Master file

Fish Tagging in Texas Bays During November 1975 - September 1976

by Gary C. Matlock and James E. Weaver

Management Data Series Number 1
Executive Summary 1979

Texas Parks and Wildlife Department
Coastal Fisheries Branch

For over a century fishery biologists have utilized marks to identify individuals or small groups of a population on recapture (Raleigh et al. 1973). Information obtained from recaptured marked fish allows inferences to be made concerning species and race distinctions, geographic distribution, migrations, spawning, age, growth, mortality rates and population size (Rounesefell 1975). Perhaps the most extensive fish tagging in the Gulf of Mexico and adjacent estuaries has been by personnel of the Florida Department of Natural Resources. The most publicized of their tagging programs was the Schlitz Tagging Program conducted in the 1960's (Ingle et al. 1962, Beaumariage 1969, Moe 1972). Monetary rewards of at least $25 and as much as $10,000 were offered as incentives for fishermen to return recaptured tagged fish. Additional studies to determine movement, mortality and population size of selected estuarine species have been conducted in Florida (Iversen and Moffett 1962, Moffett 1961, Iversen and Tabb 1962, Carr and Chaney 1976). Loesch et al. (1976) in Louisiana used fluorescent pigments to determine trawl efficiency for Atlantic croker (Micropogon undulatus) and spot (Leiostomus xanthurus).

Tagging experiments in Texas estuaries began in 1950 on the central coast and continue today. Information obtained from these efforts has dealt mainly with movement, growth, population estimates and tag shedding rates for spotted seatrout (Cynoscion nebulosus), red drum (Sciaenops ocellata) and black drum (Pogonias cromis) from Aransas Bay southward. Although tagging has continued in Texas for over 25 yr, comprehensive and comparable data for fish of the same species but in different bay systems throughout all Texas bays is lacking. In November 1975 the Texas Parks and Wildlife Department began a cooperative tagging program with the National Marine Fisheries Service to obtain data concerning movement, growth, mortality and population size of primarily red drum, black drum and southern flounder (Paralichthys lethostigma) from every major Texas bay. This report summarizes the results of the first year's efforts.

Fish for tagging were obtained during gill net and trammel net sampling operations in seven bay systems during November 1975-September 1976. Sample sites were selected at random. Only apparently healthy fish were tagged, after being weighed and measured, with internal abdominal tags. The tagging program was advertised through radio, television, newspapers and posters with notice that each tag was worth $1-$25. All data provided by each fisherman were assumed to be accurate except when approximations were stated. Approximations of length, weight or date of recapture were not used in growth calculations. Minimum distances traveled and mean growth rates were calculated for each recaptured fish when the necessary information was available. Each fisherman reporting a recaptured tagged fish was categorized as sport (did not sell the fish), commercial (sold the fish), unknown (information not available) or Texas Parks and Wildlife Department (TPWD) personnel (caught the fish while collecting an experimental sample). Fishing mortalities for sport and commercial fishermen in each bay system and on the entire coast were calculated for each species having at least five returned individuals. Coastwide survival estimates were also calculated. Several assumptions were made in each of these calculations (Ricker 1975).

During November 1975-September 1976, 3710 fish were tagged with internal abdominal tags along the Texas coast (Table 1). Most fish (95.4%) were tagged from November through May. More fish (866) were tagged in the Galveston Bay system than in any other while the fewest number of fish (398) were tagged

in the upper Laguna Madre system (Table 2). Red drum and black drum were the predominant species tagged (2893 fish).

Of the 13 species tagged, recaptures of seven species worth $518 (Table 3) were reported in Texas bays by all fishing interests (Table 4). Red drum had the largest percent recaptures with 11.6% followed by gulf flounder (P. albigutta) (9.3%), Atlantic croaker (4.0%), southern flounder (4.5%), black drum (3.4%), sheepshead (Archosargus probatocephalus) (2.9%) and spotted seatrout (2.3%). Sport fishermen reported catching 132 tagged fish while commercial fishermen reported 82 (Table 5). Experimental sampling by TPWD resulted in 12 returned fish; unknown fishermen reported 10. Tagged fish were returned during all months with the majority (72.9%) returned after March. The value of information obtained from this program far exceeded the $518 cost of rewards.

Most of the recaptured red drum (68.6%) and black drum (67.3%) traveled less than 7 miles from the tagging site (Table 6). This pattern was consistent in all bays except upper and lower Laguna Madre where the majority (50.0%) traveled more than 6 miles. The percent of red drum and black drum recaptured decreased as the distance from tagging site increased. Only 12 (7.5%) of the recaptured red drum and one (1.9%) of the recaptured black drum left the bay system where tagged (Table 4). A lack of extensive mass migration by red drum and black drum indicates that each bay system on the Texas coast can be considered a closed system for these two species.

Variation associated with the mean weight growth rate was much greater than that associated with the mean length growth rate. Therefore, length should be used as a basis for expressing growth rate. Annual mean growth rates of recaptured red drum in Texas bays ranged from 0.012 $\pm$ 0.004 inch/day (1 inch = 25.4 mm) in the Corpus Christi Bay system to 0.033 $\pm$ 0.019 inch/day in the Galveston Bay system. Mean growth rates in each bay system were not significantly different from each other. The mean growth rate for all recaptured red drum was 0.017 $\pm$ 0.003 inch/day. Without nine TPWD recaptured fish, the rate was 0.018 $\pm$ 0.004 inch/day compared with 0.009 $\pm$ 0.005 inch/day for the TPWD caught fish.

Annual mean growth rates of recaptured black drum in Texas bays ranged from -0.035 $\pm$ 0.000 inch/day in the San Antonio Bay system to 0.121 $\pm$ 0.108 inch/day in the Corpus Christi Bay system. This wide variation was probably attributable to the small sample size. The mean growth rate for all recaptured black drum was 0.029 $\pm$ 0.010 inch/day. Without three TPWD caught fish, the rate was 0.031 $\pm$ 0.009 inch/day compared with 0.005 $\pm$ 0.003 inch/day for the TPWD caught fish.

Monthly survival estimates for fish in all bays were 90.9 $\pm$ 3.2% for red drum and 80.0 $\pm$ 5.4% for black drum. A model assuming constant survival and recovery rates was selected as the best fit for both species because it was not significantly different from more complex models where one or both of the parameters were time specific. Monthly fishing mortality estimates for red drum were 1.0 $\pm$ 0.2% for sport fishermen and 1.0 $\pm$ 0.3% for commercial fishermen, assuming a 100% reporting rate. Monthly fishing mortality estimates for black drum were 0.5 $\pm$ 0.3% for sport fishermen and 0.4 $\pm$ 0.2% for commercial fishermen, assuming a 100% reporting rate. As reporting rates decrease, fishing mortality estimates increase (Fig. 1).

Hypothetical population sizes based on sport harvest (25,908 red drum/mo, 26,967 black drum/mo) as reported by Heffernan and Green (1977) ranged from 259,090 to 2,590,800 (Fig. 2) for red drum and from 539,340 to 5,393,400 (Fig. 3) for black drum on a monthly basis. It should be emphasized that these values are only first order approximations and their accuracy depends on the accuracy of harvest estimates, reporting rates and the validity of assumptions involved.

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Table 1. Number of fishes tagged with internal abdominal tags by month during November 1975-September 1976 on the Texas coast.

Species	1975		1976									
	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Total
Red drum	126	262	296	127	138	183	184	3	3	7	5	1334
Black drum	183	262	309	264	215	78	210	2	6	10	20	1559
Southern flounder	29	44	12	7	20	23	57	0	0	5	2	199
Sheepshead	11	25	43	26	20	6	67	0	2	2	3	205
Gulf flounder	1	7	0	6	6	13	7	2	1	0	0	43
Atlantic croaker	1	0	0	0	0	6	18	0	0	0	0	25
Spotted seatrout	0	0	0	80	91	32	0	0	0	0	100	303
Striped mullet	0	0	0	0	0	6	1	0	0	0	0	7
Sea catfish	0	0	0	0	0	28	0	0	0	0	0	28
Gizzard shad	0	0	0	0	0	1	0	0	0	0	0	1
Tripletail	0	0	0	0	0	0	1	0	0	0	0	1
Gulf kingfish	0	0	0	0	0	0	1	0	0	0	0	1
Spot	0	0	0	0	0	0	4	0	0	0	0	4
All species	351	600	660	510	490	376	550	7	12	24	130	3710

Table 2. Number of fishes tagged with internal abdominal tags by bay during November 1975-September 1976 on the Texas coast.

