Status of Big Bend oyster populations The view from deep history

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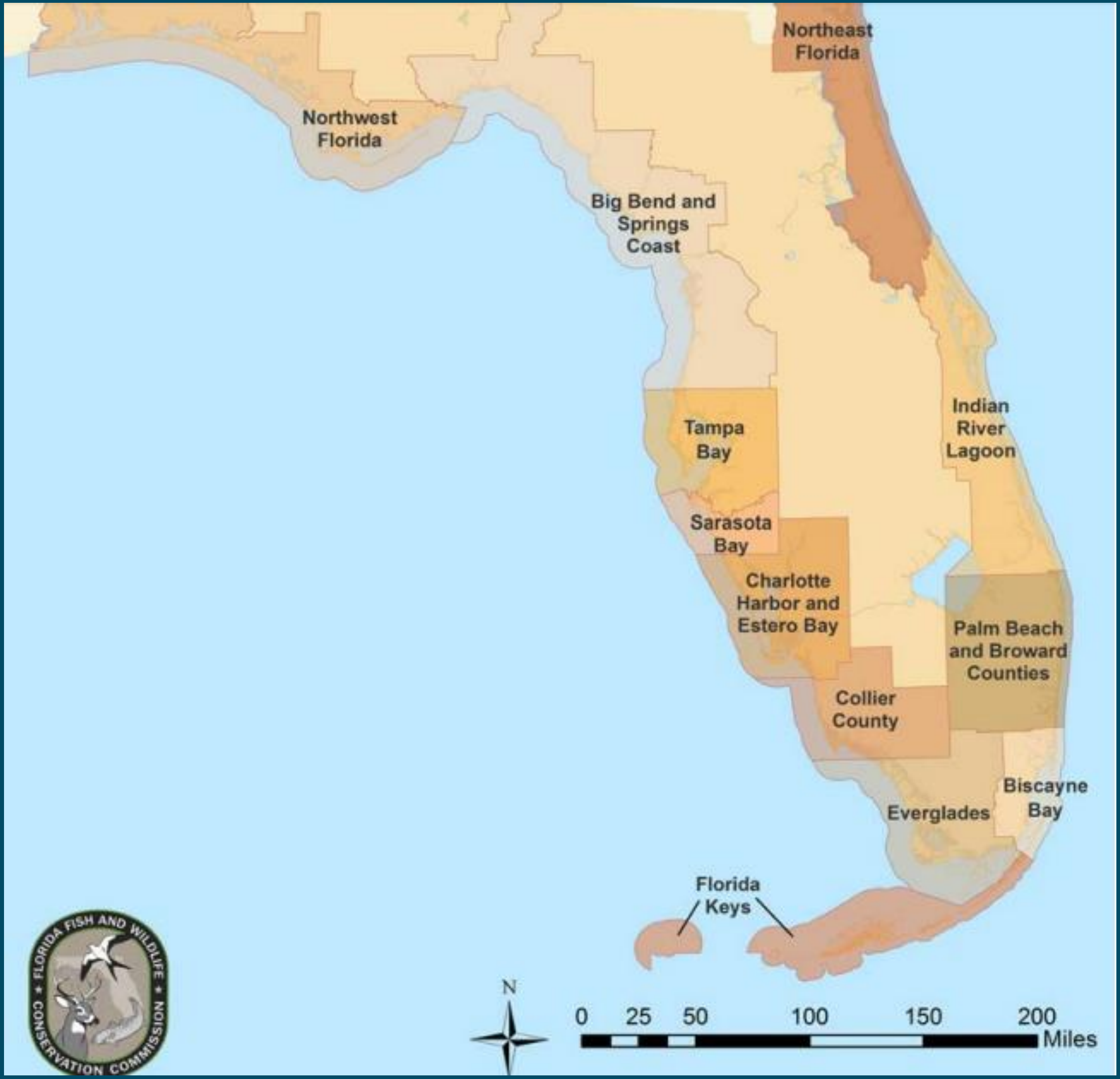


http://myfwc.com/media/4242314/chimmp2017-chapter01-introduction.pdf

"Florida's Big Bend coastline (Gulf of Mexico coast from Crystal River to Apalachee Bay) supports large expanses of oyster reef habitat that have existed for thousands of years in a region that is one of the most pristine coastal zones in the continental US."

Seavey, J.R., et al., 2011. Decadal changes in oyster reefs in the Big Bend of Florida's Gulf Coast. *Ecosphere*, *2:*1-14

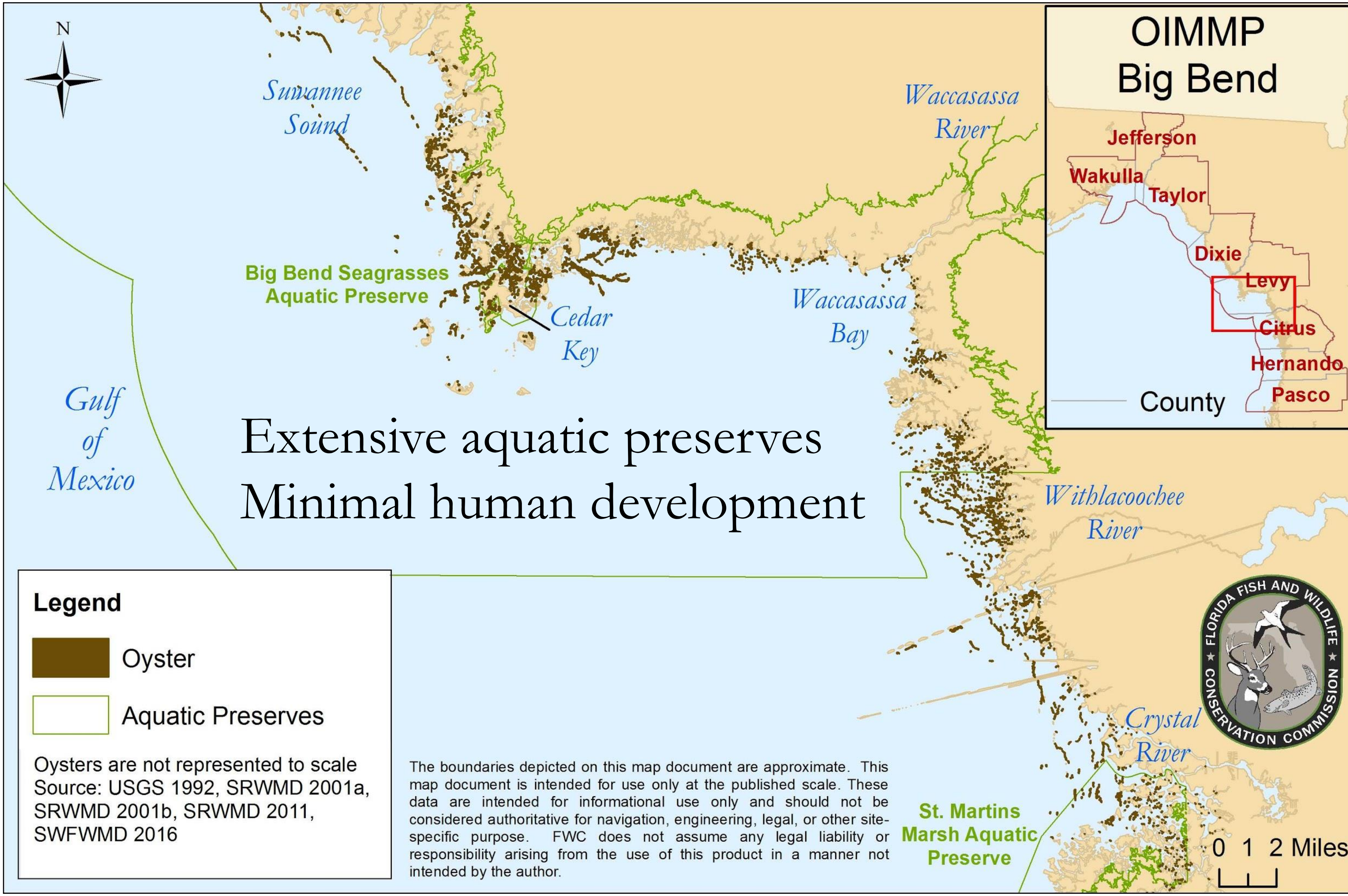
"It is worth noting that not all estuaries have suffered decline in either oyster extent or biomass since our approximate 1900 baseline; two estuaries (Apalachicola Bay, FL; Sabine Lake, TX and LA) showed stable or even increasing extent and biomass on oyster grounds."

