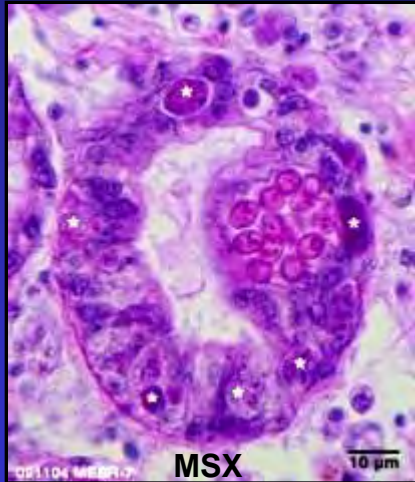


OYSTER DISEASES AND OYSTER CULTURE IN MARYLAND



CHRIS DUNGAN
MARYLAND DNR
COOPERATIVE OXFORD LABORATORY

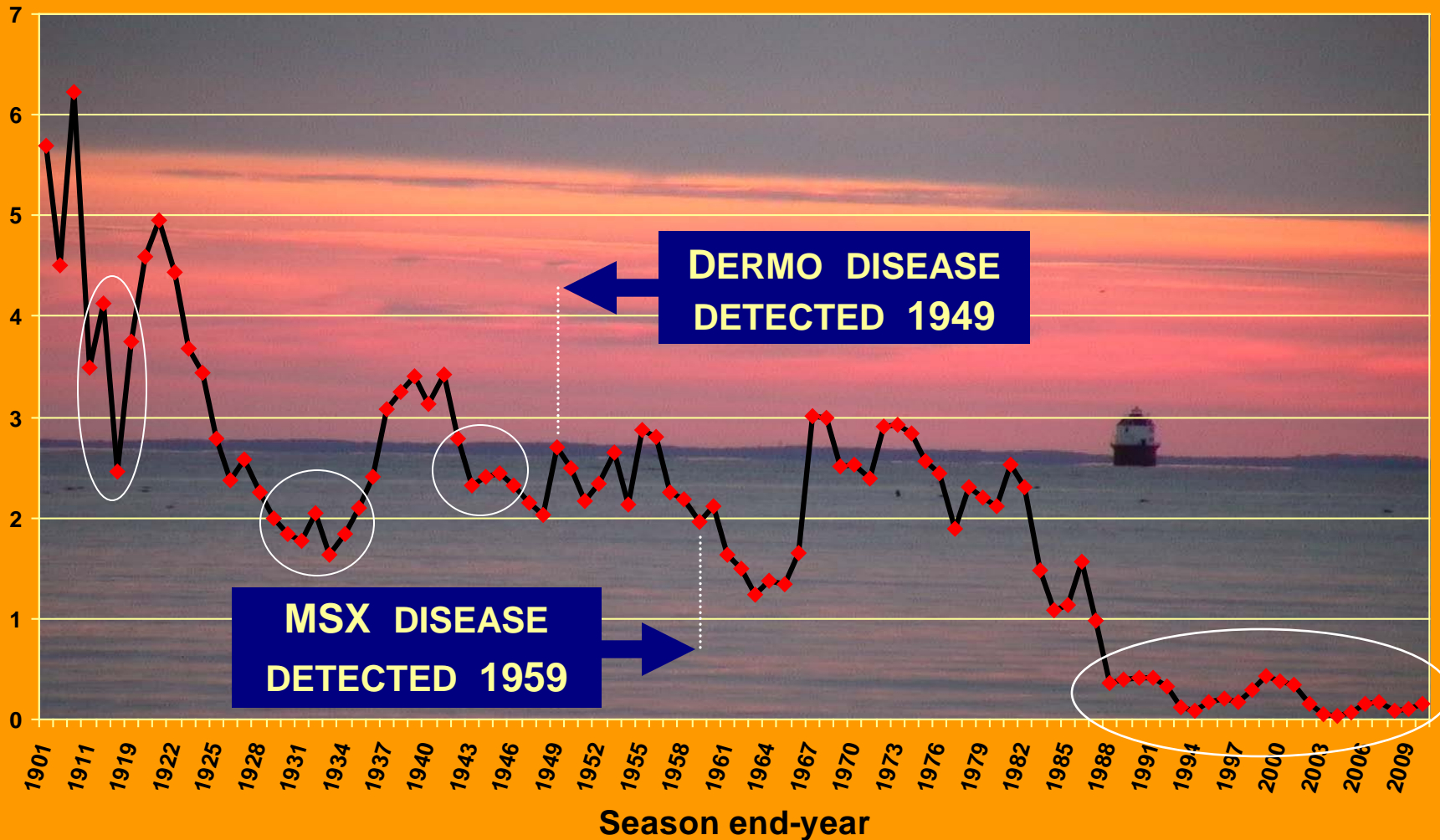
DISEASE DISTINCTIONS

- Human pathogens may be associated with oysters, without causing diseases among those oysters.
- Two protozoan pathogens cause lethal MSX and dermo diseases among Maryland oysters, but do not affect humans.
- This presentation is about oyster diseases, rather than human diseases.

WHY OYSTER
AQUACULTURE IN
MARYLAND WATERS ?