Species	Galveston	Matagorda	San Antonio	Aransas	Corpus Christi	Upper Laguna Madre	Lower Laguna Madre	Total
Red drum	258	266	249	178	129	100	154	1334
Black drum	232	228	197	288	122	277	215	1559
Southern flounder	38	38	13	22	55	9	24	199
Sheepshead	34	9	72	0	76	0	14	205
Gulf flounder	0	2	6	2	27	5	1	43
Atlantic croaker	19	0	0	0	4	0	2	25
Spotted seatrout	273	1	0	7	0	7	15	303
Striped mullet	4	0	0	0	0	0	3	7
Sea catfish	6	1	0	0	4	0	17	28
Gizzard shad	1	0	0	0	0	0	0	1
Tripletail	1	0	0	0	0	0	0	1
Gulf kingfish	0	1	0	0	0	0	0	1
Spot	0	0	0	0	1	0	3	4
All species	866	546	537	497	418	398	448	3710

Table 3. Total number of rewards paid for returned internal abdominal tags during November 1975-September 1976.

Species	Amount of reward				Total amount paid (dollars)
	$1	$5	$10	$25	
Red Drum	138	7	10	4	373
Black Drum	47	4	1	1	102
Southern Flounder	5	4			25
Sheepshead	6				6
Gulf Flounder	4				4
Atlantic Croaker	1				1
Spotted Seatrout	7				7
Total	208	15	11	5	518

Table 4. Percent of fishes tagged in each bay system on the Texas coast and returned during November 1975-September 1976.

Species	Bay system	Number tagged	Total returned		Returned from same bay system		Returned from other bay system	
			Number	Percent of total tagged	Number	Percent of total returned	Number	Percent of total returned
Red drum	Galveston	258	17	6.6	16	94.1	1	5.9
	Matagorda	273	24	8.8	23	95.8	1	4.2
	San Antonio	249	17	6.8	16	94.1	0	0.0
	Aransas	178	31	17.4	29	93.5	1	3.2
	Corpus Christi	129	26	20.2	21	80.8	5	19.2
	Upper Laguna Madre	100	15	15.0	10	66.7	4	26.7
	Lower Laguna Madre	154	29	18.8	29	100.0	0	0.0
	Texas Coast	1341	159	11.6	144	90.6	12	7.5
Black drum	Galveston	232	4	1.7	4	100.0	0	0.0
	Matagorda	241	9	3.7	9	100.0	0	0.0
	San Antonio	197	3	1.5	3	100.0	0	0.0
	Aransas	288	16	5.6	15	93.8	1	6.3
	Corpus Christi	122	4	3.3	4	100.0	0	0.0
	Upper Laguna Madre	277	6	2.2	6	100.0	0	0.0
	Lower Laguna Madre	215	11	5.1	11	100.0	0	0.0
	Texas coast	1572	53	3.4	52	98.1	1	1.9
Southern flounder	Galveston	38	1	2.7	1	100.0	0	0.0
	Matagorda	38	2	5.3	2	100.0	0	0.0
	San Antonio	13	0	0.0	0		0	
	Aransas	22	1	4.5	1	100.0	0	0.0
	Corpus Christi	55	3	5.5	2	66.7	1	33.3
	Upper Laguna Madre	9	2	22.2	1	50.0	1	50.0
	Lower Laguna Madre	24	0	0.0	0		0	
	Texas coast	199	9	4.5	7	77.8	2	22.2

Table 4. Percent of fishes tagged in each bay system on the Texas coast and returned during November 1975-September 1976.

Species	Bay system	Number tagged	Total returned		Returned from same bay system		Returned from other bay system	
			Number	Percent of total tagged	Number	Percent of total returned	Number	Percent of total returned
Red drum	Galveston	258	17	6.6	16	94.1	1	5.9
	Matagorda	273	24	8.8	23	95.8	1	4.2
	San Antonio	249	17	6.8	16	94.1	0	0.0
	Aransas	178	31	17.4	29	93.5	1	3.2
	Corpus Christi	129	26	20.2	21	80.8	5	19.2
	Upper Laguna Madre	100	15	15.0	10	66.7	4	26.7
	Lower Laguna Madre	154	29	18.8	29	100.0	0	0.0
	Texas Coast	1341	159	11.6	144	90.6	12	7.5
Black drum	Galveston	232	4	1.7	4	100.0	0	0.0
	Matagorda	241	9	3.7	9	100.0	0	0.0
	San Antonio	197	3	1.5	3	100.0	0	0.0
	Aransas	288	16	5.6	15	93.8	1	6.3
	Corpus Christi	122	4	3.3	4	100.0	0	0.0
	Upper Laguna Madre	277	6	2.2	6	100.0	0	0.0
	Lower Laguna Madre	215	11	5.1	11	100.0	0	0.0
	Texas coast	1572	53	3.4	52	98.1	1	1.9
Southern flounder	Galveston	38	1	2.7	1	100.0	0	0.0
	Matagorda	38	2	5.3	2	100.0	0	0.0
	San Antonio	13	0	0.0	0		0	
	Aransas	22	1	4.5	1	100.0	0	0.0
	Corpus Christi	55	3	5.5	2	66.7	1	33.3
	Upper Laguna Madre	9	2	22.2	1	50.0	1	50.0
	Lower Laguna Madre	24	0	0.0	0		0	
	Texas coast	199	9	4.5	7	77.8	2	22.2

Table 4. (Cont'd.).

Species	Bay system	Number tagged	Total returned		Returned from same bay system		Returned from other bay system	
			Number	Percent of total tagged	Number	Percent of total returned	Number	Percent of total returned
Sheepshead	Galveston	34	0	0.0	0		0	
	Matagorda	9	0	0.0	0		0	
	San Antonio	72	3	4.2	1	33.3	2	66.7
	Aransas	0						
	Corpus Christi	76	3	3.9	2	66.7	1	33.3
	Upper Laguna Madre	0						
	Lower Laguna Madre	14	0	0.0	0		0	
	Texas coast	205	6	2.9	3	50.0	3	50.0
Gulf flounder	Galveston	0						
	Matagorda	2	1	50.0	1	100.0	0	0.0
	San Antonio	6	2	33.3	2	100.0	0	0.0
	Aransas	2	0	0.0	0		0	
	Corpus Christi	27	1	3.7	1	100.0	0	0.0
	Upper Laguna Madre	5	0	0.0	0		0	
	Lower Laguna Madre	1	0	0.0	0		0	
	Texas coast	43	4	9.3	4	100.0	0	0.0
Spotted seatrout	Galveston	273	7	2.6	5	83.3	1	16.7
	Matagorda	1	0	0.0				
	San Antonio	0						
	Aransas	7	0	0.0				
	Corpus Christi	0						
	Upper Laguna Madre	7	0	0.0				
	Lower Laguna Madre	15	0	0.0				
	Texas coast	303	7	2.3	5	83.3	1	16.7
Atlantic croaker	Galveston	19	1	5.3	1	100.0	0 0.0	
	Matagorda	0						
	San Antonio	0						
	Aransas	0						
	Corpus Christi	4						
	Upper Laguna Madre	0	0	0.0				
	Lower Laguna Madre	2	0	0.0				
	Texas coast	25	1	4.0	1	100.0	0	0.0

Table 5. Total number of fish returned from Texas bays by fishermen during November 1975-September 1976.

Species	Fishing interest	1975 N	1975 D	1976 J	F	M	A	M	J	J	A	S	Nov-Sept
Red drum	Sport	1	2	4	6	3	2	9	10	16	16	13	82
	Commercial	0	1	3	4	6	12	6	13	3	4	7	59
	TPWD*	0	0	0	1	2	0	5	1	0	0	0	9
	Unknown	0	0	1	0	1	3	0	4	0	0	0	9
	Total	1	3	8	11	12	17	20	28	19	20	20	159
Black drum	Sport	0	1	0	8	4	3	2	3	5	2	3	31
	Commercial	1	0	1	2	3	2	2	1	5	0	2	19
	TPWD	0	0	0	1	0	0	0	1	0	0	1	3
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	1	1	1	11	7	5	4	5	10	2	6	53
Southern flounder	Sport	0	0	0	0	2	0	2	3	0	0	1	7
	Commercial	0	2	0	0	0	0	0	0	0	0	0	2
	TPWD	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	2	0	0	2	0	2	2	0	0	1	9
Sheepshead	Sport	0	0	0	1	0	2	0	0	0	0		3
	Commercial	0	0	1	0	0	0	0	0	0	1		2
	TPWD	0	0	0	0	0	0	0	0	0	0		0
	Unknown	0	0	0	0	1	0	0	0	0	0		1
	Total	0	0	1	1	1	2	0	0	0	1		6
Gulf flounder[a]	Sport	0	0	1	0	0	0	0	1	0	1		3
Atlantic croaker[a]	Sport	0	0	0	0	0	0	0	1	0	0		1
Spotted seatrout[a]	Sport	0	0	0	0	0	1	1	0	2	3		7

[a]Tag returns reported by sport fishermen only.

Table 6. Number of returned tagged fish moving from site of tagging on the Texas coast.