Zu Ermgassen, P.S. et al., 2012. Historical ecology with real numbers: past and present extent and biomass of an imperilled estuarine habitat. *Proc. R. Soc. B*, *279*(1742), pp.3393-3400.

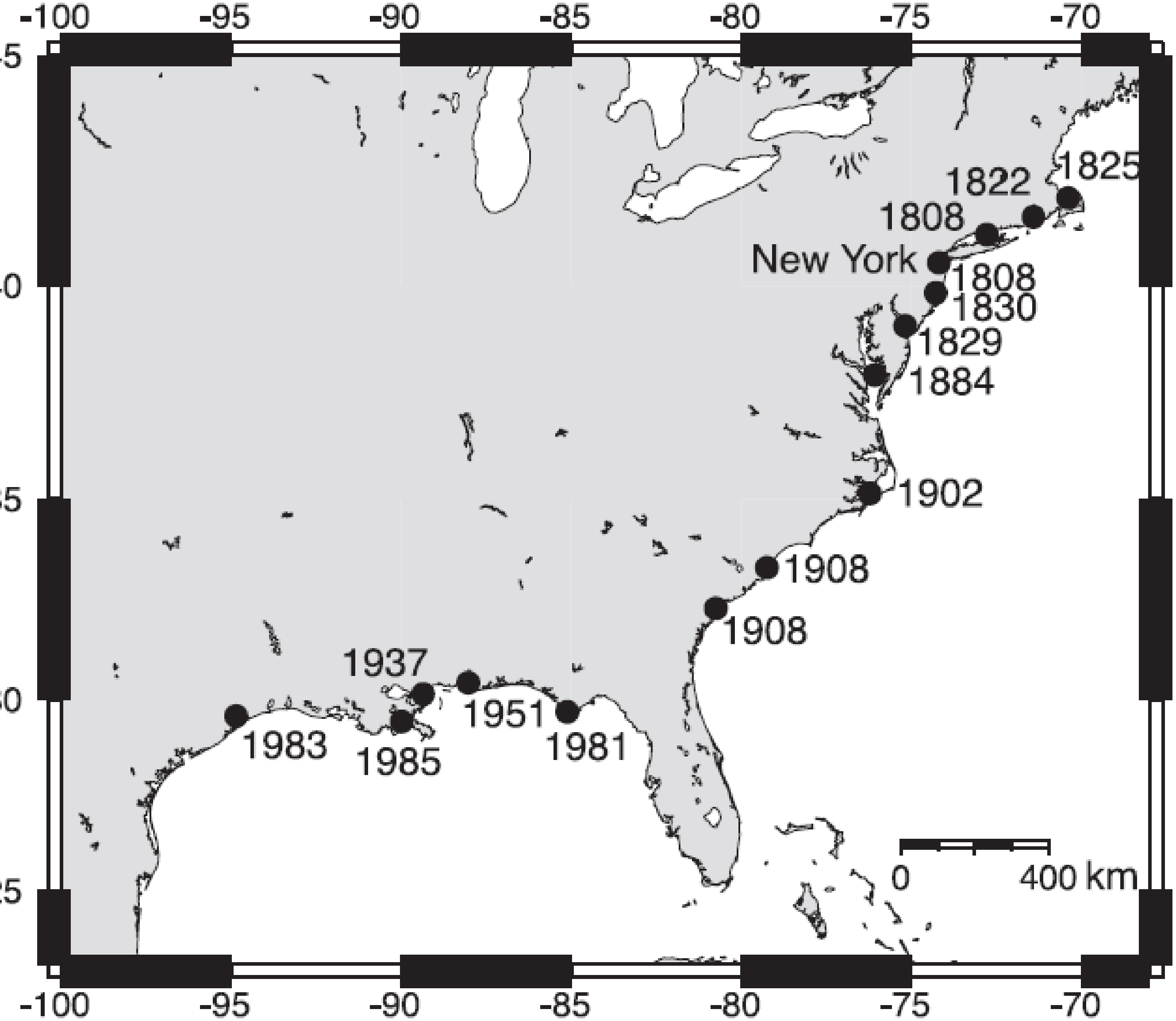
"In contrast to the situation on the Atlantic Coast, it is noteworthy that for Apalachicola Bay in the Gulf of Mexico, we estimate present day levels of filtration that are greater than historic estimates."

Zu Ermgassen, P.S., et al., 2013. Quantifying the loss of a marine ecosystem service: filtration by the eastern oyster in US estuaries. Estuaries and coasts, 36(1), pp.36-43.

Extensive aquatic preserves
Minimal human development




19G211

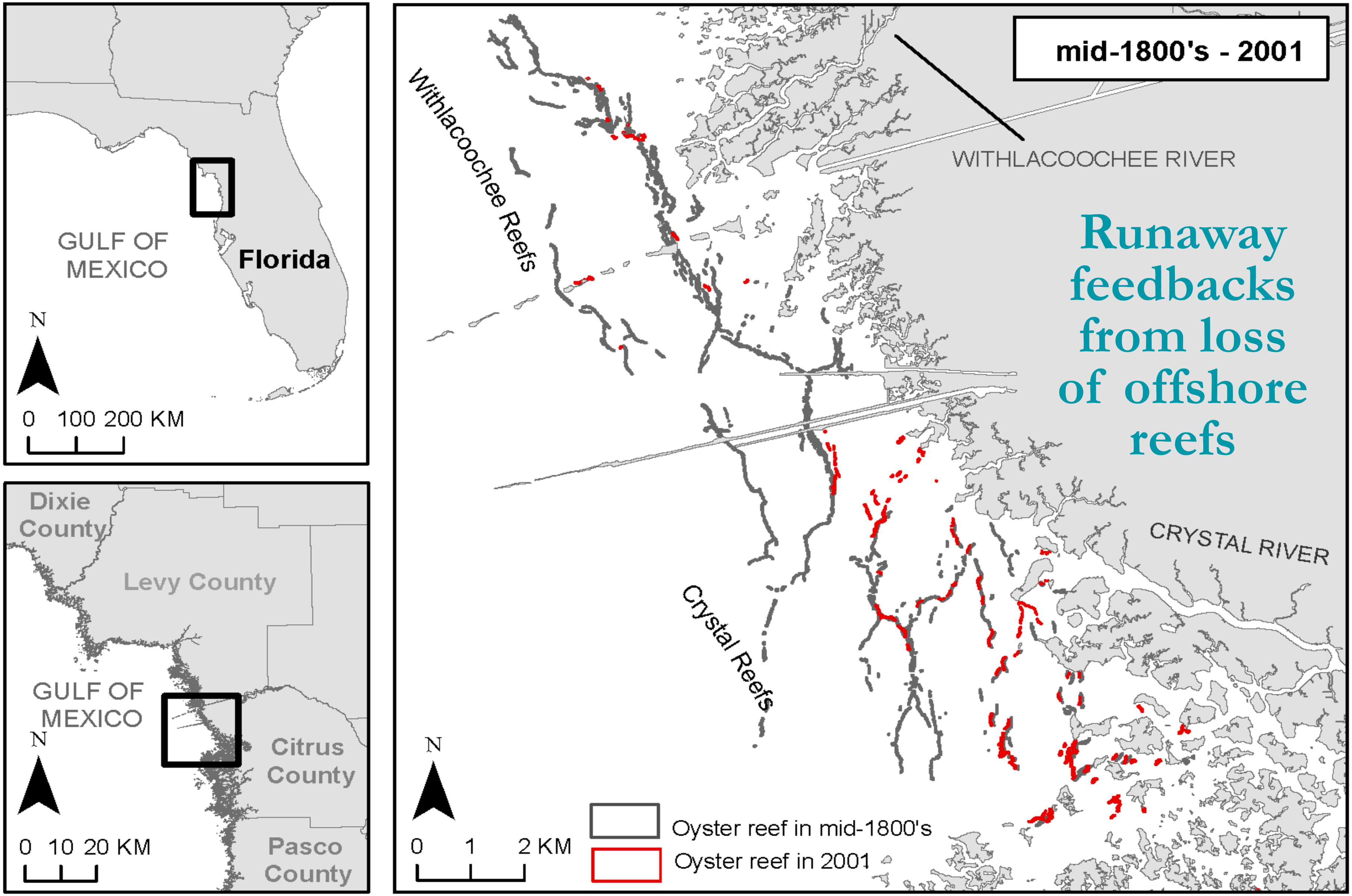


Kirby, M.X., 2004. Fishing down the coast: historical expansion and collapse of oyster fisheries along continental margins. *Proceedings of the National Academy of Sciences of the United States of America*, *101*(35), pp.13096-13099.

