# Red tide toxin accumulation in fish

Jerome P. Naar[1], Leanne J. Flewelling[2], and Jan H. Landsberg[2]

[1]Center for Marine Science, University of North Carolina, Wilmington, NC

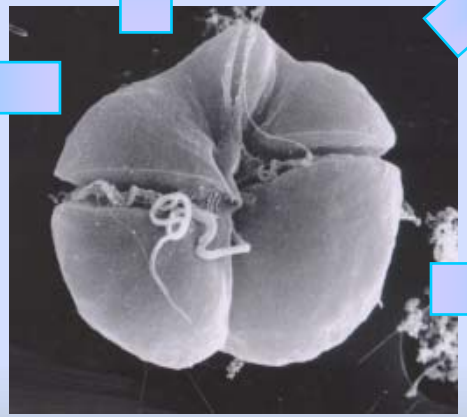
[2]Florida Fish & Wildlife Conservation Commission, Florida Fish & Wildlife Research Institute, St. Petersburg, FL


# Effects of Red Tide

Fish Kills

Toxic shellfish

Respiratory irritation



Animal mortalities

# Ichthyotoxicity

Fish Kills

Fish kills in the Gulf of Mexico have been reported since as far back as 1844.

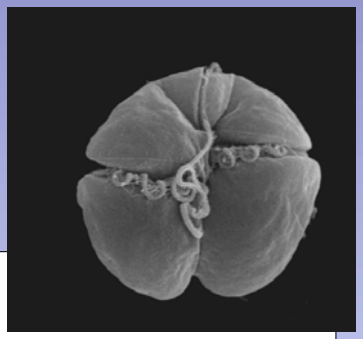
Fish bioassay-guided fractionation was originally used to isolate the toxins.

Brevetoxins routinely cause massive fish kills. No reports of human illnesses due to fish consumption despite annual red tides.

Fish exposed by ingestion, or absorption of toxins across gills, or potentially by transfer of toxins up food web.

Accumulation in or food-web transfer by fish has not typically been regarded as a risk to higher trophic levels.

