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Do Environmental Conditions Drive the Tortugas Pink Shrimp Fishery?

Pete Sheridan

Abstract

Pink shrimp have been a valuable fishery for southwest Florida since fishermen began harvesting in earnest in the late 1950's. Proximity to population centers in central and south Florida not only made pink shrimp relatively easy to exploit but also brought them in contact with increasing and varied anthropogenic stresses. Declining landings in recent years (figure 1) may be linked to environmental variation in rainfall and runoff that interact with human factors such as water management and habitat alteration. There is no evidence that primary fishing and spawning grounds, which lie offshore between Key West and Tampa, have been affected. Shallow seagrass, mangrove and marsh habitats that form nurseries for juvenile pink shrimp, however, are on the receiving end of upland human activities. Mark-recapture studies conducted by the National Marine Fisheries Service (NMFS) indicated that seagrass-covered Florida Bay (part of Everglades National Park) is the primary nursery area for the Tortugas fishery. This region, lying south of the Miami, Orlando and Tampa metropolitan areas, has suffered the cumulative impacts of surface water diversions for agricultural and urban development of southern Florida. Florida Bay itself has experienced chronic hypersalinity exacerbated by water diversions.

Relevance

The Gulf of Mexico Fishery Management Council requested NMFS to begin forecasting the Tortugas fishery in 1987. Pink shrimp landings averaged 4.55 million kg per year during 1960-1981 but had been declining at the time of the Council request. By 1989, annual landings had reached record low levels of 2.05-2.27 million kg which remain typical. Coincidentally, widespread seagrass die-off was first noted in Florida Bay in 1987 (it is continuing), low rainfall was recorded in south Florida during 1989-1991, and algal blooms have occurred in western and southern Florida Bay. How these environmental disturbances are linked, and whether they have direct or indirect effects on fisheries such as pink shrimp, are of management concern.

Data Availability

In order to forecast the shrimp fishery, it was necessary to locate and examine long-term historical data sets on which to base the forecast model. Statistics for the Tortugas pink shrimp fishery have been collected by the NMFS Southeast Fisheries Science Center in a consistent manner since 1960. Offshore fishing effort and catch of various size classes are recorded monthly from ports around the Gulf of Mexico and Southeastern United States. We felt that catch, effort, or catch per unit effort for the 12 months prior to a forecast date could be used to forecast the upcoming year's harvest. Perhaps a better indicator would be catch or catch per unit effort of juveniles in nearshore waters, but there are no pertinent long term data sets.

Both the National Weather Service and Everglades National Park monitor parameters

which have been directly or indirectly linked to fisheries production elsewhere, such as rainfall, wind speed and direction, and air temperature. We assembled monthly cumulative or mean values of these variables (as appropriate) for Miami, Key West, and three stations (Flamingo, Royal Palm, and Tamiami) within the park dating back to 1963.

The National Ocean Service maintains tide gauges in many coastal cities, most of them in place since the early 1900's. For southern Florida, gauges in Miami Beach, Key West, and Cedar Key are the closest to the study area. We selected monthly means of Key West sea level from 1963 forward as our indicator because of Key West's proximity to Florida Bay. Variations in sea level are a potential index of accessibility of intertidal and shallow subtidal habitats to juvenile pink shrimp in nursery habitats.

Everglades National Park monitors surface water discharges into the park from water control structures on its north and east boundaries, as well as ground water levels in a series of wells throughout the park. Construction of water diversion canals in south Florida began at the turn of the century and was mostly complete by 1967. This water control system interrupts the natural surface sheet water flow south from Lake Okeechobee into the Everglades, a natural wetland once 80 km wide and 160 km long. As indices of the amount of fresh water reaching the coast of Florida Bay, we collated total monthly surface discharge into the park and monthly mean water levels at the three wells nearest the coast from 1963 forward. Long-term salinity measurements within Florida Bay, which would be a good indicator of physiological stress on pink shrimp and could improve forecasts, are not yet available from Everglades National Park.

Results

We examined this data set using statistical correlation and regression techniques to identify a set of variables that provides a reasonable forecast of pink shrimp landings. Historically, November was the first month with landings exceeding 0.45 million kg after the summer lows. Since 1987, we have provided a forecast for the November-October "fishing year" using variables measured during the previous May-October (figure 1). In 1990, we forecast 1.77-1.91 million kg with actual landings of 2.09 million kg, and in 1991 we forecast 1.95-2.14 million kg with 2.13 million kg landed. The predictor variables consistently include surface water discharges and well water levels in Everglades National Park. While the mechanisms are as yet unexplained, these findings demonstrate the importance of fresh water to pink shrimp production.

Our 1992 forecast was an optimistic 2.82-3.09 million kg, based largely on increased water inputs and levels in Everglades National Park that should lower salinities in Florida Bay. The bay suffers some continuing problems that have not been figured into our forecast model. The seagrass die-off is progressing, and our research indicates that disturbed habitats (bare sediments and algal and seagrass colonization zones) support lower densities of fishes and invertebrates and their foods than do healthy seagrasses. In addition, the die-off results in resuspension of sediments and nutrients, reduced water clarity, increased frequency and size of algal blooms, and thus more stress on the seagrasses. The algal blooms have been implicated in the die-off of sponges in southern Florida Bay (favorite habitats for juvenile spiny lobsters), but we do not know whether algal blooms affect pink shrimp. Finally, central portions of the bay still exhibit hypersaline conditions but these may be alleviated by this summer's test of increased fresh water diversion to the drainage basin leading to this area.

