

ID: W2750367525

TITLE: Fleet behavior is responsive to a large-scale environmental disturbance: Hypoxia effects on the spatial dynamics of the northern Gulf of Mexico shrimp fishery

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ABSTRACT:

The northwestern Gulf of Mexico shelf experiences one of the largest seasonal hypoxic zones in the western hemisphere. Hypoxia (dissolved oxygen, DO < 2.0 mg·L⁻¹) is most severe from May to August during the height of the Gulf shrimp fishery, but its effects on the fishery are not well known. Prior studies indicate that hypoxia alters the spatial dynamics of shrimp and other species through habitat loss and aggregation in nearby oxygenated refuge habitats. We hypothesized that hypoxia-induced changes in the distribution of shrimp also alter the spatial dynamics of the Gulf shrimp fleet. We integrated data on the geographic distribution of shrimp tows and bottom DO to evaluate the effects of hypoxia on spatial patterns in shrimping effort. Our analyses indicate that shrimping effort declines in low DO waters on both the Texas and Louisiana shelf, but that considerable effort still occurs in low DO waters off Louisiana, likely because riverine nutrients fuel both benthic production and low bottom DO in the same general regions. The response of the shrimp fleet to hypoxia on the Louisiana shelf was complex with shifts in effort inshore, offshore, westward, and eastward of the hypoxic zone, as well as to an oxygenated area between two hypoxia regimes associated with the Mississippi and the Atchafalaya River outflows. In contrast, effort on the Texas shelf mostly shifted offshore in response to low DO but also shifted inshore in some years. Spatial patterns in total shrimping effort were driven primarily by the number of shrimp tows, consistent with aggregation of the fleet outside of hypoxic waters, though tow duration also declined in low DO waters. Overall, our results demonstrate that hypoxia alters the spatial dynamics of the Gulf shrimp fishery with potential consequences for harvest interactions and the economic condition of the fishery.

SOURCE: PloS one

PDF URL: <https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0183032&type=printable>

CITED BY COUNT: 28

PUBLICATION YEAR: 2017

TYPE: article

CONCEPTS: ['Shrimp', 'Hypoxia (environmental)', 'Benthic zone', 'Oceanography', 'Submarine pipeline', 'Fishery', 'Environmental science', 'Habitat', 'Continental shelf', 'Spatial ecology', 'Ecology', 'Biology', 'Geology', 'Chemistry', 'Oxygen', 'Organic chemistry']