MARYLAND OYSTER HARVESTS 1901 - 2010

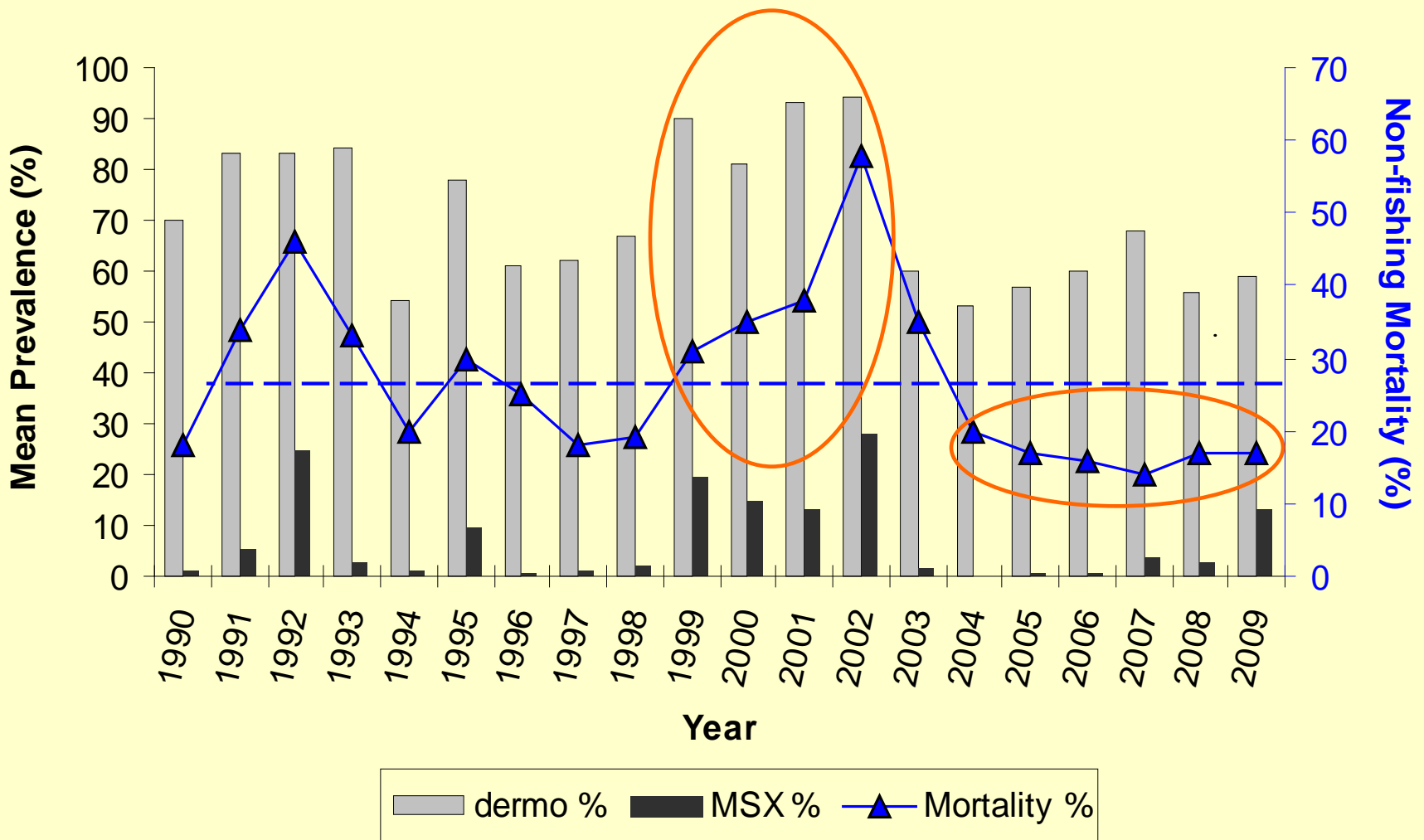
Million bushels



OYSTER DISEASES &
OYSTER PATHOGENS IN
MARYLAND WATERS

MARYLAND CHESAPEAKE BAY: 1990 – 2009

ANNUAL PREVALENCES FOR MSX AND DERMO DISEASES vs. NON-FISHING OYSTER MORTALITY



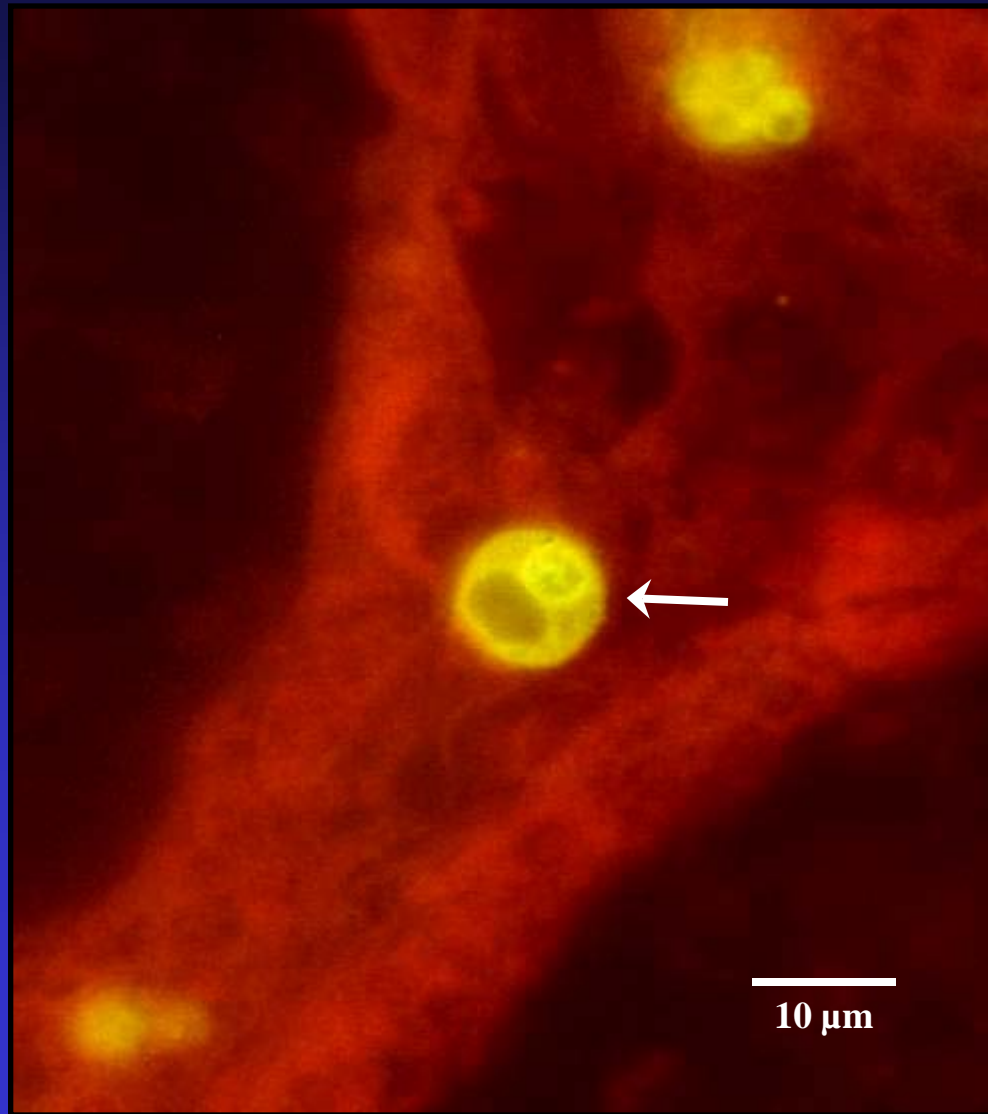
DERMO DISEASE

PERKINSUS MARINUS

OYSTER DERMO DISEASE IS CAUSED BY

Perkinsus marinus, the green-fluorescent protozoan pathogen shown infecting red-fluorescent oyster digestive tissues here.

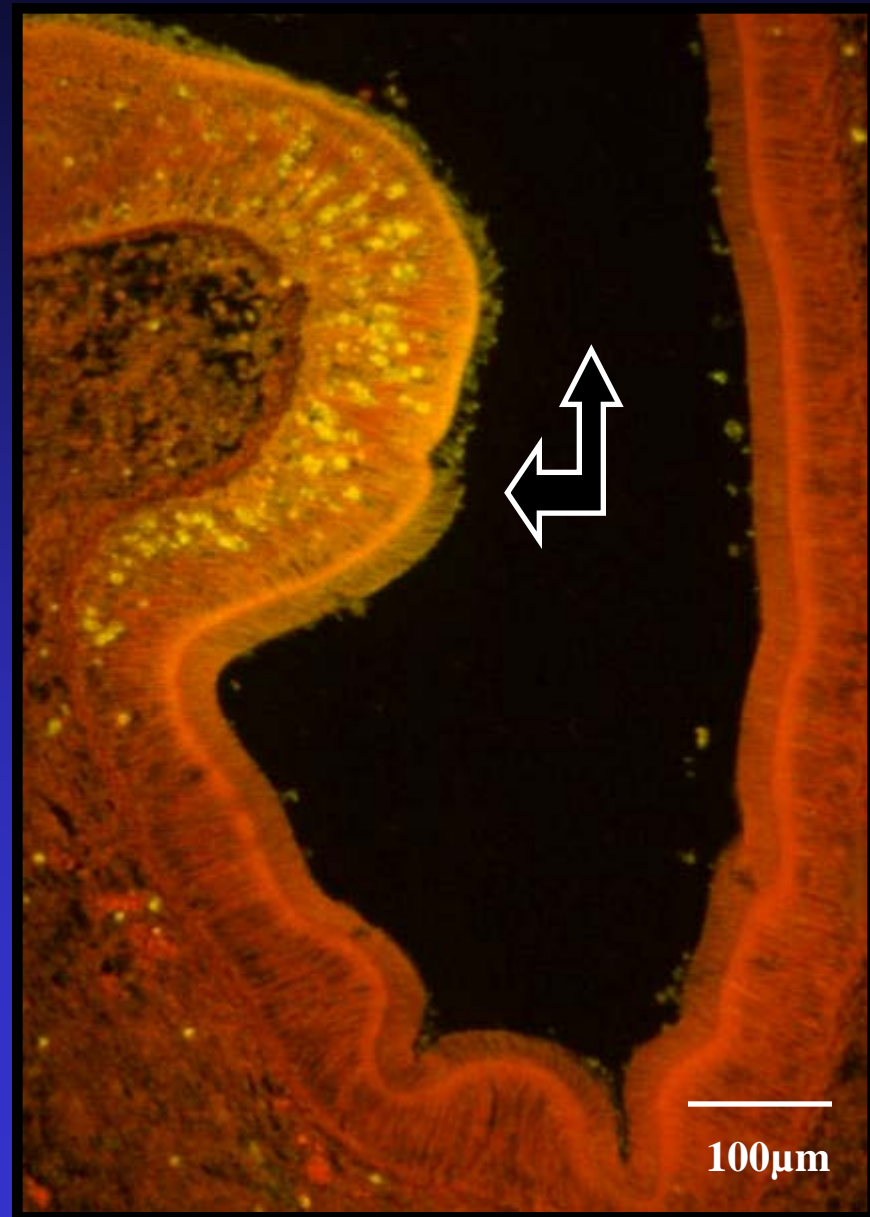
The largest, central pathogen cell is the same size as a human blood cell. It shows an unstained vacuole and a brightly stained nucleus.



DERMO DISEASE IN OYSTER STOMACH

A moderate *P. marinus* lesion with many parasite cells (yellow-green) in an oyster stomach lining (red).

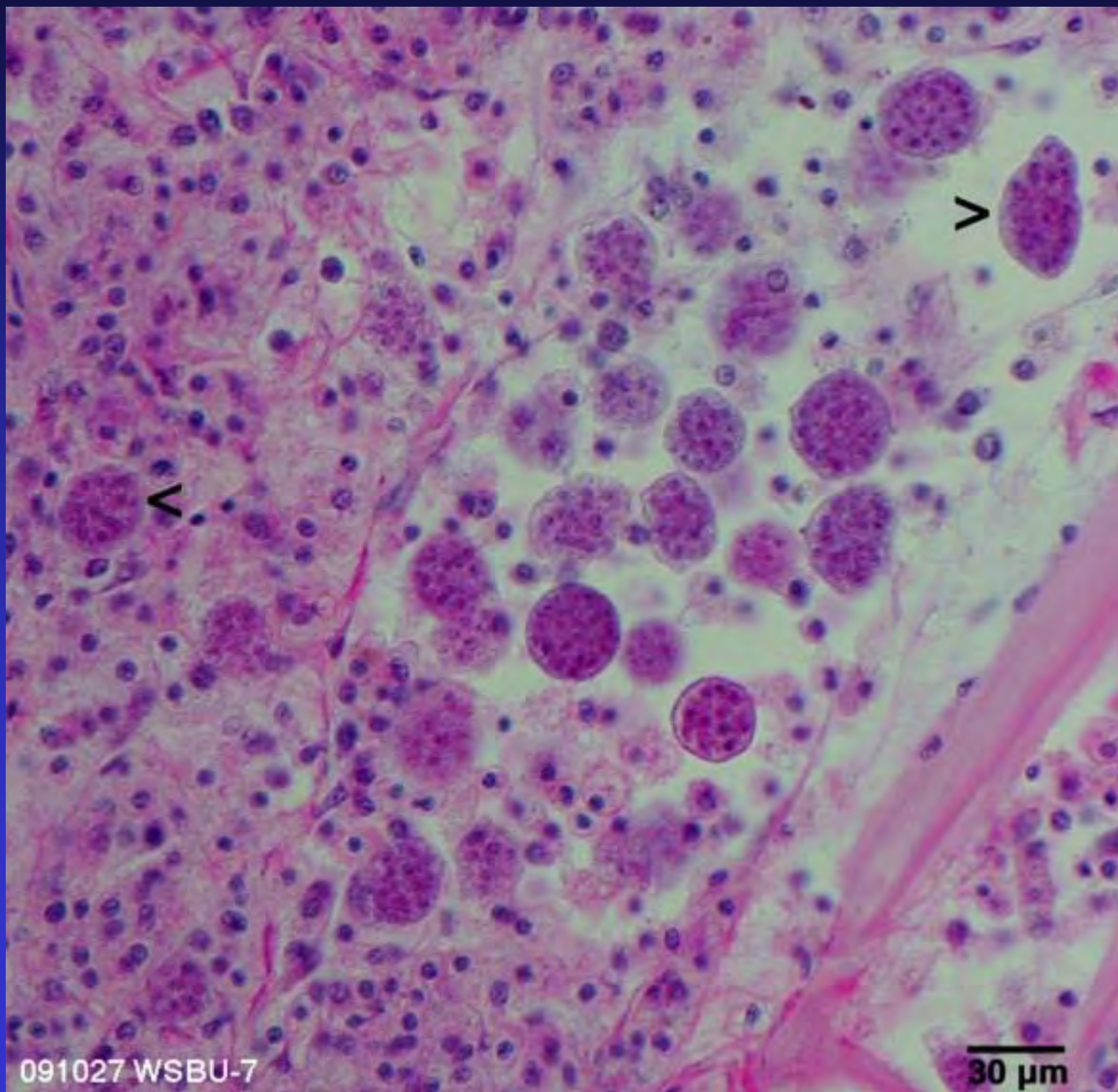
The interior of the (empty) stomach is black here, and the ciliated border of the stomach lining is damaged where infected.



