Disease and environmental influences on oyster health and production

Relevance for fisheries, aquaculture & restoration

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Where are we today with oyster health, and where are we going under a changing marine environment?

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Perspective grounded in data

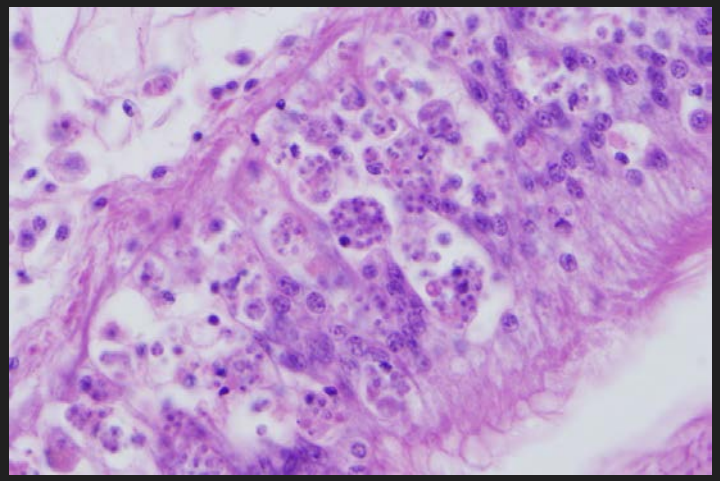
- **Oyster disease monitoring**
- Origins in the 1950s
- Targeted surveillance, wild oysters
- ~ 57 samples annually, from 32 Virginia oyster reefs

- **Aquaculture biosecurity**
- Passive surveillance, farm samples
- > 100 cases annually
- Virginia, Maryland and beyond

> 10,000 oysters evaluated annually

Evolutionary ecology as a prism

How are ecological interactions changing as a function of evolutionary change?

