photos: Jim Moore

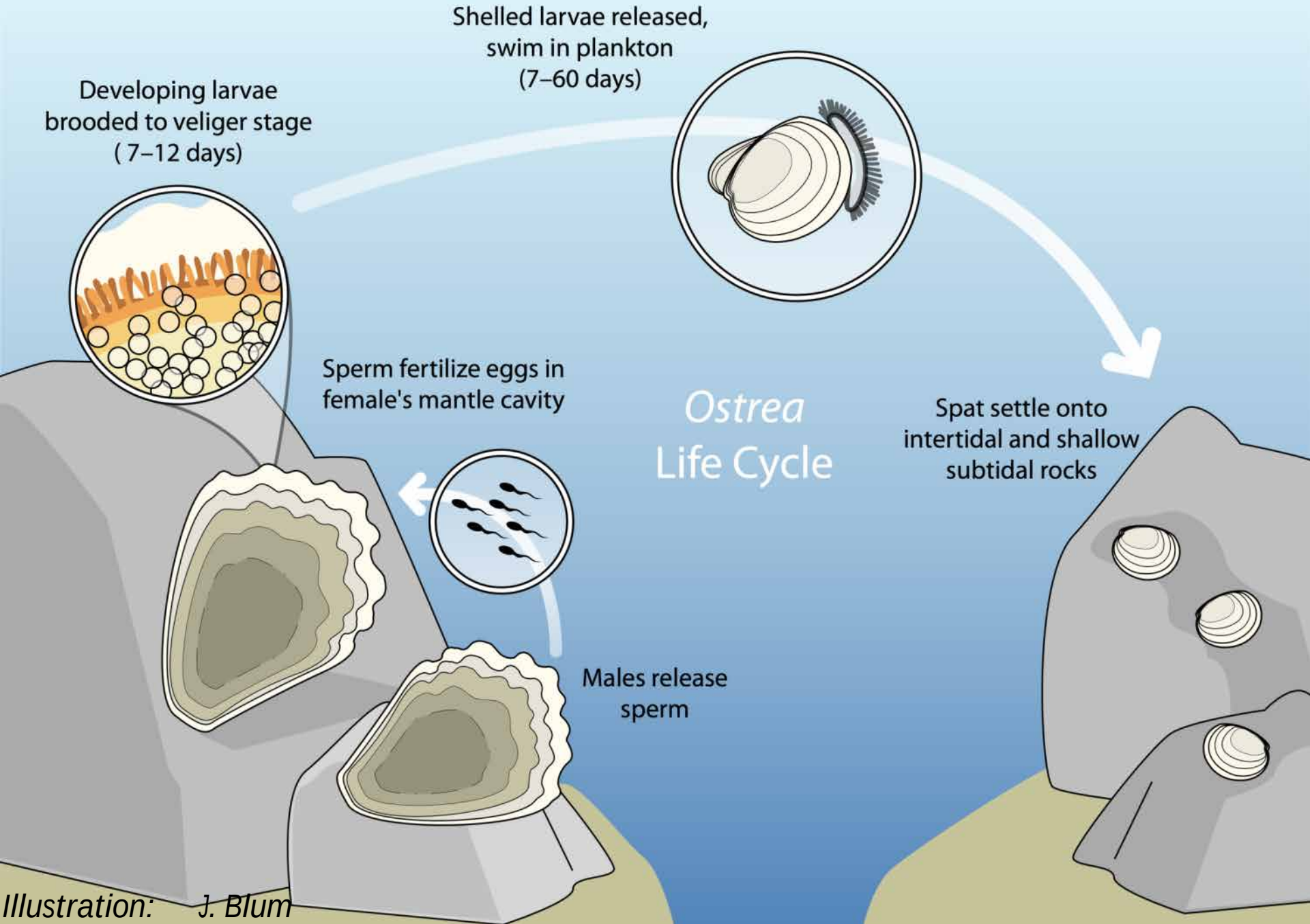


Illustration: J. Blum

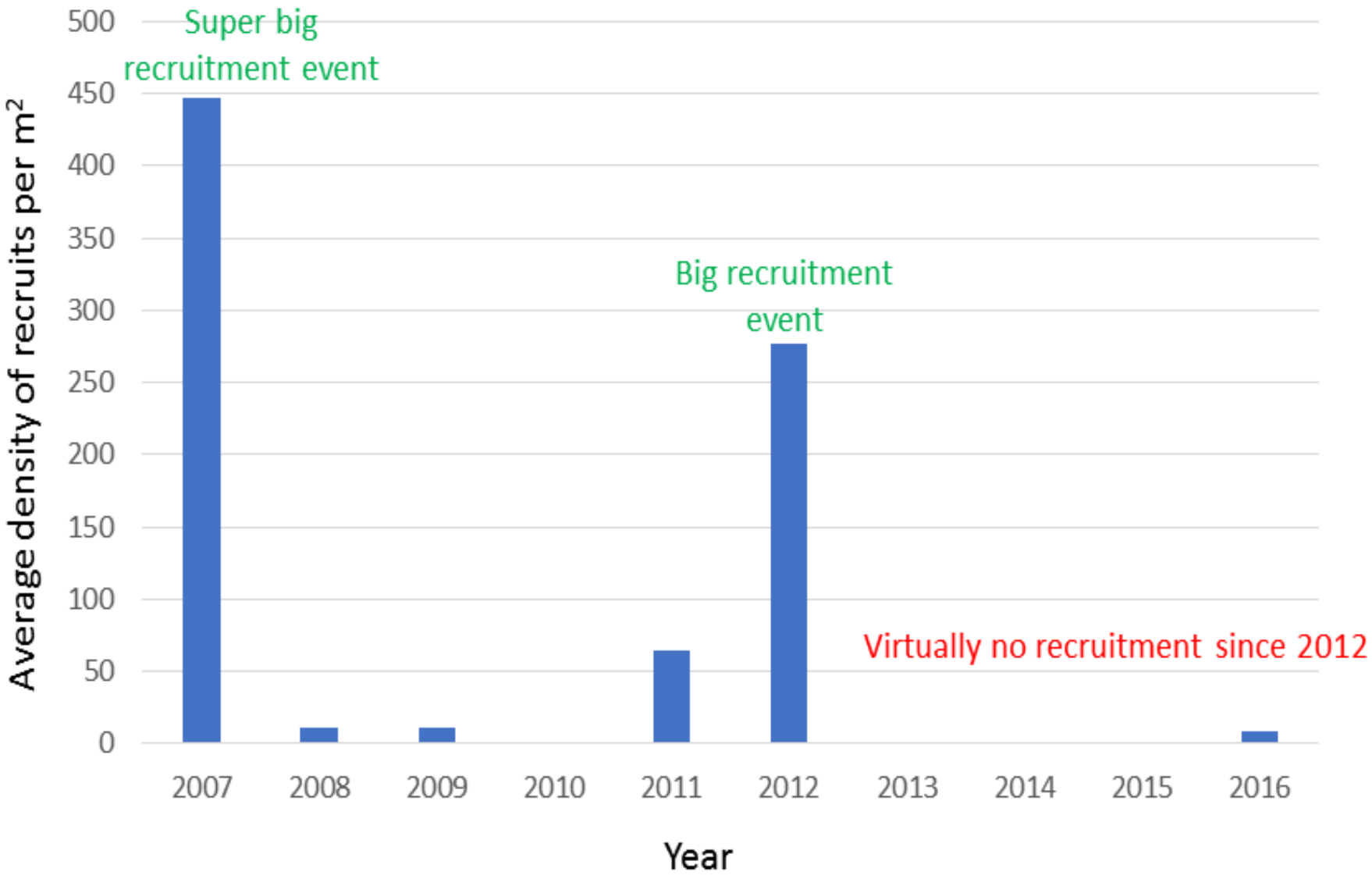
In 2012, about 3500 oysters settled on the clam shell necklaces

The team studied restoration success and published a paper about the findings (Zabin, Wasson & Fork 2016, *Biological Conservation*)

Monitoring of oyster recruitment on tiles has shown that reproduction in Elkhorn Slough is rare

In 2007 and 2012, lots of baby oysters settled on tiles.
In all other years, virtually no baby oysters showed up.