Long-term degradation

"During our study period (1982 to 2011), we found a 66% net loss of oyster reef area (124.05 ha) with losses concentrated on offshore (88%), followed by nearshore (61%), and inshore reefs (50%)."

Seavey, J.R., et al., 2011. Decadal changes in oyster reefs in the Big Bend of Florida's Gulf Coast. *Ecosphere*, *2*:1-14



Oyster reef extent offshore of Withlacoochee and Crystal rivers in the mid-1800s and 2001. Map by S. Hesterberg. Data sources: Raabe et al. 2004, SRWMD 2001a.

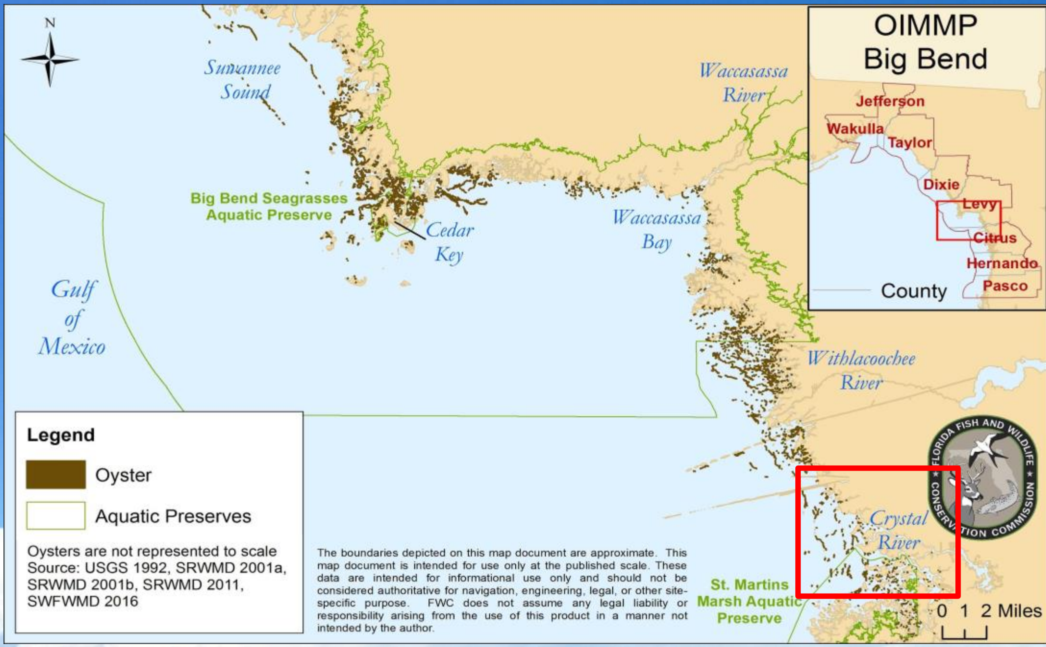
Conservation Paleobiology

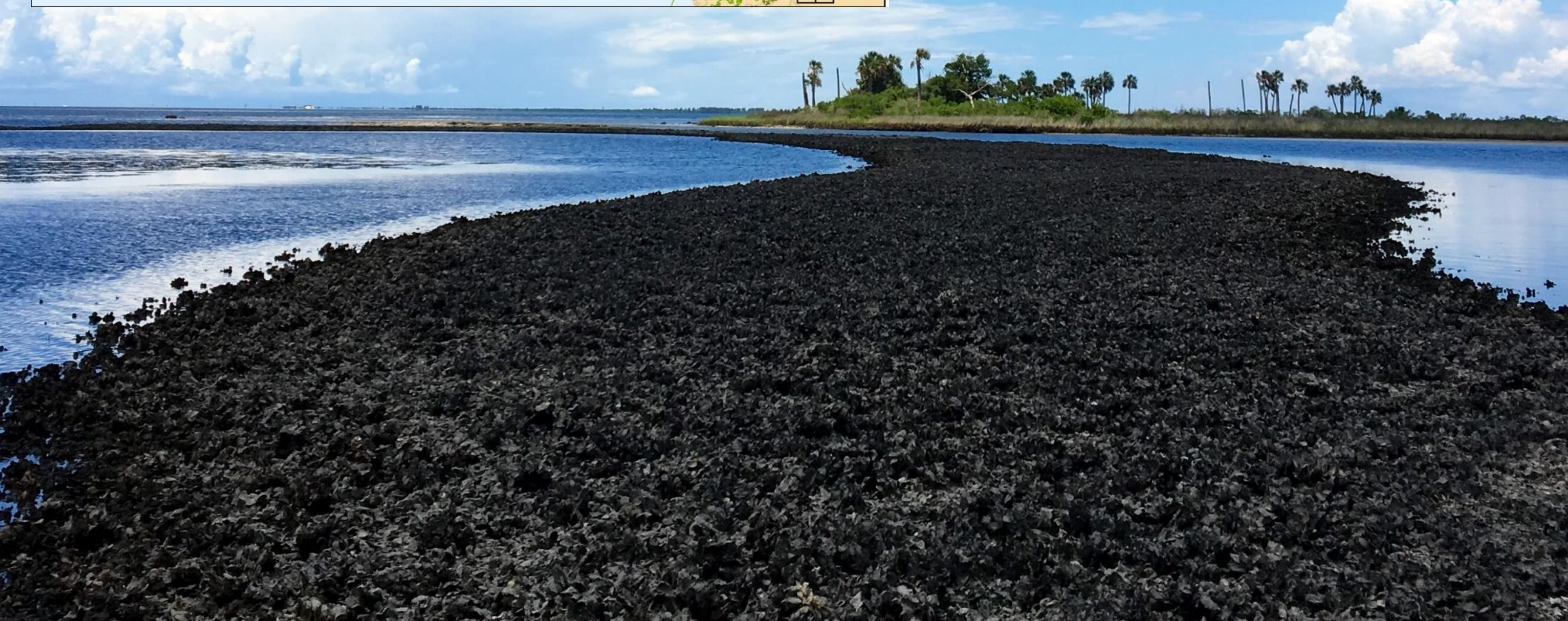
AIMS:

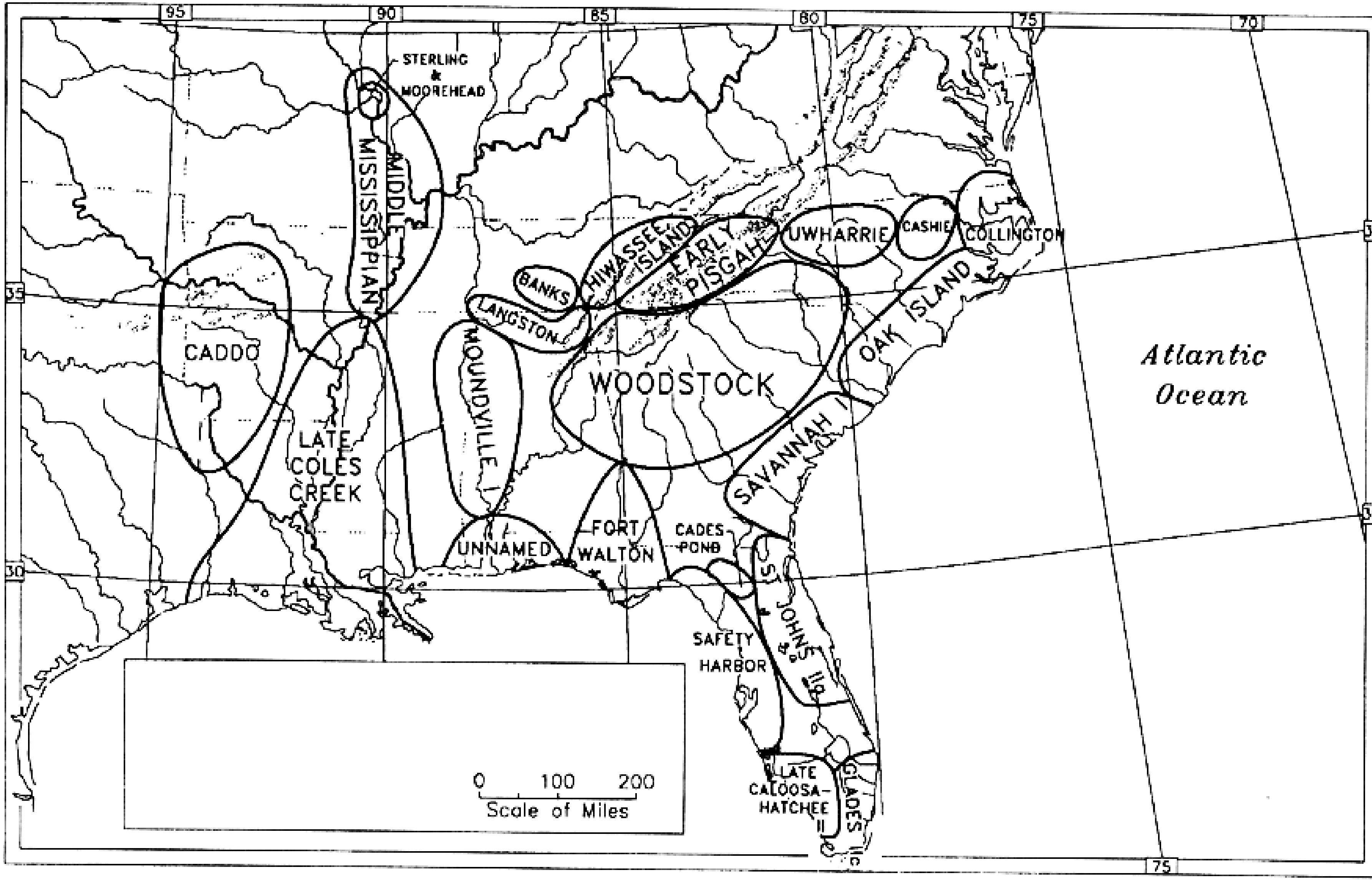
- Bring attention to the deep historical roots of human influence on the biosphere
- Provide alternative models for what a healthy reef looks like

DATA:

- Archaeology
- Paleontology


OIMMP
Big Bend
N
Suwannee Sound
Waccasassa River
Big Bend Seagrasses Aquatic Preserve
Cedar Key
Waccasassa Bay
Gulf of Mexico
Withlacoochee River
Crystal River
St. Martins Marsh Aquatic Preserve
Jefferson
Wakulla
Taylor
Dixie
Levy
Citrus
Hernando
Pasco
County
Legend
Oyster
Aquatic Preserves
Oysters are not represented to scale
Source: USGS 1992, SRWMD 2001a, SRWMD 2001b, SRWMD 2011, SWFWMD 2016
The boundaries depicted on this map document are approximate. This map document is intended for use only at the published scale. These data are intended for informational use only and should not be considered authoritative for navigation, engineering, legal, or other site-specific purpose. FWC does not assume any legal liability or responsibility arising from the use of this product in a manner not intended by the author.
0 1 2 Miles
FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION





95
90
85
80
75
70
35
30
STERLING & MOOREHEAD
MIDDLE MISSISSIPPIAN
CADDO
LATE COLES CREEK
BANKS
LANGSTON
MOUNDVILLE I
HIWASSEE ISLAND
EARLY PISGAH
UWHARRIE
CASHIE
COLLINGTON
OAK ISLAND
WOODSTOCK
SAVANNAH I
UNNAMED
FORT WALTON
CADES POND
ST. JOHNS IIa
SAFETY HARBOR
LATE CALOOSAHATCHEE II
GLADES IIc
Atlantic Ocean
0 100 200
Scale of Miles

Crystal River is one of the largest mound complexes in Florida. Dates to 1000 BC to AD 1000.

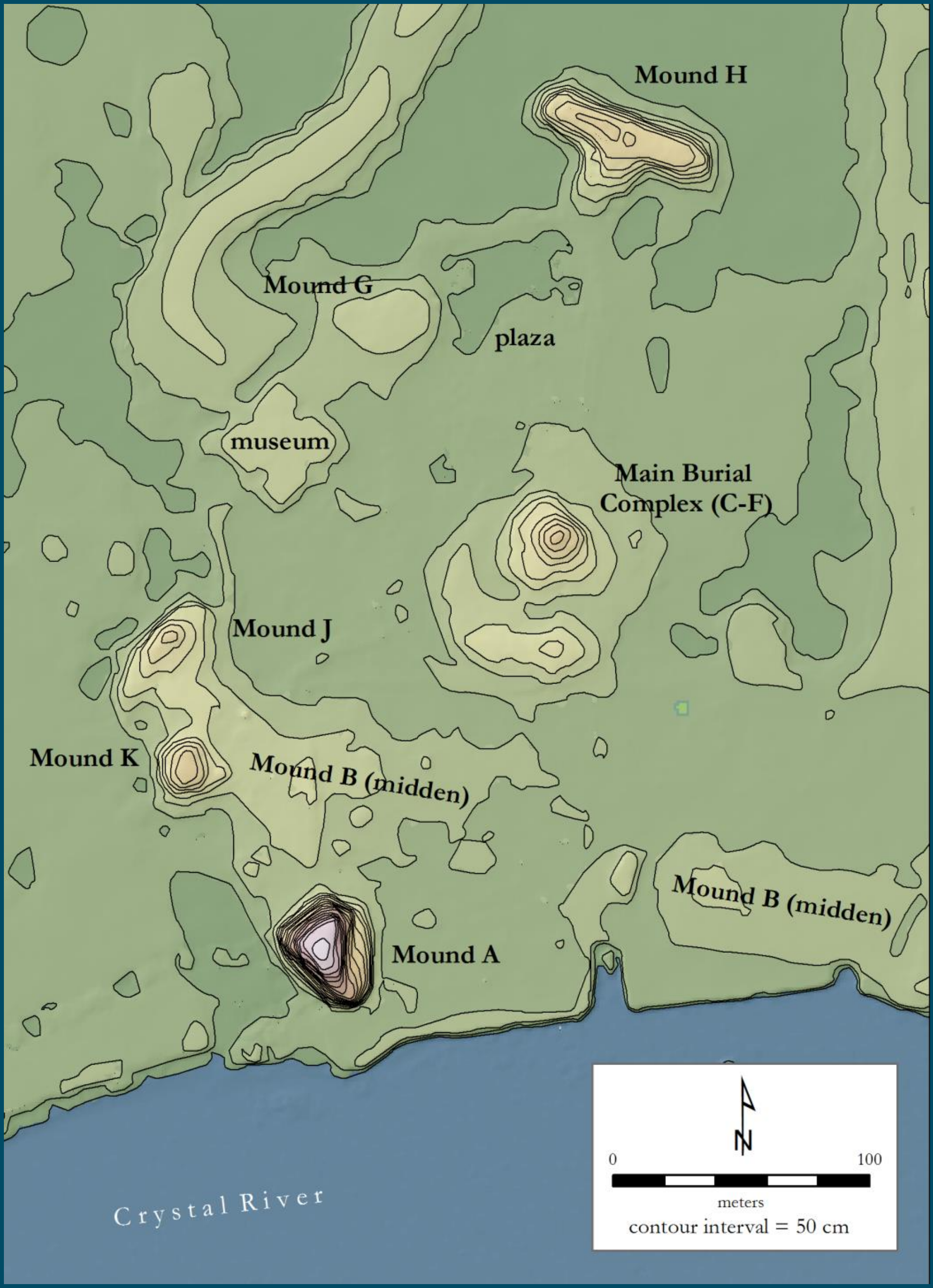
Before at least one-third of it was borrowed away for fill in the 1950s, Mound A was one of the largest mounds in Florida.

