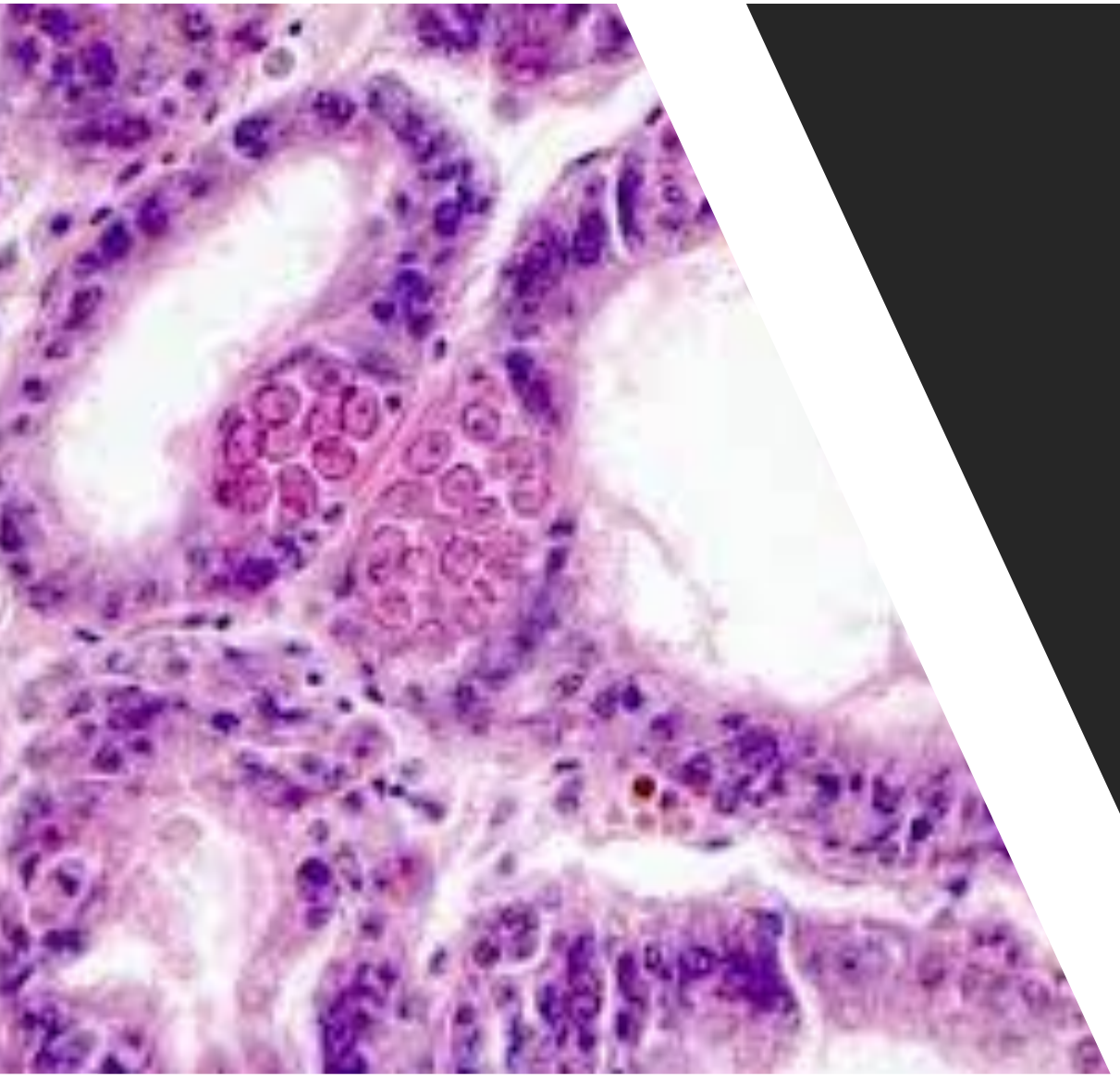


# *Haplosporidium nelsoni* and MSX disease

Chelsea Bergman

MEES 718I

Invasive species management

# Background

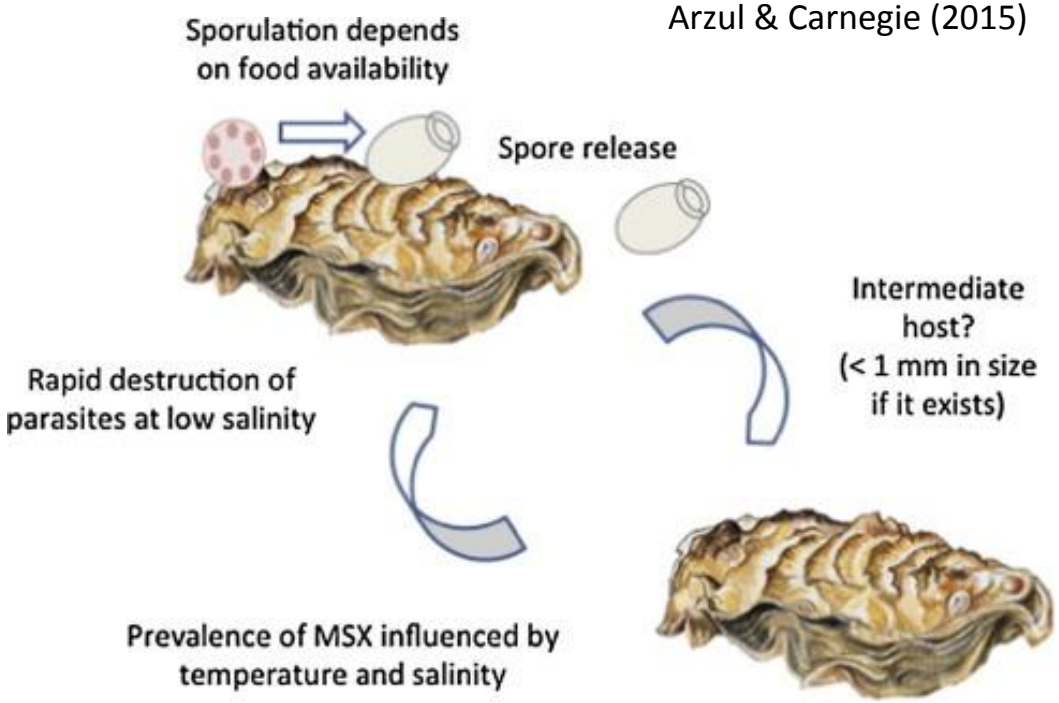
## *Haplosporidium nelsoni*

- Pathogen
  - Classification
    - Formally known as *Minchinia nelsoni*
    - Protistan parasite