Recruitment failure since 2012: no baby oysters

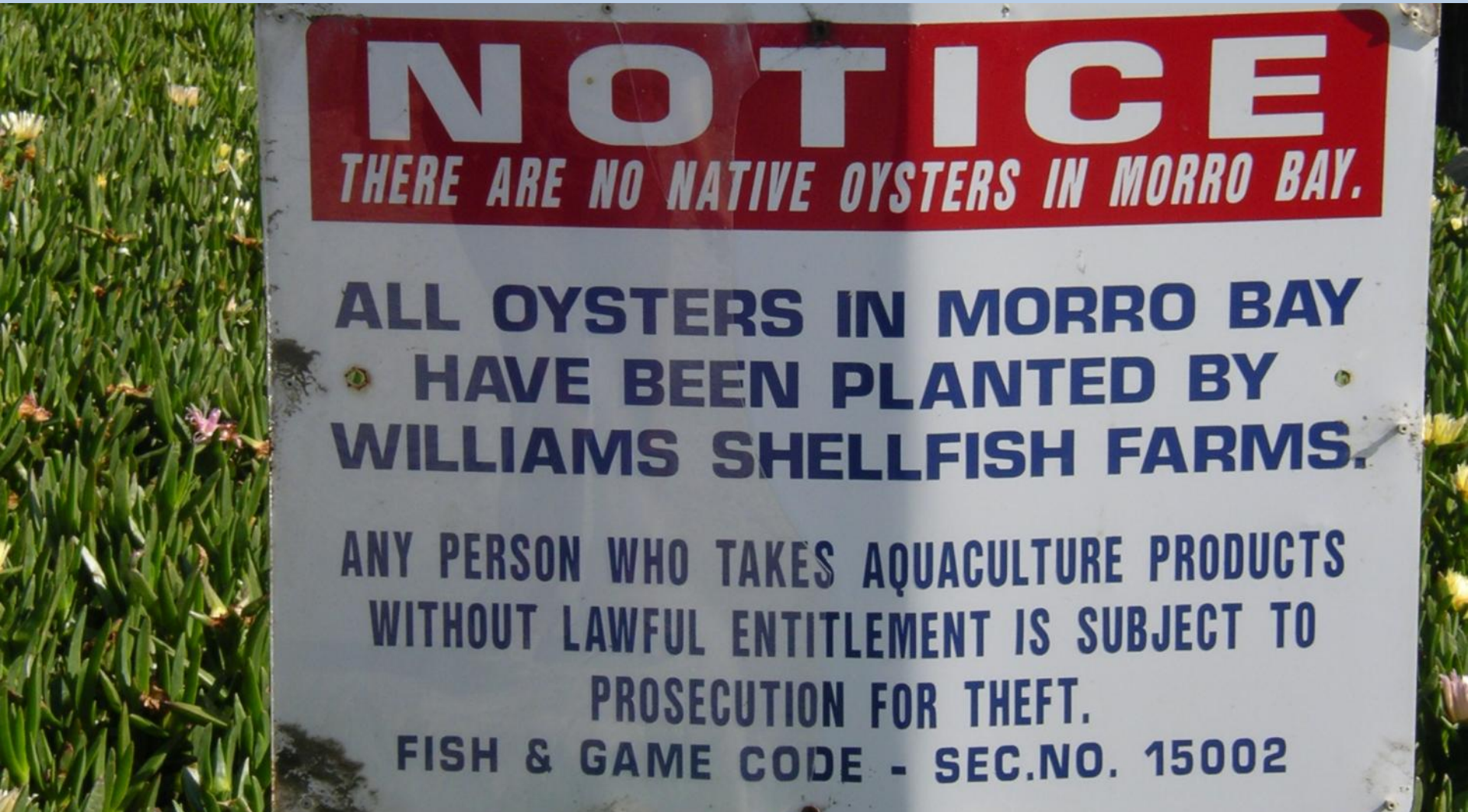


A collaborative investigation examining recruitment at sites all along Coast found small population size and cold summers to be correlated with reproductive failure

