

INTERACTIONS BETWEEN ARTISANAL FISHERIES AND FISH SPAWNING AGGREGATIONS: A CASE STUDY OF THE CORVINA FISHERY IN THE GULF OF CALIFORNIA, MEXICO

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Introduction

Fish spawning aggregations (FSAs) are defined as large, temporally and spatially discrete gatherings of fish that form for the sole purpose of reproduction (Sadovy de Mitcheson et al., 2008). FSAs represent important sources of revenue for artisanal fisheries worldwide, because the high density and abundance of fish present at predictable sites and time periods serve as easy opportunities for large harvests with little effort. Unfortunately, their predictability in time and space also makes FSAs particularly vulnerable to overexploitation (Sadovy de Mitcheson and Erisman, 2010). Aggregation-based fisheries are rarely sustainable and overfishing can have rapid, negative effects on harvested populations. More than 79% of documented aggregation sites in the tropics have declined or disappeared (Sadovy de Mitcheson et al., 2008).

The Gulf of California is one of the most productive fisheries regions in the world, and much of this productivity stems from artisanal fisheries that operate throughout its coastlines (Cisneros-Mata, 2010). The fishery for the Gulf corvina (*Cynoscion othonopterus*), a marine fish endemic to the northern Gulf, has emerged as one of the most productive artisanal fisheries in the entire Gulf over the last decade. Annual landings have averaged 2,500 metric tons per year since 1998 (Erisman et al., 2010) and exceeded 5,500 metric tons in 2002. The Gulf corvina fishery ranks only below the shrimp fishery in terms of the most profitable fisheries of the northern Gulf, with annual ex-vessel revenues ranging from 2 to 3 million USD from 2002 to 2010 (Rodríguez-Quiroz et al., 2010; Erisman et al., 2010).

The entire fishery occurs from late February to early May, when adult corvina migrate into the Colorado River Delta region to form massive spawning aggregations within its estuaries (Román-Rodríguez, 2000). During this time period, artisanal fishers harvest large volumes of reproductively active fish by setting gill nets along known migration routes outside the river and at spawning sites within the river and its estuaries. Although the river and its estuaries have been included within a no-take marine reserve since 1993, enforcement has been sporadic at best and mass harvesting of corvina within the reserve occurs relatively unabated during most years.

Objectives and Methods

The objective of this study was to describe the interaction between the reproductive patterns of corvina and artisanal fishing activities for corvina in the Colorado River Delta region of the northern Gulf. Detailed commercial records were acquired from the main commercial buyer at the Gulf of Santa Clara for the years of 2006-2008 and analyzed to estimate daily trends of landings and fishing effort. Catch surveys and GPS tracking exercises were conducted daily at two main landings sites (Gulf of Santa Clara, El Zanjón) in 2009-10 to characterize fine-scale details of the corvina spawning cycle and movement patterns of corvina spawning aggregations.

Results

Our results revealed a complete synchronization between the reproductive cycle of adult corvina and the fishing activities of artisanal fisheries in the region. Spawning and fishing both followed a semi-lunar cycle that began one week before and ended one day before the new and full moons of March and April. From 8 to 5 days before the moon (dbm), aggregations were dispersed outside the mouth of the river (Figure 1). Females were mature but not actively spawning, as ovaries were dominated by yolk-globule stage oocytes. From 4 to 2 dbm, aggregations were densely packed within the estuaries. During this time, all females were actively spawning, as evidenced by the presence of hydrated or fully ovulated oocytes. By the final day of the fishing and spawning cycle, most fish had migrated out of the estuaries and the delta region completely. The few females captured during this period were in the “spent” condition, with ovaries dominated by post-ovulatory follicles and widespread atresia.

Landings and catch-per-unit-effort (CPUE) increased steadily between 8 to 5 dbm, when fish were outside the reserve and the estuaries (Figure 2). Landings and CPUE were both highest from 4 to 2 dbm, when all fish were spawning inside the estuaries. Fishing ended abruptly 1 to 0 dbm, when fish migrated out of the delta region after spawning.