    - Causative agent of MSX (multinucleated sphere X) disease
  - Disease diagnosis – Histology, Hemolymph smears, and molecular techniques (PCR)
  - Life history - unknown

## Oysters

- Hosts
  - *Crassostrea gigas*
  - *Crassostrea virginica*

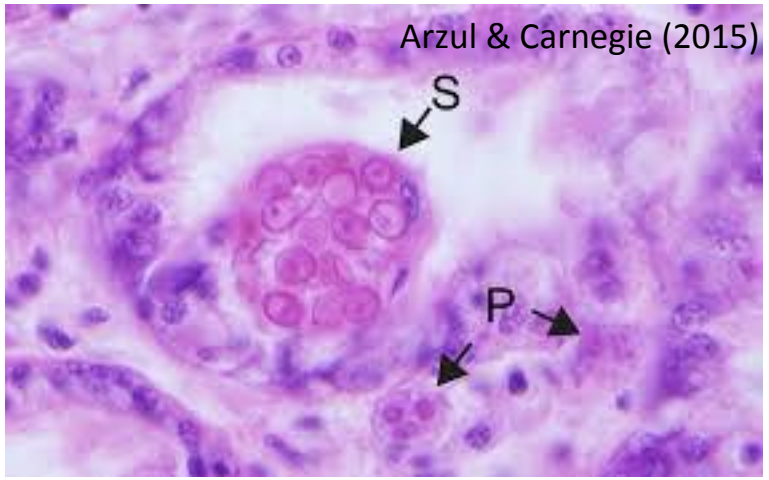
Arzul & Carnegie (2015)