Species	Minimum distance traveled (miles)								Number with movement data available
	0-3	4-6	7-9	10-12	13-15	16-18	19-21	21	
Red drum	81	24	11	13	7	7	4	6	153
Black drum	26	7	4	1	2	3	2	4	49
Southern flounder	7	1	0	0	1	0	0	0	9
Sheepshead	1	0	0	2	0	0	0	3	6
Gulf flounder	2	1	1	0	0	0	0	0	4
Atlantic croaker	1	0	0	0	0	0	0	0	1
Spotted seatrout	2	0	0	2	0	0	1	1	6

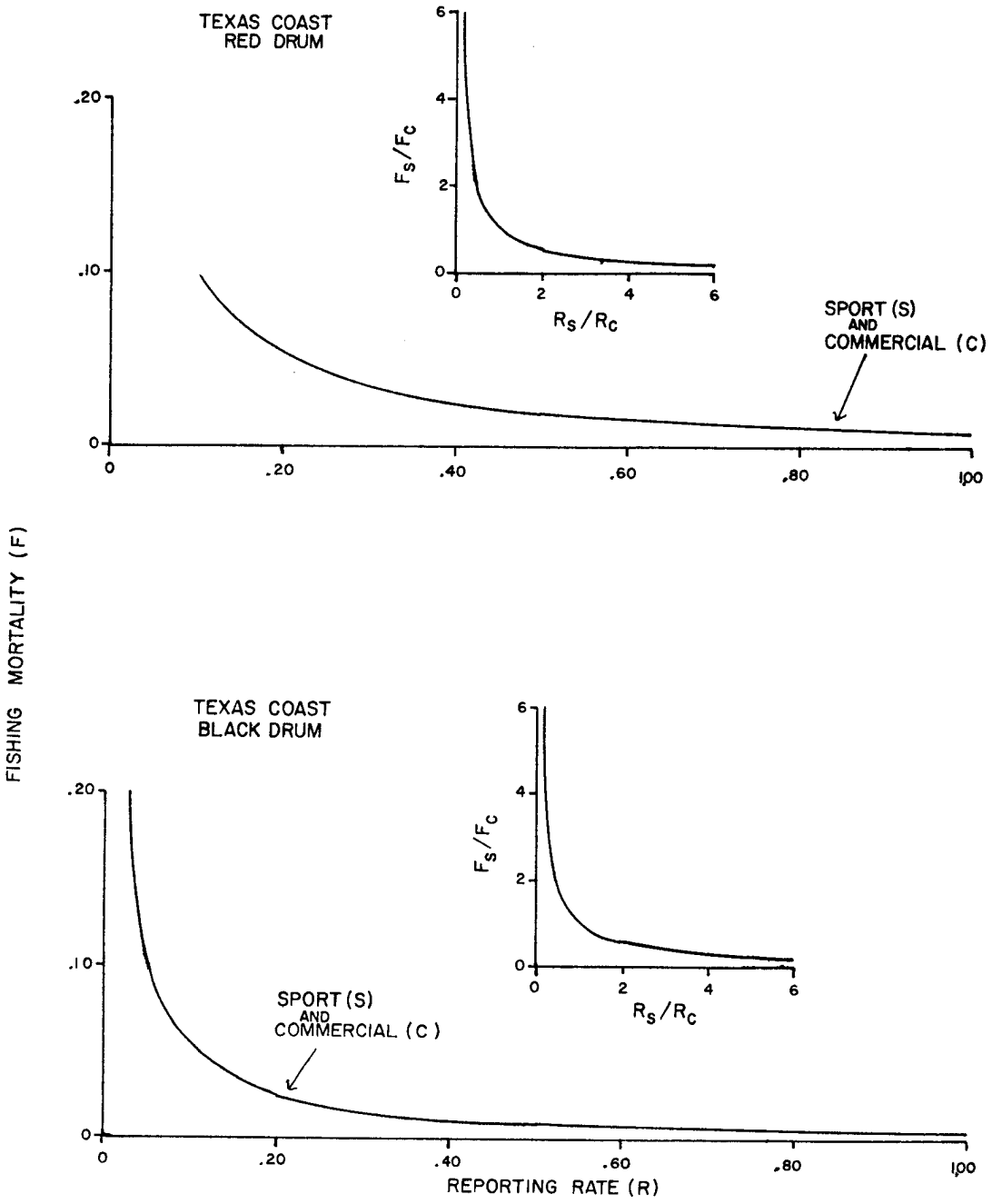

Figure 1. Effect of reporting rate (percentage of recapture rate) on monthly fishing mortality (percentage of population) estimate of red drum and black drum by sport and commercial fishermen on the Texas coast for November 1975-September 1976.

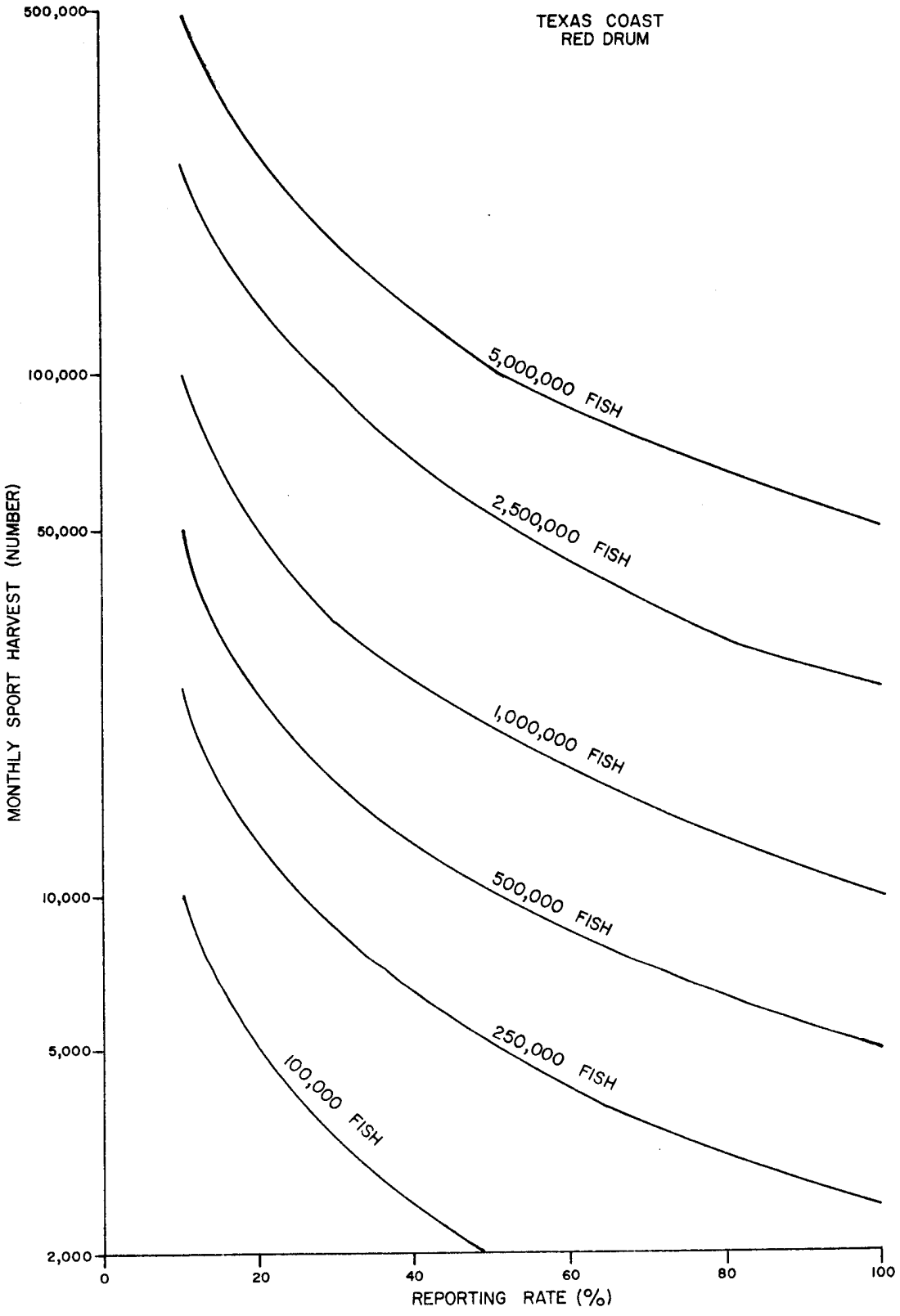

Figure 2. Estimates of red drum abundance in Texas bays using monthly reporting rates and harvest by sport fishermen.

