Hypoxia Impacts on Fishery Management

Jeff Rester
Habitat/SEAMAP Coordinator
Gulf States Marine Fisheries Commission

Fisheries

The northern Gulf of Mexico supports commercial and recreational fisheries which generate over $2 billion annually. These fisheries are directly impacted by hypoxia. Fishery resources are affected by direct mortality of managed species and their prey, decreased fecundity, loss of habitat, decreased growth, and increased susceptibility to predation.

Direct Mortality

Mobile species will usually move away from hypoxic waters unless hypoxic waters trap organisms near land.

Benthic species that cannot escape hypoxic waters usually die thereby reducing the amount of prey available to managed species.

Decreased Fecundity

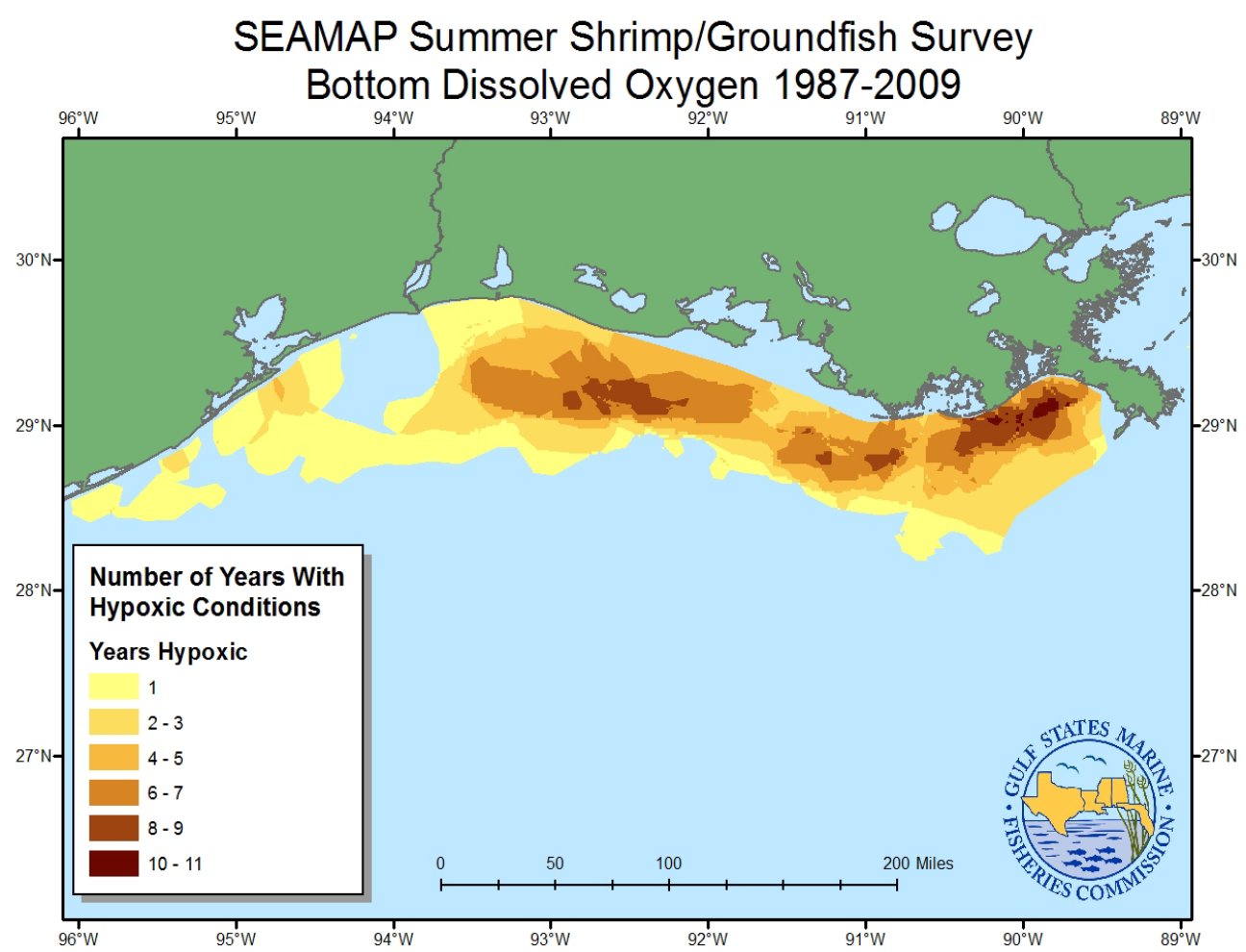
Thomas and Rahman (2009, 2011) - Suggest severe reproductive impairment can occur over large coastal regions in marine fish populations exposed to seasonal hypoxia, with potential long-term impacts on population abundance.