# Introduction

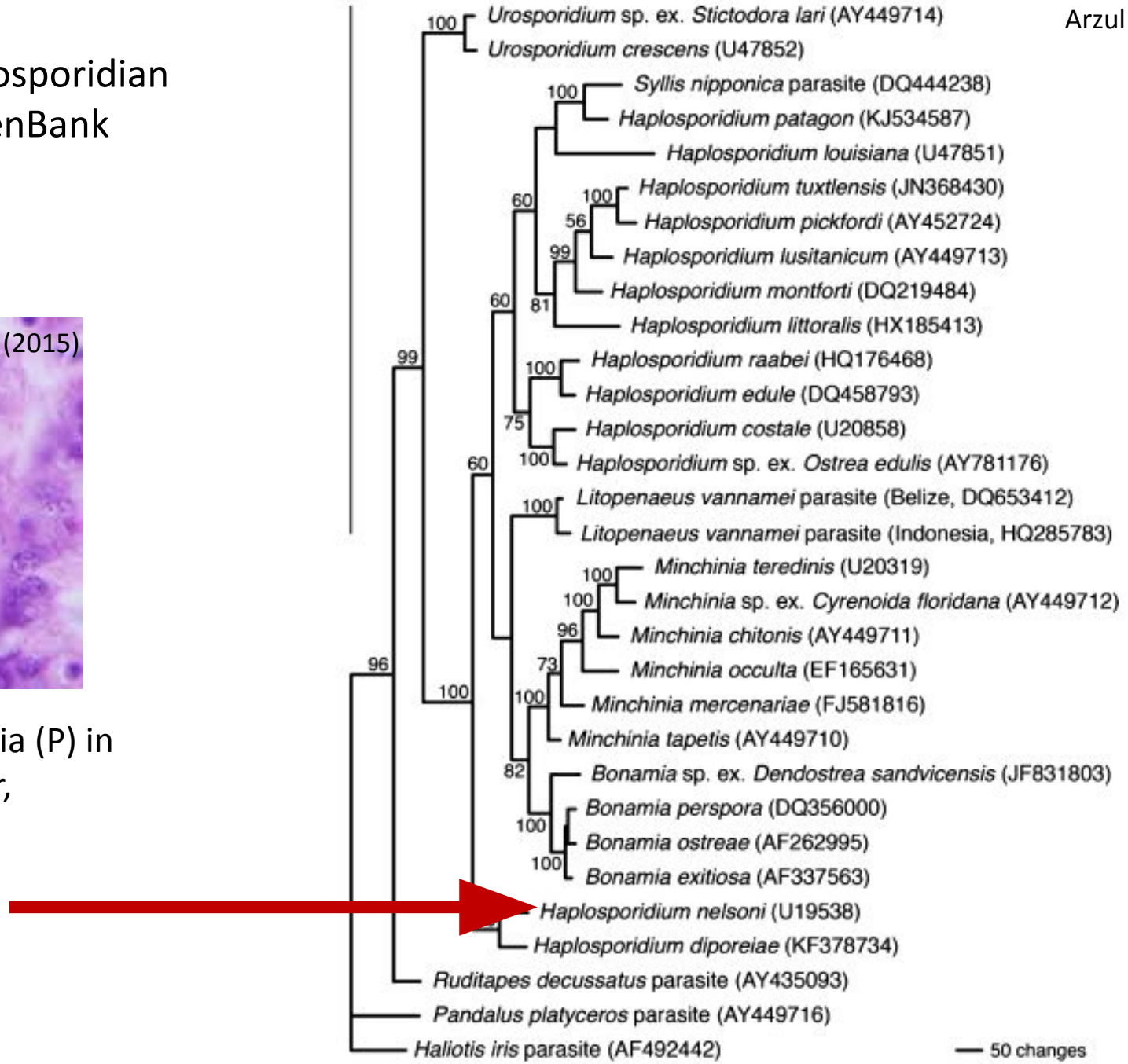
- Diagnostics and Pathology –
  - Plasmodia
  - Extracellular infections
  - Gill epithelium and subsequently become dispersed through all tissues.
  - Sporulation occurs in the epithelium of the digestive diverticula and plasmodia develop into sporocysts, with spore walls forming around each nucleus.
  - Histological method does not become reliably accurate until the parasite density is ca. 103 to 104 parasites gramme $^{-1}$ wet weight.
  - Hemolymph or tissue smears, although this method is less sensitive than tissue section histology.
  - Molecular diagnosis using specific DNA primers and PCR is considerably more sensitive, although it is not currently in routine use.
- *H. nelson* is an exotic pathogen that may have been inadvertently introduced to mid-Atlantic USA estuaries along with *C. gigas* oysters
- Native *C. virginica* oysters were naïve hosts for the exotic MSX disease pathogen, infectivity and virulence of *H. nelsoni* were extreme among the wild *C. virginica* oysters that were abundant then in Delaware and Chesapeake bays

Phylogenetic analysis of haplosporidian sequences available in the GenBank database




*H. nelsoni* spores (S) and plasmodia (P) in a rare heavy infection of an oyster, Crassostrea virginica, from lower Chesapeake Bay

Arzul & Carnegie (2015)



# Environmental Conditions

Proliferates at temperatures ≥10˚C.