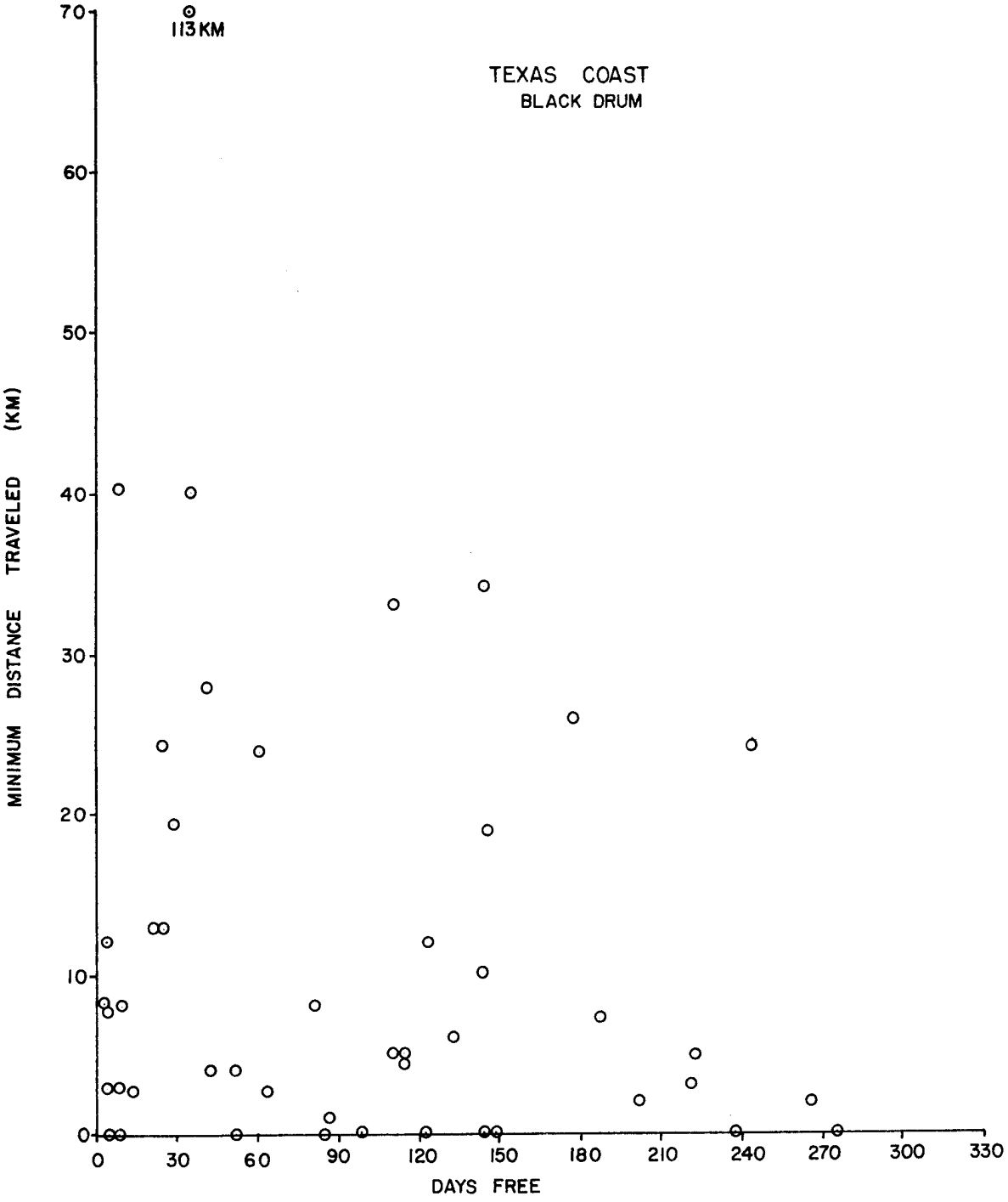

Figure 3. Relationship between minimum distance traveled and days free for black drum tagged on the Texas coast.

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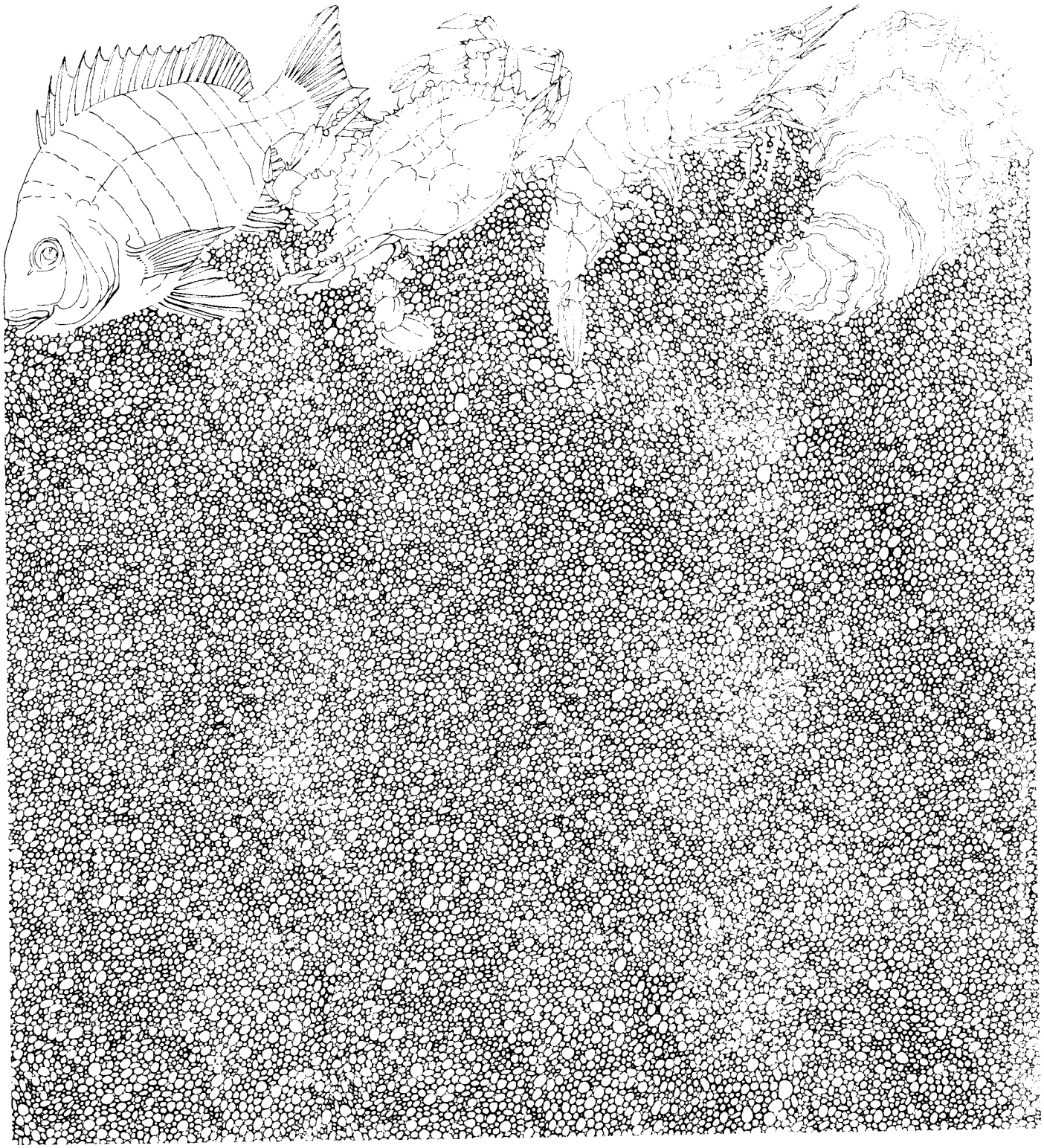

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MATERIALS AND METHODS

Fish for tagging were obtained during gill and trammel net sampling in the Galveston, Matagorda, San Antonio, Aransas, Corpus Christi, upper Laguna Madre and lower Laguna Madre Bay systems during November 1975 - September 1976. The location of each net set was selected at random as part of a finfish population assessment program conducted in each of the seven bay systems. Monofilament gill nets of 7.6-, 10.2-, 12.7- and 15.2-cm stretched mesh and multifilament trammel nets of 7.6-cm stretched mesh in the inner wall were used. Hook and line were used to obtain spotted seatrout in the Galveston Bay system.

Numbered internal abdominal tags with external streamer were inserted in apparently healthy fish using the technique described by Moffett (1961). Prior to release each fish was measured (total length to the nearest 5 mm), weighed when possible (to the nearest 5 g) and dipped in 100 ppm Furacin. Frequency figures of total length were constructed for each species having at least 30 individuals tagged. Tags were made of semi-hard glossy blue or green plastic (25.4 X 6.4 x 0.8 mm) with round corners. From a single hole in the center extended a section of bright yellow flexible plastic hollow tubing (about 50 mm long; O.D. = 2.1 mm; I.D. = 1.0 mm). "TEXAS PWD, ROCKPORT" or "TEXAS PWD, SEABROOK" was printed on each tag. No estimate of tagging mortality was obtained during this study.