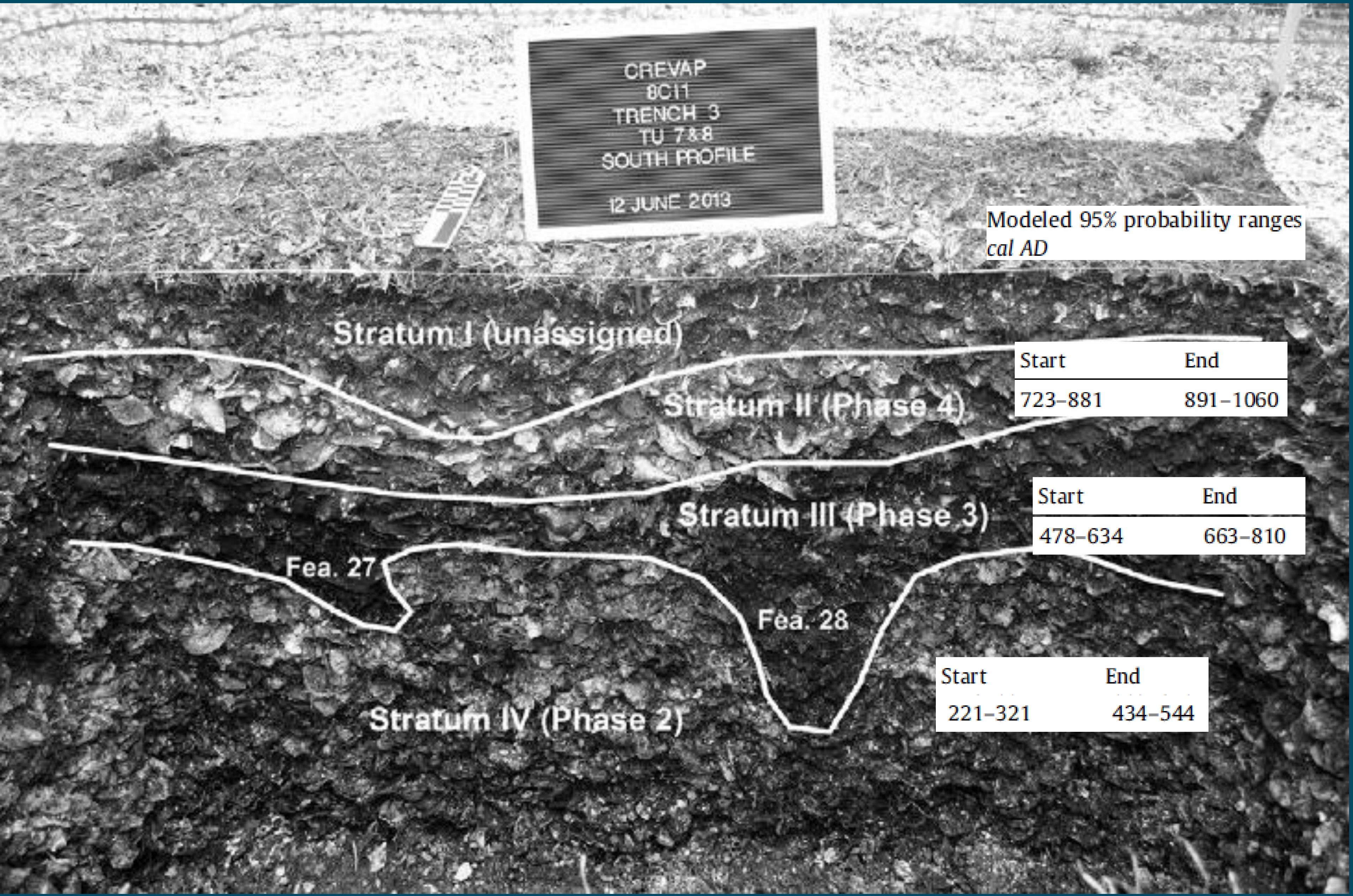
Three platform mounds (A, H, K)

burial mound (G)

burial complex (C-F)

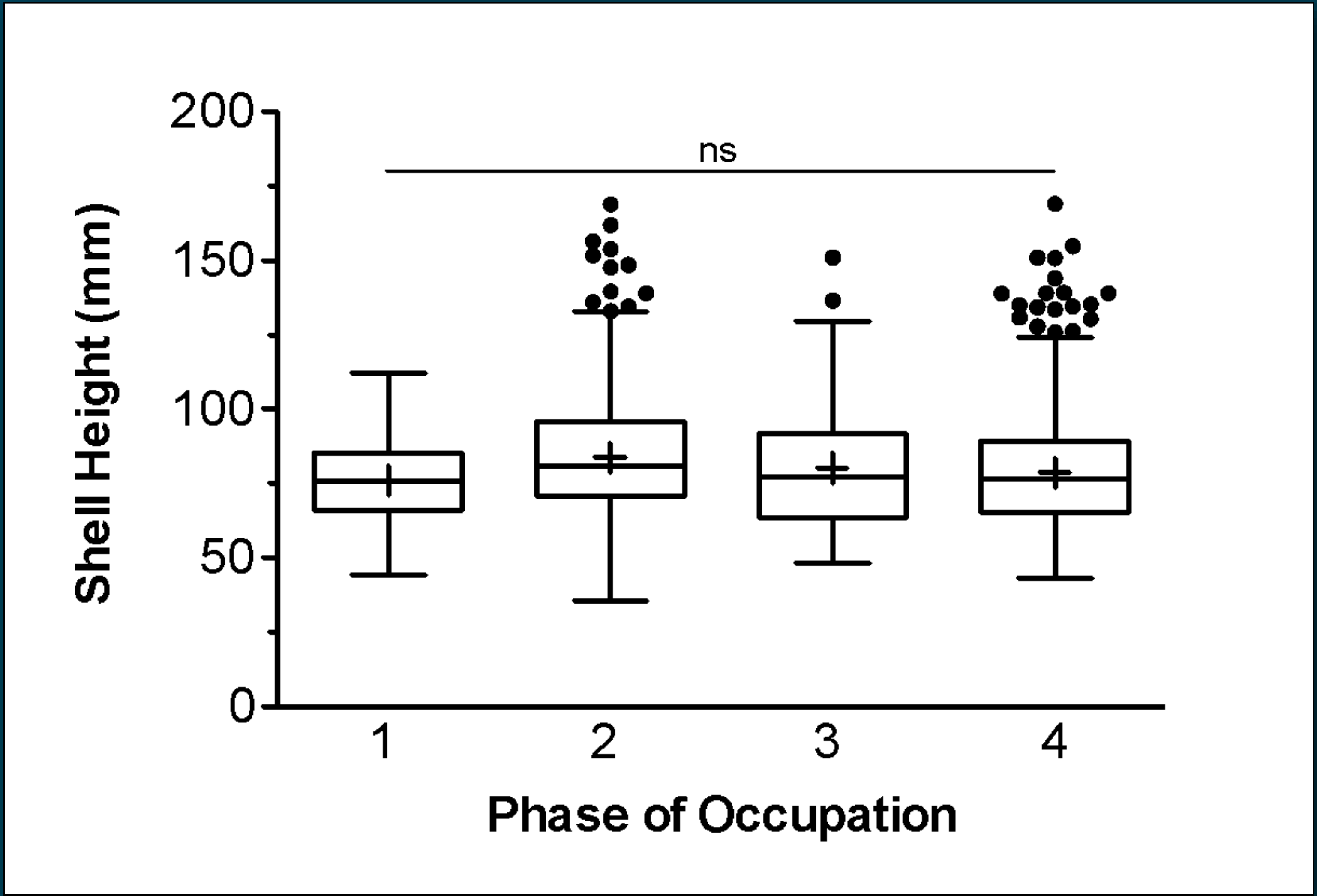
large shell midden (B)