Rarely found in oysters living at ≤ 10 ppt or less

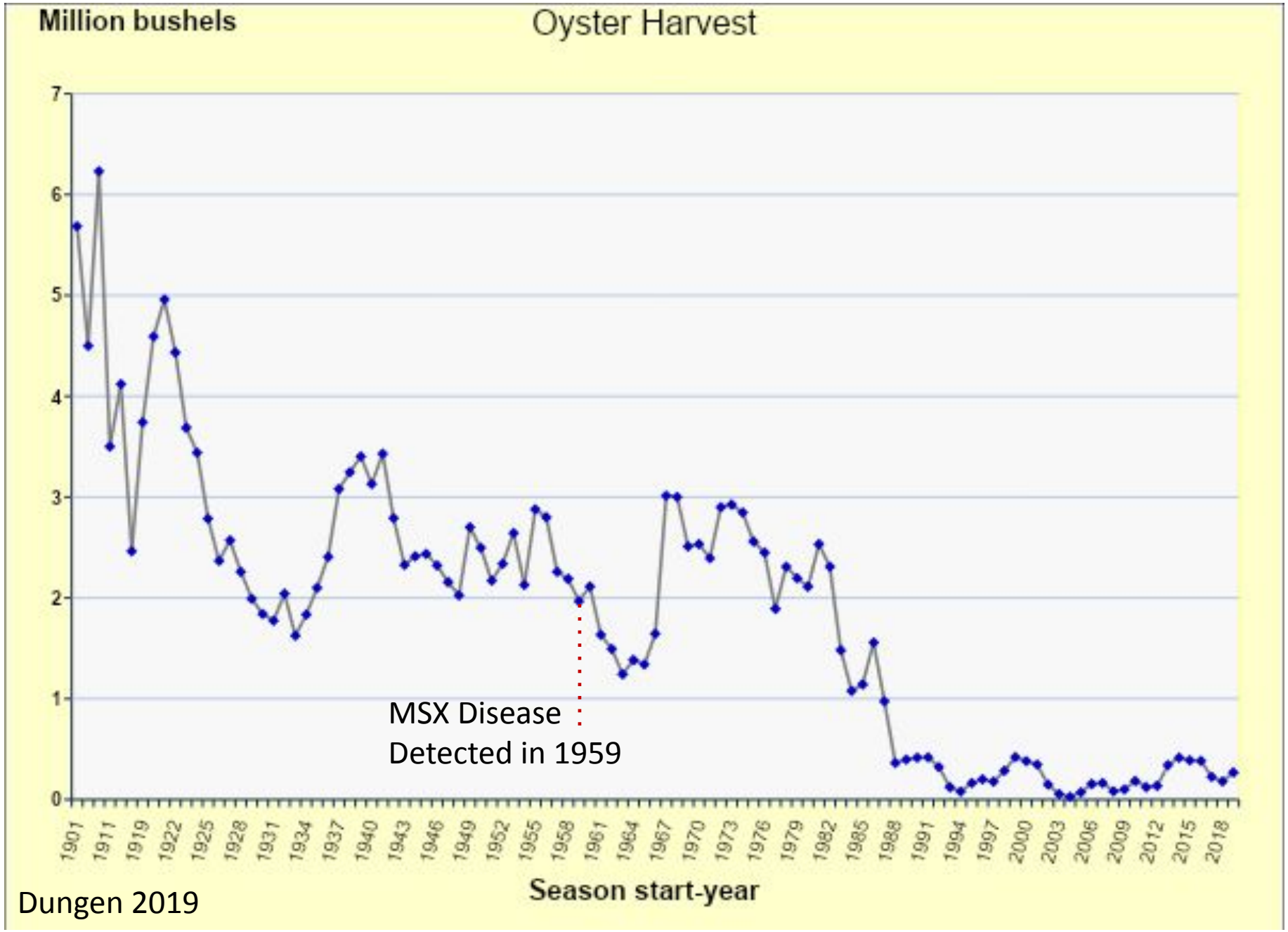
Salinities of 15 ppt or higher are associated with epizootics and drought conditions

Seasonality –

- Mid-May through October
- Rapid multiplication - summer and heavy mortalities in autumn.
- High prevalence in winter lead to subsequent mortality events in spring when temperatures warm
- A second prevalence peak may occur in late May or early June, with consequent mortalities.
- A multiyear cycle of infection prevalence
- Low prevalence years following cold winters

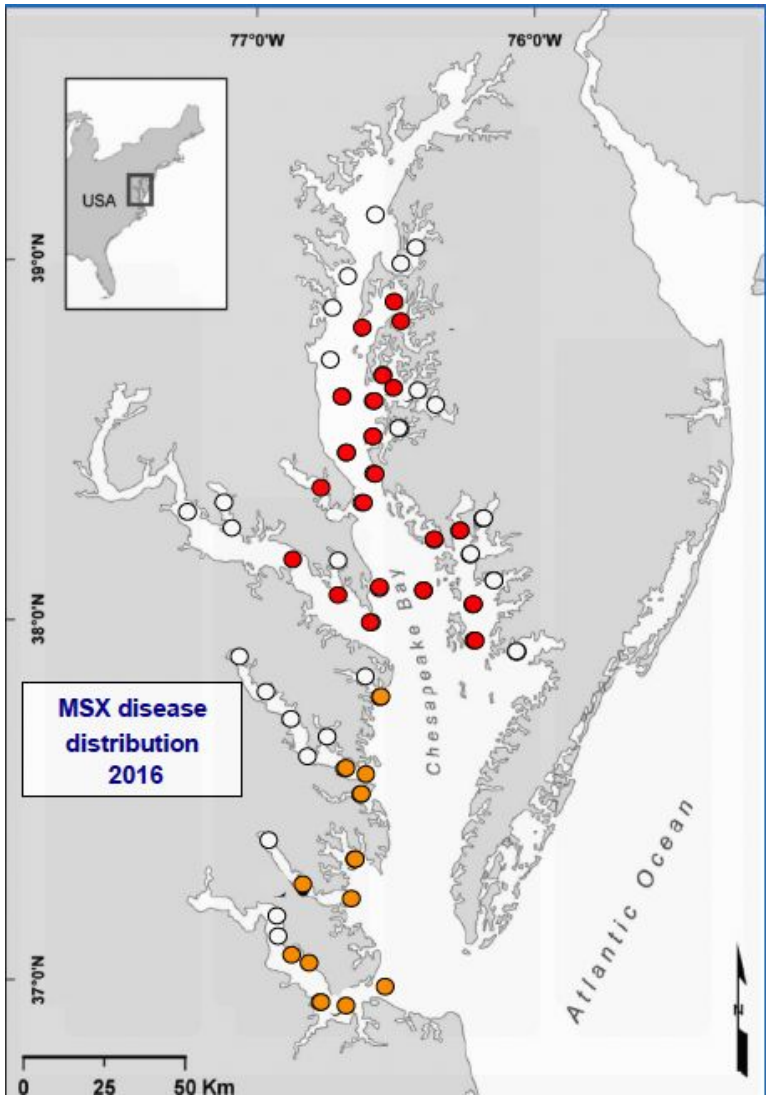
# MSX DISEASE ORIGINS IN THE CHESAPEAKE BAY