Hypoxia has been shown to decrease growth in fish. Larger fish can be exponentially more fecund than smaller fish.

Creekmore (2011) - Using a range of mild, intermediate, and severe hypoxia conditions, a bioenergetics model predicted an 18-29% decrease in the long-term population abundance of Atlantic croaker.

Habitat Loss

Craig et al. (2005) - Hypoxia has caused an approximately 25% loss of brown shrimp habitat on the Louisiana continental shelf with shifts in distribution and associated high densities both inshore and offshore of the hypoxic region.



Habitat Loss

Zimmerman (2003) - Summer hypoxia off Louisiana blocks access of juvenile shrimp migrating to offshore feeding grounds. Brown shrimp habitat value decreased in areas where severe hypoxia killed infaunal annelid worms.

Craig and Crowder (2005) - Brown shrimp and Atlantic croaker moved into cooler or warmer waters due to hypoxia.

Switzer et al. (2009) - Hypoxia rendered large areas of the Gulf of Mexico unsuitable as flatfish habitat.

Zhang et al. (2009) - Observed that hypoxia can influence the spatial distribution of pelagic species including their spatial overlap, in both horizontal and vertical dimensions.

Habitat Loss

Hazen et al. (2009) – While pelagic habitat is usually not directly impacted by hypoxia, hypoxia can induce vertical or horizontal displacement of fish causing potential indirect bioenergetic or trophic interactions potentially leading to changes in growth, exposure to predators, and foraging behavior.