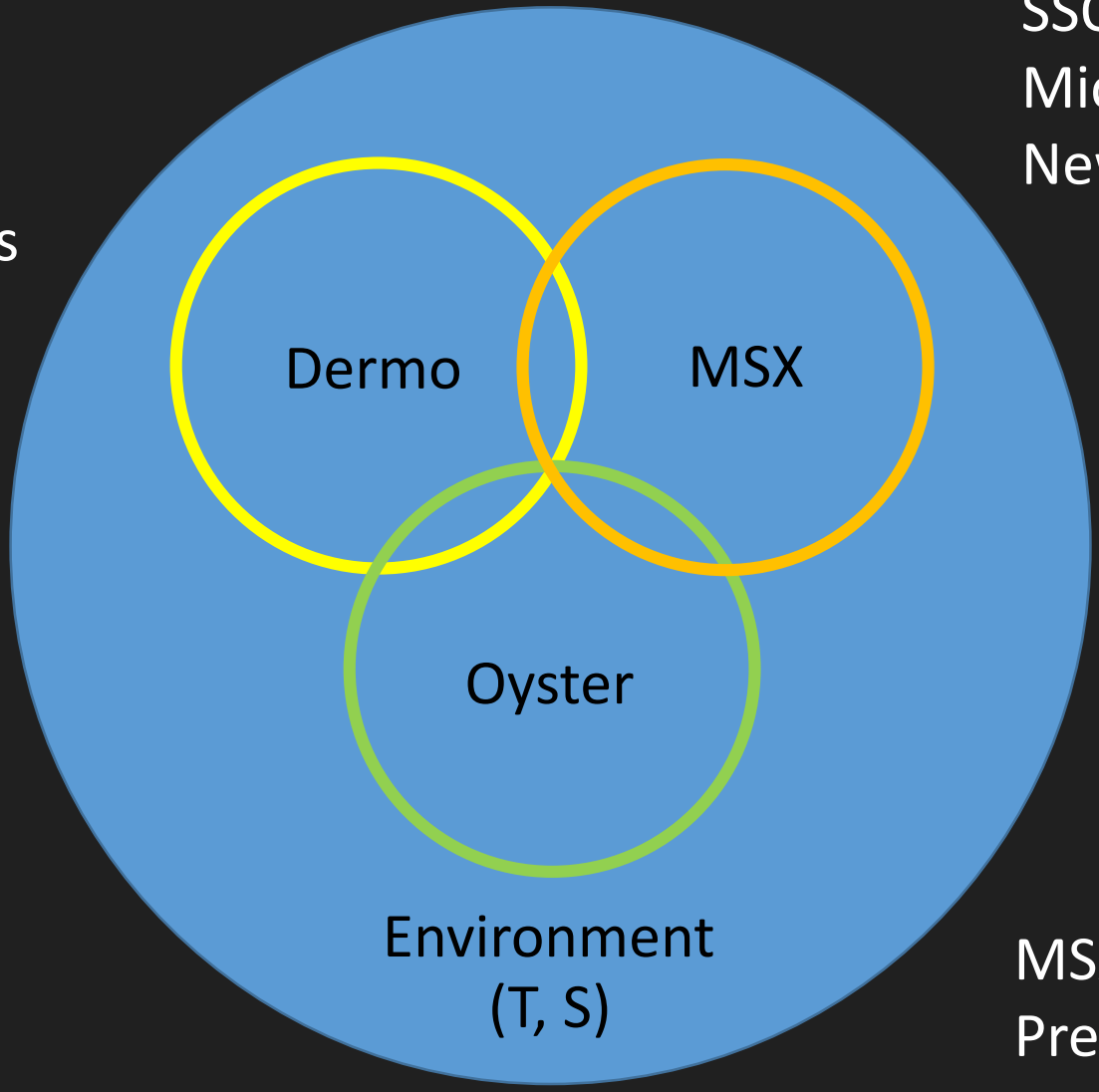


- **Resistance and tolerance evolution in oysters**
- MSX resistance (Carnegie & Burreson 2011)
- Dermo tolerance (Huey 2018, Huey et al. in prep)

- **Virulence evolution in dermo**
- Emergence of a hypervirulent phenotope in the 1980s (Carnegie et al. submitted)