MSX DISEASE

HAPLOSPORIDIUM NELSONI

MSX DISEASE - PLASMODIA



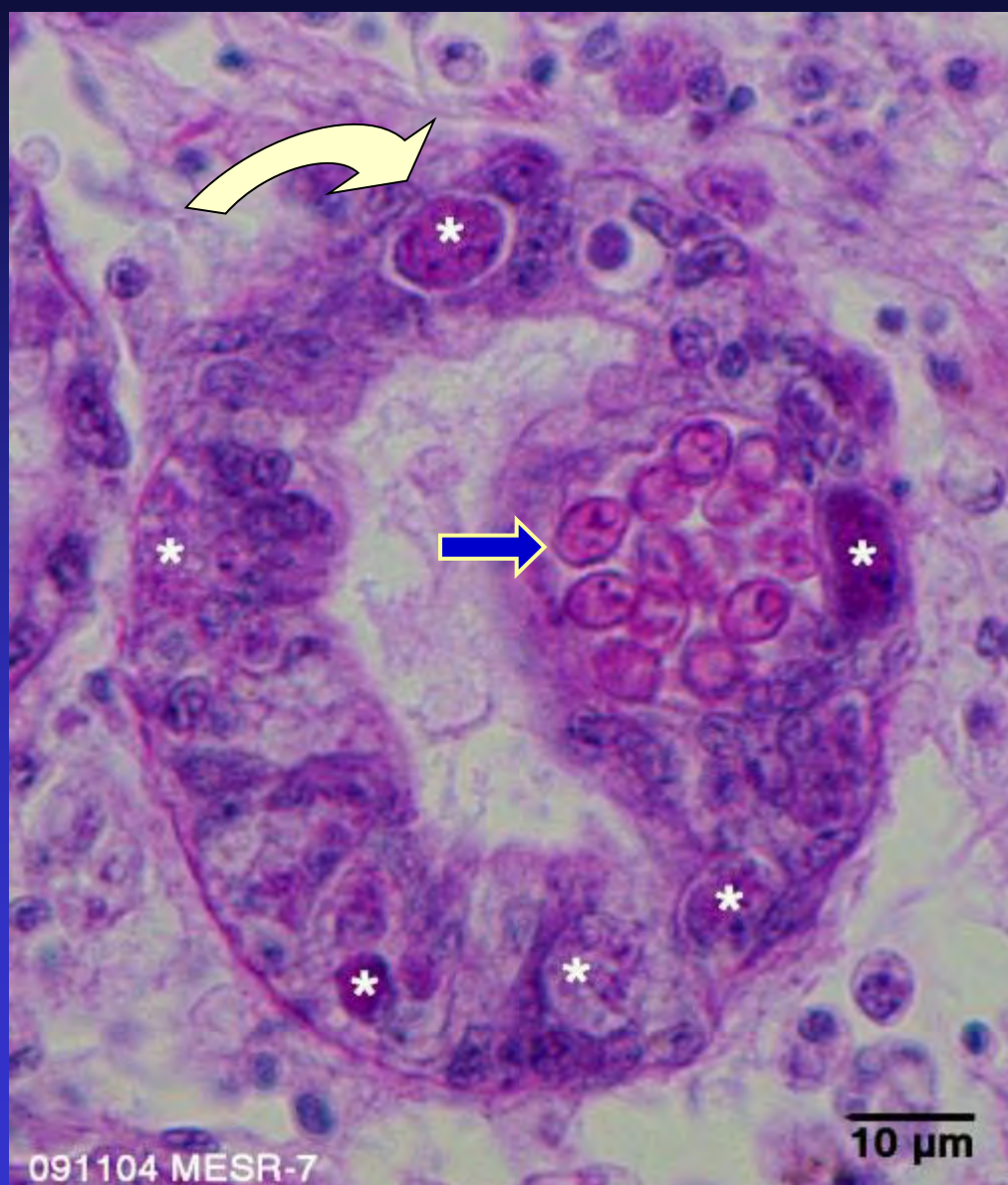
Large plasmodia > with multiple nuclei (violet dots) crowd smaller oyster cells in and around a gill vein.

MSX

**Multi-nucleated
Sphere**

X (= unknown)

MSX DISEASE - SPORES



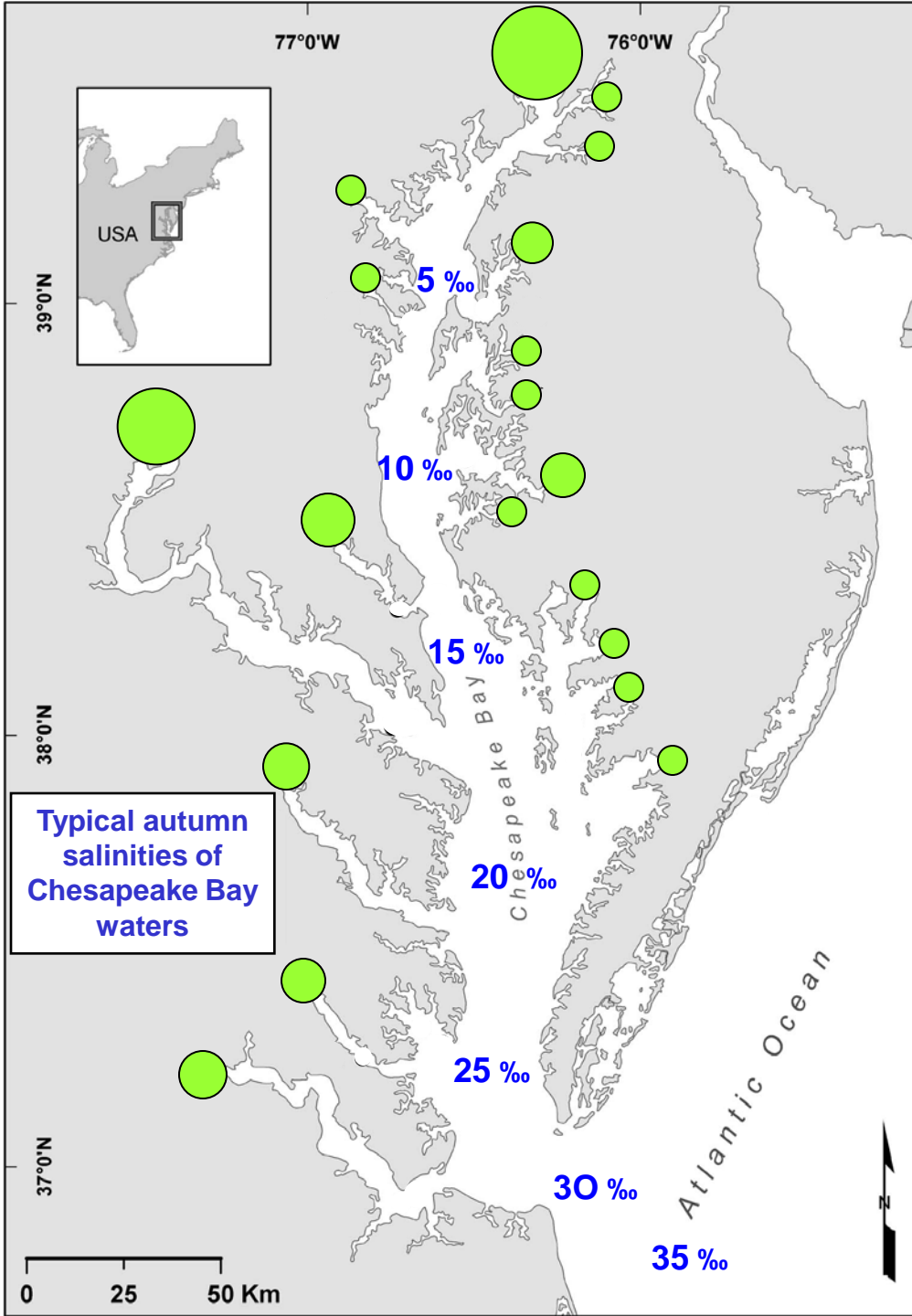
**CIRCULATING MSX
PLASMODIA (*) MAY
INVADE THE FOOD-
ABSORBING EPITHELIA
OF DIGESTIVE GLAND
TUBULES TO FORM
SPORES (⇒).**

BOTH MSX AND DERMO DISEASE
KILL OYSTERS WHEN THEIR
PATHOGENS PROLIFERATE TO REACH
EXTREMELY HIGH DENSITIES IN THE
TISSUES OF INFECTED OYSTERS.

MODULATING FACTORS FOR OYSTER DISEASES & MORTALITIES

- WATER TEMPERATURE
- WATER SALINITY
- MORTALITY SEASONS
- OYSTER AGE
- OYSTER RESISTANCE

ESTUARY WATERS



- Water salinities decrease from 35 ‰ to < 1 ‰, along upstream gradients from the ocean, and from the mainstem toward tributary headwaters.
- Salinities at specific locations vary dramatically between seasons and years, based on rainfall frequencies and volumes. ●
- Water temperatures vary seasonally from 0°C (32°F), up to 30°C (86°F) during summer.