Posters were placed at commercial fish houses, fish camps, fishing piers and sporting goods stores to publicize the program. In addition, the program was publicized on radio and television stations in cities adjacent to each bay system as well as in newspapers and the Departmental magazine throughout Texas. Each individual returning a tag was requested to provide the total length, weight, date and location of catch, and whether the individual was a sport or commercial fisherman. For every 100 tags released there were two $25 rewards, five $10 rewards, five $5 rewards and eighty-eight $1 rewards. A monetary reward was paid by the National Marine Fisheries Service for each tag returned regardless of the amount of information available.

It was assumed that all data provided by each fisherman were accurate except when approximations were stated. Approximations of length, weight or date of recapture were not used in growth rate calculations. Minimum distances traveled were obtained by plotting the tagging and recapture sites and measuring the shortest aquatic distance (to the nearest km) between the two sites on NOAA Nautical Charts dated August 1975. Fish movement was grouped by 5 km increments from the site of tagging. Fish traveling > 35 km were grouped together for analysis. Both the percents and distance increments for red drum and black drum were transformed to common logarithms. Linear regressions were fit to the transformed data and the correlation coefficient (r) determined for each regression (Croxton 1953). The direction traveled was defined as the resultant cardinal direction of the longest vector on the shortest aquatic route from the tagging site to the return site. Time free (to the nearest day) was the time between tagging and recapture excluding the date tagged and including the date returned. If the exact recapture date was not available, the date the tag was reported was used as the recapture date.

Mean growth rates were calculated as follows:

$$\text{Mean Growth Rate} = \frac{\sum_{i=1}^{i=n}\left[\frac{\Delta(\text{Total Length})}{\text{Days Free}}\right]_i}{n}$$

and

$$\text{Mean Growth Rate} = \frac{\sum_{i=1}^{i=n}\left[\frac{\Delta(\text{Weight})}{\text{Days Free}}\right]_i}{n}$$

where n = number of fish with total length or weight data and exact date of recapture available. Each total length and weight was converted to metric units prior to calculations. Mean growth rates for red drum from each bay system were compared using analysis of variance (Freund 1962).

Each fisherman reporting a recaptured tagged fish was categorized as sport (did not sell the fish), commercial (sold the fish), unknown (information not available) or Texas Parks and Wildlife Department (TPWD) personnel (caught the fish while collecting an experimental sample). Fishing mortalities for sport and commercial fishermen in each bay system were calculated for each species having at least five total returned individuals according to the empirical formulae:

$$\text{Fishing mortality} = \frac{\text{Number of tags reported}}{\text{Number of tags released X Reporting rate}}$$

where

$$\text{Reporting rate} = \frac{\text{Number of recaptured tagged fishes reported}}{\text{Number of tagged fishes recaptured}}$$

Tagging mortality was assumed to be zero. If a fish was tagged in one bay system and reported from a different bay system, its emigration was ignored in these calculations. Fishing mortality for each user group for red drum and black drum on the Texas coast was estimated by 1) determining the monthly survival rate using a program provided by Brownie et al. (1978) in which rates are estimated for models based on assumptions concerning constancy of recovery and survival rates; 2) calculating for each month of tagging the number of tagged fish available in the month immediately following using the formula:

$$N_t = SN_{t-1}$$

where S = survival rate, N = number of tagged fish available and t = month; 3) estimating the mean monthly fishing mortality using the formula:

$$\text{Mean monthly fishing mortality} = \frac{\sum_{i=1}^{i=n}\left[\frac{(\text{Number of tags reported})_t}{N_t}\right]_i}{n}$$

and 4) estimating the annual fishing mortality by multiplying the mean monthly fishing mortality by 12. Although no estimate of variance is provided for this number its reliability is a function of the variance associated with the survival estimate, of the variance associated with the mean monthly fishing mortality and of the variance associated with the expansion of the mean monthly fishing mortality to an annual fishing mortality.

For species with at least five returns by sport fishermen, population size in each bay system during the 11-mo study was estimated using sport harvest and sport reporting rate according to the empirical formula:

$$N = \frac{\text{Number tagged during study}}{\text{Number returned by sport fishermen during study}} \times \text{Sport harvest} \times \text{Sport reporting rate}$$

where N = number of individuals in the population. Population sizes were estimated using data from sport fishermen only because they provided the majority of the returns; however, the same formula and procedures apply to data obtained from commercial fishermen.

Again, tagging mortality was assumed to be equal to zero, as was tag shedding, immigration and emigration. The same calculation was used to obtain N for the Texas coast.

RESULTS

During November 1975 - September 1976, 3730 fish were tagged with internal abdominal tags along the Texas coast (Table 1). Most fish (95.4%) were tagged from November through May. More fish (866) were tagged in the Galveston Bay system than in any other while the fewest number of fish (398) were tagged in the upper Laguna Madre system (Table 2 and Appendix A). Red drum and black drum were the predominant species tagged (2913 fish). The total number of fish of each species tagged in each bay system was similar except for the 273 spotted seatrout tagged in the Galveston Bay system and the 148 sheepshead tagged in the San Antonio (72) and Corpus Christi (76) Bay systems.

All of the red drum, black drum, southern flounder, gulf flounder, sheepshead and spotted seatrout tagged on the Texas coast exceeded 200 mm except for two gulf flounder (160 and 190 mm) and one sheepshead (160 mm). Tagged red drum ranged from 275 to 815 mm with about 70% ranging in length from 305 to 440 (Figures 1 and 2 and Appendix B). Tagged black drum ranged from 205 to 1075 mm with no single size range accounting for a large percentage. Tagged southern flounder (Paralichthys lethostigma) ranged from 205 to 595 mm with about 70% ranging in length from 270 to 430 mm. Tagged sheepshead (Archosargus probatocephalus) ranged from 160 to 495 mm with about 70% ranging in length from 310 to 420 mm. Tagged spotted seatrout ranged from 205 to 785 mm with about 70% ranging in length from 230 to 320 mm. Tagged gulf flounder ranged from 160 to 375 mm with about 70% ranging in length from 220 to 335 mm.

Of the 13 species tagged, recaptures of seven species worth $518 (Table 3) were reported in Texas bays by all fishing interests (Table 4 and Appendix C). Red drum had the largest percent recaptures with 11.6% followed by gulf flounder (9.3%), Atlantic croaker (4.0%), southern flounder (4.5%), black drum (3.4%), sheepshead (2.9%) and spotted seatrout (2.3%). Sport fishermen reported catching 132 tagged fish while commercial fishermen reported 82 (Table 5 and Appendix D and E). Experimental sampling by the Texas Parks and Wildlife Department resulted in 12 returned fish; unknown fishermen returned 10. Tagged fish were returned during all months with the majority (72.9%) being returned after March. Red drum and black drum were returned from every bay system (Table 4 and Appendix C). Southern flounder were returned from every bay system except the San Antonio Bay and the lower Laguna Madre systems. Only six sheepshead, tagged in the San Antonio and Corpus Christi Bay systems, were returned. Gulf flounder (four fish) were returned from the Matagorda, San Antonio and Corpus Christi Bay systems. One Atlantic croaker and seven spotted seatrout were returned from the Galveston Bay system and by sport fishermen.

Red Drum

The majority (68.6%) of the returned red drum traveled $\leq$ 10 km from the tagging site (Table 6 and Appendix F) with 90.6% of these fish remaining in the bay system where tagged (Table 4 and Appendix C). This pattern was consistent in all bays except upper and lower Laguna Madre where the majority of red drum ($\geq$ 50.0%) traveled $\geq$ 10 km. Approximately 3% (0.5-5.1%) of the red drum tagged each month from November through May traveled > 10 km. Of the 48 fish traveling > 10 km, 31 moved south, 7 north, 7 east and 2 west (Table 7 and Appendix G).

The percent of red drum recaptured decreased as the distance from tagging site increased (Figure 3). This relationship can be expressed in the form:

$$Y = 2.68 - 1.42X$$
$$(r^2 = 0.956)$$

where Y = log percent, X = log distance (upper limit of each 5 km increment) and r^2 = the correlation coefficient. Only 12 of 159 returned red drum were recaptured outside the bay system where tagged (Table 4 and Appendix C and E). More red drum from the upper Laguna Madre (26.7%) and Corpus Christi Bay (19.2%) systems left the system than in any other bay. Of those red drum traveling from one bay system to another, all but two were recovered in bay systems adjacent to the system where tagged (Appendix G). Both of these fish were returned from Matagorda Bay; one was tagged in the Aransas Bay system and the other in the upper Laguna Madre system. Tagged red drum were free 4-316 days with no apparent relationship between time free and distance traveled (Figure 4 and Appendix H).