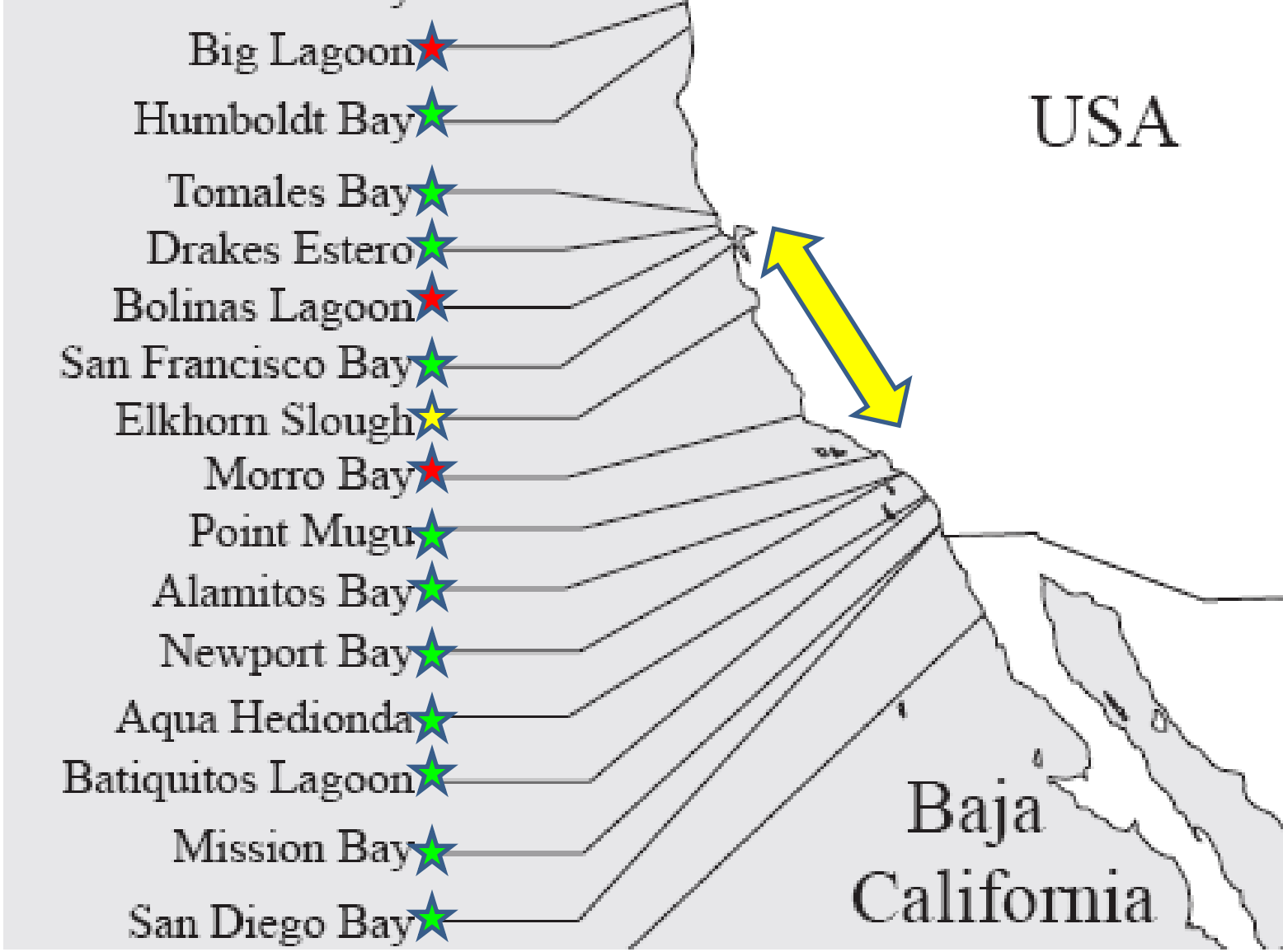
Wasson et al. 2016, *Ecology*

Restoration efforts continued, using clam shell stakes (more robust than necklaces)….
but no baby oysters settled on them

Morro Bay's native oysters went extinct. With 6+ years of failed reproduction, Elkhorn Slough's oysters are at risk of also disappearing entirely from the estuary where they have existed for 10,00 years



Sites with and without Olympia oysters
(Data from Polson et al. 2009)



If Elkhorn Slough populations of Olympia oysters go locally extinct, connectivity between northern and southern California populations will be lost