MARYLAND OYSTER DISEASES AND PATHOGENS

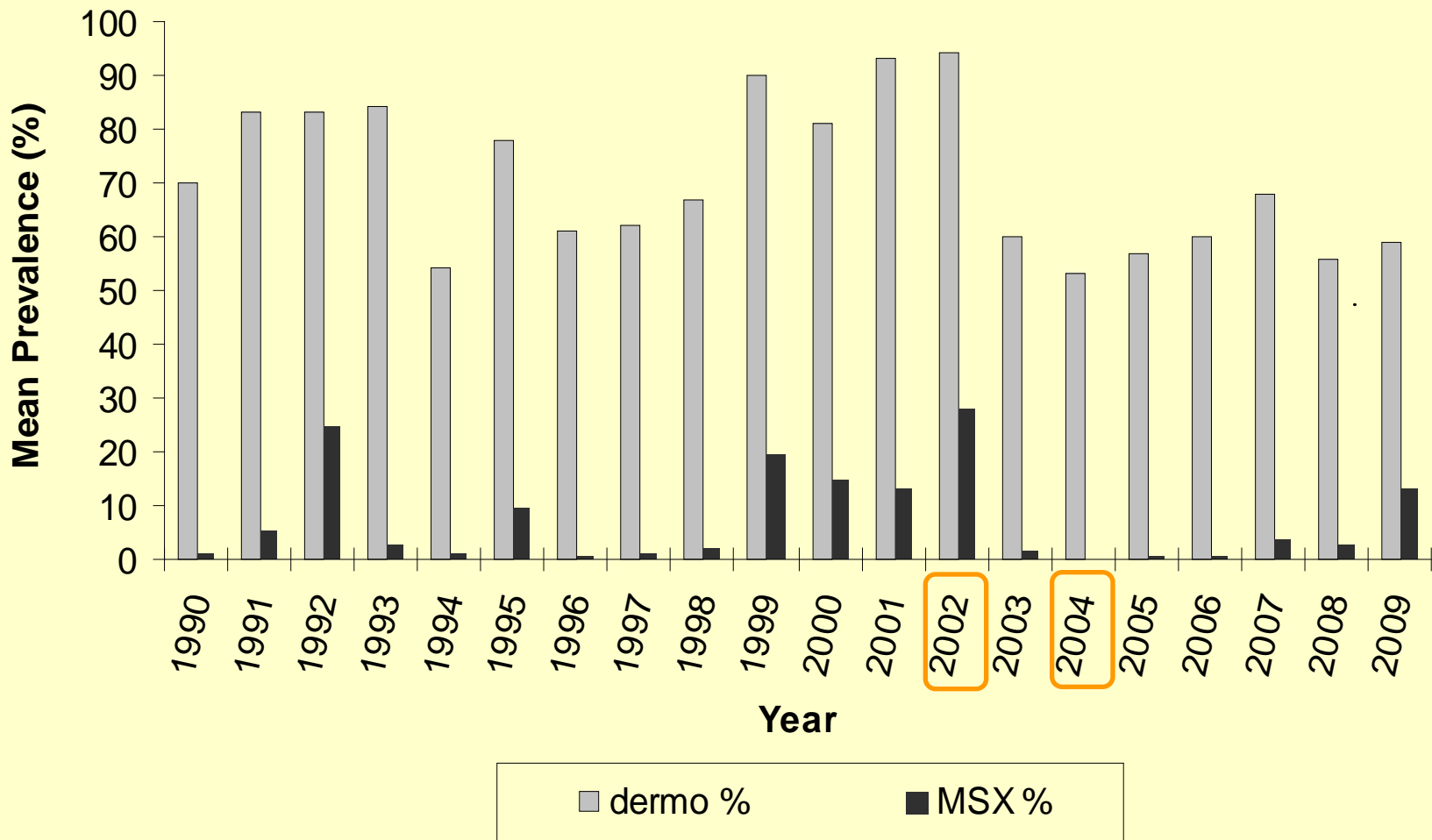
Protozoan Diseases	MSX	Dermo
Pathogen	<i>Haplosporidium nelsoni</i>	<i>Perkinsus marinus</i>
<u>Minimum salinity</u>	10 ‰	3 ‰
Optimum salinity	15 - 30 ‰	10 - 20 ‰
Optimum temp.	20 °C (May)	28 °C (August)
<u>Maximim pathology</u>	20 °C + >15 ‰	>25 °C + >9 ‰
Virulence	acute	acute or chronic
Transmission	mechanism unknown	direct between hosts

MARYLAND OYSTER DISEASES: MORTALITY IMPACTS

Protozoan Diseases	MSX	Dermo
Pathogen	<i>Haplosporidium nelsoni</i>	<i>Perkinsus marinus</i>
Optimum salinity	15 - 30 ‰	10 - 20 ‰
Optimum temp.	20 °C (May - June)	28 °C (July - October)
Maximum mortality	to 99%	to 99%
Affected ages	Spat - adults	Spat - adults
Mortality season	May – September	July - October

MARYLAND CHESAPEAKE BAY: 1990 – 2009

ANNUAL PREVALENCES FOR MSX AND DERMO DISEASES



DERMO DISEASE

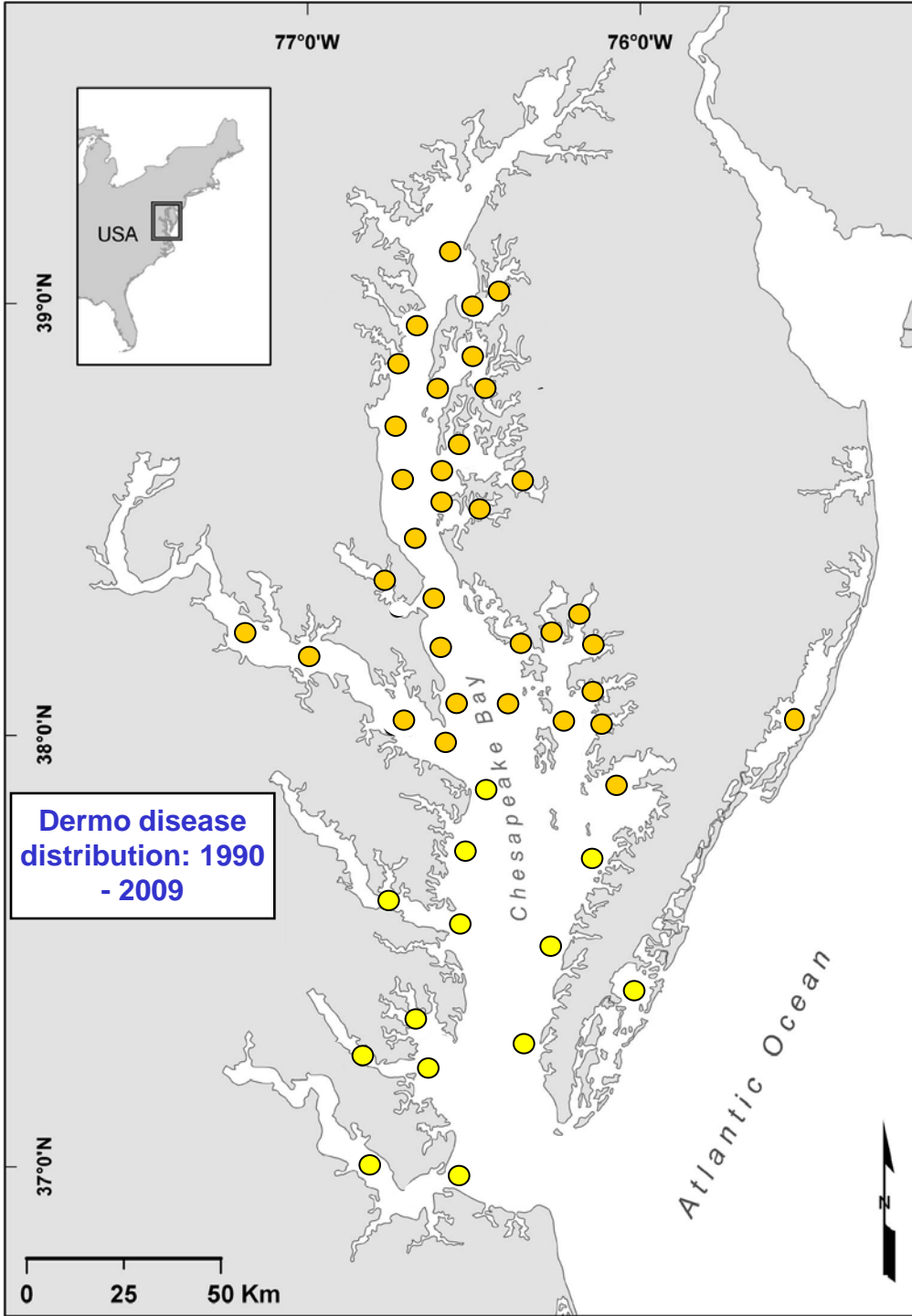
PERKINSUS MARINUS

ANNUAL MEAN PREVALENCE:

53% - 94%

DERMO DISEASE PATHOLOGY

- *Perkinsus marinus* prefers heat and salt. Maximum pathology occurs during August - October of drought years.
- Dermo disease is transmitted directly by infectious cells disseminated over long distances in the water, following their release among feces and decomposing tissues of live and dead infected oysters.
- Can be lethal in 2-4 weeks by overwhelming infections.
- Chronic infections may persist over years, during periods of low water salinities and/or temperatures.
- Modest resistance occurs among selectively bred and wild oysters.



DERMO DISEASE DISTRIBUTION IN MARYLAND WATERS ● 1990 – 2009

Dermo disease has been broadly and consistently distributed among oysters in Maryland tidal waters during recent decades.