# Brevetoxin transfer in fish?



*Karenia brevis*

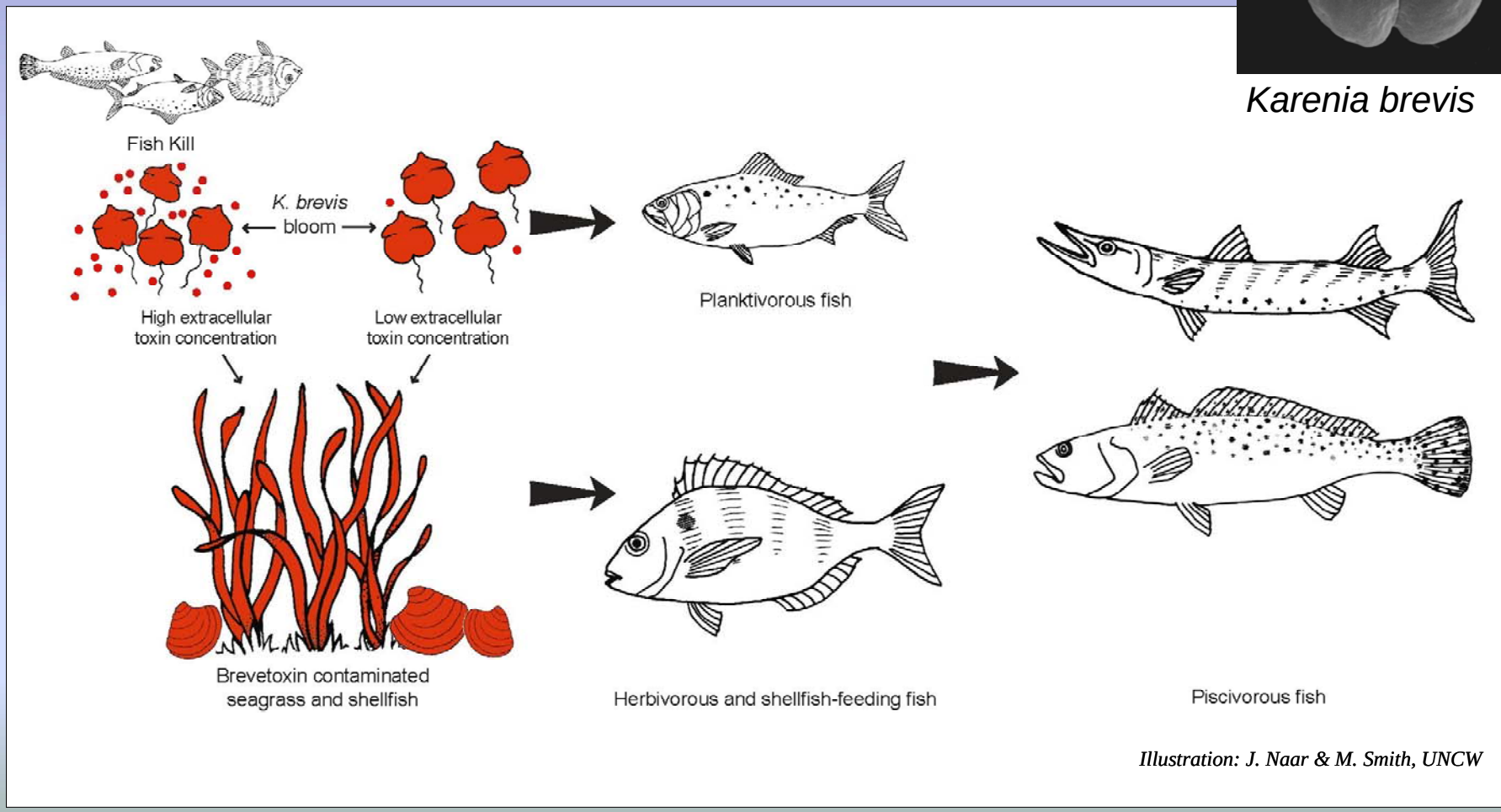



*Illustration: J. Naar & M. Smith, UNCW*

# Brevetoxin transfer to planktivorous fish

**Striped mullet, (*Mugil cephalus*)**

**Juvenile mullet were collected in North Carolina and acclimated for two days in culture medium.