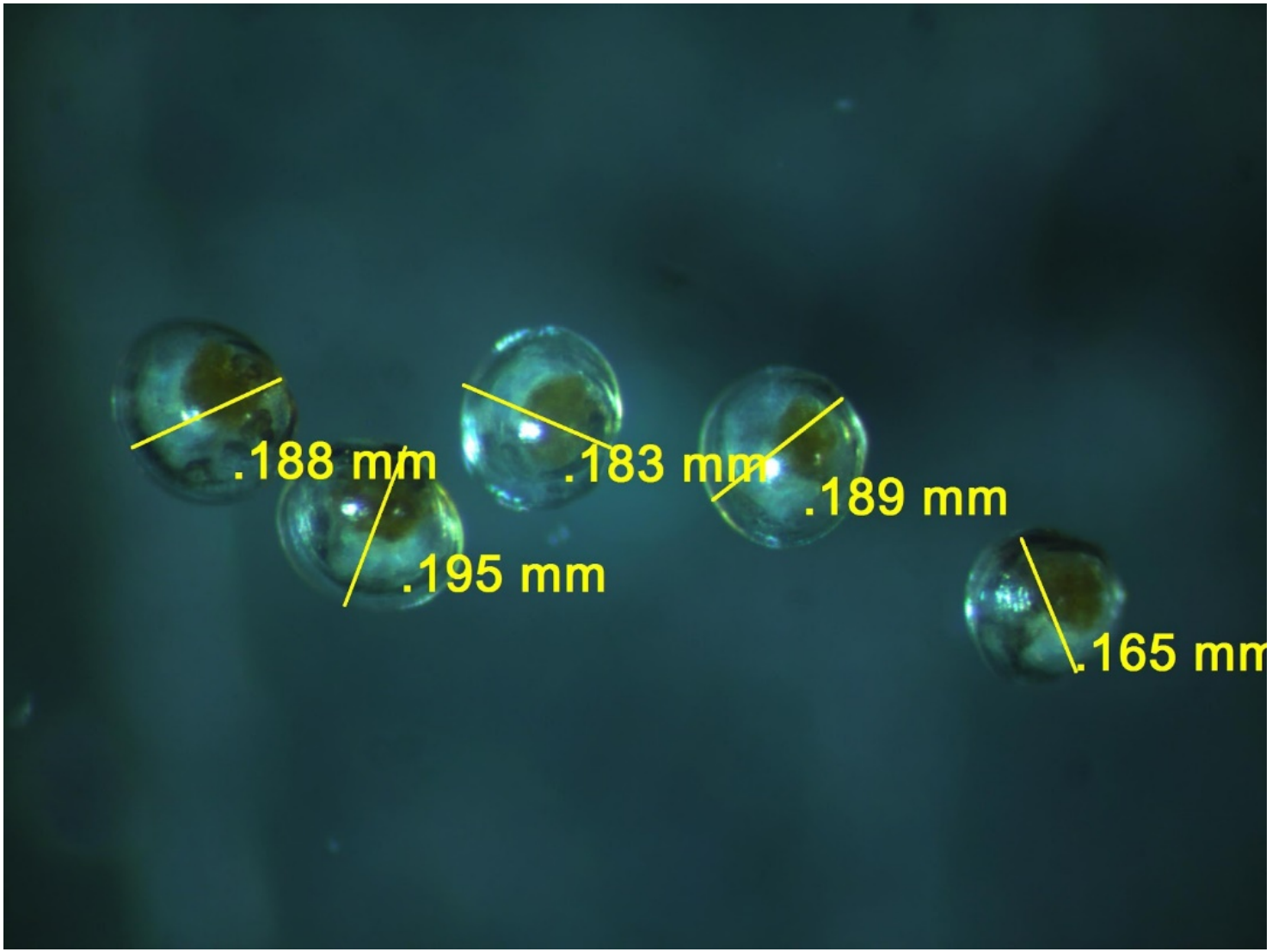
To increase oyster populations on the Elkhorn Slough Reserve and prevent local extinction, in 2017 a collaborative team initiated the first aquaculture project in California designed to restore Olympia oysters

Olympia oyster larva at Moss Landing Marine Laboratories. *Photo by Dan Gossard*

50 adults were collected from the Slough and brought to Moss Landing Marine Laboratories, where they were well fed and subject to changing temperatures to encourage reproduction