MSX DISEASE

HAPLOSPORIDIUM NELSONI

ANNUAL MEAN PREVALENCE:

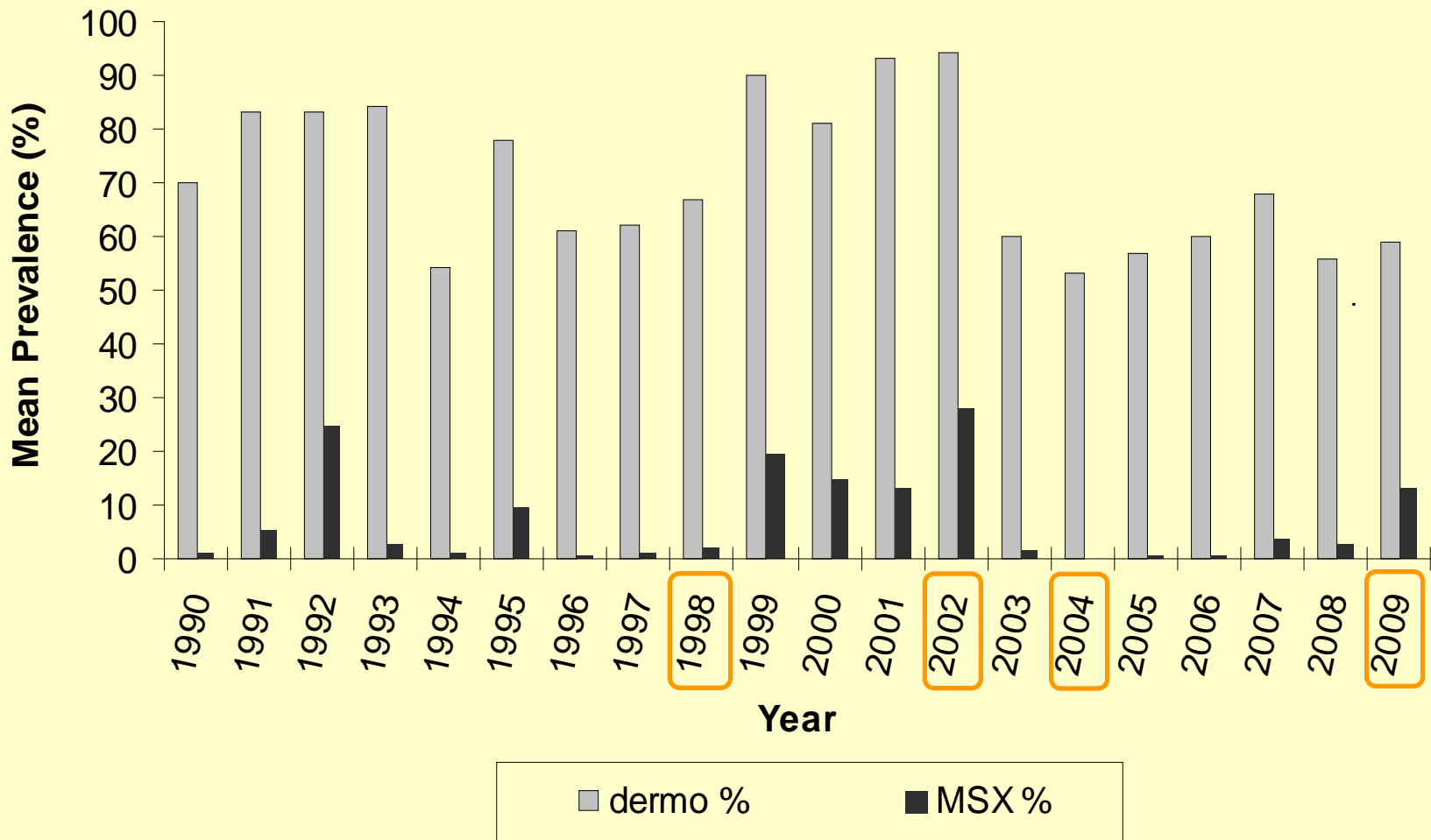
0.2% - 28%

MSX DISEASE PATHOLOGY

- *Haplosporidium nelsoni* likes heat, and requires salt. Maximum MSX disease pathology occurs during June-October of drought years.
- Disease transmission mechanism unknown. Apparently waterborne, but may require a non-oyster alternate host or vector.
- Lethal among naïve and non-resistant oysters in 3-5 weeks by overwhelming, seasonal infections during May-October.
- Undetected during periods of low salinities, but quickly re-occurs (months) when water salinities exceed 15 ‰.
- Strong resistance among wild Virginia and Delaware Bay oysters, and among artificially selected hatchery oysters.