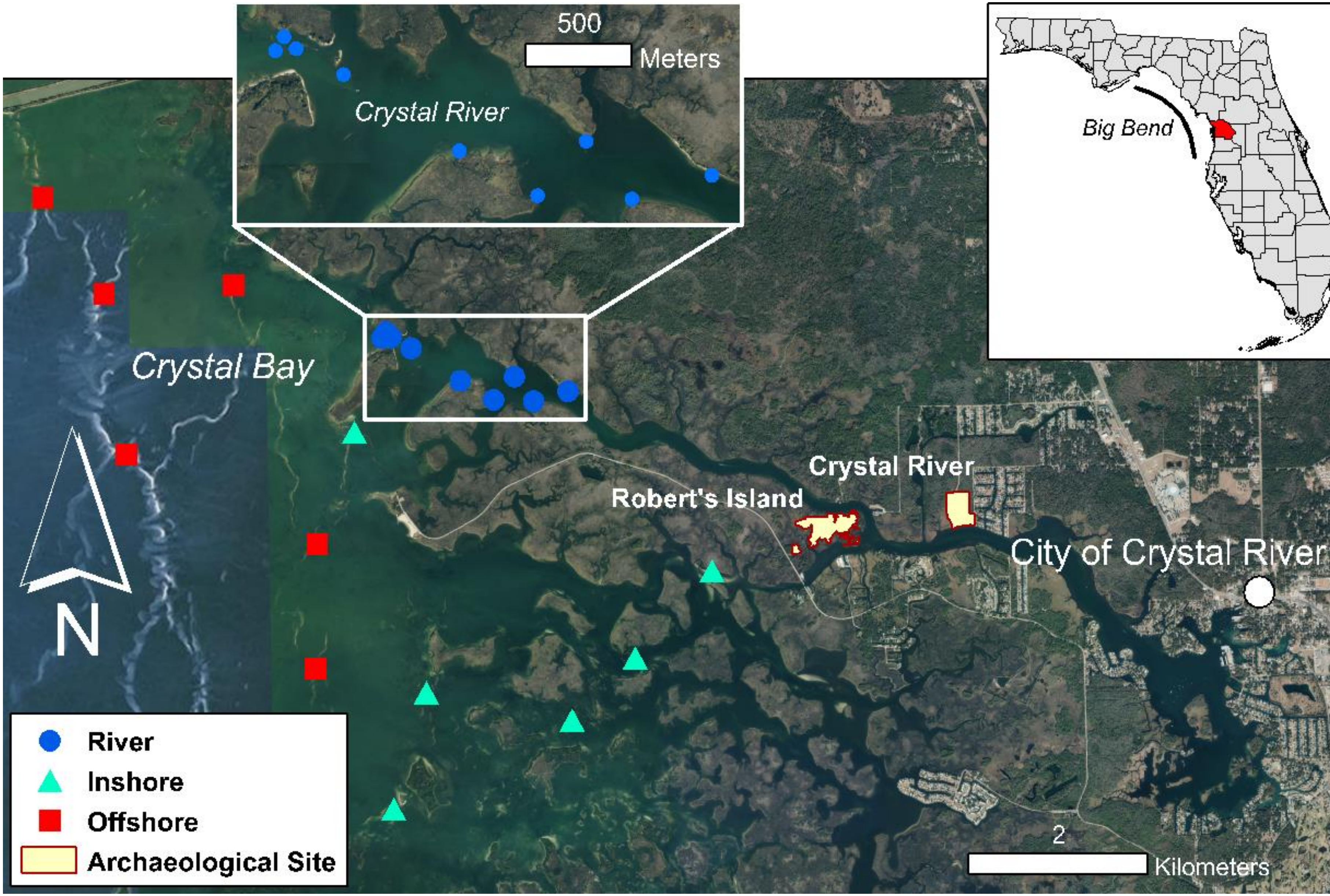
CREVAP
8C11
TRENCH 3
TU 7&8
SOUTH PROFILE
12 JUNE 2013
Modeled 95% probability ranges
cal AD
Stratum I (unassigned)
Stratum II (Phase 4)
Start End
723–881 891–1060
Stratum III (Phase 3)
Start End
478–634 663–810
Fea. 27
Fea. 28
Start End
221–321 434–544
Stratum IV (Phase 2)


Barnacles
Oyster
Charcoal
Ceramics
Bone
Marsh
Clam
Crown
Conch
Limestone

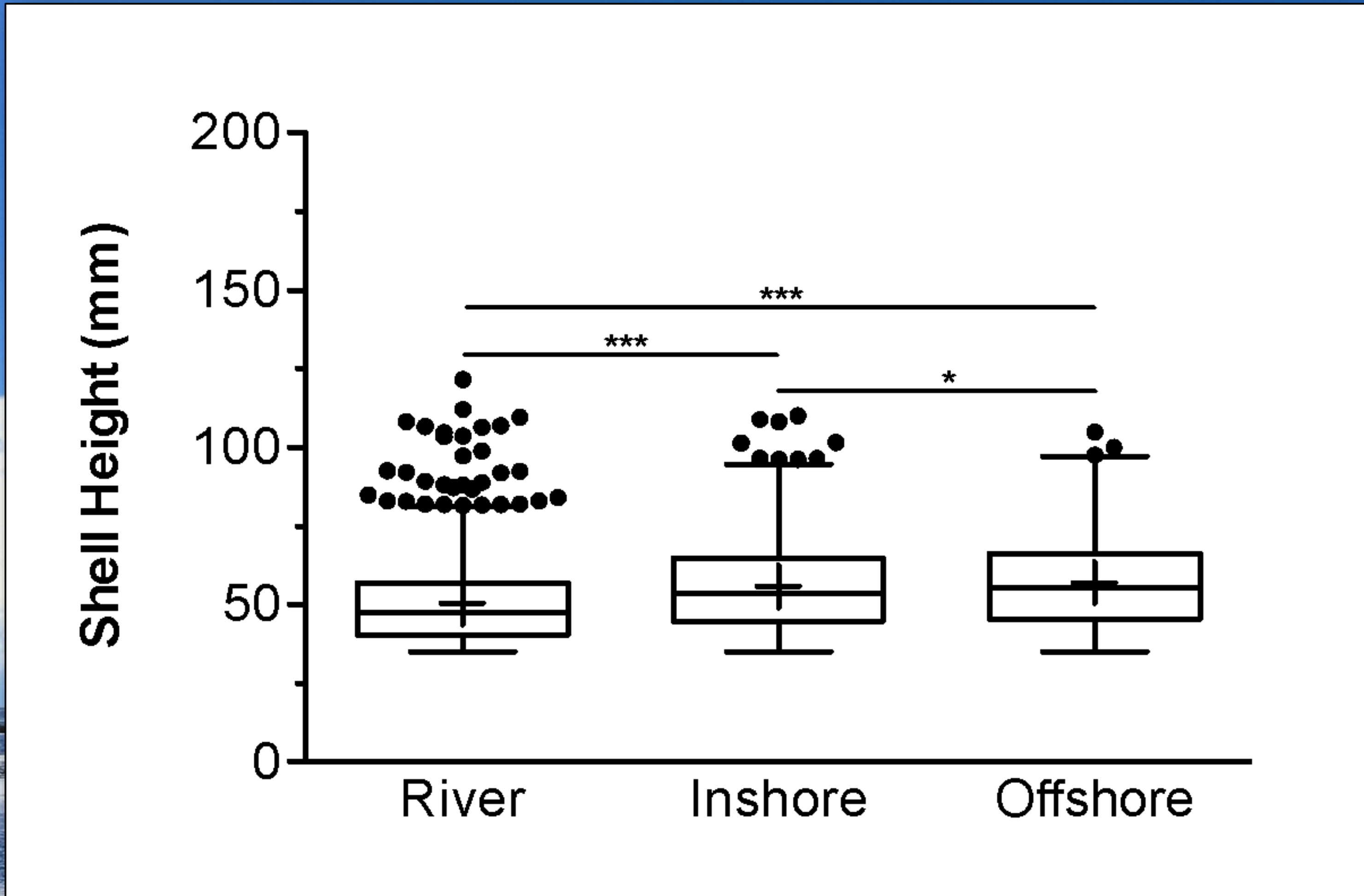


No change in oyster size over 1000 yr of intensive harvest

Box and whisker plots show the median (central line), mean (cross), first and third quartiles (box), as well as 1.5× the interquartile range (whiskers). Circles are measurements within 3× the interquartile range of the median.