Adult oysters on rocks

100,000s of tiny larvae were produced

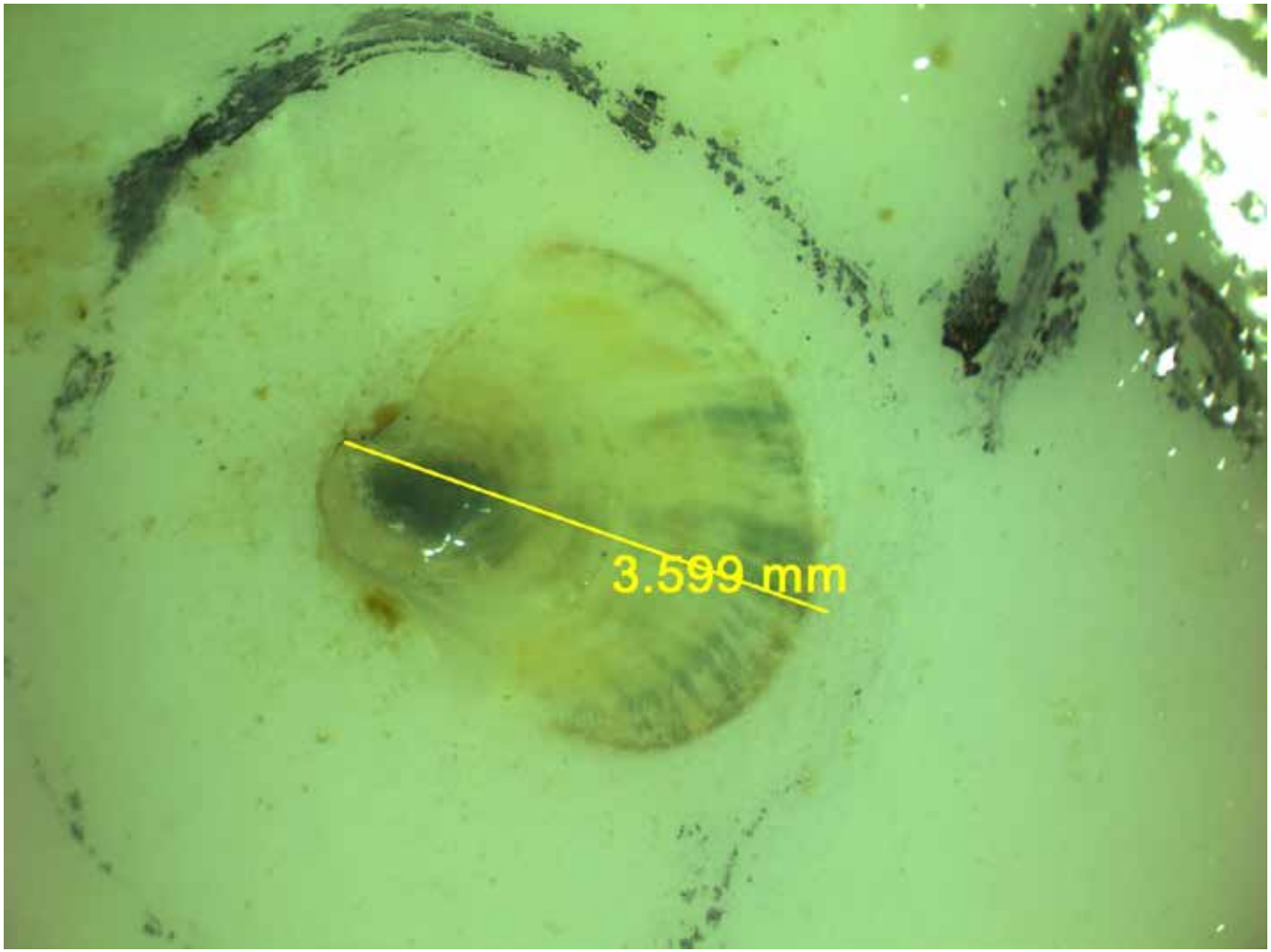


Olympia oyster larvae with green algal food in guts. *Photo by Dan Gossard*

Strings of clam shells were hung in tanks with larvae, to provide them places to settle

Photos by Dan Gossard

Thousands of larvae settled on the clam shells



Newly settled Olympia oyster. *Photo by Josiah Inovejas*

In October 2018, the clams shells with baby oysters were brought to Elkhorn Slough

Oysters on clam shell.