Annual mean growth rates of recaptured red drum in Texas bays ranged from 0.30 $\pm$ 0.11 mm/day in the Corpus Christi Bay system to 0.85 $\pm$ 0.47 mm/day in the Galveston Bay system. Mean growth rates in each bay system (Appendix I) were not significantly different from each other ($F = 1.14$; $df = 6, 103$; $P > 0.05$). The annual mean growth rate for 110 measured and 72 weighed red

drum was 0.43 ± 0.08 mm/day and 2.4 ± 2.3 g/day (Table 8). These growth rates were calculated using all recaptured red drum including nine fish recaptured by TPWD. Without these nine fish growth rates were 0.45 ± 0.09 mm/day and 3.3 ± 0.4 g/day compared with 0.23 ± 0.13 mm/day and 0.6 ± 0.3 g/day for the TPWD-caught fish. Size at tagging did not appear to affect growth rate (Figure 5 and Appendix J).

Sport fishermen reported catching 82 tagged red drum; commercial fishermen reported catching 59 (Table 5). Although the average size of red drum caught by both groups was about the same (400 mm), sport fishermen harvested more small fish (< 400 mm) than commercial fishermen (Figure 6).

Data presented in Table 9 (see also Appendix E) resulted in an estimated monthly survival rate of 90.9 ± 3.2% for red drum. The model assuming constant survival and recovery rates was selected as the best fit because it was not significantly different ($P > 0.05$) from more complex models where one or both of the parameters are time specific. By subtraction, the monthly total mortality rate was 9.1 ± 3.2%. At a reporting rate of 100.0% for both sport and commercial fishermen, the mean monthly fishing mortality would be 1.0 ± 0.2% (annual mortality = 12%) for sport fishermen and 1.0 ± 0.3% (annual mortality = 12%) for commercial fishermen. By summing these two rates and dividing by the total mortality, the percent of monthly mortality due to fishing would be 2.0% of the population or 22.0% of the total mortality. At reporting rates < 100.0%, monthly fishing mortality estimates would increase to a maximum of 10.0% for either user group (Figure 7). At equal reporting rates, both sport and commercial fishermen would inflict the same fishing mortalities on the red drum population. The effects of reporting rates on red drum fishing mortality estimates in each bay system are presented in Appendix K. Coast-wide population estimates for red drum using reporting rates by sport fishermen and total sport harvest are provided in Figure 8. Population estimates for red drum in individual bay systems are provided in Appendix L.

A total of 4690 red drum was caught with experimental sampling gear. Nine of these fish had been previously tagged.

Black Drum

The majority (67.3%) of the returned black drum traveled ≤ 10 km from the tagging site (Table 6 and Appendix F), with 98.1% of these fish remaining in the bay system where tagged (Table 4 and Appendix C). This pattern was consistent in all bays except in upper Laguna Madre where 66.7% of the fish traveled > 10 km. Of the 15 fish traveling > 10 km, 8 traveled north, 3 south, 4 east and 0 west (Table 7 and Appendix G).

The percent of black drum recaptured decreased as the distance from tagging site increased (Figure 3). This relationship can be expressed in the form:

$$Y = 2.51 - 1.33X$$

$$(r^2 = 0.738)$$

where Y = log percent, X = log distance (upper limit of each 5 km increments) and r^2 = the correlation coefficient. Only 1 of 53 returned black drum

was recaptured outside the bay system where tagged (Table 4 and Appendix C and E). This fish was tagged in Aransas Bay and recovered in the Matagorda Bay system. Tagged black drum were free 2-274 days with no apparent relationship between time free and distance traveled (Figure 9 and Appendix H).

Annual mean growth rates of recaptured black drum in Texas bays ranged from -0.90 ± 0.00 mm/day in the San Antonio Bay system to 3.08 ± 2.74 mm/day in the Corpus Christi Bay system (Appendix I). This wide variation was probably a result of the small sample size. The annual mean growth rate for 28 measured and 13 weighed black drum was 0.73 ± 0.25 mm/day and 0.1 ± 1.6 g/day (Table 8). These growth rates were calculated using all recaptured black drum including three fish recaptured by TPWD. Without these three fish the growth rate was 0.80 ± 0.23 mm/day compared with 0.13 ± 0.07 mm/day for the TPWD caught fish. Size at tagging did not appear to affect the growth rate (Figure 10).

Sport fishermen reported catching 31 tagged black drum; commercial fishermen reported 19 (Table 5). The majority (64.0%) of black drum caught by sport fishermen were < 400 mm while commercially caught fish were all > 400 mm (Figure 6). Data presented in Table 10 (see also Appendix E) resulted in an estimated monthly survival rate of 80.0 ± 5.4% for black drum. By subtraction, the monthly total mortality rate was 20.0 ± 5.4%. At a reporting rate of 100.0% for both sport and commercial fishermen, the mean monthly fishing mortality would be 0.5 ± 0.3% (annual mortality ≅ 6.0%) for sport fishermen and 0.4 ± 0.2% (annual mortality ≅ 4.8%) for commercial fishermen. By summing these two rates and dividing by the total mortality, the percent of monthly mortality due to fishing would be 4.5% of the total mortality or 0.9% of the population. At reporting rates < 100.0%, monthly fishing mortality estimates would increase to a maximum of 20.0% for either user group (Figure 7). At equal reporting rates, both sport and commercial fishermen would inflict the same fishing mortalities on the black drum population. The effects of reporting rates on black drum fishing mortality estimates in several bay systems are presented in Appendix M.

Coast-wide population estimates for black drum using reporting rates by sport fishermen and total sport harvest are provided in Figure 11. Population estimates for black drum in selected bay systems are provided in Appendix M.

A total of 4535 black drum was caught with experimental sampling gear. Three of these fish had been previously tagged.

Other Species

Southern flounder, gulf flounder and Atlantic croaker demonstrated little movement with at least 67% of the recaptured individuals traveling ≤ 10 km (Table 11). The majority (66.7%) of the sheepshead and spotted seatrout traveled > 15 km. No relationship between distance traveled and days free was apparent.

Growth rates for southern flounder, gulf flounder, sheepshead and spotted seatrout ranged from -0.55 ± 0.82 mm/day for spotted seatrout to 1.05 ± 0.24 mm/day for southern flounder (Table 8).

The data for these species were considered insufficient for any additional analysis on a coast-wide basis.

DISCUSSION

Only red drum and black drum had sufficient returns to warrant extensive analysis and discussion of the data. The reliability of conclusions derived from this tagging study is dependent upon the accuracy of data provided by both sport and commercial fishermen, since it was assumed that all data (except approximations of length and weight) were valid. It was also assumed that no differential behavior between tagged and untagged individuals existed. If either assumption was not met, conclusions about the populations may be erroneous.

Annual tag return rates for red drum (11.6%) and black drum (3.4%) were comparable to rates of 6.0-13.3% for red drum and 0.0-4.3% for black drum reported by Simmons and Breuer (1962). Tagging programs conducted in Florida during 1962-1964 resulted in considerably higher return rates for both species--35.0-46.2% for red drum and 25.0-48.9% for black drum (Beaumariage 1964, Beaumariage and Wittich 1966). The return rates obtained by Florida personnel may have been affected by extensive publicity, payment of extremely high monetary rewards (as much as $10,000) and the transplanting of some tagged fishes.

Rewards paid during this 11-mo tagging study totaled $518 and resulted in coast-wide return rates ranging from 2.3% to 11.6% by species. Whether or not the number of recaptured fish actually reported to TPWD was influenced by the reward offer is unknown. However, Rawstron (1971) indicated that monetary rewards do increase reporting rates. If the $518 did increase the reporting rate, this is a small price to pay for data necessary for effective fisheries management.

Movement of sciaenids was characterized by Moe (1972) as broad and random with loosely coordinated, temperature induced migrations and with strong offshore or deep-water spawning migrations. Results of the present study indicate that red drum and black drum exhibit little movement ($\leq$ 10 km) with essentially no intrabay, bay-Gulf, or bay-river migrations. These data also support the conclusions of Simmons and Breuer (1962) regarding red drum--that on an annual basis each Texas bay may be considered a closed system for management purposes--and extend that conclusion to black drum. Red drum and black drum tagged in Florida with Petersen disk tags, Floy streamer tags and internal abdominal tags with external streamer have for several years consistently shown little movement. The majority ($>$ 85%) of the recaptured fish traveled $<$ 5 nmi from the tagging site (Ingle et al. 1962, Beaumariage and Wittich 1966, Beaumariage 1969).