**

**Healthy *K. brevis* cultures in log phase growth were diluted to four cell densities (500, 1000, 2000, and 4000 cells/mL) in 4-L aquaria.**

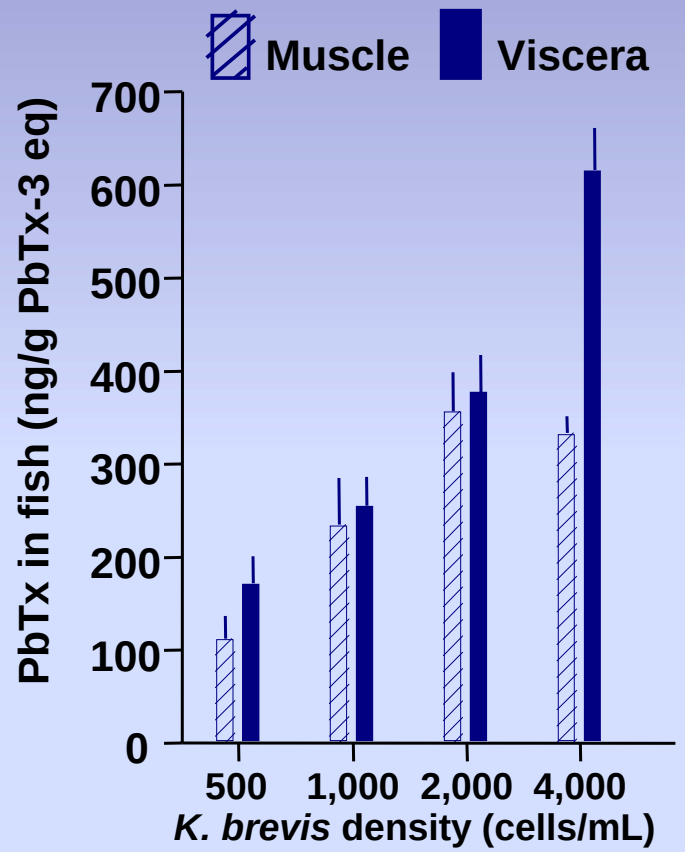
**Ten fish were introduced into each aquarium.**

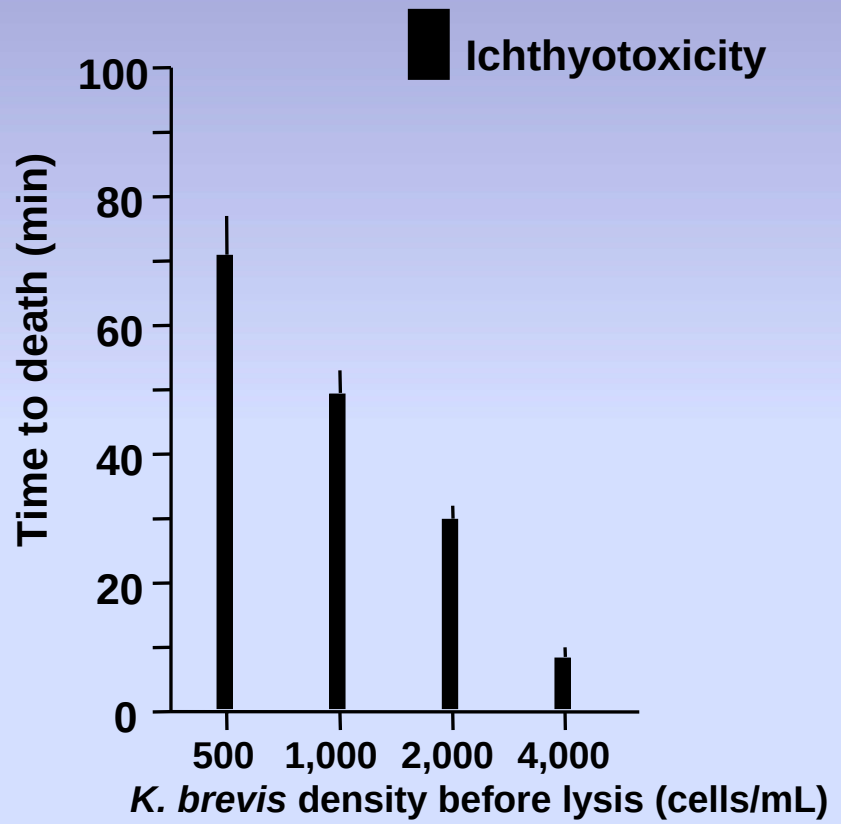
**Five fish were collected from each aquarium after 6 hours and then again after 24 hours.**