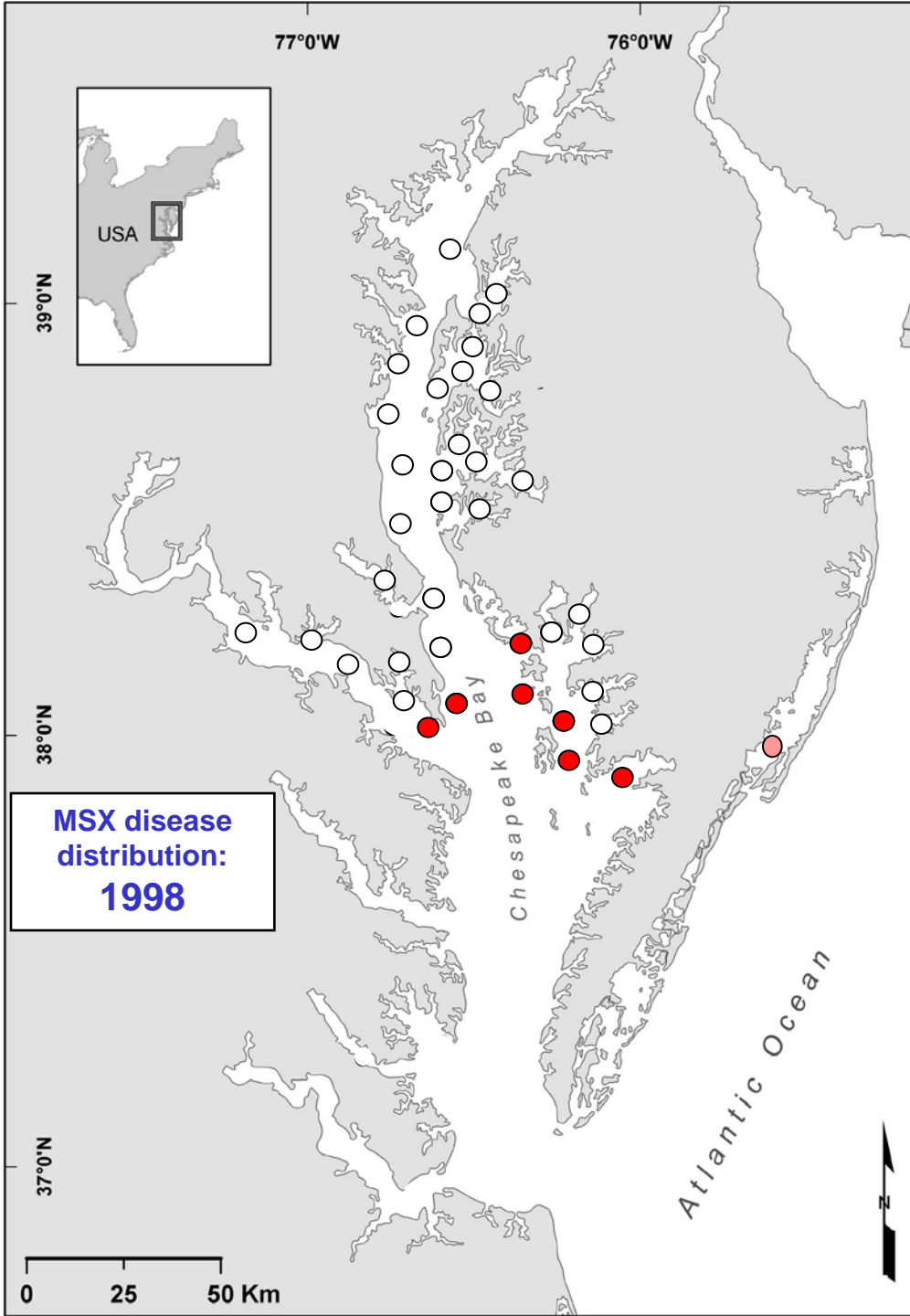
MARYLAND CHESAPEAKE BAY: 1990 – 2009

ANNUAL PREVALENCES FOR MSX AND DERMO DISEASES



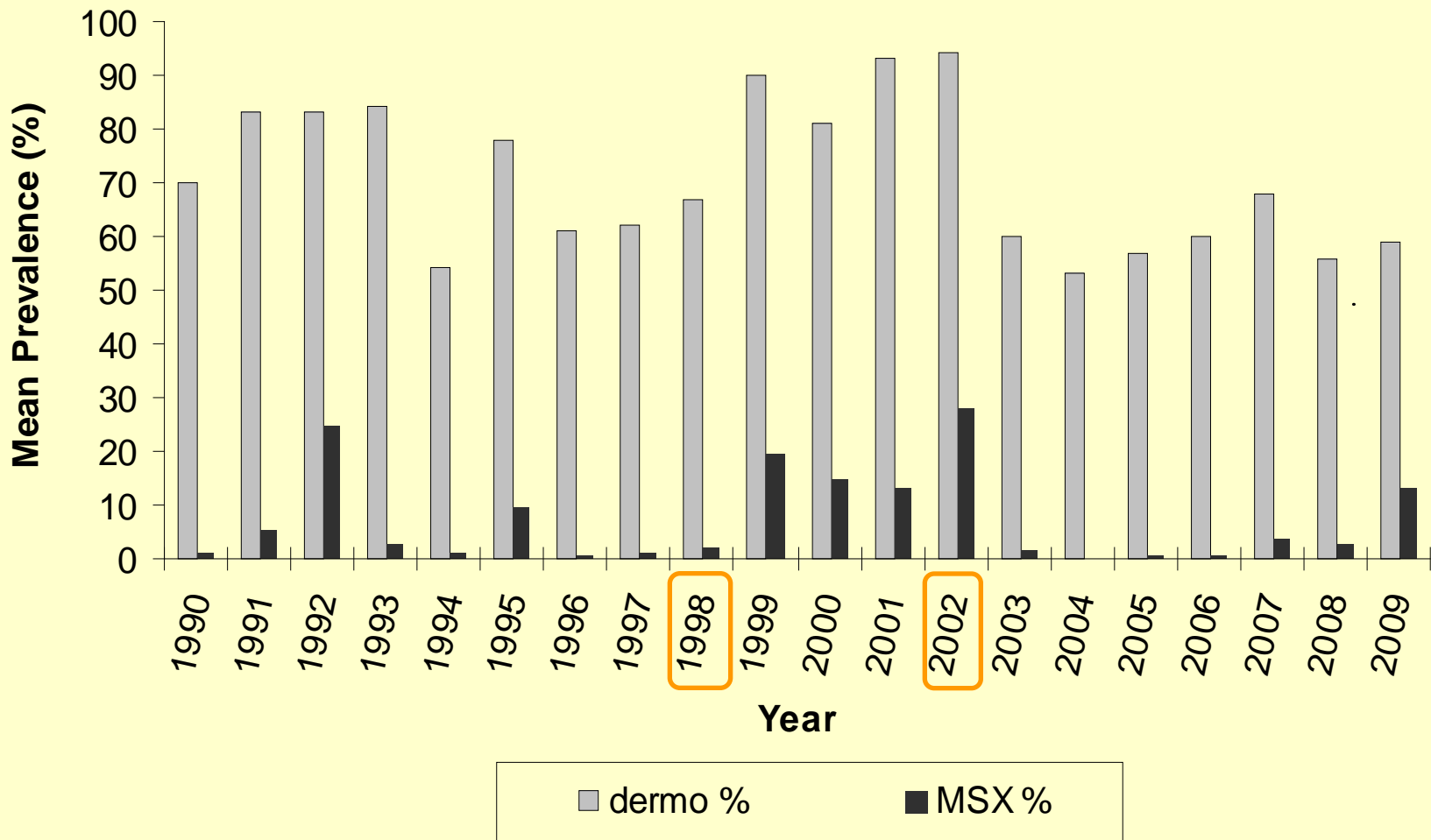
MSX DISEASE DISTRIBUTION IN MARYLAND WATERS ● 1998

During 1998, MSX disease occurred in a near-minimum historic range, and only at high-salinity sites.



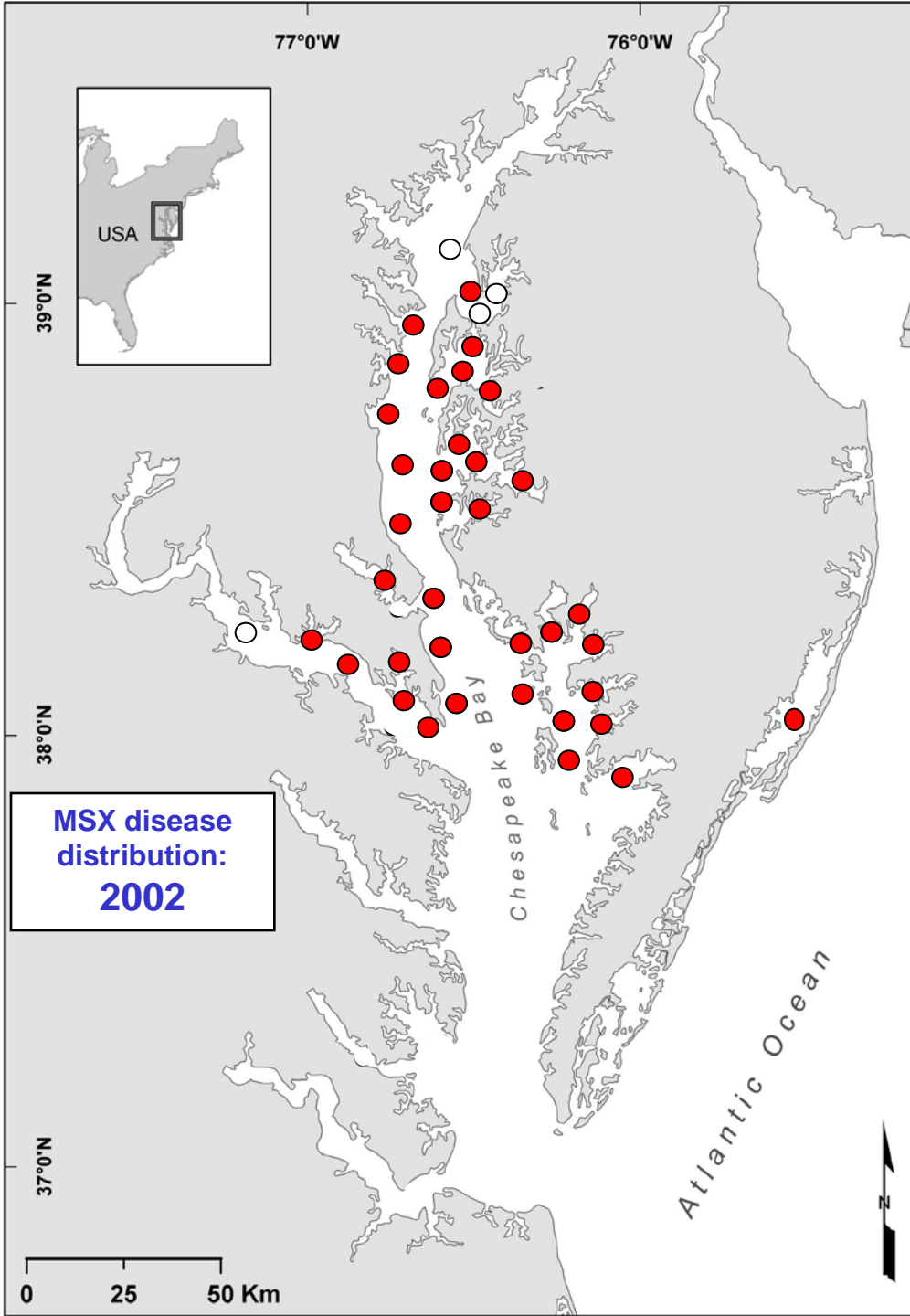
MARYLAND CHESAPEAKE BAY: 1990 – 2009

ANNUAL PREVALENCES FOR MSX AND DERMO DISEASES



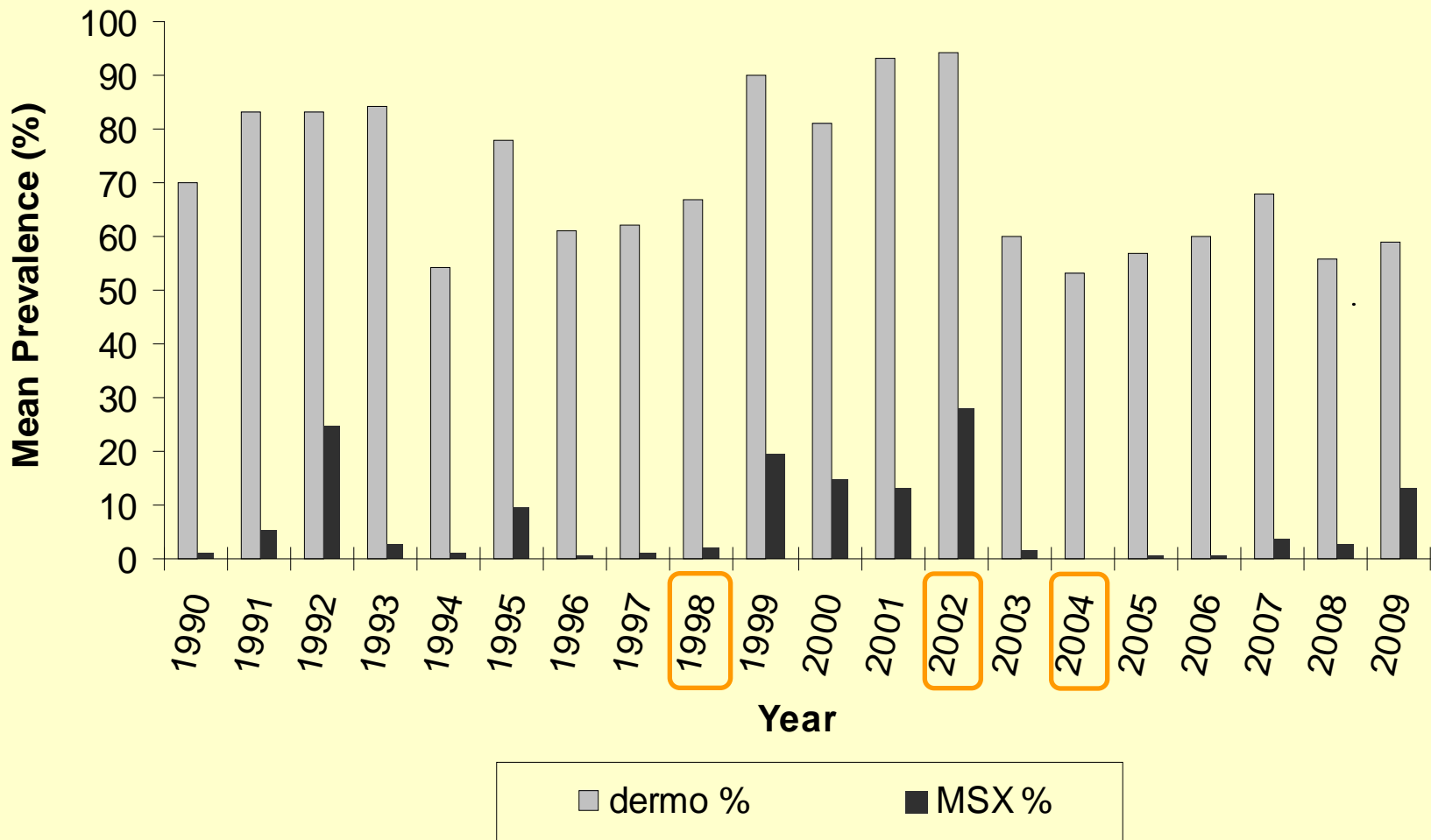
MSX DISEASE DISTRIBUTION IN MARYLAND WATERS ● 2002

After the 4th year of drought conditions (1999-2002), MSX disease occurred at its maximum historic range during 2002.