Pearson (1929) and Gunter (1945) concluded that red drum generally migrate to the Gulf during fall and return to the bays in spring; therefore, it is possible that red drum in the present study left the tagging site and returned at a later date. Although possible, it is doubtful that such a mass migration occurred during the present study since 1) only two red drum and no black drum were caught in the Gulf of Mexico, 2) no relationship existed between days free and distance traveled for either species

and 3) individuals of both species were recaptured during the entire study period. In addition, Carr and Chaney (1976) tracked a red drum in Florida for 2 days with an ultrasonic transmitter and found that the fish moved 1.6 km south, 1.2 km north and then 2.0 km south of the tagging site.

Requisite to the conclusion that red drum exhibited little movement during this study is the presence of fishing pressure (success) in all areas--bay, river and Gulf.

Simmons and Breuer (1962) concluded that although movements described by Pearson (1929) and Gunter (1945) do occur, they may be less pronounced and cover shorter periods than had been assumed. If, as indicated by Simmons and Breuer (1962), red drum spawning occurs in the Gulf by fish > 700-800 mm (SL) it is unlikely that tagging data would have reflected the migration since most of the fish in the present study were < 700 mm (TL) at tagging.

Both red drum and black drum demonstrated a large variation in the extent and direction of weight changes during this 11-mo study. Inaccurate weight data on recapture may have partially contributed to the variance. Sex, size, environmental factors and sample size may also have resulted in the large variance in weight growth rates. Although total length growth rates may have been affected by these same factors, it appears as though total length changes were less sensitive to error than were weight changes.

Growth rates were determined for red drum ranging in length from 275 to 815 mm and for black drum ranging in length from 205 to 1075 mm at tagging. According to Simmons and Breuer (1962) these tagged red drum would be of year classes I, II and III. Theiling and Loyacano (1976), Beaumariage (1964), Simmons and Breuer (1962), Miles (1950) and Pearson (1929) provided data for year class I-III red drum that showed growth rates of 0.34, 0.25, 0.59, 0.52 and 0.45 mm/day respectively, These values all fall within two standard errors of the calculated growth rate of 0.43 $\pm$ 0.16 mm/day using all recapture data from the present study as well as within two standard errors of the value (0.23 $\pm$ 0.13 mm/day) calculated for nine TPWD-caught fish.

Tagged black drum were of year class I-XV, with the majority in year class I-V (Simmons and Breuer 1962, Richards 1973). Beaumariage (1964), Richards (1973), Simmons and Breuer (1962) and Pearson (1929) provided data for similar sized black drum that showed growth rates of 0.59, 0.43, 0.14 and 0.68 mm/day, respectively. In the present study the calculated growth rate using all fish (0.73 $\pm$ 0.25 mm/day) approximated those reported by Beaumariage and Pearson while the rate for three TPWD-caught fish (0.13 $\pm$ 0.7 mm/day) approximated that reported by Simmons and Breuer. With only 28 black drum measured at recapture during this study, additional, more accurately collected data are needed.

In contrast to Pearson's (1929) and Simmons and Breuer's (1962) data the present data indicate that red drum and black drum growth rates do not decrease with age (total length). The apparent contradiction may be the result of small sample size, reliability of data obtained from fishermen and accuracy of calculations. In addition, different techniques used to determine growth rates in the various studies may have resulted in

different estimates. For example, Pearson (1929) used length-frequency data; Richards (1973) used otoliths. Growth rate may also have been affected by environmental factors (temperature, for example).

Fishing mortality for red drum and black drum on the Texas coast was calculated on a monthly instead of an annual basis because the data were sufficient to do so. Data were insufficient to calculate mortality on a bay-by-bay basis.

Implicit in the calculation of fishing mortality and population size estimates were several assumptions, including: 1) no handling mortality, 2) no tag loss, 3) natural mortality of tagged and untagged individuals identical, 4) reporting rate of recaptured tags ranging from > 0% to 100%, 5) no differential catch rates for each gear type between tagged and untagged individuals, 6) random mixing of tagged fish with untagged fish or fishing pressure proportional to distribution of fish throughout all bays and 7) no recruitment to catchable population during the study period.

If any of the first three assumptions were violated, the effective number of tagged fish available for recapture would decrease, probably resulting in an increase in fishing mortality and a decrease in population size estimates. No data are available on handling mortality for red drum. Elam (1971b) found that initial mortality of black drum caught in gill nets was about 40% with 70% mortality after 30 days captivity in ponds. When handling mortality of black drum was assumed to be constant at 50%, the resultant total mortality was 20% and was not time-specific. This value was identical to the value calculated when handling mortality was 0%. Apparently, sufficient fish were released that the analysis was unable to detect a change in the total mortality for estimates of 0% and 50% handling mortality. This may not have been the case if handling mortality had approximated a higher value. A study to determine the extent of handling mortality for each species and each capture gear is desirable.

Following a 9-mo study period Elam (1971a) reported that internal abdominal tag retention was 87% for both red drum and black drum. During this period mortalities of tagged red drum and black drum were 8% and 84%, respectively. In the control group, mortalities were 5% for red drum and 73% for black drum.

Reporting rates of recaptured tagged fish for sport and commerical fishermen were not determined during this study. If, however, one reporting rate was applied to both groups, and if the value overestimated the actual value, then an underestimate of fishing mortality would result. In addition, if one reporting rate was applied to both groups when differential rates actually existed, the fishing mortality for each group would be in error. Total fishing mortality estimates, however, may be valid, depending on the sign and extent of discrepancy between the assigned and actual reporting rate for each group. Rawstron (1971) estimated that 39-69% of the fish caught by anglers at Folsom Lake, California were not reported. If all fishermen reported 50% of their tags, the fishing mortality would be about 4% per month (2% by sport and 2% by commercial fishermen) for red drum and about 2% for black drum. Simmons and Breuer (1962) stated that at a 50% reporting rate, fishing mortality by sport fishermen in the late 1950's

did not exceed 30%. By expanding the monthly estimate in the present study (2% at 50% reporting rate) to an annual estimate and recognizing that the reliability is decreased, the sport fishing mortality would be 24%--about the same value as in the 1950's. If the reporting rate was the same in 1975 as in the 1950's, sport fishing mortality has remained relatively stable while pressure has increased (Simmons and Breuer 1962, Heffernan and Green 1977). However, the reporting rate in 1975 could have been higher than in the 1950's because of the monetary reward offered in 1975 (Rawstron 1971).

Since the internal abdominal tag was inserted inside the abdominal cavity and since the external streamer was a smooth tubular plastic, there was no reason to expect that tagged fish were more susceptible to capture than untagged ones. Simmons and Breuer (1962) noted that both red drum and black drum exhibit schooling behavior which can result in biased fishing mortalitites. Since fish for tagging were obtained from and released at randomly selected sites throughout each bay system it is reasonable to assume that random mixing of tagged and untagged fishes was accomplished. Fishing pressure was distributed throughout all bay systems on the Texas coast (Heffernan and Green 1977); therefore, both aspects of assumption six were met.

Recruitment of red drum and black drum to the catchable population was probably negligible because of spawning season and growth rate. Red drum spawning occurs in late summer and early fall; the young fish reach 325 mm at the end of 1 yr (Simmons and Breuer 1962). Black drum spawning occurs from February through April; young fish reach ~210-250 mm in 1.5 yr (Simmons and Breuer 1962). The present study began in late fall and extended through early fall; red drum and black drum spawned near the start of the study period did not reach the tagged size range until after completion of the study.

By using data presented by Heffernan and Green (1977) and assuming that values obtained for 1976-77 are applicable to the previous year, the monthly sport harvest of red drum was 25,908. The calculated monthly commercial harvest was 48,635 red drum ($F_s/F_c = 0.5$), assuming that reporting rates were equal for both groups. The reported harvest of red drum by commercial fishermen was 50,353/mo (900,319 kg divided by 1.49 kg/fish divided by 12 mo/yr) (Anonymous 1976, Heffernan and Green 1977). Data were not available for black drum.

When monthly sport harvest estimates for red drum (25,908/mo) and black drum (26,967/mo) and Figures 8 and 11 are used to estimate population size on a monthly basis, red drum abundance ranged from 259,090 to 2,590,800 and black drum abundance ranged from 539,340 to 5,393,400. These values are only first-order approximations and their accuracy depends on the accuracy of harvest estimates, reporting rates and the validity of the assumptions mentioned above.

CONCLUSIONS

1. The value of the data obtained during this 11-mo tagging study far surpassed the $518 cost of rewards paid.

2. Annual return rates of internal abdominal tags approximated values obtained during previous studies conducted in Texas but were generally less than values obtained in Florida.

3. Whether values obtained for annual return rates in different years and areas reflect differences in fishing mortality rates or reporting rates is unknown.

4. Each bay system on the Texas coast can be considered a closed system since neither red drum nor black drum generally traveled > 10 km from the tagging site and generally remained in the system where tagged.

5. Growth rates should be expressed in total length rather than weight since the variation in calculated mean weight growth rate was much greater than that of mean length growth rate.