**Muscle and viscera analyzed for brevetoxins by ELISA and LC-MS.**

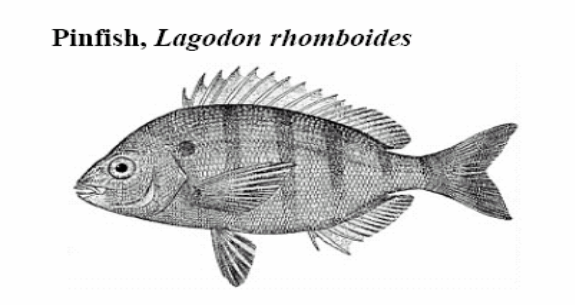
**No fish died during the experiment.**

# Accumulation of brevetoxins in mullet



# Brevetoxin transfer to carnivorous/omnivorous fish





Pinfish and croakers were collected in North Carolina.

Exposed to clams naturally intoxicated by a red tide in Florida.

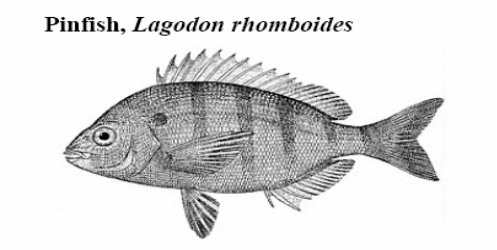
Fed for the first two weeks with only contaminated clams and for the second two weeks with nontoxic clams from North Carolina.

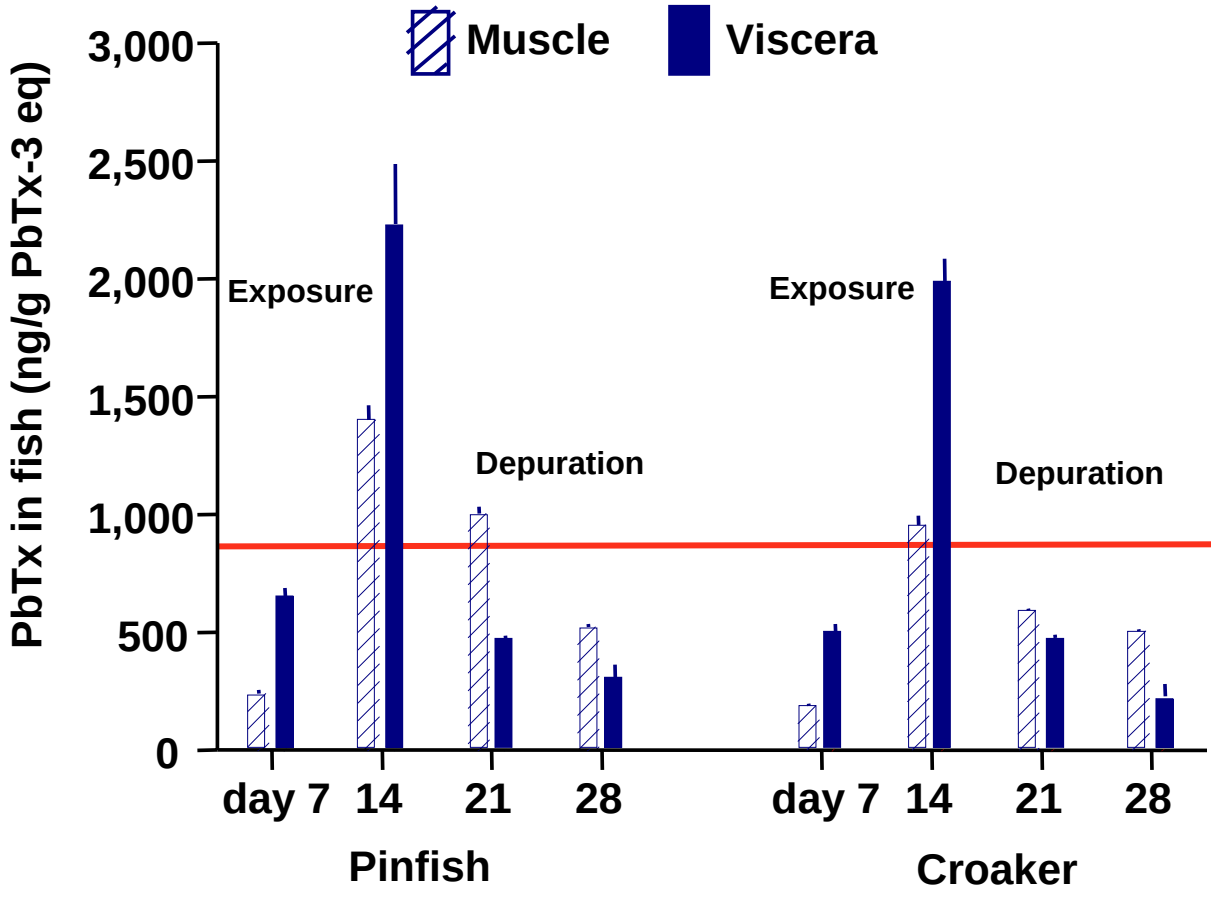
Three fish per species sampled at day 0,7,14,21,and 28.