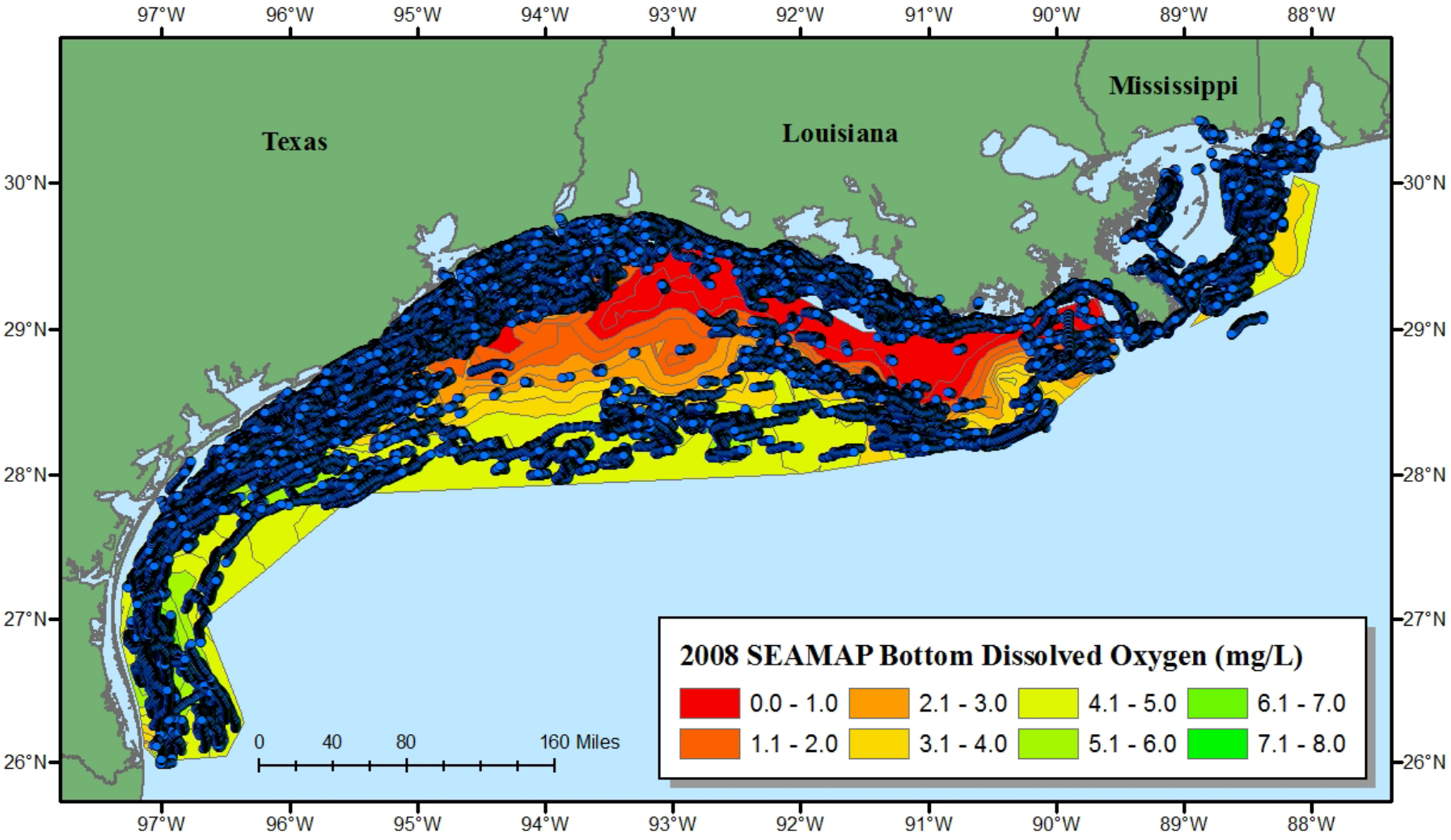
Effects of Hypoxia on Fisheries

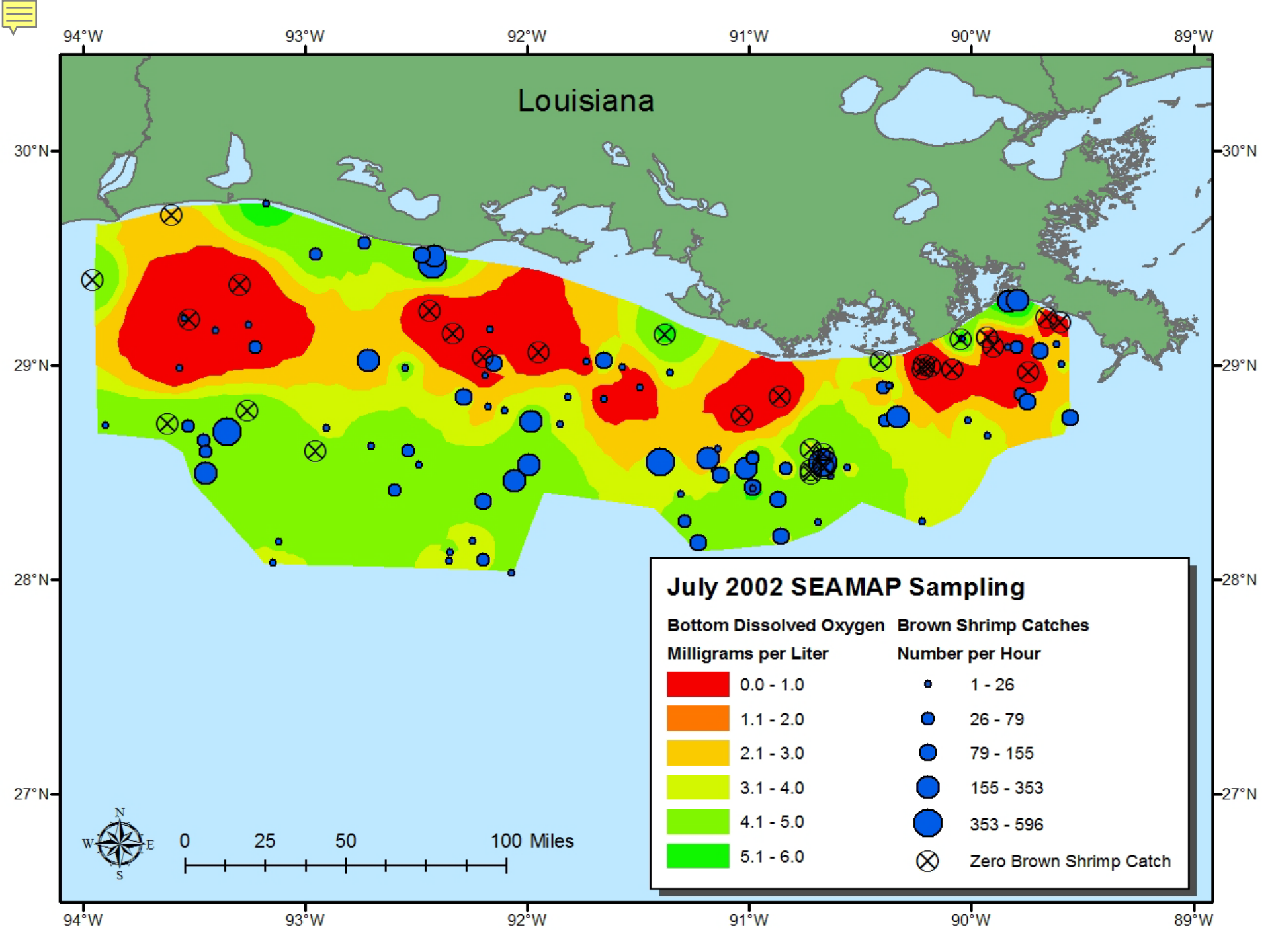
Using fishery landings and effort data, Diaz and Solow (1999) found a negative relationship between annual brown shrimp catch per unit effort and a hypoxia index in the Gulf of Mexico that suggests a negative effect of hypoxia on shrimp production.

