12-1977

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DOI: 10.18785/negs.0102.04

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Recommended Citation

Russell, M. 1977. Apparent Effects of Flooding on Distribution and Landings of Industrial Bottomfish in the Northern Gulf of Mexico. *Northeast Gulf Science* 1 (2).
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APPARENT EFFECTS OF FLOODING ON DISTRIBUTION AND LANDINGS OF INDUSTRIAL BOTTOMFISH IN THE NORTHERN GULF OF MEXICO¹

by

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ABSTRACT: Evidence is presented that suggests river discharge affected bottomfish distribution from January through June 1972 and 1973. Also, normal commercial concentrations of industrial bottomfish were not seen on the inshore grounds from Mobile Bay, Ala. to Trinity Shoal, La. during peak flood periods in 1973. Comparison between river runoff and annual bottomfish landings for the last 17 years, however, indicates that flooding may be beneficial to annual production, by increasing availability of nutrients and extending the estuarine nursery boundaries.

Industrial bottomfishing in the northern Gulf of Mexico in 1975 produced 102 million pounds (46,266,896 kg) of finfish, valued at \$2.7 million, for petfood industries in Louisiana and Mississippi.

Industrial bottomfish in the northern Gulf of Mexico are represented by at least 177 species in 65 families (Roithmayr 1965). In 1975, Sciaenidae represented 80% of the landings, of which Atlantic croaker (*Micropogon undulatus*) accounted for 72% (Roithmayr, personal communication). Commercial concentrations of Atlantic croaker were found generally from Perdido Bay, Fla. to Trinity Shoal, La. from shore to 50 fathoms (92 m).

The Alabama, Tombigbee, Mississippi, and Atchafalaya rivers are major river systems draining into the area between Perdido Bay and Trinity Shoal. During peak runoff these rivers profoundly influence the marine environment, including distribution of commercial bottomfish (Ho and Barrett 1977, White 1975).

The threat of the Mississippi River flooding New Orleans resulted in the opening of the Bonnet Carre Spillway on April 8, and the Morganza Spillway on April 17, 1973. Opening these two spillways diverted large volumes of silt-laden freshwater from the Mississippi River into the bottomfish nursery grounds through Lake Pontchartrain and the Atchafalaya River. The purpose of this study was to determine the flood's effect on commercial fishing for industrial bottomfish.

METHODS

Captains on the industrial fishing boats provided the catch data: catch per drag, hours fished, location, depth, and tons unloaded. Catch per unit effort (CPUE) is expressed as kilograms per hour and used as an index of commercial concentration of industrial bottomfish. Effort represented actual hours fished, and did not include vessel search time or trynet sampling as described by Gutherz et al. (1975). Data representing less than 10 hr. of effort per month were not used

¹ Contribution Number 78-11P, Southeast Fisheries Center, Pascagoula, Laboratory.

because it represented an inadequate sample.

Historical industrial landings statistics were provided by the National Marine Fisheries Service Statistics and Market News Division, (546 Carondelet Street, Room 412, New Orleans, LA 70130). Daily flow rates in cubic meters per second (cms) for the Alabama, Tombigbee, Mississippi, and Atchafalaya rivers were provided by the U.S. Army Corps of Engineers in Mobile, Ala. and Baton Rouge, La. Earth Resources Technology Satellite Multispectral Scanner Photographs defined limits of influence for the Mississippi River east of the Delta before and after opening the spillway (EROS, Experiments and Evaluation Office).

Landings were separated and analyzed in two distinct time groups. The period 1957 to 1966 included only Mississippi based vessel and landings, with lower

catch rates. From 1967 to 1973 demand increased with a resultant increase in catch rates and fishes were landed in both Miss. and La. During the latter period utilization of the catch also increased.

Study Area

Fishing effort in that area influenced by the discharge from the Alabama and Tombigbee rivers was limited or absent during the peak flood period and therefore not considered in this study.

The combined Mississippi and Atchafalaya rivers' discharge represents about 90% of the total annual discharge on the Louisiana coast (Perret et al. 1971). However, the Atchafalaya River is considered here as part of the Mississippi River because it is the main distributary of the Mississippi River, and receives more than 30% of the river's flood waters (Perret et al. 1971).

General flow patterns were determined from Earth Resources Technology

Figure 1. — Chart of area affected by 1972 and 1973 floods. The solid black lines represent the division between those areas influenced by the Mississippi, Alabama, and Tombigbee rivers. The slashed line indicates the additional area coming under the influence of the Mississippi River after the opening of the Bonnet Carre Spillway on April 8, 1973.

Satellite Multispectral Scanner (ERTS) photos. A line running from Curlew Island, La. east northeast to the 20-fathom curve represented the eastern boundary of the area influenced by the Mississippi River before opening the Bonnet Carre Spillway (Figs. 1 and 2A). After its opening on April 8, 1973 flood water moved through Lake Pontchartrain and Lake Borgne and met flood waters discharging through the Mississippi River Delta. This increased the sphere of influence of the Mississippi River flood waters as redefined by a line running southeast from Cat Island, Miss. to the 20-fathom (37 m) curve (Figs. 1 and 2B).

RESULTS

Runoff vs. Catch Rate

The 1972 and 1973 January-June discharge rates for the Mississippi River have been compared with the average monthly discharge for the 17-year period 1957 through 1973. The January 1973 flow rate was high and remained high throughout the study period with the peak flow in May. Highest flow rate recorded was in May 1973 and was nearly double the 17-year average. However, average January-June flow rates in 1972 were normal based on the 17-year average (Table 1).