In the Chesapeake Bay region

DO
pH
HABs
Pollutants

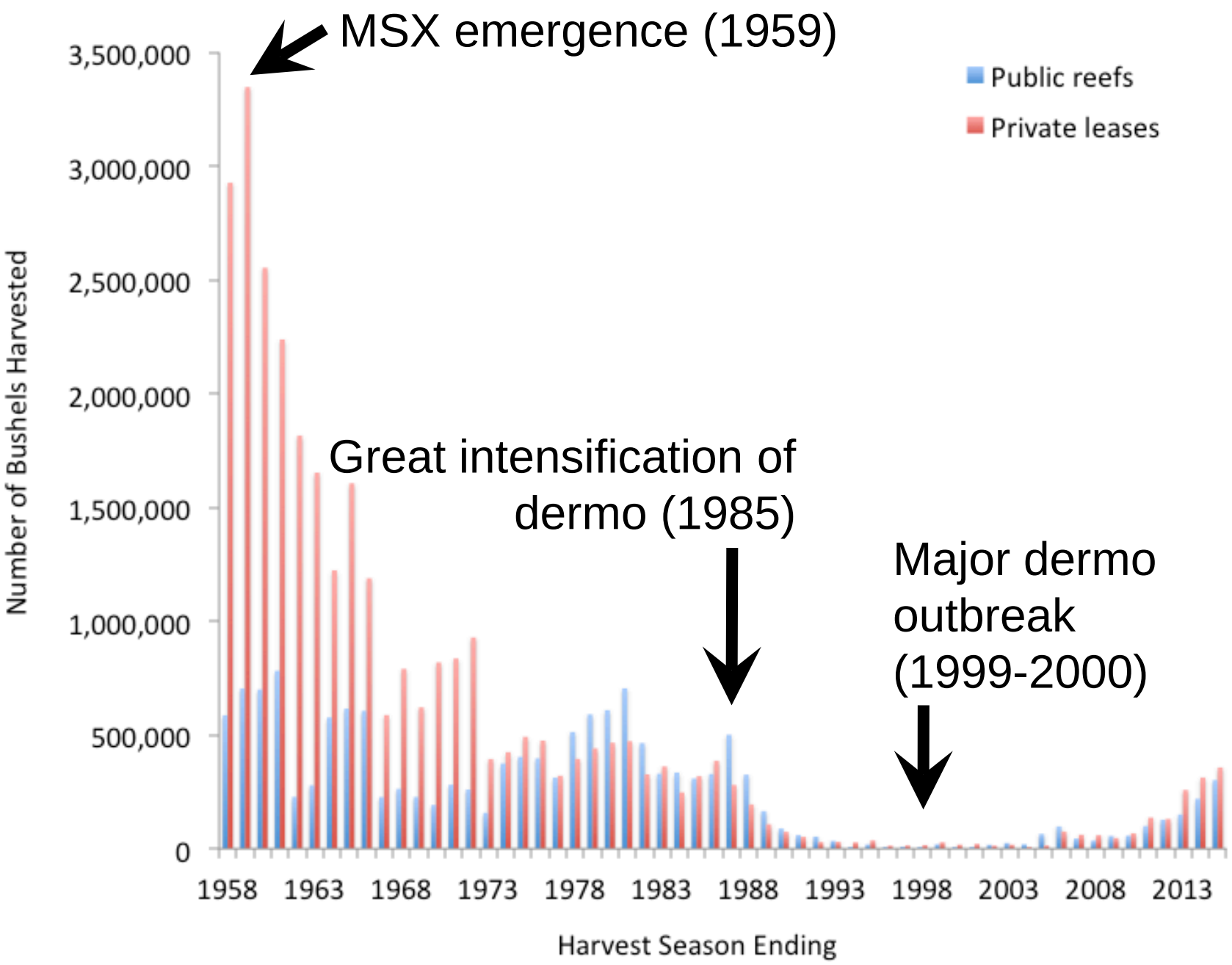


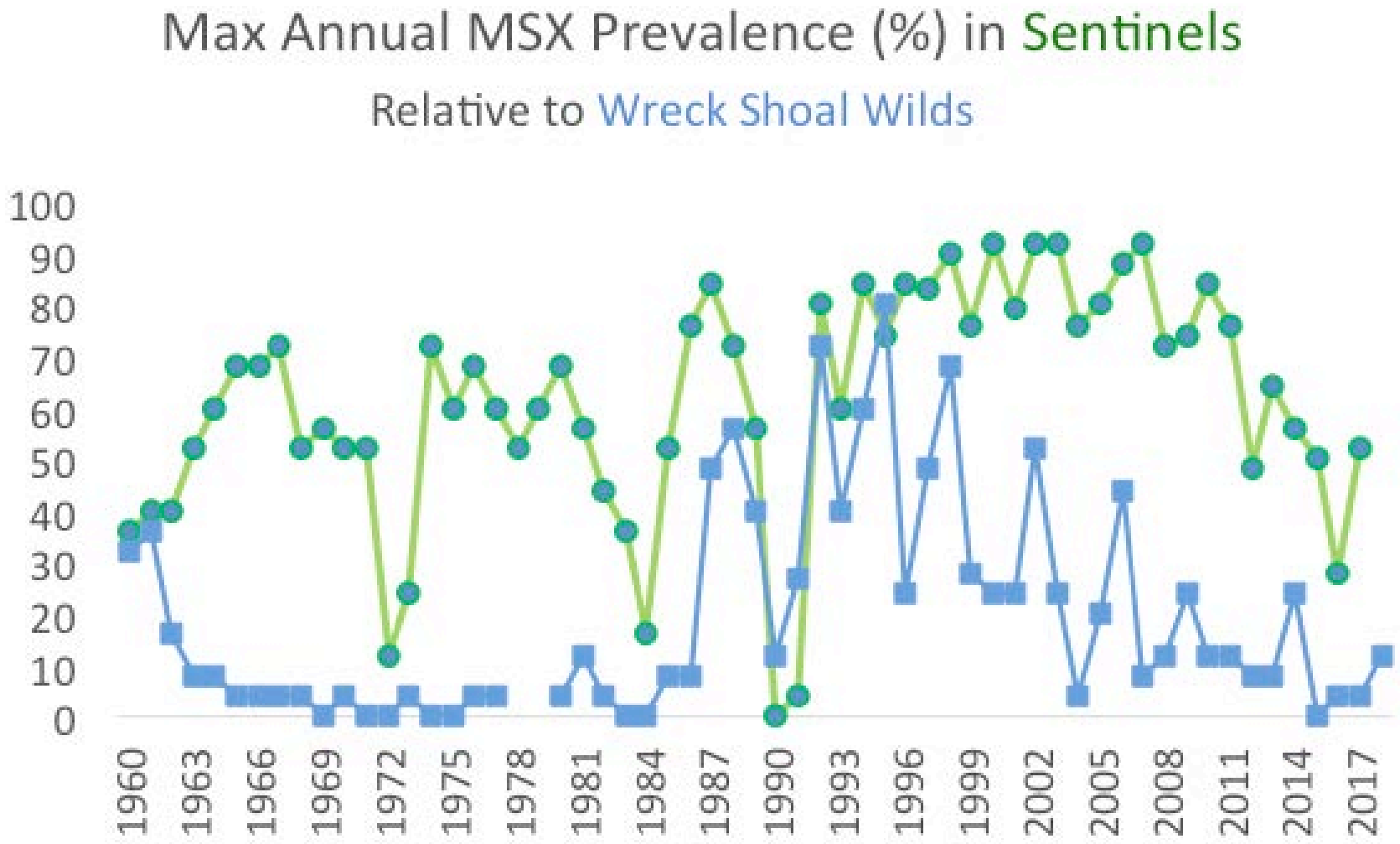
SSO
Microbiome
New pathogens

MSX int. host(s)
Predators, etc.