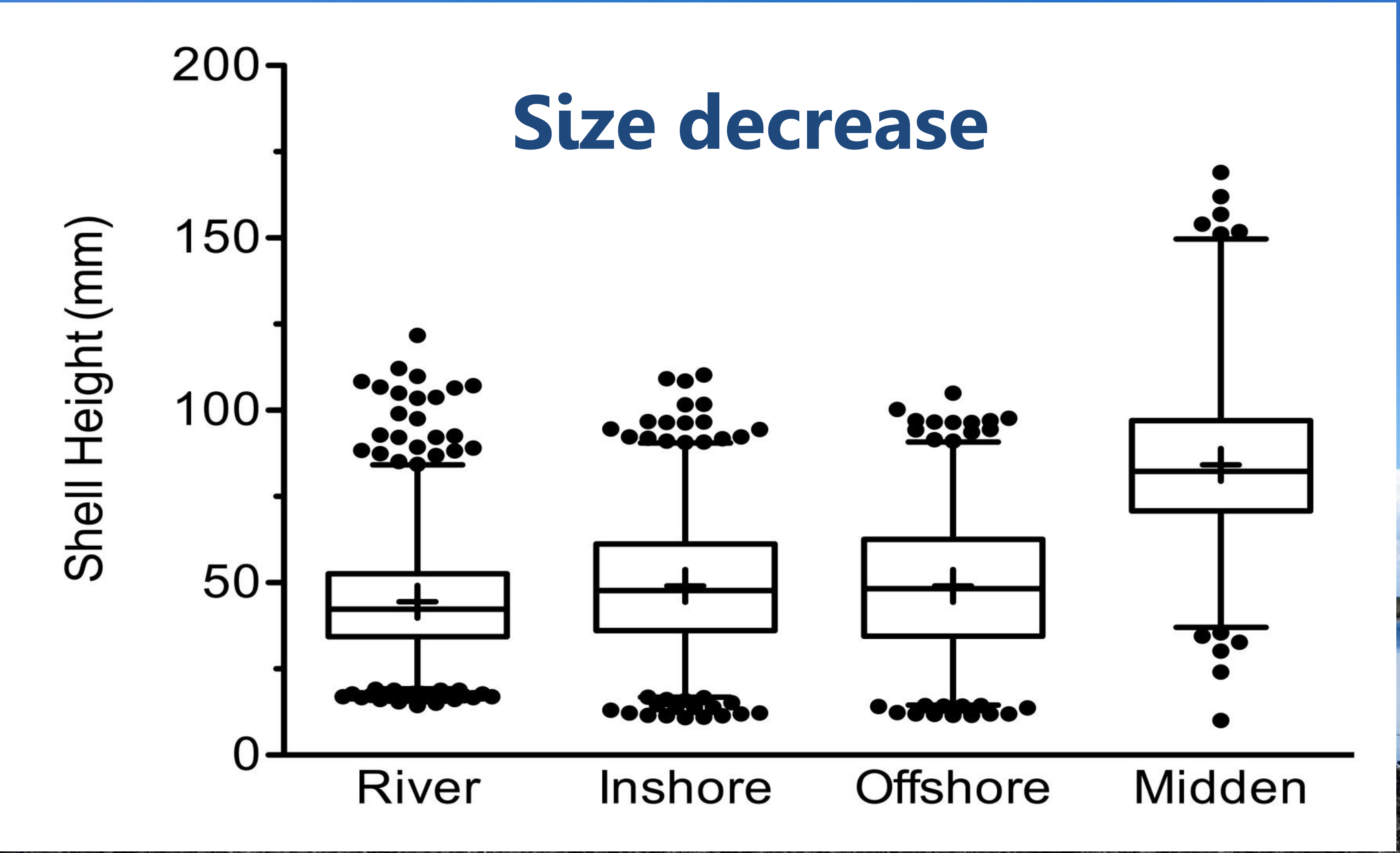


500
Meters
Crystal River
Big Bend
Crystal Bay
N
Crystal River
Robert's Island
City of Crystal River
River
Inshore
Offshore
Archaeological Site
2
Kilometers

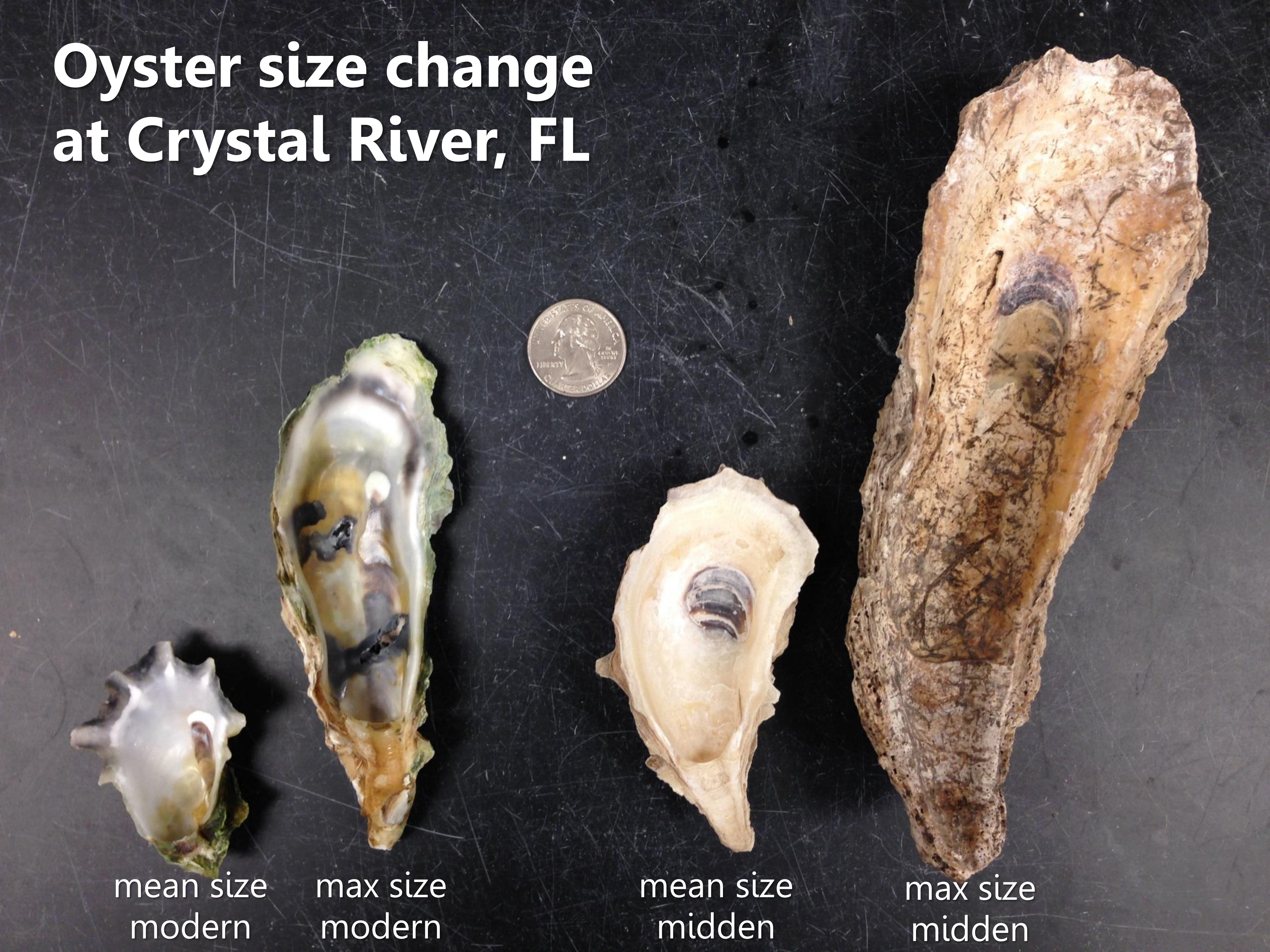


No change in oyster size today along steep salinity gradient

Box and whisker plots show the median (central line), mean (cross), first and third quartiles (box), as well as 1.5× the interquartile range (whiskers). Circles are measurements within 3× the interquartile range of the median.