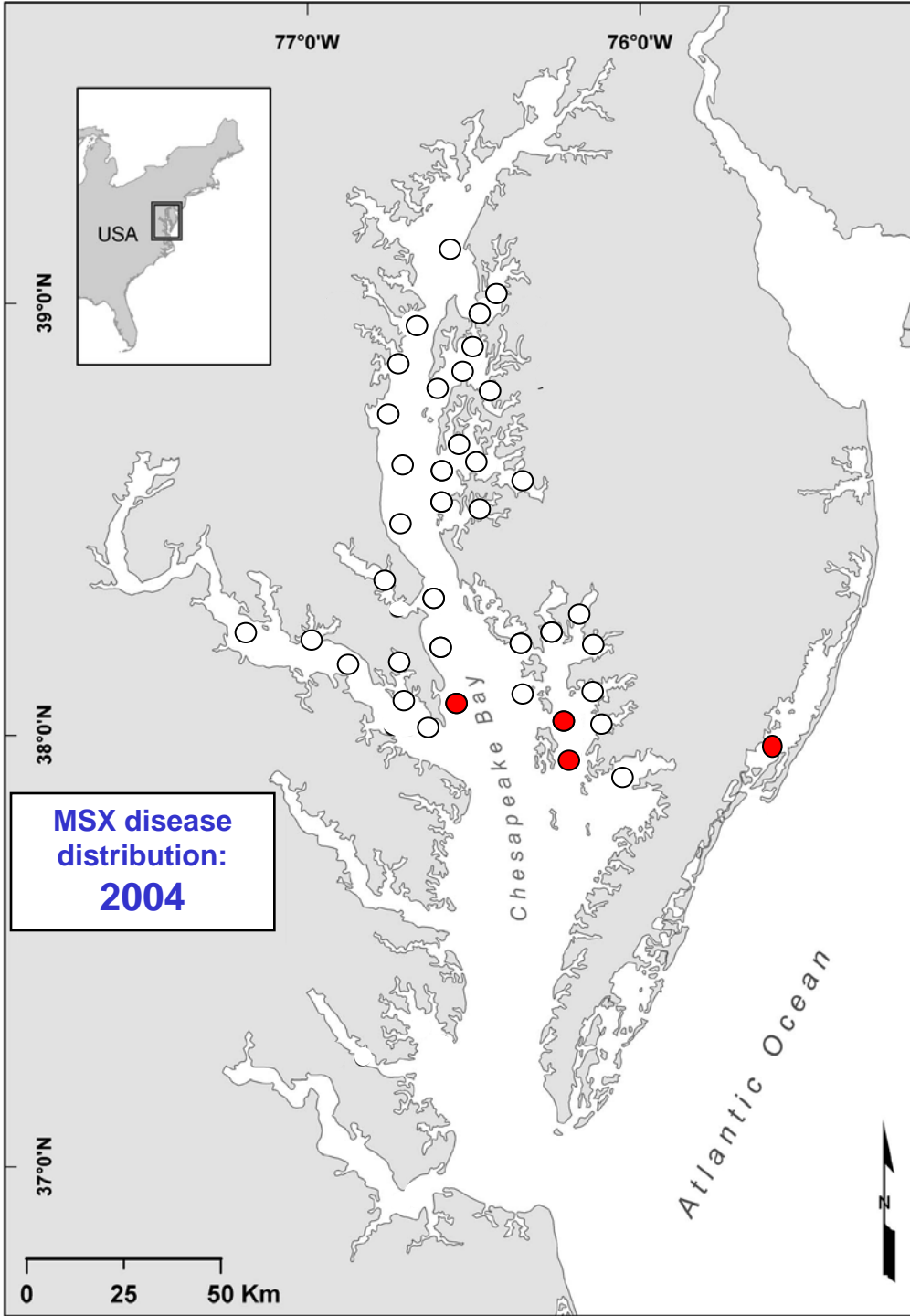
MARYLAND CHESAPEAKE BAY: 1990 – 2009

ANNUAL PREVALENCES FOR MSX AND DERMO DISEASES



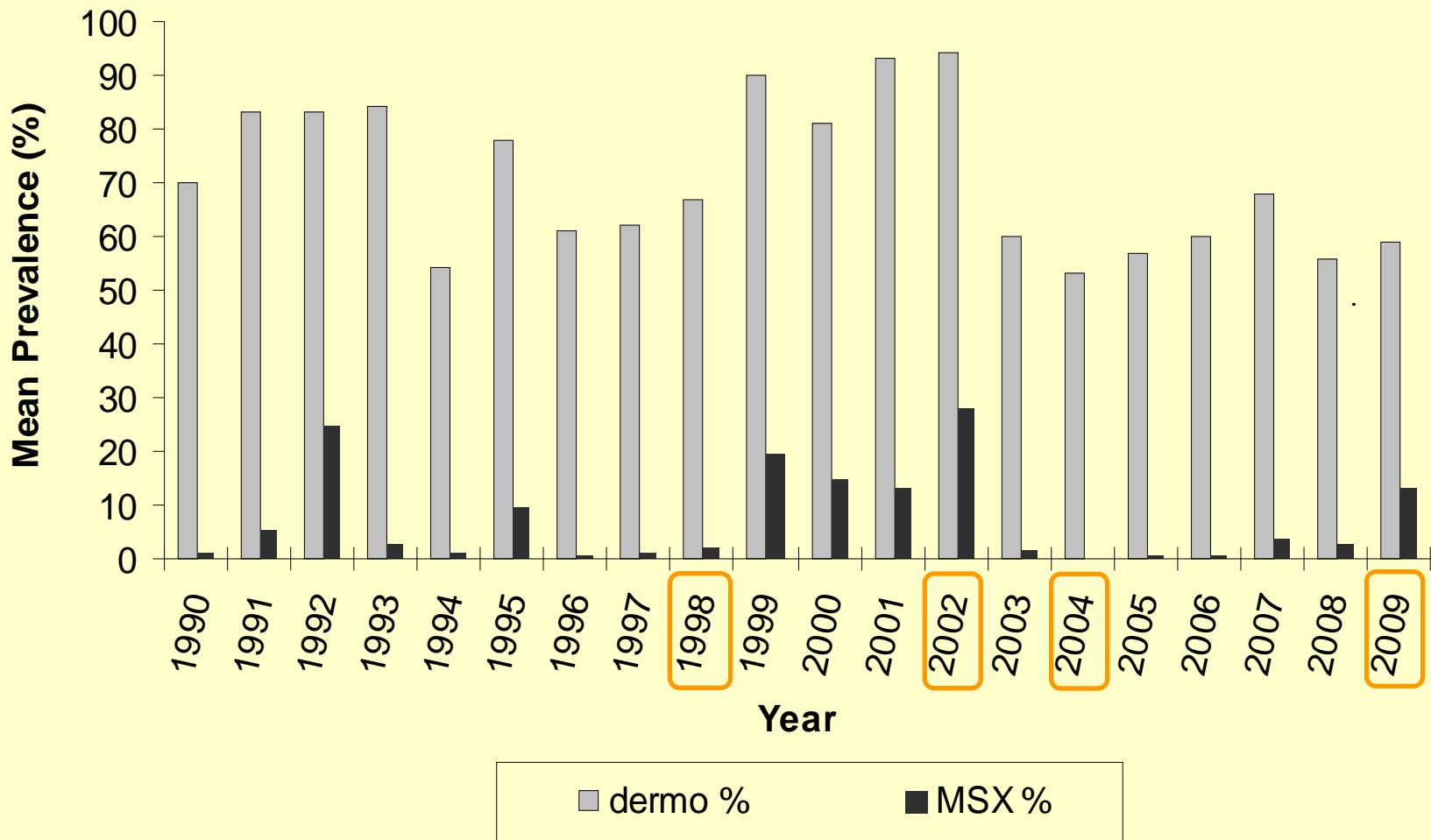
MSX DISEASE DISTRIBUTION IN MARYLAND WATERS ● 2004

During 2004, MSX disease occurred in a minimum historic range; only at high-salinity sites.