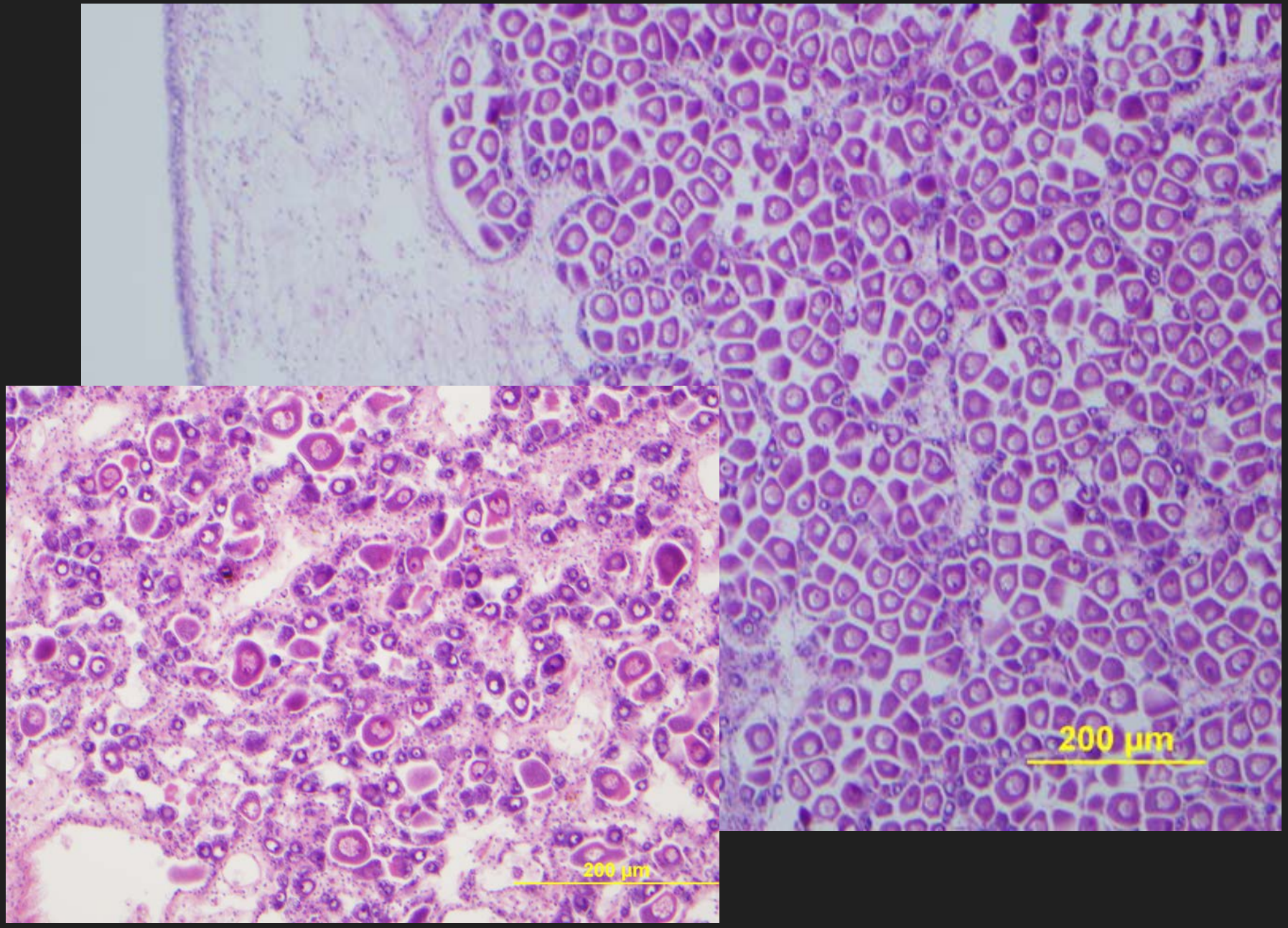
So where are we today?

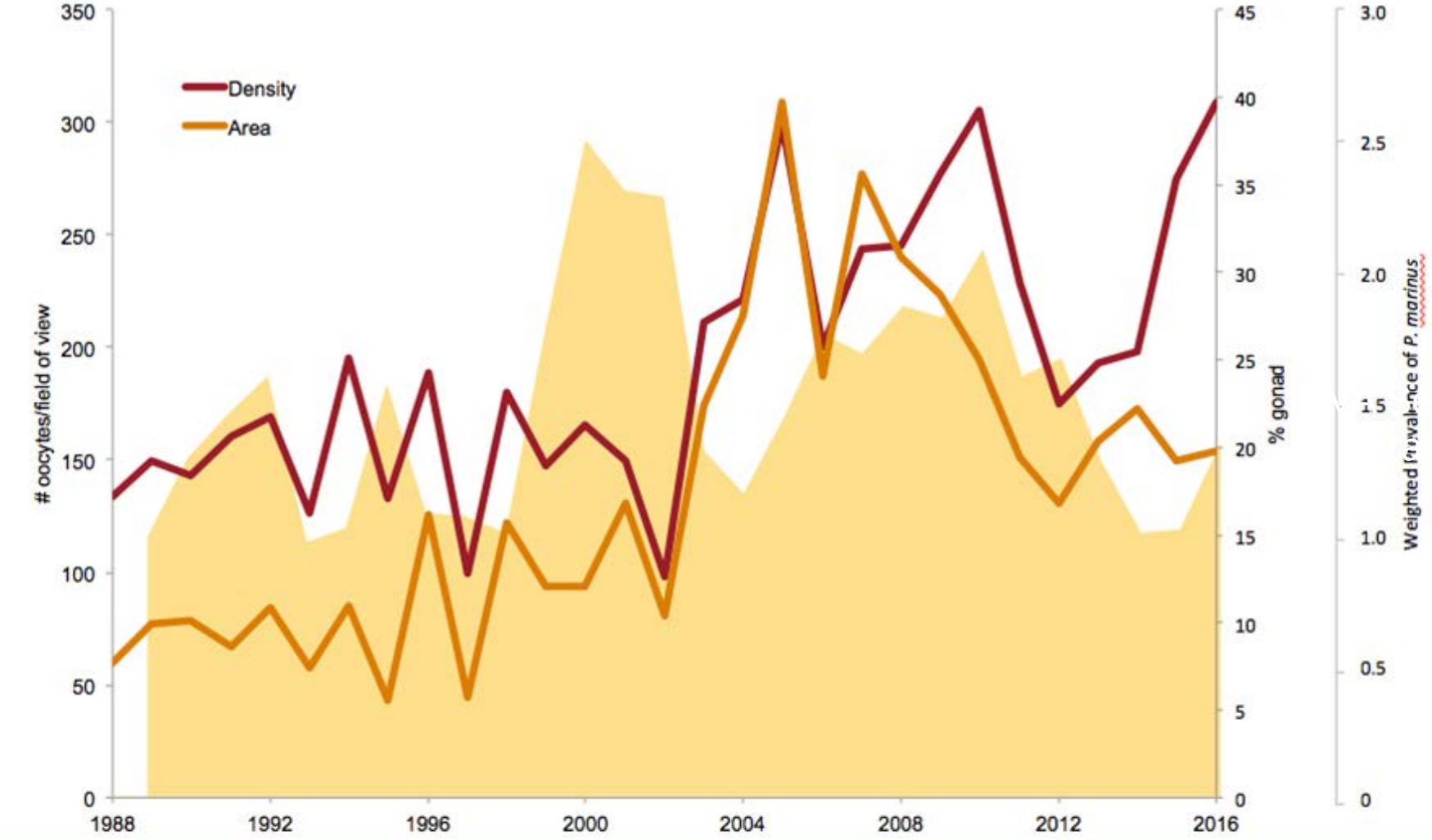
Oyster disease pressure has never been more intense