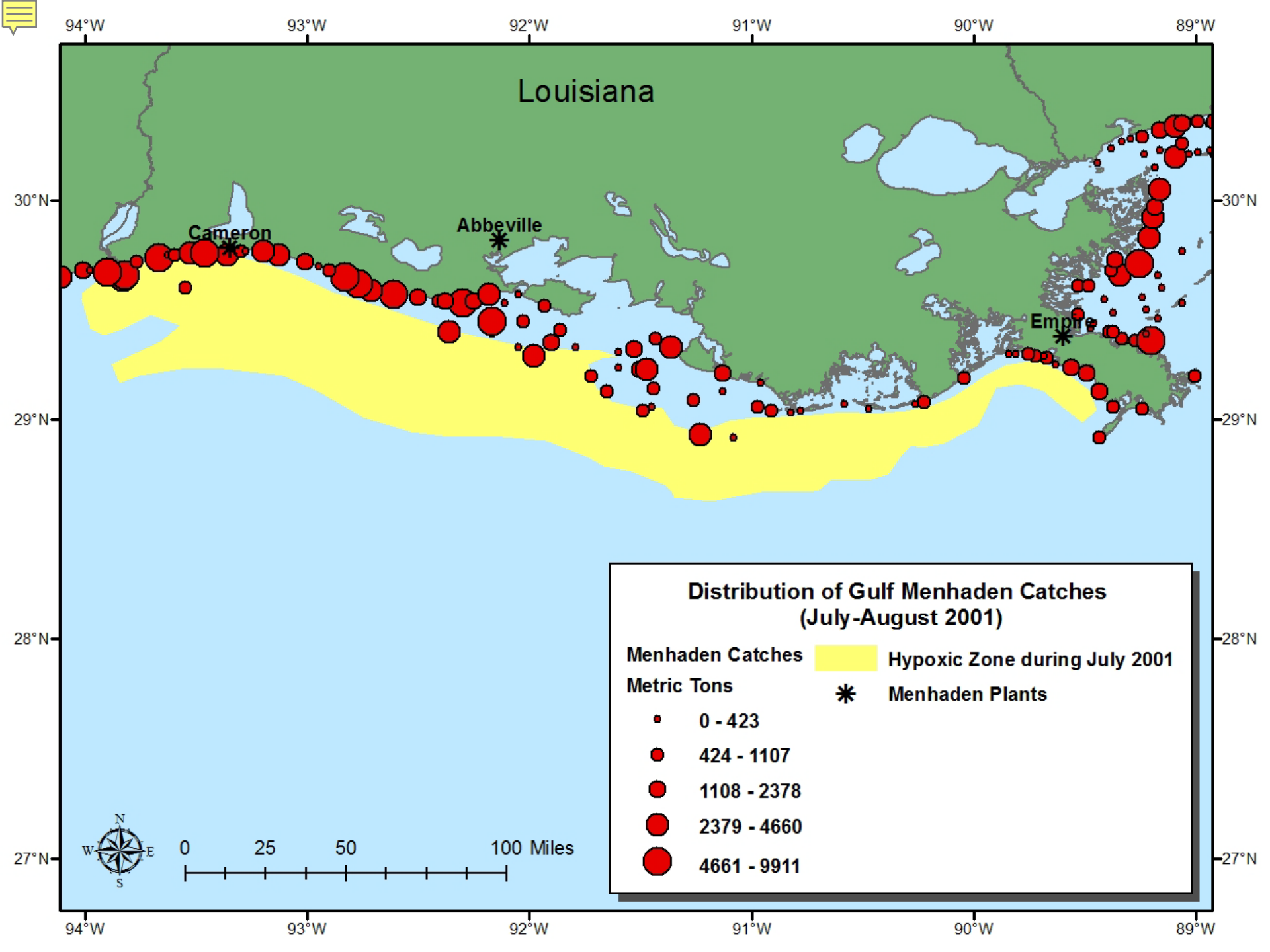
Zimmerman and Nance (2001) found that since the expansion of hypoxia in 1990, there has been a noticeable declining trend in catch per unit effort of brown shrimp.