Conclusions

The known vulnerability of FSAs to fishing and the complete synchronization of spawning and fishing activities for the corvina suggest that current fishing practices and harvest levels are not sustainable. The highly restricted geographic distribution of corvina coupled with a prior history of a population collapse present additional concerns for the health of the stock and the fishery. Finally, there is a marked history of failure of aggregation-based fisheries in this region. Between the 1920's and the late 1960's, artisanal fishers in the northern Gulf harvested large volumes of the totoaba (*Totoaba macdonaldi*), a closely related species to the corvina also endemic to the Gulf of California, during its spawning aggregation periods in the Delta region each year. After several decades of unmanaged fishing pressure, the entire fishery collapsed. The totoaba is now restricted from harvest in Mexico, is listed as critically endangered by the International Union for the Conservation of Nature (IUCN), and is regulated as an endangered species by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

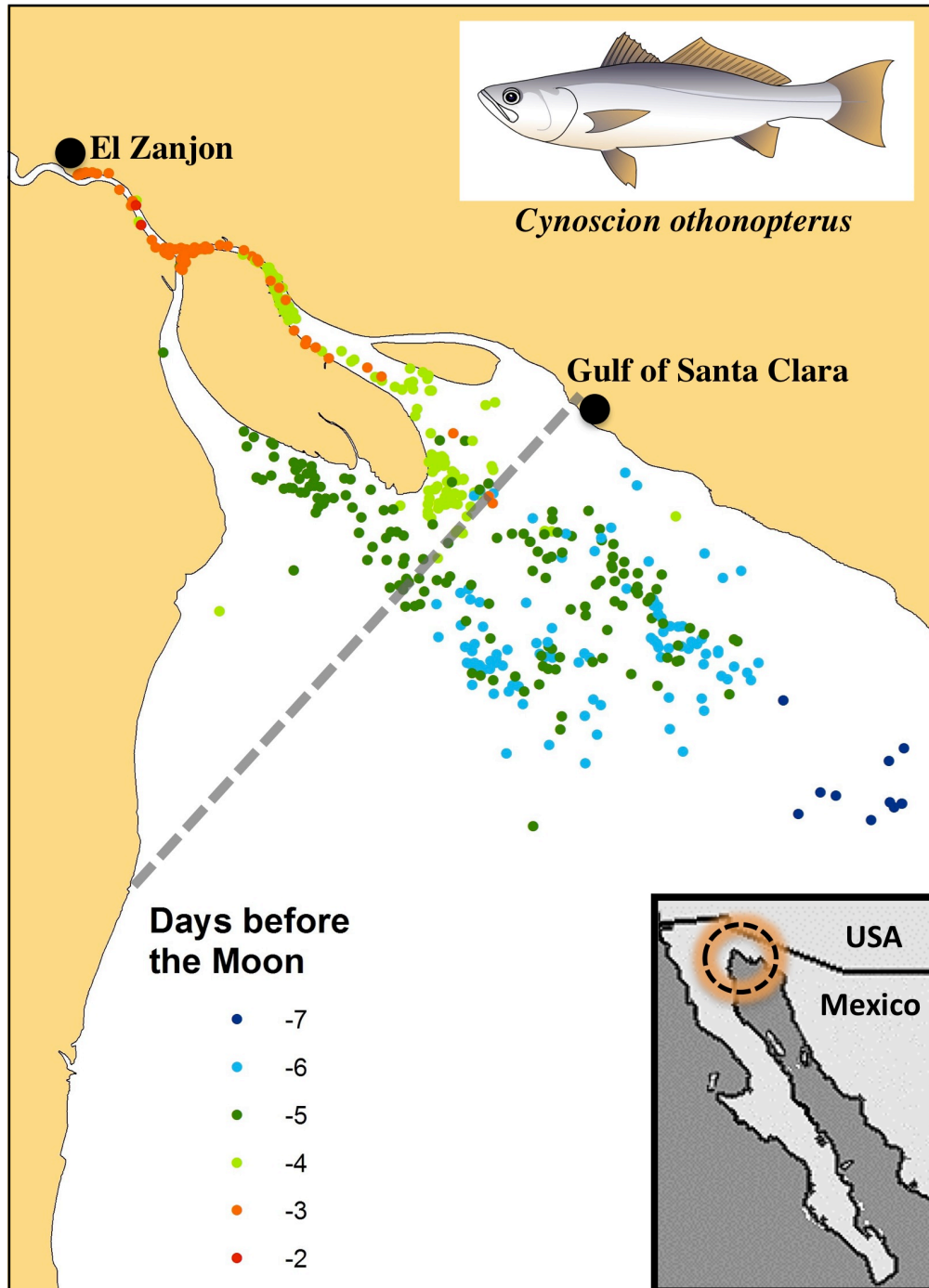


Figure 1. Map of Colorado River Delta region of the upper Gulf of California, showing the locations of Gulf corvina spawning aggregations, organized by lunar day. Colored dots represent exact locations in which fishers located or captured corvina, acquired with GPS tracking devices. The grey dashed line indicates the boundary of the no-take marine reserve.

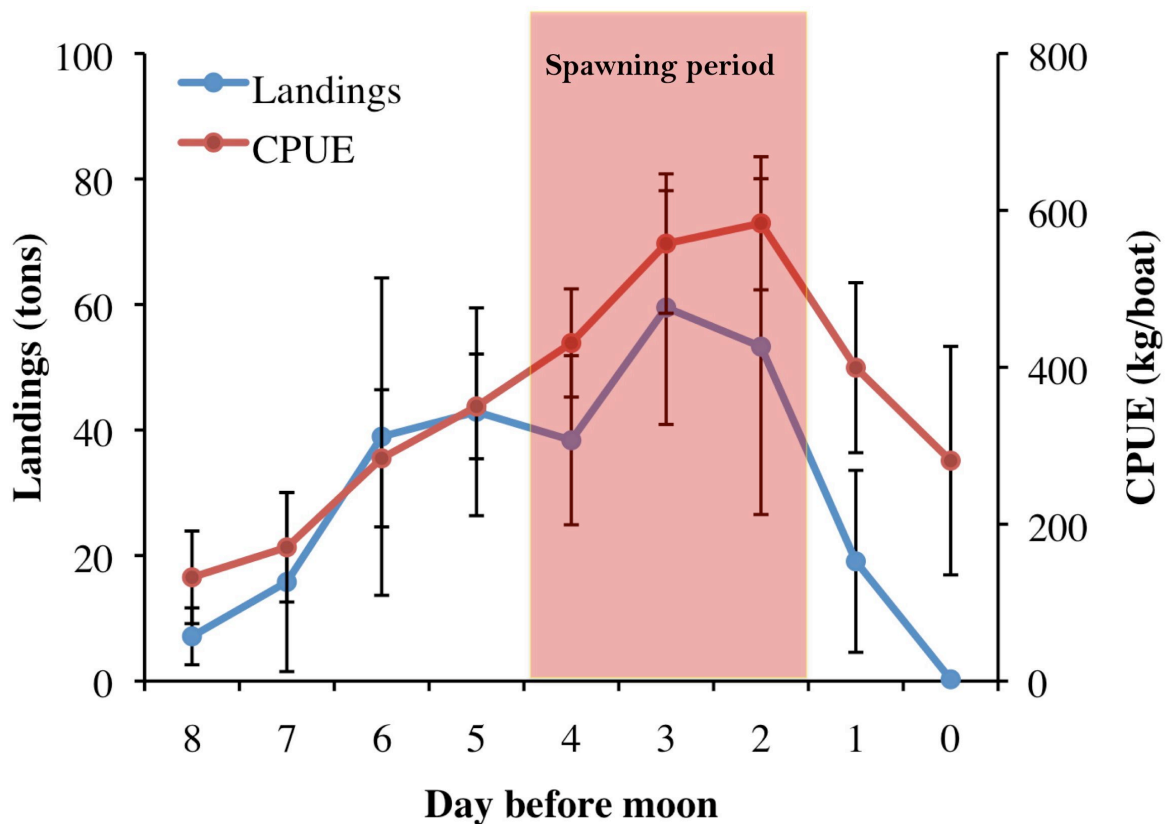


Figure 2. Daily landings and effort trends of the commercial fishery for corvina at the Gulf of Santa Clara, organized by lunar day. The pink column indicates days in which adult corvina spawn within the estuary of the marine reserve.

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