MSX emergence (1959)
Great intensification of dermo (1985)
Major dermo outbreak (1999-2000)
Public reefs
Private leases
Number of Bushels Harvested
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
1958
1963
1968
1973
1978
1983
1988
1993
1998
2003
2008
2013
Harvest Season Ending



Updated from Carnegie and Burreson 2011


200 µm
200 µm


Density
Area
oocytes/field of view
% gonad
Weighted prevalence of P. marinus
0
50
100
150
200
250
300
350
0
5
10
15
20
25
30
35
40
45
0
0.5
1.0
1.5
2.0
2.5
3.0
1988
1992
1996
2000
2004
2008
2012
2016

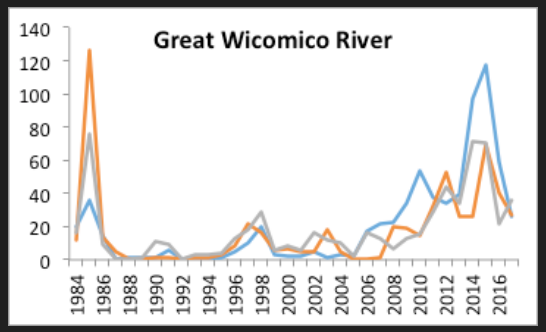
Improved abundance, longevity, ability to reproduce

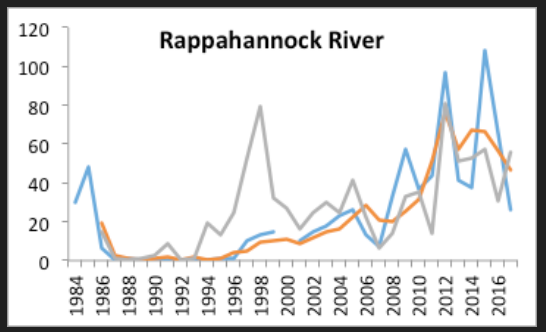
Increased size, increased fecundity

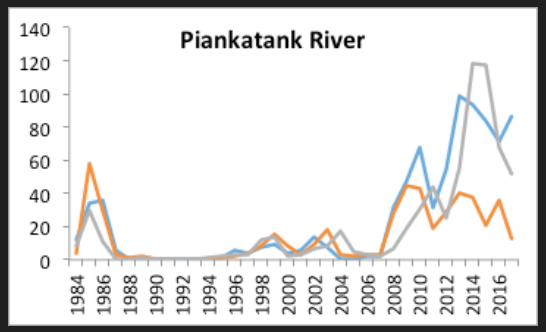
Bigger, heavier shells more resistant to dissolution and taphonomic processes; improved recruitment substrate