Muscle and viscera analyzed for brevetoxins by ELISA and LC-MS.

No fish died during the experiment.


Atlantic croaker, *Micropogonias undulatus*


Pinfish, *Lagodon rhomboides*


Muscle
Viscera
PbTx in fish (ng/g PbTx-3 eq)
3,000
2,500
2,000
1,500
1,000
500
0
Exposure
Depuration
Exposure
Depuration
day 7
14
21
28
day 7
14
21
28
Pinfish
Croaker

# Experimental conclusions

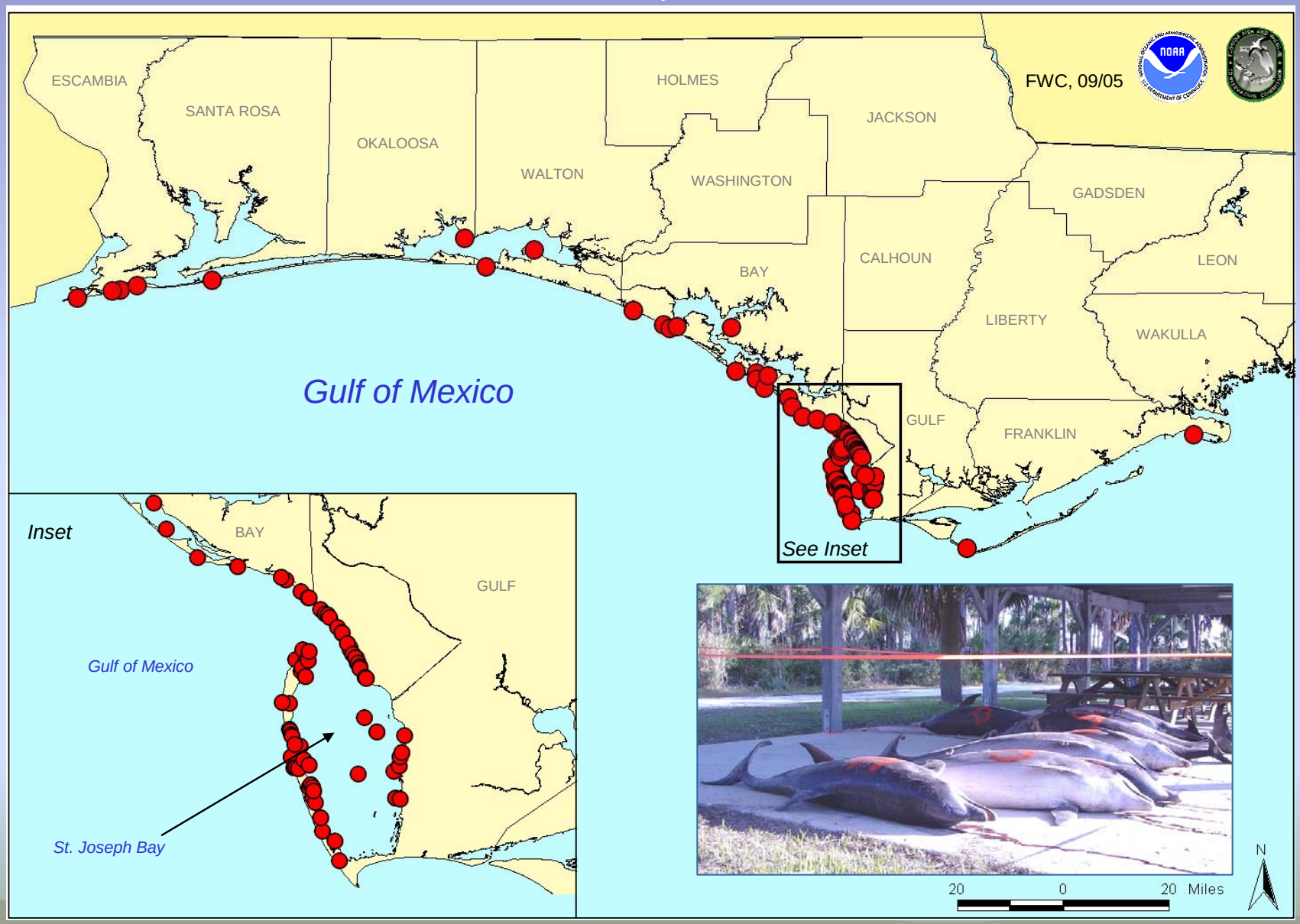
**Fish can survive and accumulate PbTx when exposed through their diet.**

**These two routes occur naturally:**

- **Shellfish remain contaminated with brevetoxins after *K. brevis* blooms have dissipated.**
- **Blooms with low dissolved toxin concentrations have been observed.**