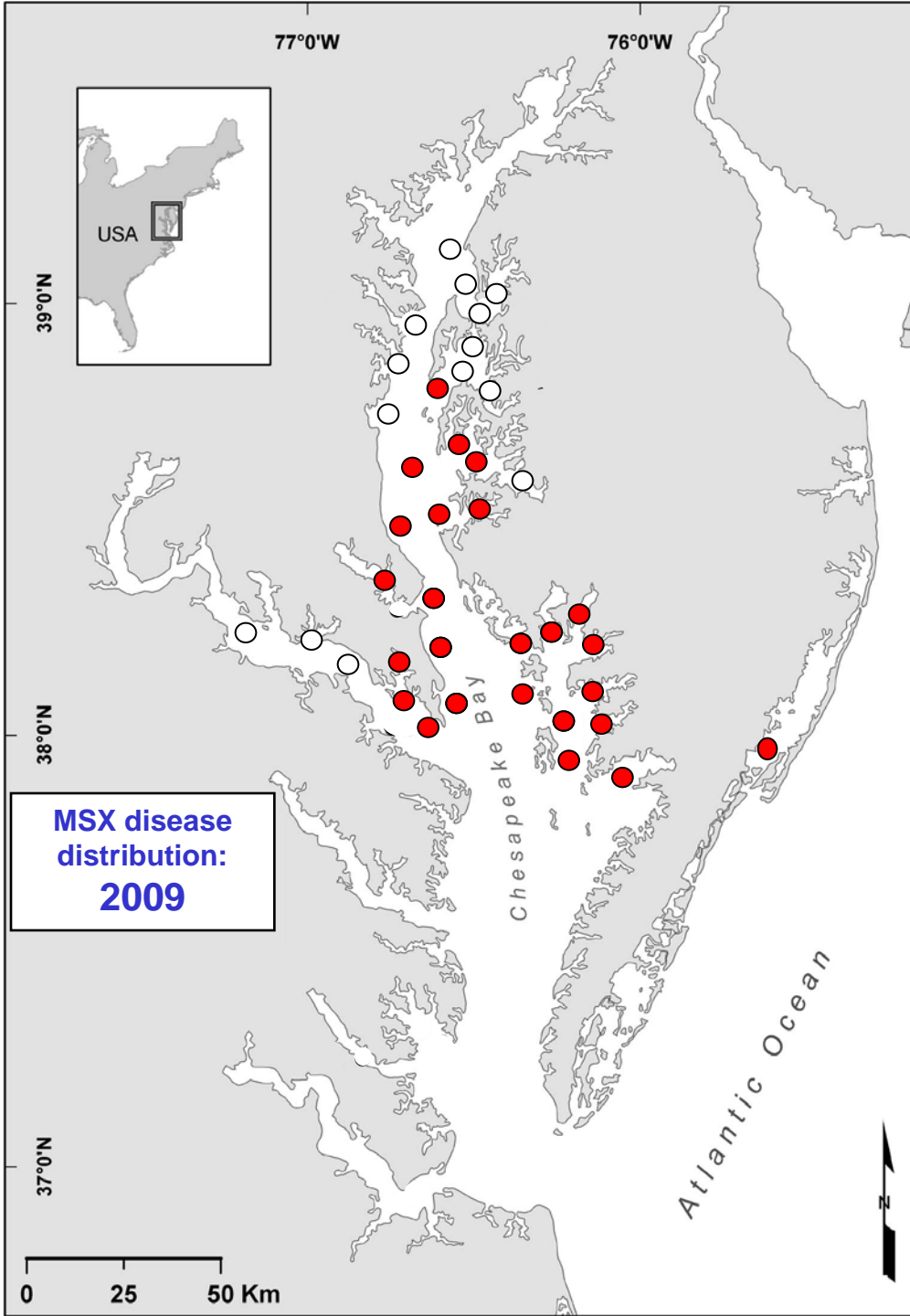
MARYLAND CHESAPEAKE BAY: 1990 – 2009

ANNUAL PREVALENCES FOR MSX AND DERMO DISEASES



MSX DISEASE DISTRIBUTION IN MARYLAND WATERS ● 2009

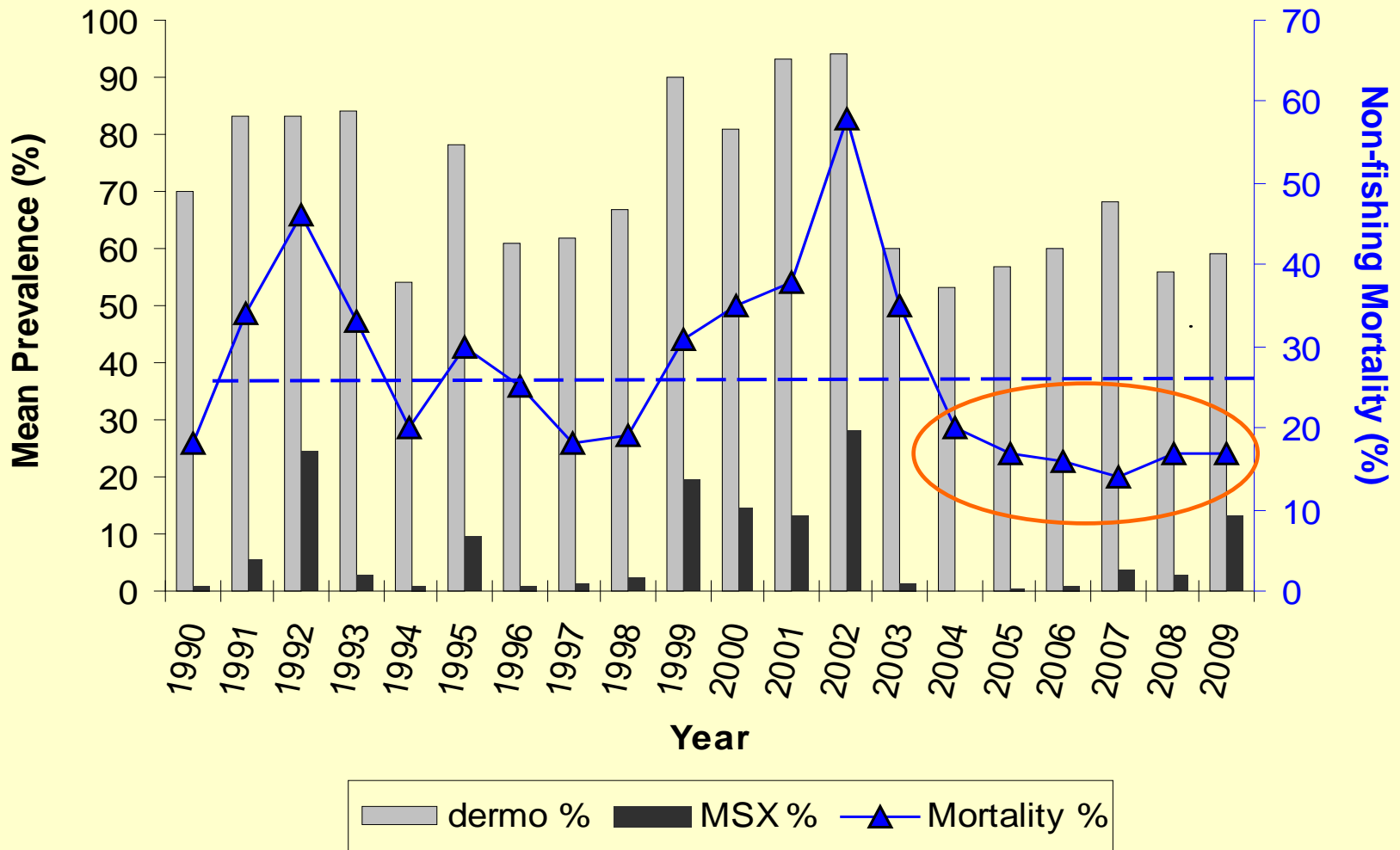
After 6 recent years (2003 - 2008) of nominal prevalences and restricted distributions, the distribution and mean prevalence for MSX disease expanded significantly during 2009, without an increase in mortality among wild oysters.



1990 – 2009 MARYLAND

NON-FISHING OYSTER MORTALITY vs.

ANNUAL PREVALENCES FOR MSX AND DERMO DISEASES



OYSTER MORTALITIES VS. DISEASE PRESSURES: 2003 - 2009

- **Measures for dermo disease were consistently moderate during 2003-2009.**
- **Measures for MSX disease were nominal during 2003-2009, but increased during 2009.**
- **Moderate oyster mortalities of 17-20% during 2003-2008, remained low at 17% during 2009.**
- **Moderate mortalities in the face of variable 2003-2009 disease pressures, may reflect enhanced disease resistances among survivors of the 1999-2002 drought, and their progeny.**

RESISTANCE TO MSX DISEASE

- Resistance to MSX disease is widespread among wild Virginia and New Jersey oyster populations that are consistently selected by MSX disease.

Intermittently selected Maryland wild oysters remain susceptible to MSX disease, in general.

- Strong resistance or tolerance to MSX disease has been achieved by selective breeding of hatchery oyster lines since the 1970s.

Oysters derived from the DEBY lineage have performed well in field trials in both Virginia and Maryland waters that are endemic for MSX disease.

RESISTANCE TO DERMO DISEASE

- In dermo disease-endemic Virginia waters, some large oysters have survived consistent dermo disease selection, when protected from fishing mortality.

These large oysters show lower infection intensities than smaller sympatric oysters, and may represent valuable, disease-resistant parent stocks for passive and active oyster population restoration.

- Several disease-resistant or –tolerant *C. virginica* oyster strains have been developed by selective breeding. Oysters derived from the DEBY lineage have performed well in field trials in both Virginia and Maryland waters that are endemic for MSX disease, dermo disease, or both.

MANAGING CULTURED
OYSTER PRODUCTION IN
MARYLAND WATERS,
TO MINIMIZE DISEASE
IMPACTS

THERE ARE PREVENTION
AND MANAGEMENT
OPTIONS.

THERE ARE NO CURES
FOR DERMO AND MSX
DISEASES.

MODULATING FACTORS FOR OYSTER DISEASES & MORTALITIES

- WATER TEMPERATURE
- WATER SALINITY
- MORTALITY SEASONS
- OYSTER AGE
- OYSTER RESISTANCE

KNOW THE PHYSICAL AND DISEASE PROFILES AT YOUR SITE(S)

- WATER SALINITY ‰ = PPT (PARTS PER THOUSAND)
- TEMPERATURE °C OR °F
- OYSTER DISEASE TRENDS

www.dnr.state.md.us/fisheries/commercial/oysters/fallsurvey

WATER SALINITY REFRACTOMETER



- \$130 - \$450
- Automatic temperature compensation
- 0 - 100 ‰ (0 - 10 %)
- Leica, Reichert, Atago, Fisher

SELECT SHELLSTOCKS FOR GROWTH AND SURVIVAL

- **TRIPLOID vs. DIPLOID**
 - GROWTH
 - SURVIVAL
- **DISEASE RESISTANCE**
 - GROWTH
 - SURVIVAL

QUESTIONS ?