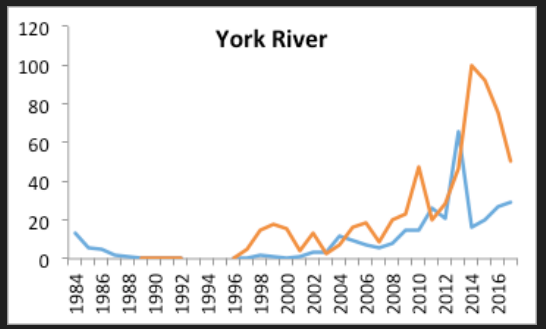
Increased fertilization efficiency

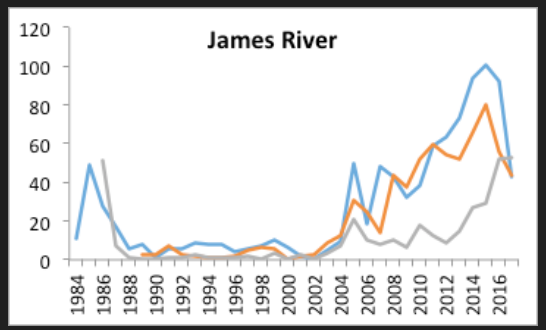
Increased settlement, recruitment





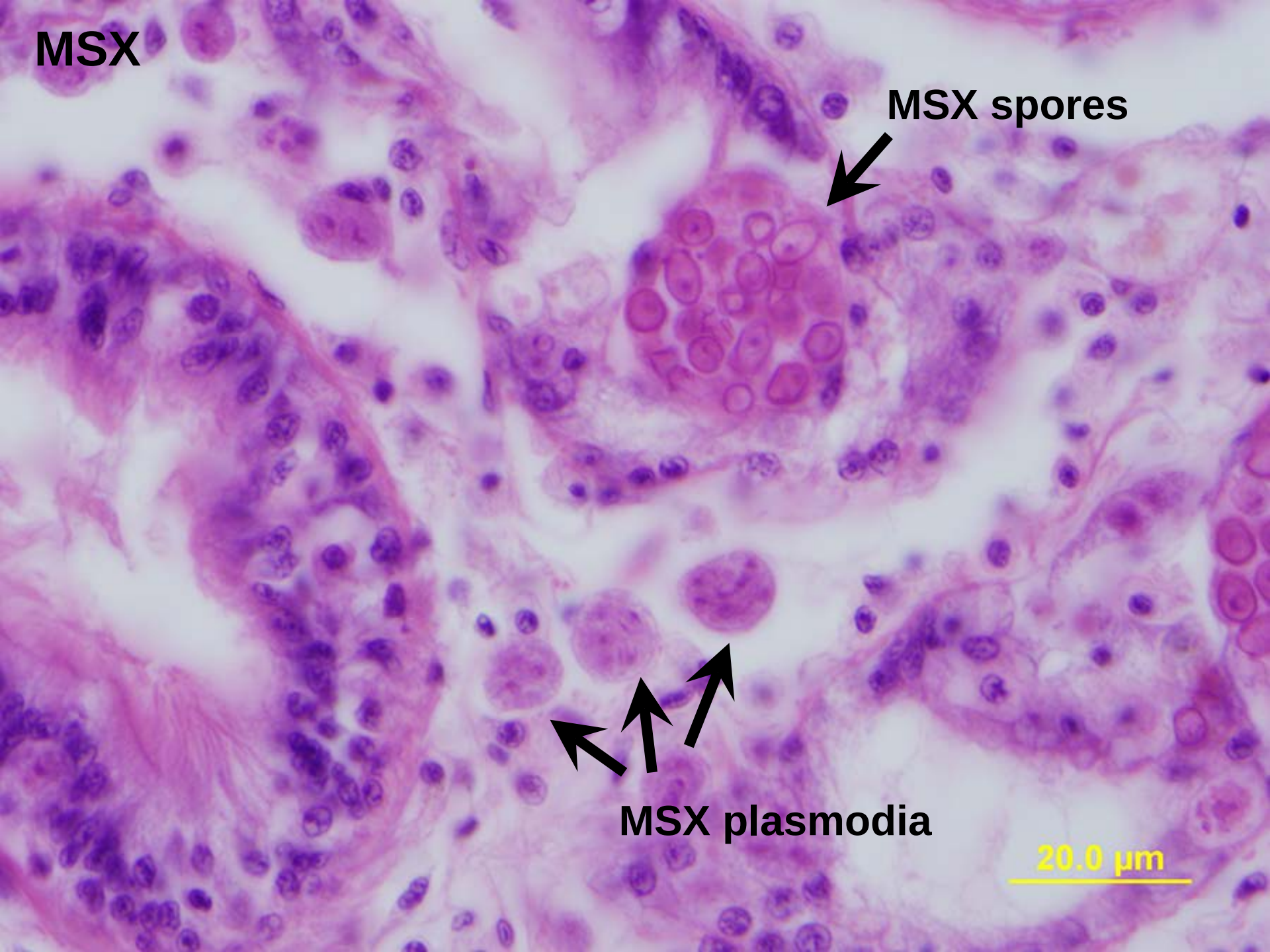


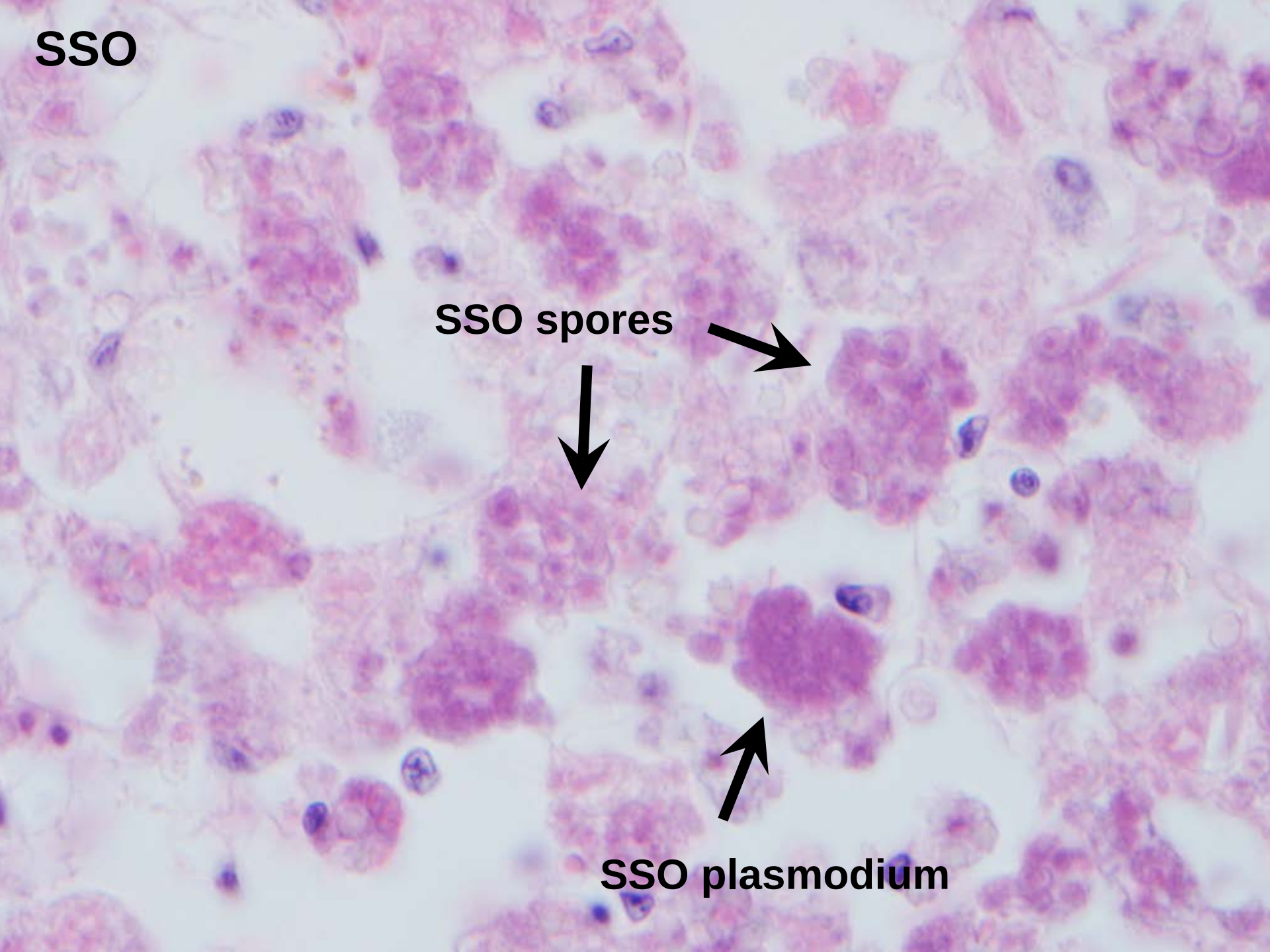




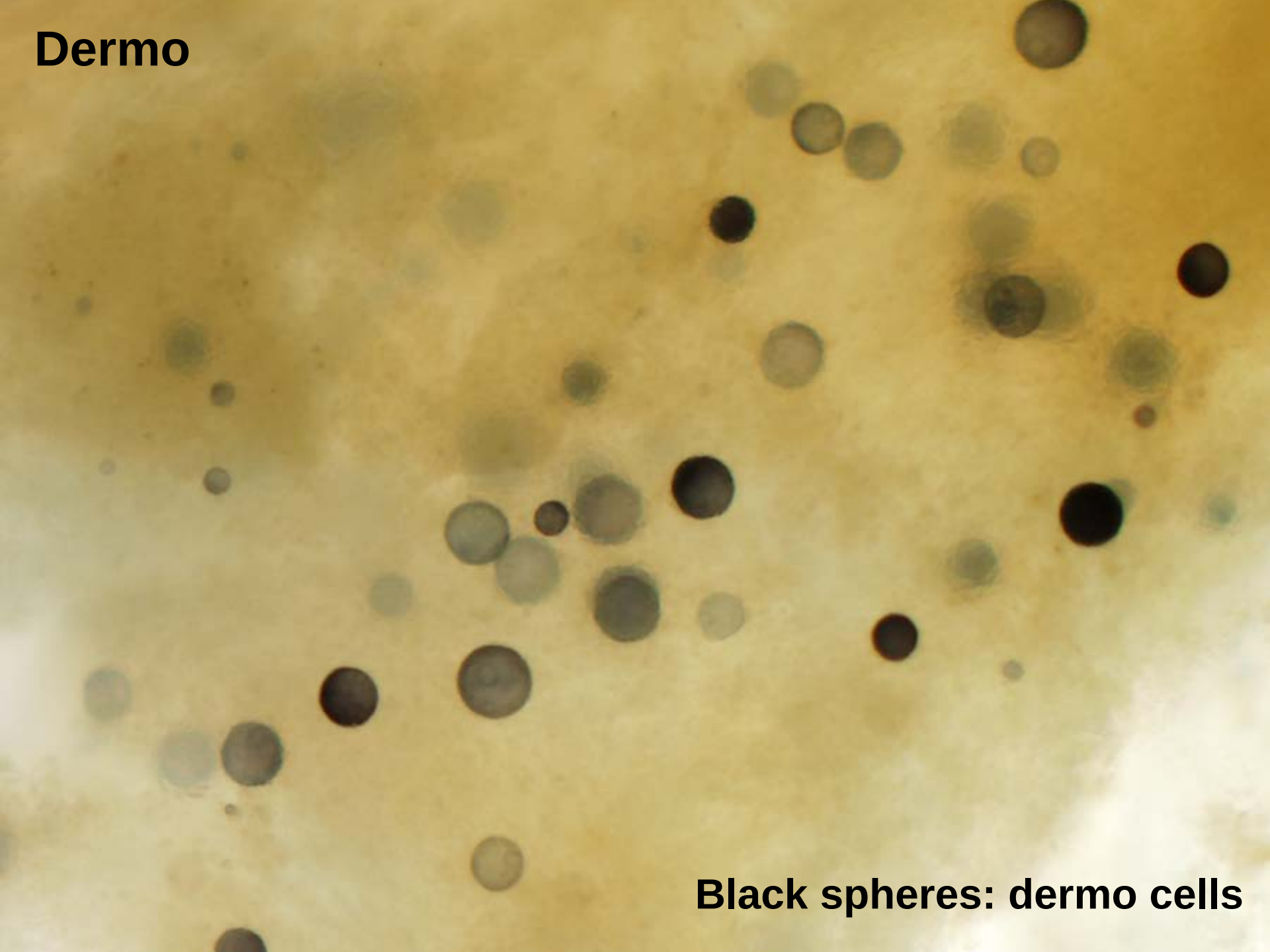
Data: Market oysters/bushel from VIMS Molluscan Ecology Lab (Mann/Southworth) dredge survey
Each graph represents trends for a single reef, all in high-disease areas

What will a changing marine environment bring?


MSX
MSX spores
MSX plasmodia
20.0 µm


SSO
SSO spores
SSO plasmodium

Dermo



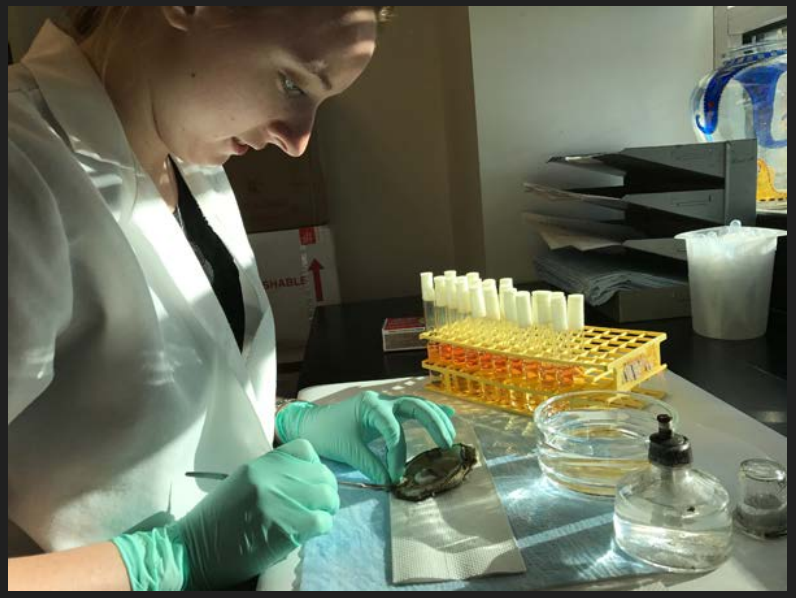
Black spheres: dermo cells

What about altered seawater chemistry, hypoxic challenges, HAB toxins, pollutants . . . ?

What can we do?

Aquaculture

- **Maintain focus on availability of resistance lines**
- Includes conservation of wild germplasm from which lines can be generated



- **Improve surveillance, and management of shellfish health in the context of interstate transfers**
- Rapid detection and prevention of emerging diseases

What can we do?

Wild and restored populations

- **Embrace conservation as the foundation of long-term oyster resilience: preserving genetic diversity for response to future environmental change**
- **Accept that dermo will be abundant in restoration contexts**

What can we do?

- **Consider that aquaculture may *mitigate* disease in wild and restored populations**
- Synergies between aquaculture and restoration to be considered in MSP?

Global Aquaculture Advocate

ENVIRONMENTAL & SOCIAL RESPONSIBILITY (/ADVOCATE/CATEGORY/ENVIRONMENTAL-SOCIAL-RESPONSIBILITY)

Can oyster farms protect wild oysters from disease?

Monday, 10 June 2019

By Bonnie Waycott

A recent study shows frequently harvested filter feeders can keep wild populations healthy

Ben-Horin et al. 2018, Aquaculture-Env. Interactions 10:557-567