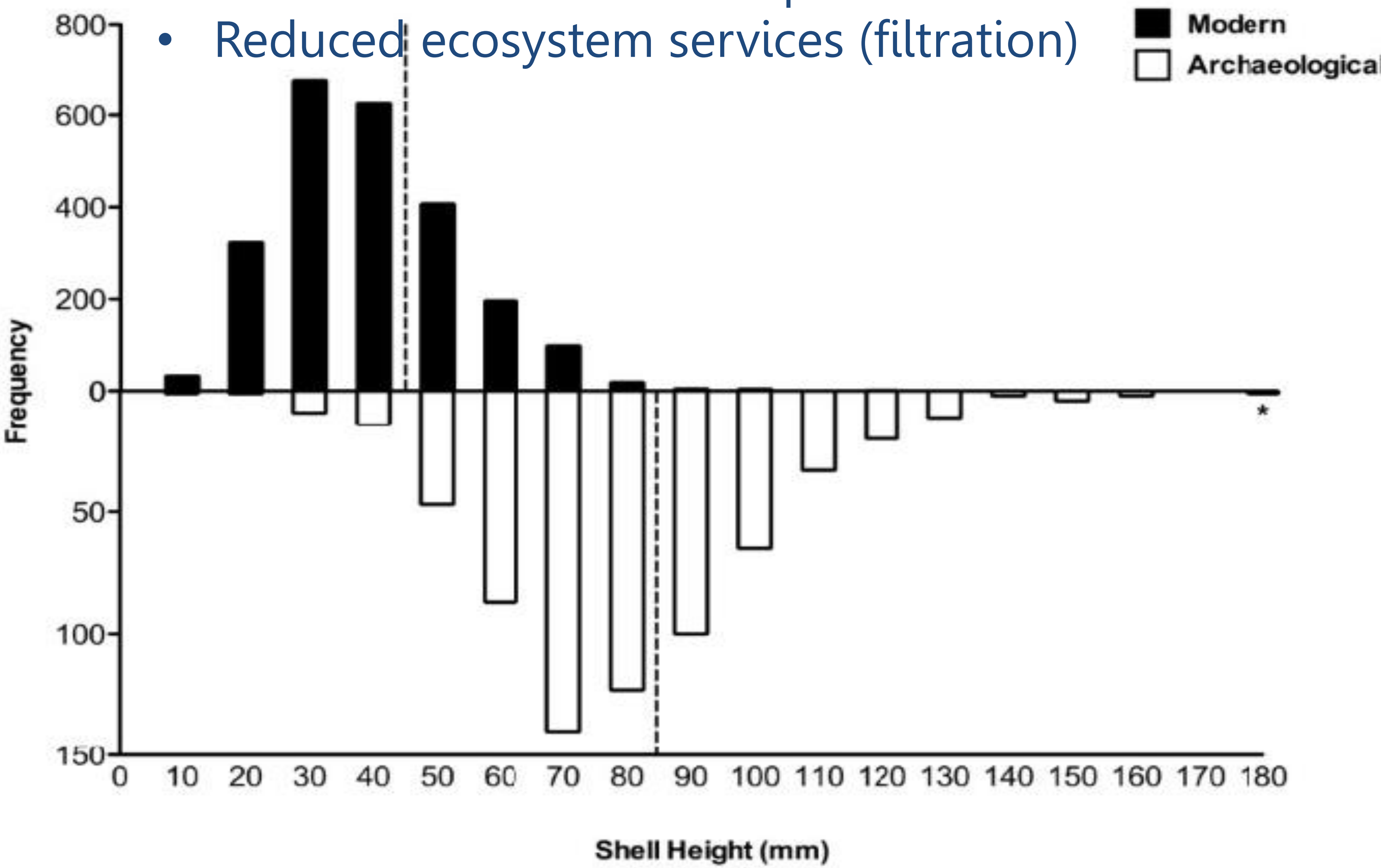


Box and whisker plots show the median (central line), mean (cross), first and third quartiles (box), as well as 1.5× the interquartile range (whiskers). Circles are measurements within 3× the interquartile range of the median.


Oyster size change
at Crystal River, FL
mean size
modern
max size
modern
mean size
midden
max size
midden

Truncated size structure

- Less habitat and less complex habitat
- Reduced ecosystem services (filtration)



Hesterberg, S.G., et al., 2017. Three-dimensional interstitial space mediates predator foraging success in different spatial arrangements. *Ecology*, *98*:1153-1162.

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ARTICLES

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Body size shifts and early warning signals precede the historic collapse of whale stocks

Christopher F. Clements[1*], Julia L. Blanchard[2,3], Kirsty L. Nash[2,3], Mark A. Hindell[2,4] and Arpat Ozgul[1]

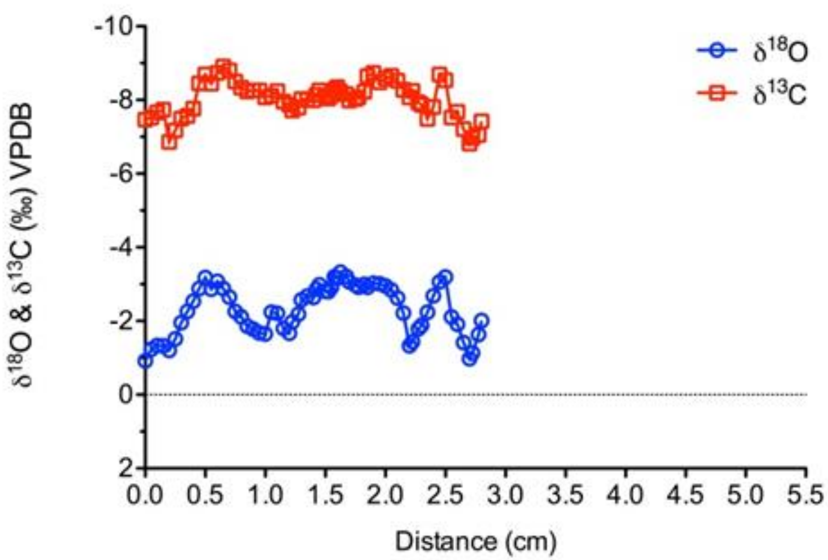
Predicting population declines is a key challenge in the face of global environmental change. Abundance-based early warning signals have been shown to precede population collapses; however, such signals are sensitive to the low reliability of abundance estimates. Here, using historical data on whales harvested during the 20th century, we demonstrate that early warning signals can be present not only in the abundance data, but also in the more reliable body size data of wild populations. We show that during the period of commercial whaling, the mean body size of caught whales declined dramatically (by up to 4 m over a 70-year period), leading to early warning signals being detectable up to 40 years before the global collapse of whale stocks. Combining abundance and body size data can reduce the length of the time series required to predict collapse, and decrease the chances of false positive early warning signals.

Are modern oysters slower growing or shorter lived?

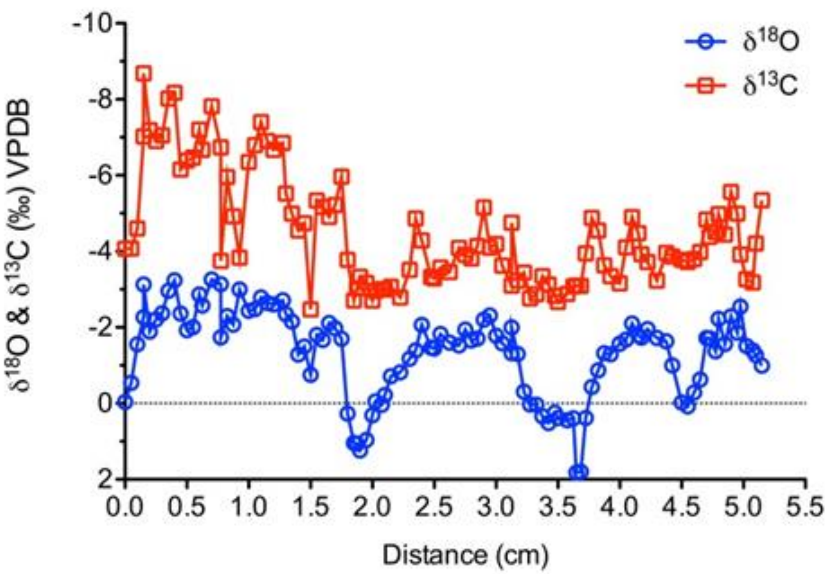
Truncated year-class structure

- Growth rates and longevity have both declined
- Older individuals buffer populations from recruitment failure
- Modern populations have higher proportion of dead shell, dominated by shell destruction vs production dynamics

Modern CR oyster



Archaeological CR oyster



Oxygen isotope sclerochronology profiles of *C. virginica* hinges from modern Crystal River (Left) and archaeological mound (Right). Distances (x-axes) are distances along the sample hinges. Oxygen isotopes ratios vary with temperature. Carbon isotopes in molluscan shell are influenced by temperature, growth rate, environmental C flux, and reproduction. Cycles in blue record seasonal variation in temperature.

Conclusions

- The "healthiest" oyster reefs left are severely degraded relative to natural baselines.
- Populations exhibit early warning signs of collapse.
- Can self-sustaining oyster habitat be achieved in populations with reduced generation times?

Mann and Powell (2007)