Photos by Chela Zabin

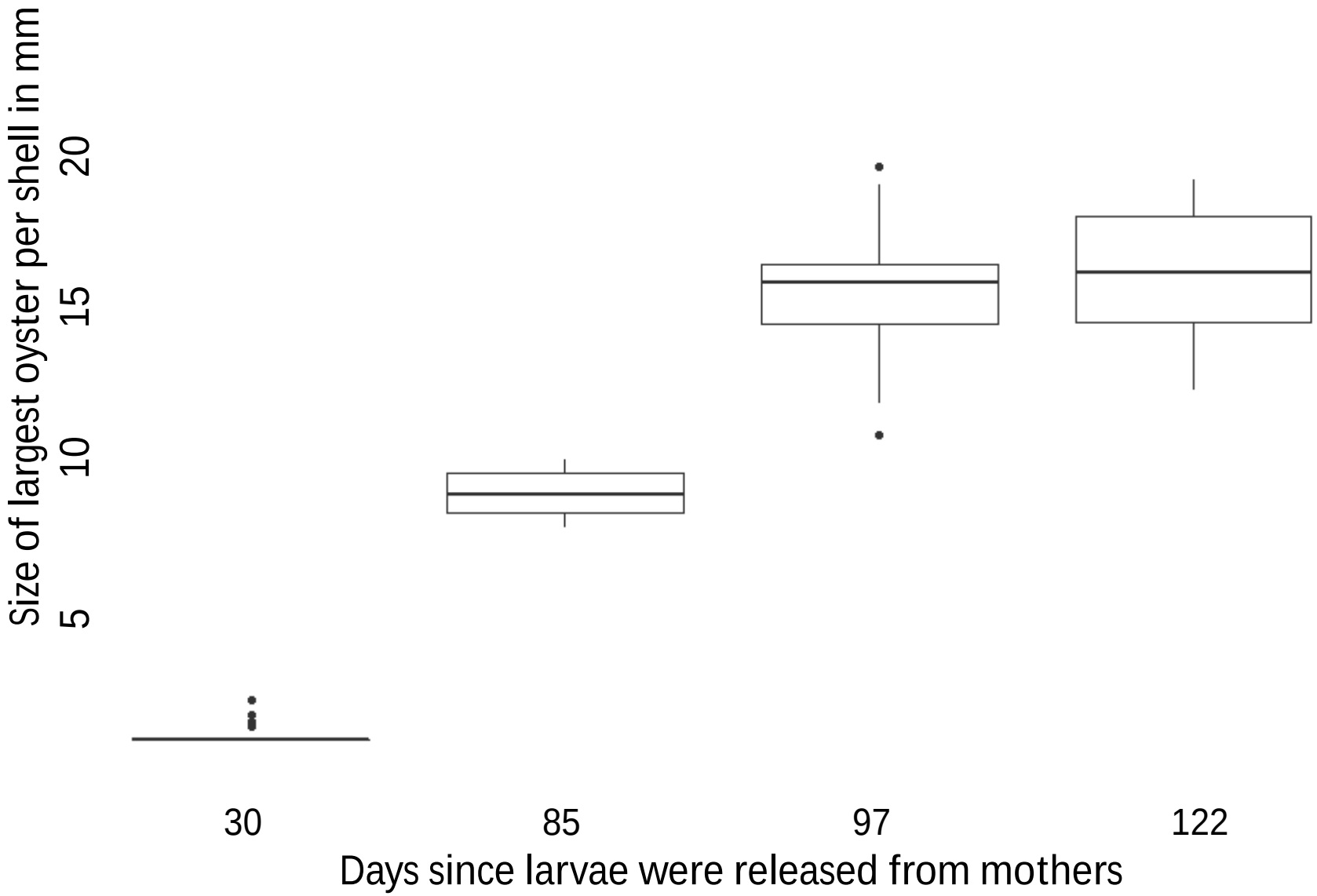
Teams of volunteers, students, and staff came to help

Assembly on the banks of South Marsh, Elkhorn Slough. *Photo by Brendan Tougher*

They counted the number of oysters on each shell, and measured the largest on each

Photos by Brendan Tougher

Data collected by volunteers showed size differences by larval ages (number of days since release in lab)



Clusters of shells were attached to wooden stakes

Photos by Scott Nichols and Brendan Tougher

The stakes were placed at three nearby sites on the Elkhorn Slough Reserve

Photo: Brendan Tougher

In total, 2400 larger juveniles (3+ months old) and about 17,000 tiny baby oysters (1 month old) were put out into Elkhorn Slough, into an area with only 200 live adults