**This was illustrated in St. Joseph Bay in the Florida Panhandle in 2004.**

# Bottlenose Dolphin Die-off (n=107) in the Panhandle, Florida (March 10 - April 13, 2004)



# Brevetoxins in water from Panhandle

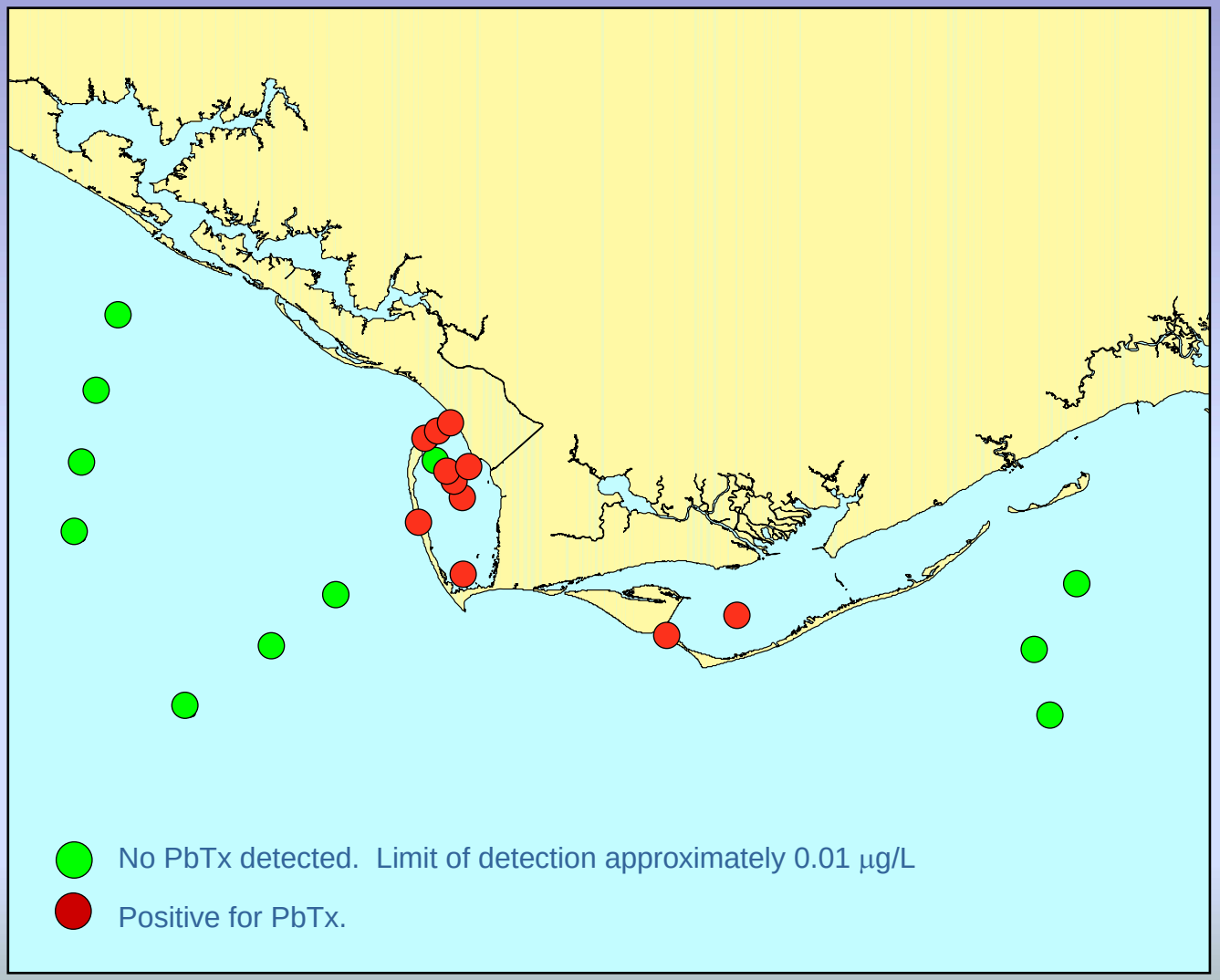
**Water samples collected in March 2004.**