O'Connor and Whitall (2007) found a negative correlation between the size of the annual hypoxic zone and landings of brown shrimp, confirming and extending the findings of Zimmerman and Nance (2001).

2008 SEAMAP Bottom Dissolved Oxygen and July Shrimping Effort




Louisiana
94°W
93°W
92°W
91°W
90°W
89°W
30°N
29°N
28°N
27°N
July 2002 SEAMAP Sampling
Bottom Dissolved Oxygen
Milligrams per Liter
0.0 - 1.0
1.1 - 2.0
2.1 - 3.0
3.1 - 4.0
4.1 - 5.0
5.1 - 6.0
Brown Shrimp Catches
Number per Hour
1 - 26
26 - 79
79 - 155
155 - 353
353 - 596
Zero Brown Shrimp Catch
N
W
E
S
0
25
50
100 Miles


Louisiana
Cameron
Abbeville
Empire
94°W
93°W
92°W
91°W
90°W
89°W
30°N
29°N
28°N
27°N
Distribution of Gulf Menhaden Catches
(July-August 2001)
Menhaden Catches
Metric Tons
0 - 423
424 - 1107
1108 - 2378
2379 - 4660
4661 - 9911
Hypoxic Zone during July 2001
Menhaden Plants
N
W
E
S
0
25
50
100 Miles

Catch Per Unit Effort

One goal of analyzing data on fish stocks is to be able to allow managers to make informed decisions about setting catch levels. Fisheries managers want to maximize yield from most fisheries.

In most cases, as fish are removed from a population, that population will decrease in abundance, and the average size of fish in the population will also decrease. Existence of sustainable fisheries is based on an increase in surplus production as abundance decreases towards a level corresponding to maximum sustainable yield (MSY).

Catch Per Unit Effort

Catch per unit effort (CPUE) from both fishery independent and fishery dependent data sources are used in stock assessments as a measure of relative abundance for species of interest.

CPUE can be influenced by

- efficiency of the fishing fleet
- changes in targeting by the fishery
- changes in size of the fishing fleet
- environmental factors

Effects of Hypoxia on Fisheries

Even though catch per unit effort (CPUE) may increase when hypoxia is present, Kociolek (2011) found that on average, landings of large shrimp decrease in the presence of seasonal hypoxia whereas landing of smaller, less valuable shrimp increase significantly.

Conclusion

In order to effectively manage marine fisheries, managers need to be able to quantify the impacts of hypoxia on fish populations. Ecosystem based fishery management models should be able to account for the impacts of hypoxia, but ecosystem based management is not here yet.

While estimates of lost fishery production and financial losses to commercial and recreational fisheries remain elusive, they are real.

Commercial and recreational fishermen must traverse the hypoxic zone in order to reach suitable fishing grounds and incur increased operating costs due to increased fuel expenditures and travel times. Hypoxia also has both direct and indirect impacts on fish stocks.

Gulf States Marine Fisheries Commission

2404 Government Street

Ocean Springs, MS 39564

228-875-5912

www.gsmfc.org