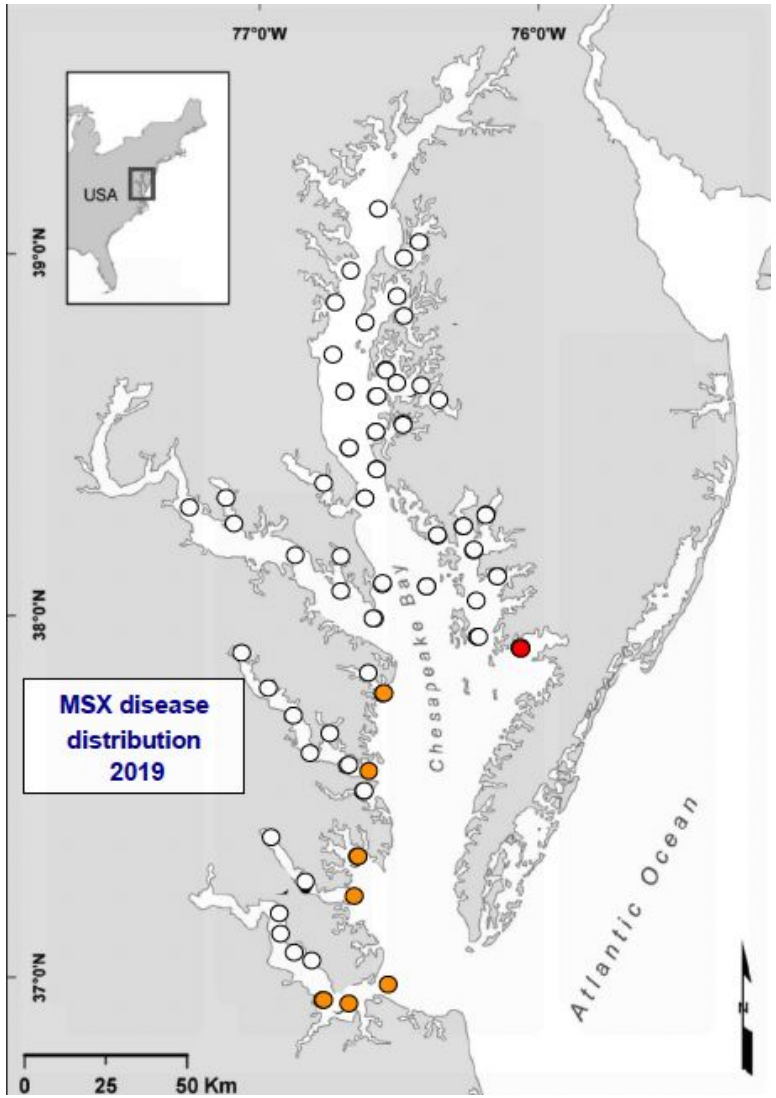
- *H. nelsoni* appears to be a benign parasite of *C. gigas*
- Introduced to USA coastal waters by experimental introductions of Pacific oysters before 1957 or transfers of ballast waters or other infectious vehicles from Asian sources.
- 1957 – MSX first identified as the previously unknown protozoan disease that was decimating Delaware Bay oysters.
- 1959 – Mortality events in the Chesapeake Bay
- Oyster mortality due to this parasite exceeded 90% on reefs in lower Delaware and Chesapeake Bays during the early years of the epizootic
- Oyster populations in Chesapeake Bay have minimal resistance to *H. nelsoni*
- Virginia oysters preside in low-salinity sanctuaries of the middle to upper reaches of the large rivers of the lower Chesapeake's western shore (summer-fall salinities < 20 ppt)
  - Reduced *H. nelsoni* activity
  - Limited predation
  - Limited *Perkinsus marinus* parasitism.


Million bushels
Oyster Harvest
7
6
5
4
3
2
1
0
MSX Disease
Detected in 1959
1901
1911
1919
1922
1925
1928
1931
1934
1937
1940
1943
1946
1949
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
Season start-year