**Low levels PbTx found throughout SJB.**

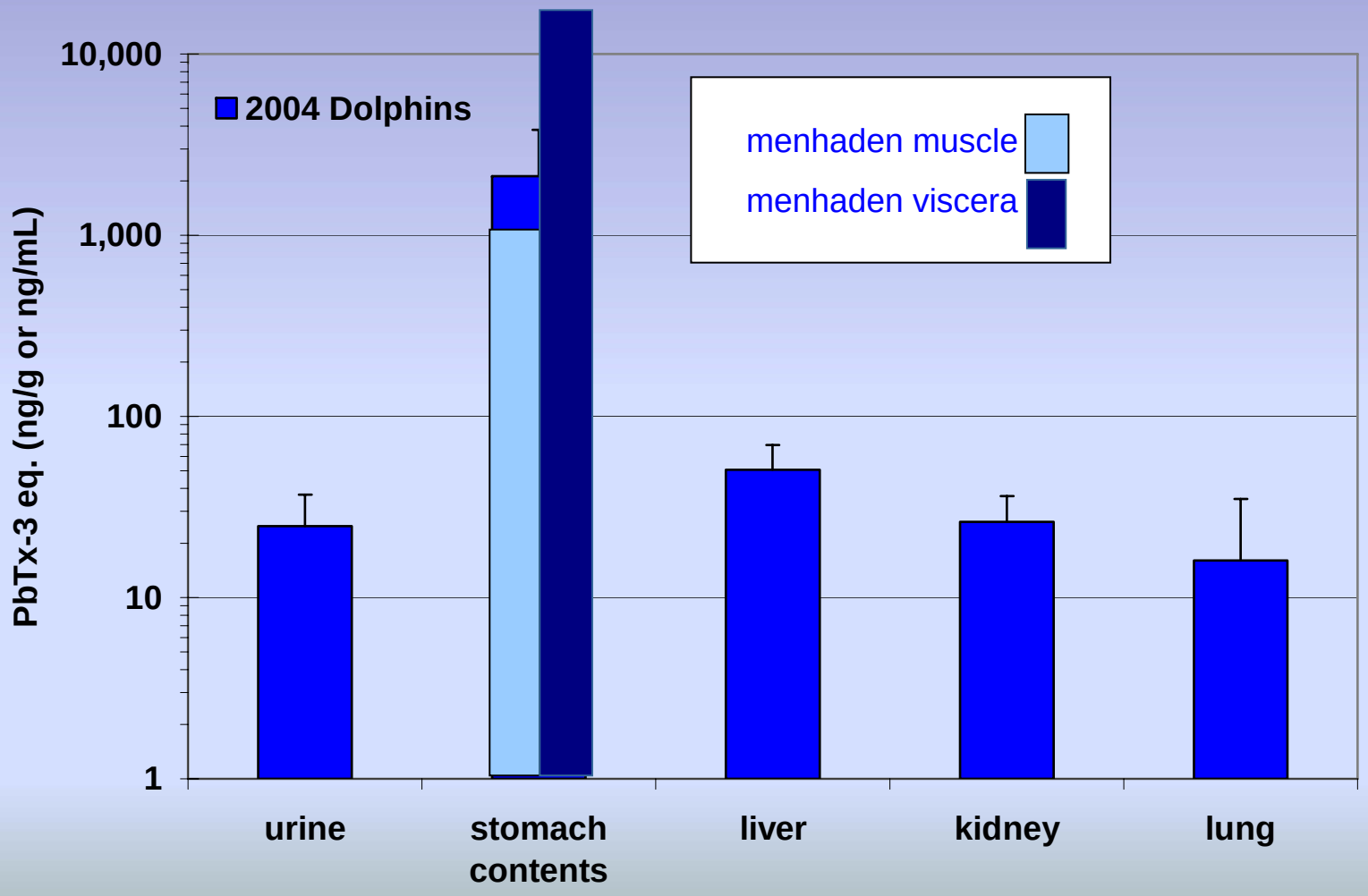
**Concentrations ranged from 0.2 to 1.5 μg/L.**

**Typical of post bloom values in SW FL.**

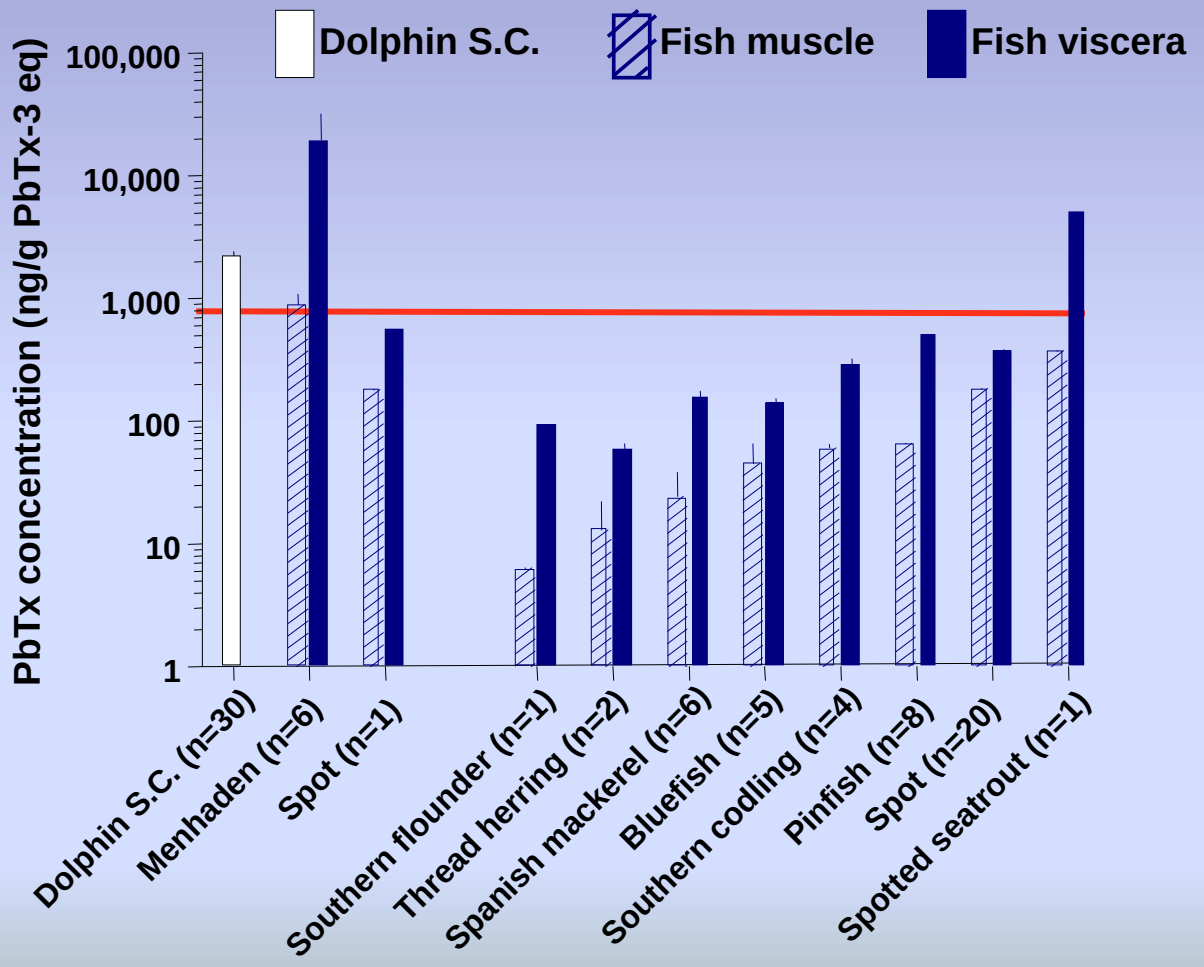
**Nothing detected offshore or in any April samples.**