Comparison of 1972 flow rates and CPUE in 0-15 fathoms showed that as flow rate increased catch rate decreased, and when flow rate decreased catch rate increased. This trend was also present until May in 16-30 fathoms. Flow rate peaked in May, yet the catch rate increased. This increase is believed to be the result of fish moving from inshore to offshore grounds (Table 1).

Flow rates during the 1973 flood period remained well above the 17-year average. During this period catches continued to decrease in 0-15 fathoms until bottomfish became unavailable in April. In May, juvenile croaker forced

out of the estuaries near Cat Island, Miss. were taken inside 15 fathoms. The availability of croakers in 16 to 30 fathoms throughout the flood period is believed to be the result of stocks moving offshore.

When similar consumer demand periods are analysed a relationship between flow rate and landings is seen. Flooding is considered to have occurred during 6 of the 17 years of available data. Above average landings are observed in greater than 50 percent of flood years. Conversely, below average landings are noted in greater than 50 percent of the years where flow rates were below average.

DISCUSSION

Inshore stocks of industrial bottomfish appeared to disperse into the deeper offshore waters during the 1973 spring flood. In March and April 1973 the National Ocean Survey's Fisheries Research Ship OREGON II conducted a research cruise between Perdido Bay and Ship Shoal, La. in depths of 5 to 50 fathoms. Distribution patterns showed that inshore densities of bottomfish, specifically croaker, were unusually low. In early May 1973 a transect line east of the Delta from 10 to 100 fathoms was sampled to find what effects the flood had on the distributional patterns of bottomfish. Croaker were found from 20 to 90 fathoms with the highest concentrations between 40 and 80 fathoms. Normally, croaker are seldom caught in depths exceeding 40 fathoms and are generally not seen in depths exceeding 60 fathoms (Guthertz, 1976).

The cause of this unusual distribution pattern is unknown; however, it did occur during a period of peak flooding, and the influence of several flooding characteristics should be considered. These are:

- 1) silt carried down by the runoff,

Figure 2A. — The Mississippi River on January 16, 1973 before the opening of the Bonnet Carré Spillway.

Figure 2B. — The Mississippi River after diversion of flood waters into Lake Pontchartrain, Lake Borgne, and the Gulf of Mexico extending the influence of the Mississippi River. Flood waters can be seen moving in an easterly direction to Cat Island and south into the Gulf of Mexico.

- 2) reduced salinity due to influx of fresh water,
- 3) temperature differential between colder runoff and warmer oceanic Gulf water

Atlantic croakers are normally found on muddy bottoms in turbid water. Although increased turbidity should not affect croaker abundance or distribution, increased silting may.

Large amounts of fresh water may stimulate an offshore movement by lowering temperatures or salinities. Stratification of size groups by salinity has been shown by Franks et al. (1972). Older, larger croaker prefer deeper, more saline waters while juvenile croaker are found in shallower waters, which have a

greater range of salinities. Temperature difference between river runoff and open Gulf waters may have lowered overall temperatures. Sudden low temperatures have triggered movement of croaker into deeper waters (Hildebrand and Schroeder, 1928; Hildebrand and Cable, 1930; Wallace, 1940; Suttkus, 1954). Suttkus (1954) found that migration of immature croaker from Lake Pontchartrain was directly related to a sudden drop in temperature. Trawl catch rates vs. temperature and salinity for Mississippi state coastal waters from 1967 to 1969 showed the best average catches occurred in salinities between 35.0-39.9 ppt. and temperatures between 65.2° -70.5° (19.0° - 21.9° C) (Franks et al. 1972).

Table 1. — Mississippi River flow rates and catch per unit effort by depth zones.

0-15 fathoms depth					
1972					
Month	1957 - 1973		Flow Rate	CPUE	
	Flow	Rate			
	Average	CMS	(CMS)	kg/ hr	
					1973
					Flow
					Rate
					(CMS)
					kg/ hr
JAN	394676	492063	981	739484	1068
FEB	431746	350992	1025	680300	692
MARCH	551786	528968	844	684495	469
APRIL	610884	456122	1381	1091837	—
MAY	617489	658107	458	1206434	941*
JUNE	423951	254989	1011	830441	2153

16-30 fathoms depth					
JAN	394676	492063	838	739484	750
FEB	431746	350992	917	680300	729
MARCH	551786	528968	735	684495	801
APRIL	610884	456122	1025	1091837	694
MAY	617489	658107	1592	1206434	701
JUNE	423951	254989	1054	830442	786

* Juvenile croaker forced out of estuarine nursery areas.

Optimum combinations of turbidity, salinity, and temperature are unknown; however, movement might be in response to change in these factors.

Annual landings of industrial bottomfish appear to be in some way dependent on the magnitude of spring runoff. Ho and Barrett (1977) estimated 28.45 billion kg of nutrients were discharged into the Gulf by the Mississippi River from January through July 1973. Furthermore, the nutrient content available in the area influenced by the Mississippi River is directly related to the volume of water discharged. The combined effect of increased nutrients and temporary expansion of estuarine nursery areas during flood periods may help reduce natural mortality.

ACKNOWLEDGEMENTS

I extend my appreciation to Elmer J. Guthertz, Johnny Butler, and Dean Mericas for reviewing this manuscript.

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