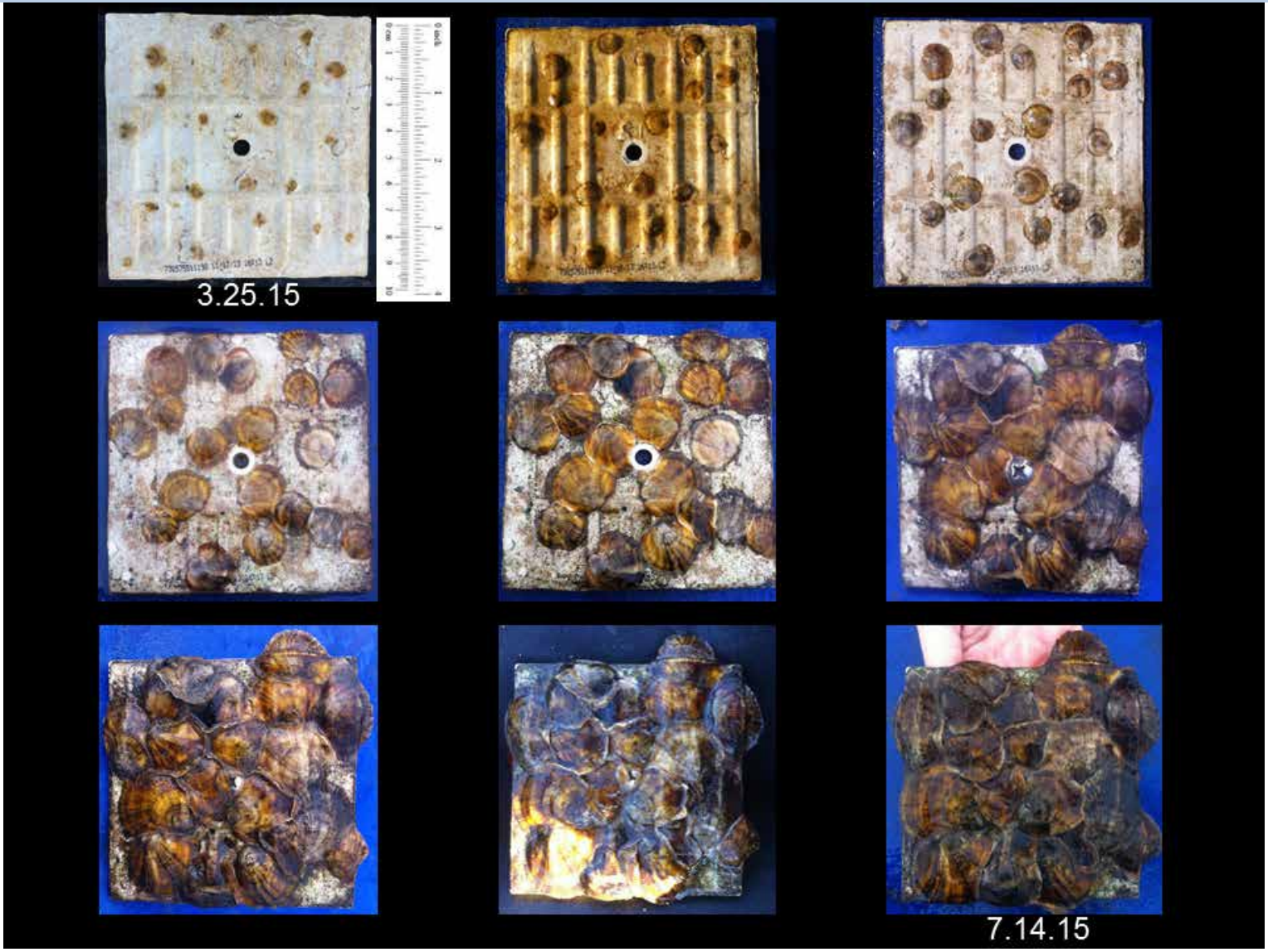
This is the first new generation of oysters in Elkhorn Slough since 2012, and the high numbers will significantly increase the population size

Lab-raised Olympia oysters on clam shells in Elkhorn Slough. *Photo by Scott Nichols*

A cause for celebration!

Moss Landing Marine Labs Director Jim Harvey pops champagne with project leader Kerstin Wasson of the Elkhorn Slough National Estuarine Research Reserve. *Photo by Brendan Tougher*

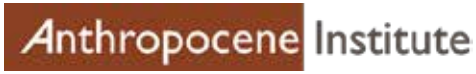
Based on past studies, we expect the baby oysters to grow well in Elkhorn Slough. We will monitor them regularly.



Oyster growth on a tile placed in Elkhorn Slough from March to July 2015 as part of a M.S. study.
Repeat photographs courtesy of Pamela Neeb Wade.

Our goal is to double the population of Olympia oysters on the Elkhorn Slough Reserve, with restoration science informing adaptive management

The aquaculture-restoration project was a partnership between many organizations



Team members

- **Elkhorn Slough NERR and Foundation**: Kerstin Wasson, Susie Fork, and many other staff members and volunteers
- **Moss Landing Marine Laboratories**: Dan Gossard, Peter Hain, Max Rintoul, Josiah Inovejas, Matt Elliott, Scott Hamilton, Mike Graham, Jim Harvey
- **Smithsonian Environmental Research Center**: Chela Zabin
- **California Sea Grant**: Luke Gardner
- **Sonoma State University**: Brent Hughes
- **Washington College**: Jill Bible

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Thank you to everyone who helped!

This summary was prepared by Kerstin Wasson, Elkhorn Slough National Estuarine Research Reserve, 25 October 2018, with gratitude to all partners.
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