While it seems that we are able to predict pink shrimp landings and that fresh water variables play a large role, we still do not understand the mechanisms involved. Many of the current Florida Bay disturbances and recommended restoration activities will impact pink shrimp landings, but we know neither the degree nor the direction of impact. The NMFS Southeast Fisheries Science Center sponsored a Florida Bay workshop for NOAA scientists in July 1993 to develop a research plan for NOAA. Many of the data gaps and research and management needs were identified, and funding to compiement other state and federal Florida Bay restoration actions is being pursued.

Illustration

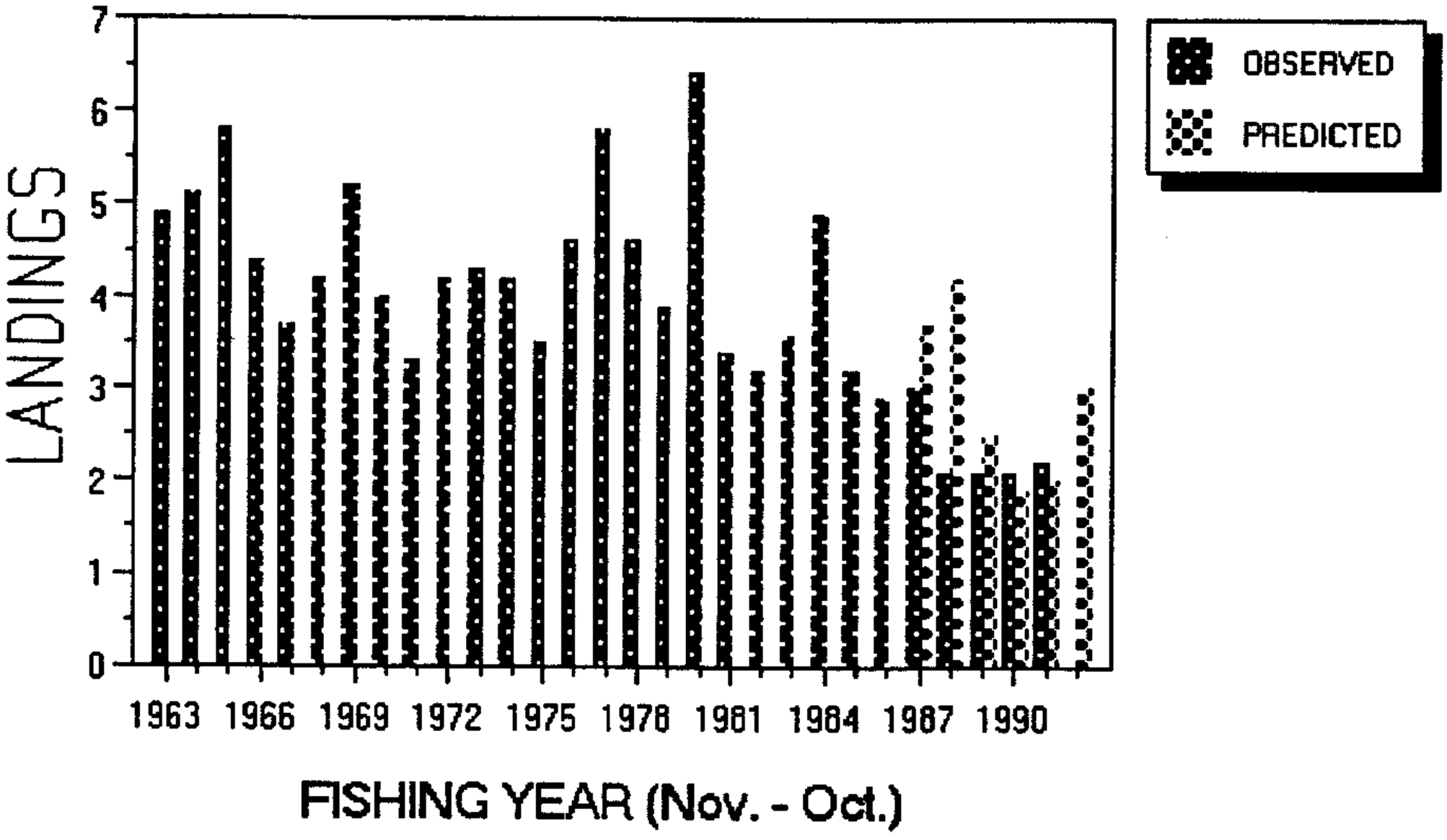

Figure 1. Tortugas pink shrimp landings (millions Kg).

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See Also

Marine Mammal Mortalities Linked to Environmental Conditions

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Tortugas Pink Shrimp

(Million Kg Landed)