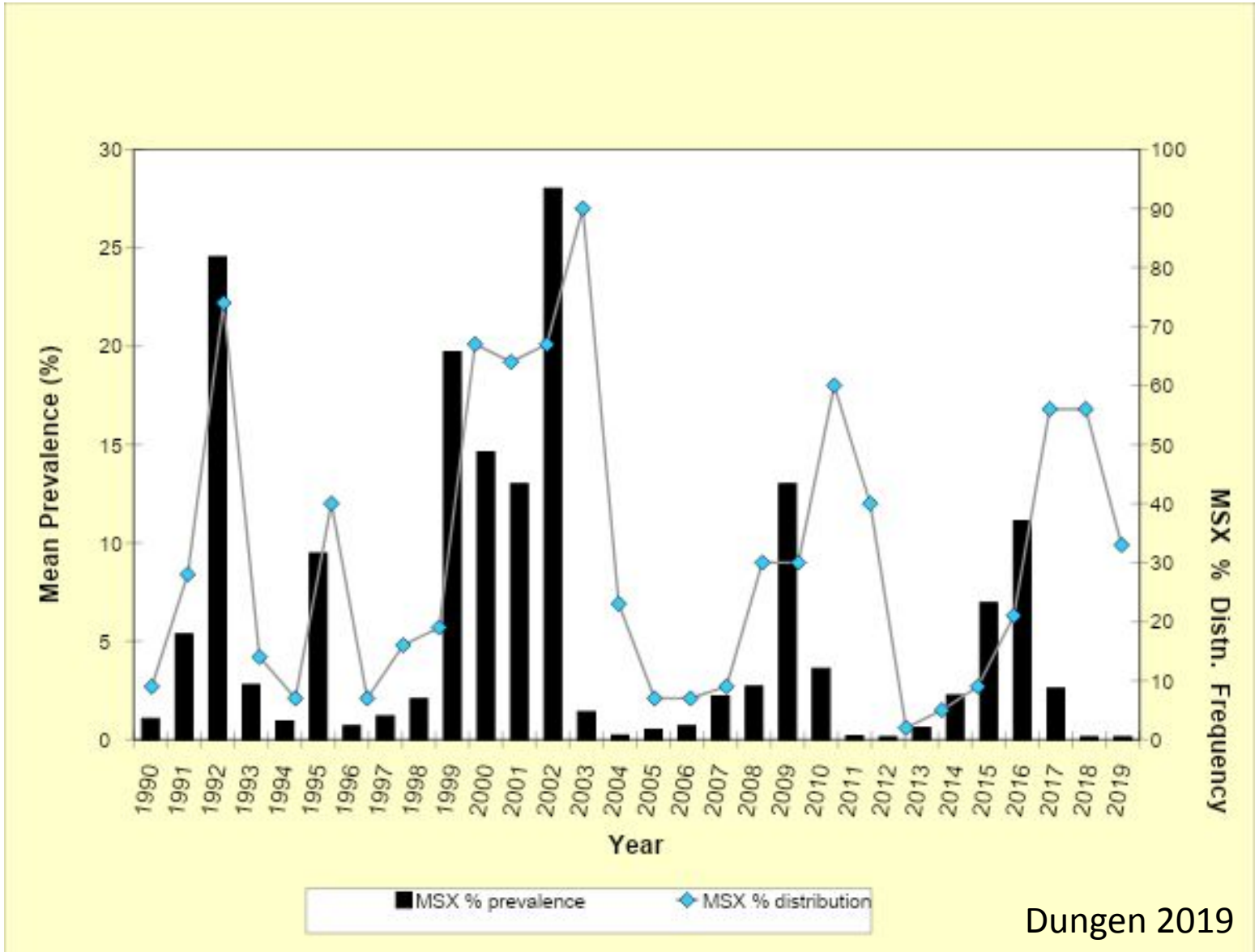
Dungen 2019

# Chesapeake Bay MSX Distribution
## 2016 vs. 2019



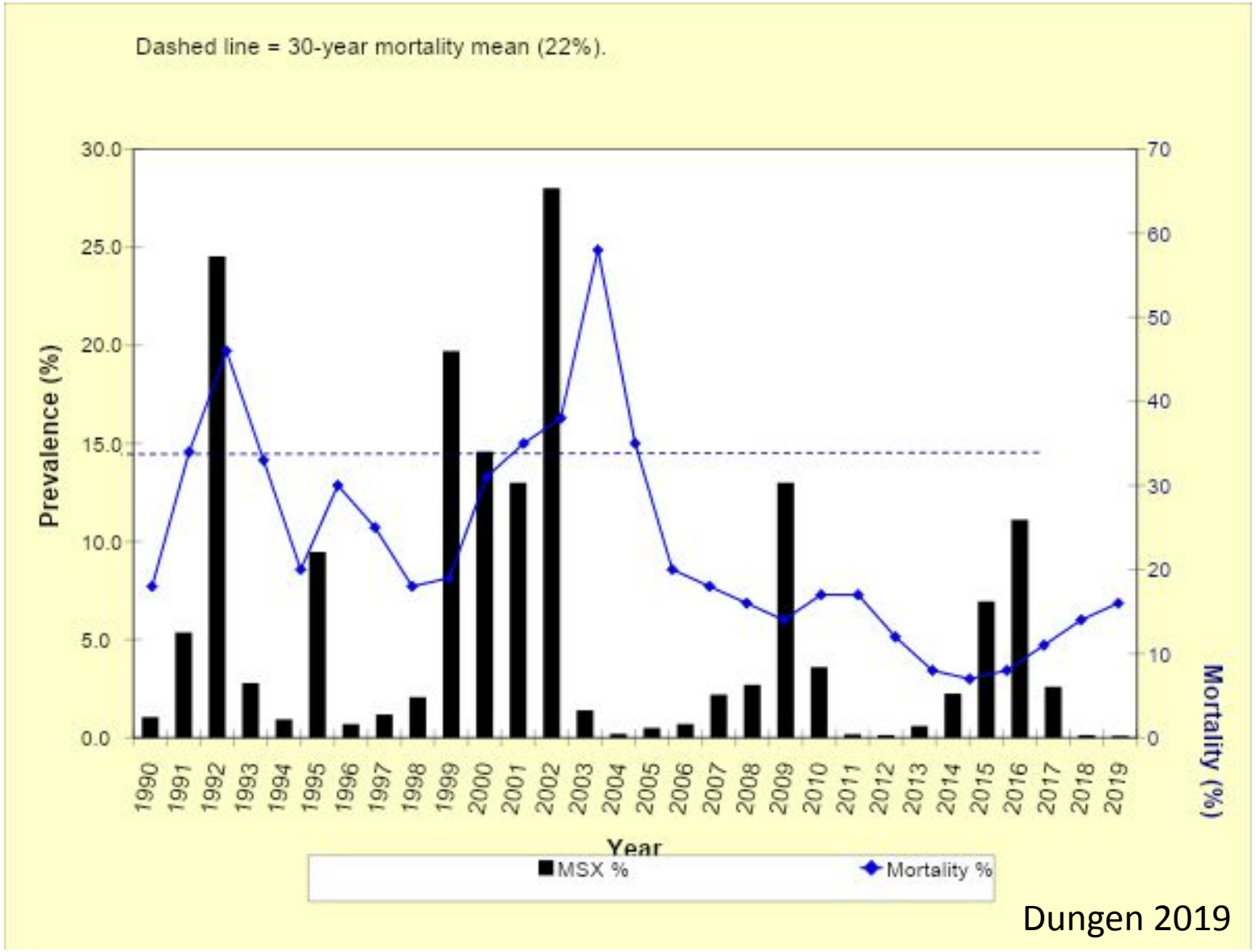



1990 - 2019 Maryland Annual Means for MSX prevalence and MSX distribution frequency among samples