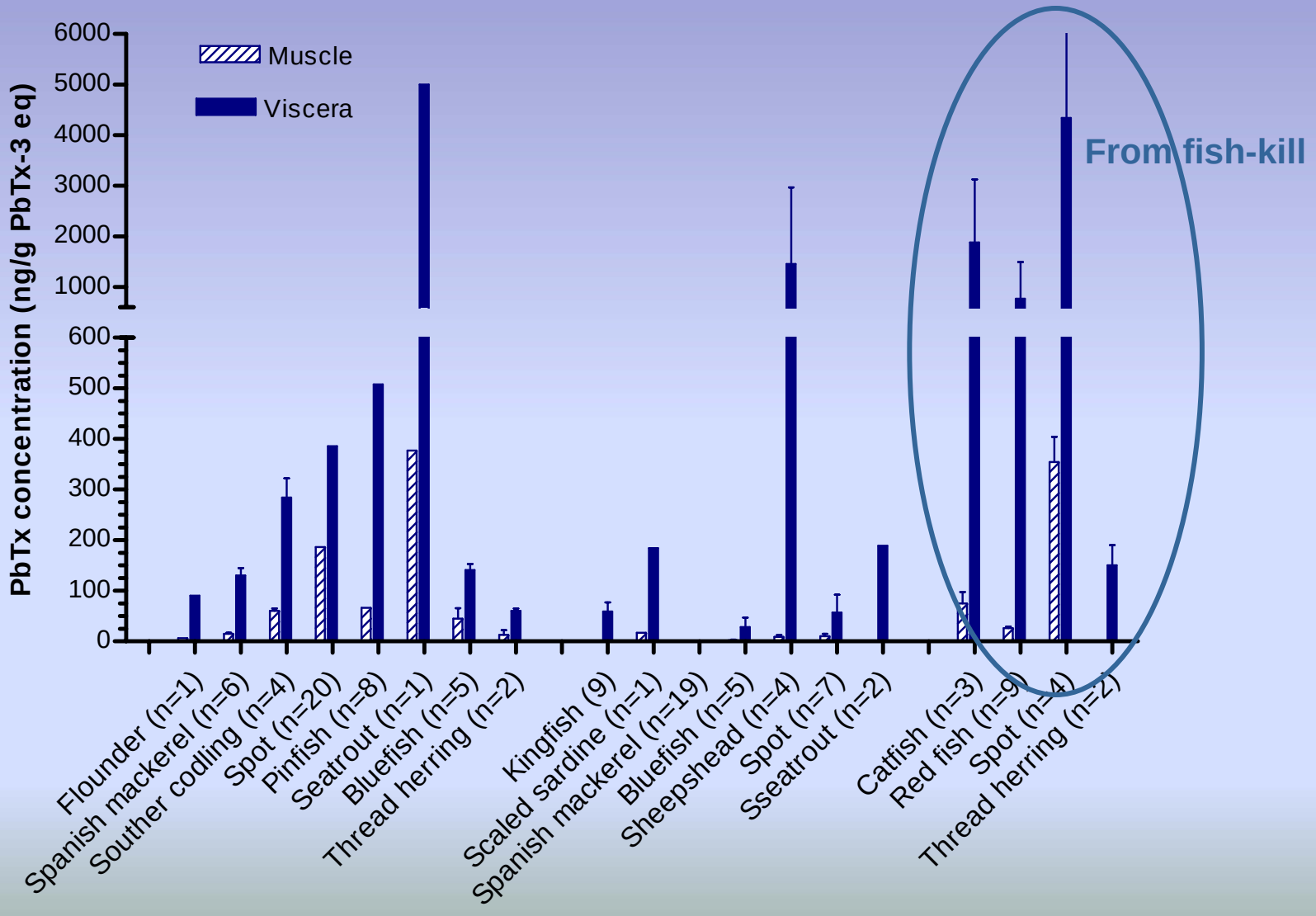
# Brevetoxins in dolphin tissues



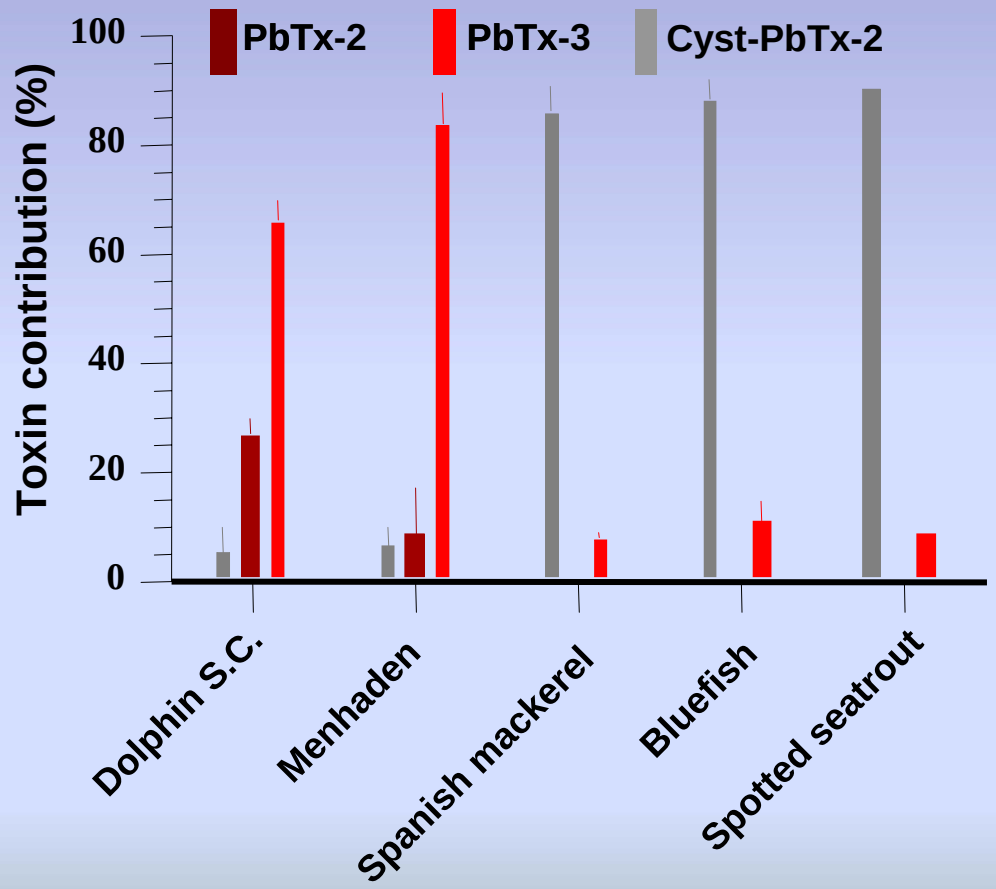
# Brevetoxins in fish from St. Joseph Bay



# Brevetoxins in fish from St. Joseph Bay



# Brevetoxins in fish from St. Joseph Bay



# Conclusions

- **PbTx can accumulate in fish with no obvious adverse impacts if they are exposed through their diet**

- **Fish can accumulate both parent brevetoxins and metabolites**

  Experiments show parent toxins are accumulated in planktivorous fish. Shellfish metabolites are accumulated in carnivorous fish

  *The toxicity of the different metabolites is still under investigation*

  *We don't know how brevetoxin is metabolized in fish*

  *Is there an upper lethal limit to ingestion of brevetoxin by fish?*

- **Transfer of PbTx through the fish food-web poses an obvious threat for aquatic animals that eat whole fish**

# Conclusions

**Is there a real human health threat from brevetoxins in fish?**

- **Ciguatoxins produced by *G. toxicus* are pre-cursors to more toxic, more highly oxygenated metabolites found in fish**
- **Conversely, brevetoxins produced by *K. brevis* are probably more toxic than metabolites**

  **Many of the brevetoxin metabolites are toxins conjugated to groups that make them more polar, less toxic, and easier to clear from the body. Toxicity studies still need to be done**

- **Humans do not typically eat whole fish**
- **Only muscle samples from 6 (2 dead, 4 live) of approx. 400 fish have exceeded 800 ng/g**
- **But actual toxicity not yet determined by mouse bioassay. LC-MS analyses are pending**
- **Data so far suggest that muscle concentrations are not typically at levels that pose a risk but the sample size needs to be much larger**

# Acknowledgements

FWRI HAB staff; FWRI Fisheries Independent Monitoring Field Staff

Funded by:

CDC Grant #U50-CCU423360-01 Expanding Existing Surveillance Systems to Include Pfiesteria, Other Harmful Algal Blooms and Marine Toxins in Florida (through the Florida Department of Health)

The State of Florida

Continuing research is being funded by NOAA's Oceans and Human Health Initiative