Dungen 2019

# 1990 –2019 Maryland Non-harvest Oyster Mortalities Vs. Annual Prevalence For MSX Disease

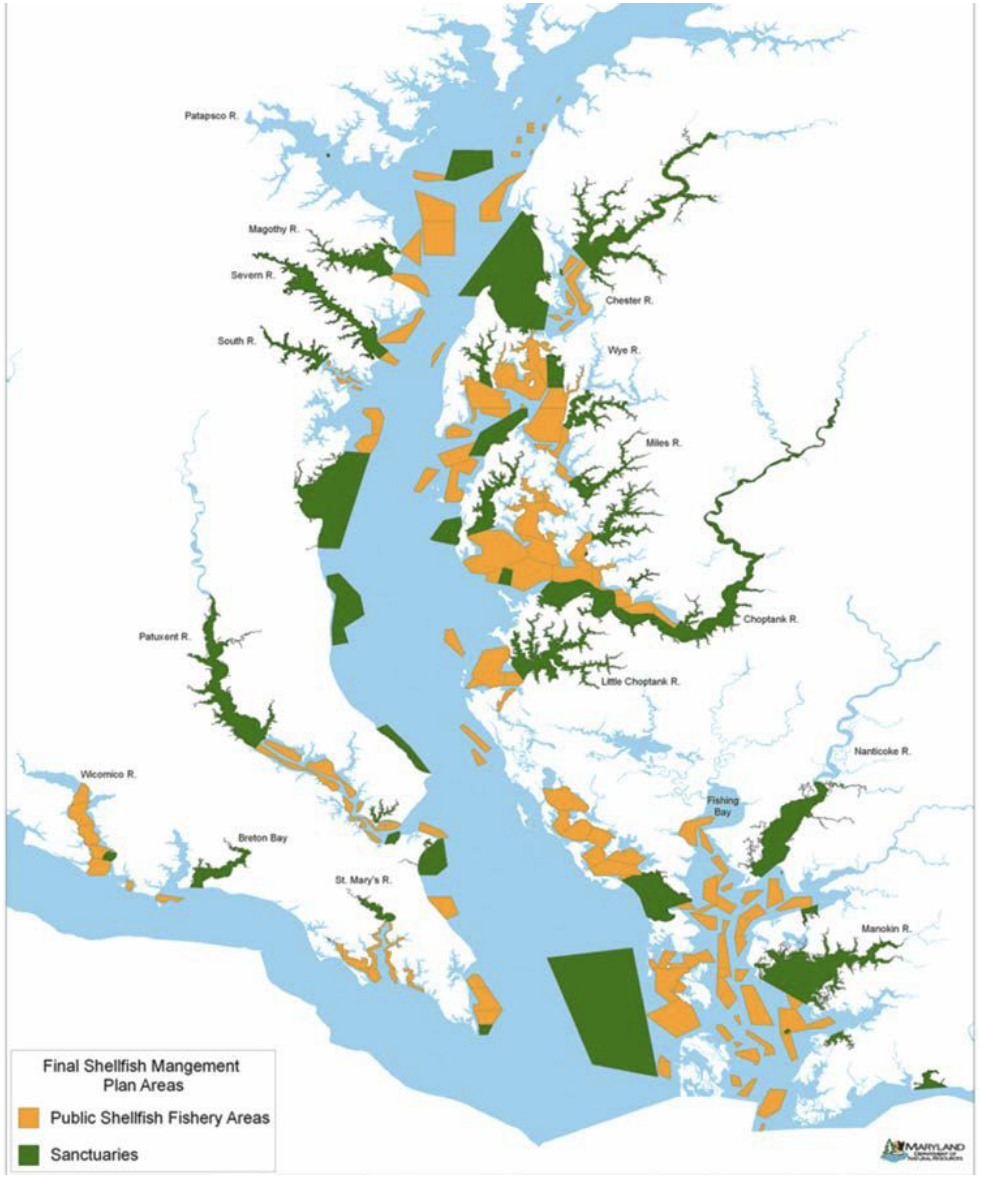



Dungen 2019

# Management

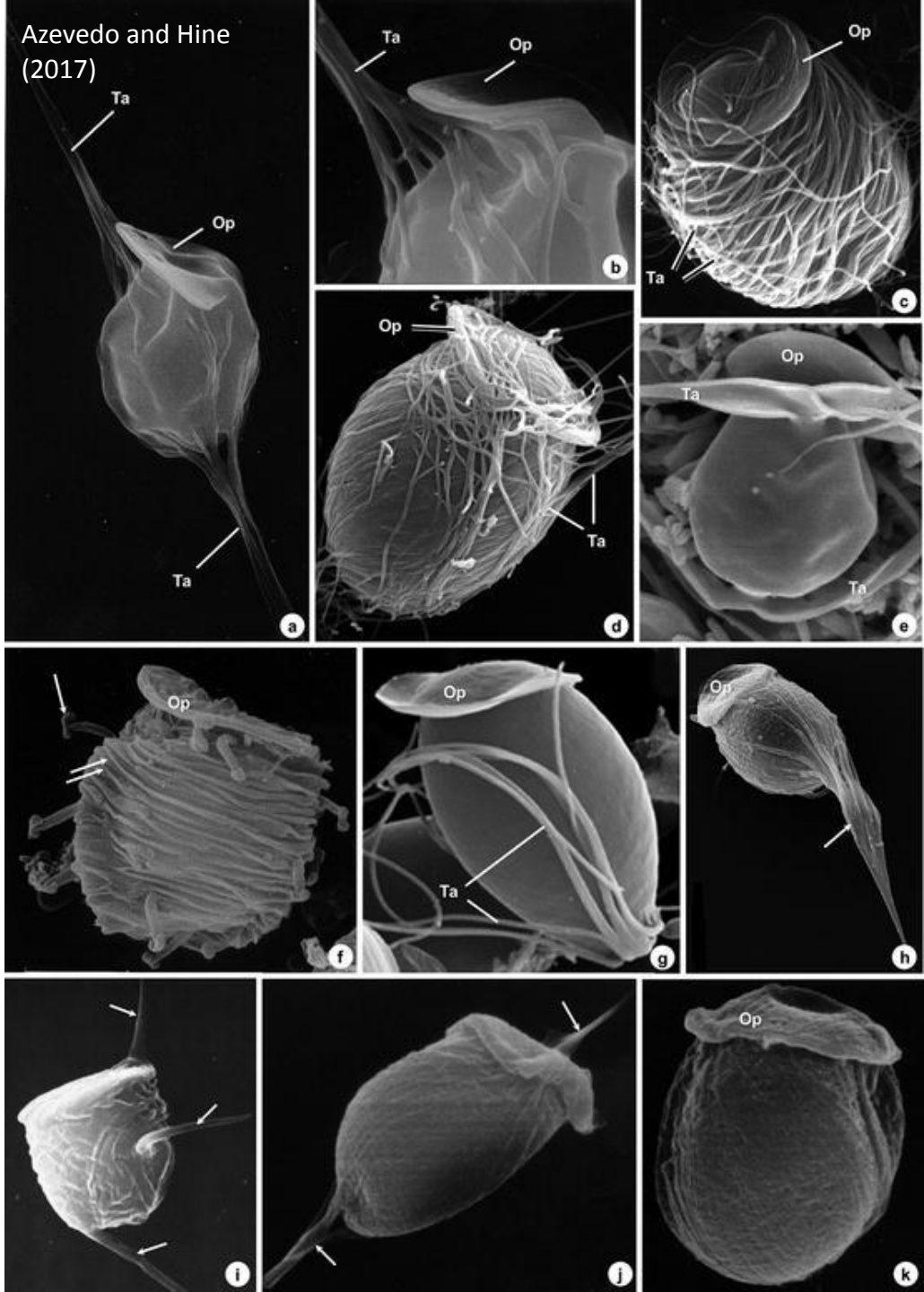
- Management plan for *H. nelsoni* – policy and mitigation plan – oyster population surveys (monitoring – MDNR- Fall oyster surveys, 15,000 oysters from 30 sites).
- EPA Chesapeake Bay Program, Oyster Disease Meeting (2007)
- Technologically limited detection outside of hosts

MDNR



# Management

- Maryland DNR Mollusc Disease Control Policy
  - 1993 Maryland Oyster Roundtable Action Plan
  - 2000 Maryland Aquatic Animal Health Policy and Implementation Plan
  - 2004 Chesapeake Bay Program (EPA) Oyster Management Plan
  - 2010 - 2019 Maryland Oyster Management Plans



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