6. Mean growth rates (total length) calculated for red drum and black drum approximated those determined during other studies.

7. Size at tagging had no relationship with growth rate.

8. Monthly survival estimates were 90.9 $\pm$ 3.2% for red drum and 80.0 $\pm$ 5.4% for black drum.

9. Monthly fishing mortality estimates for red drum were 1.0 $\pm$ 0.2% for sport fishermen and 1.0 $\pm$ 0.3% for commercial fishermen, assuming a 100% reporting rate. Monthly fishing mortality estimates for black drum were 0.5 $\pm$ 0.3% for sport fishermen and 0.4 $\pm$ 0.2% for commercial fishermen, assuming a 100% reporting rate.

10. As reporting rates decreased, fishing mortality estimates increased.

11. Reporting rate estimates are essential if accurate fishing mortality estimates are to be calculated.

12. Assumptions implicit in this type of tagging study were met or the effects of violating them considered.

13. Hypothetical population sizes of red drum and black drum were determined on a monthly basis using the most current available data. The accuracy of abundance estimates depends on accuracy of harvest estimates, reporting rates and the validity of assumptions made.

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Table 1 . Number of fishes tagged with internal abdominal tags by month during November 1975 - September 1976 on the Texas coast.

	1975		1976									
Species	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Total
Red drum	126	262	296	127	138	183	184	3	3	7	5	1334
Black drum	183	262	309	264	215	78	210	2	6	10	20	1559
Southern flounder	29	44	12	7	20	23	57	0	0	5	2	199
Sheepshead	11	25	43	26	20	6	67	0	2	2	3	205
Gulf flounder	1	7	0	6	6	13	7	2	1	0	0	43
Atlantic croaker	1	0	0	0	0	6	18	0	0	0	0	25
Spotted seatrout	0	0	0	80	91	32	0	0	0	0	100	303
Striped mullet	0	0	0	0	0	6	1	0	0	0	0	7
Sea catfish	0	0	0	0	0	28	0	0	0	0	0	28
Gizzard shad	0	0	0	0	0	1	0	0	0	0	0	1
Tripletail	0	0	0	0	0	0	1	0	0	0	0	1
Gulf kingfish	0	0	0	0	0	0	1	0	0	0	0	1
Spot	0	0	0	0	0	0	4	0	0	0	0	4
All species	351	600	660	510	490	376	550	7	12	24	130	3710

Table 2 . Number of fishes tagged with internal abdominal tags by bay during November 1975 - September 1976 on the Texas coast.

Species	Galveston	Matagorda	San Antonio	Aransas	Corpus Christi	Upper Laguna Madre	Lower Laguna Madre	Total
Red drum	258	266	249	178	129	100	154	1334
Black drum	232	228	197	288	122	277	215	1559
Southern flounder	38	38	13	22	55	9	24	199
Sheepshead	34	9	72	0	76	0	14	205
Gulf flounder	0	2	6	2	27	5	1	43
Atlantic croaker	19	0	0	0	4	0	2	25
Spotted seatrout	273	1	0	7	0	7	15	303
Striped mullet	4	0	0	0	0	0	3	7
Sea catfish	6	1	0	0	4	0	17	28
Gizzard shad	1	0	0	0	0	0	0	1
Tripletail	1	0	0	0	0	0	0	1
Gulf kingfish	0	1	0	0	0	0	0	1
Spot	0	0	0	0	1	0	3	4
All species	866	546	537	497	418	398	448	3710

Table 3. Total number of rewards paid for returned internal abdominal tags during November 1975 - September 1976.

Species	Amount of reward				Total amount paid (dollars)
	$1	$5	$10	$25	
Red Drum	138	7	10	4	373
Black Drum	47	4	1	1	102
Southern Flounder	5	4			25
Sheepshead	6				6
Gulf Flounder	4				4
Atlantic Croaker	1				1
Spotted Seatrout	7				7
Total	208	15	11	5	518

Table 4. Percent of fishes tagged in each bay system on the Texas coast and returned during November 1975 - September 1976.

Species	Bay system	Number tagged	Total returned		Returned from same bay system		Returned from other bay system	
			Number	Percent of total tagged	Number	Percent of total returned	Number	Percent of total returned
Red drum	Galveston	258	17	6.6	16	94.1	1	5.9
	Matagorda	273	24	8.8	23	95.8	1	4.2
	San Antonio	249	17	6.8	16	94.1	0	0.0
	Aransas	178	31	17.4	29	93.5	1	3.2
	Corpus Christi	129	26	20.2	21	80.8	5	19.2
	Upper Laguna Madre	100	15	15.0	10	66.7	4	26.7
	Lower Laguna Madre	154	29	18.8	29	100.0	0	0.0
	Texas coast	1341	159	11.6	144	90.6	12	7.5
Black drum	Galveston	232	4	1.7	4	100.0	0	0.0
	Matagorda	241	9	3.7	9	100.0	0	0.0
	San Antonio	197	3	1.5	3	100.0	0	0.0
	Aransas	288	16	5.6	15	93.8	1	6.3
	Corpus Christi	122	4	3.3	4	100.0	0	0.0
	Upper Laguna Madre	277	6	2.2	6	100.0	0	0.0
	Lower Laguna Madre	215	11	5.1	11	100.0	0	0.0
	Texas coast	1572	53	3.4	52	98.1	1	1.9
Southern flounder	Galveston	38	1	2.7	1	100.0	0	0.0
	Matagorda	38	2	5.3	2	100.0	0	0.0
	San Antonio	13	0	0.0	0		0	
	Aransas	22	1	4.5	1	100.0	0	0.0
	Corpus Christi	55	3	5.5	2	66.7	1	33.3
	Upper Laguna Madre	9	2	22.2	1	50.0	1	50.0
	Lower Laguna Madre	24	0	0.0	0		0	
	Texas coast	199	9	4.5	7	77.8	2	22.2

Table 4 . (Cont'd.)

Species	Bay system	Number tagged	Total returned		Returned from same bay system		Returned from other bay system	
			Number	Percent of total tagged	Number	Percent of total returned	Number	Percent of total returned
Sheepshead	Galveston	34	0	0.0	0		0	
	Matagorda	9	0	0.0	0		0	
	San Antonio	72	3	4.2	1	33.3	2	66.7
	Aransas	0						
	Corpus Christi	76	3	3.9	2	66.7	1	33.3
	Upper Laguna Madre	0						
	Lower Laguna Madre	14	0	0.0	0		0	
	Texas coast	205	6	2.9	3	50.0	3	50.0
Gulf flounder	Galveston	0						
	Matagorda	2	1	50.0	1	100.0	0	0.0
	San Antonio	6	2	33.3	2	100.0	0	0.0
	Aransas	2	0	0.0	0		0	
	Corpus Christi	27	1	3.7	1	100.0	0	0.0
	Upper Laguna Madre	5	0	0.0	0		0	
	Lower Laguna Madre	1	0	0.0	0		0	
	Texas coast	43	4	9.3	4	100.0	0	0.0
Spotted seatrout	Galveston	273	7	2.6	5	83.3	1	16.7
	Matagorda	1	0	0.0				
	San Antonio	0						
	Aransas	7	0	0.0				
	Corpus Christi	0						
	Upper Laguna Madre	7	0	0.0				
	Lower Laguna Madre	15	0	0.0				
	Texas coast	303	7	2.3	5	83.3	1	16.7
Atlantic croaker	Galveston	19	1	5.3	1	100.0	0	0.0
	Matagorda	0						
	San Antonio	0						
	Aransas	0						
	Corpus Christi	4						
	Upper Laguna Madre	0	0	0.0				
	Lower Laguna Madre	2	0	0.0				
	Texas coast	25	1	4.0	1	100.0	0	0.0

Table 5 . Total number of fish returned from Texas bays by fishermen during November 1975 - September 1976.

Species	Fishing interest	1975 N	1975 D	1976 J	1976 F	1976 M	1976 A	1976 M	1976 J	1976 J	1976 A	1976 S	Nov-Sept
Red drum	Sport	1	2	4	6	3	2	9	10	16	16	13	82
	Commercial	0	1	3	4	6	12	6	13	3	4	7	59
	TPWD*	0	0	0	1	2	0	5	1	0	0	0	9
	Unknown	0	0	1	0	1	3	0	4	0	0	0	9
	Total	1	3	8	11	12	17	20	28	19	20	20	159
Black drum	Sport	0	1	0	8	4	3	2	3	5	2	3	31
	Commercial	1	0	1	2	3	2	2	1	5	0	2	19
	TPWD	0	0	0	1	0	0	0	1	0	0	1	3
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	1	1	1	11	7	5	4	5	10	2	6	53
Southern flounder	Sport	0	0	0	0	2	0	2	3	0	0	1	7
	Commercial	0	2	0	0	0	0	0	0	0	0	0	2
	TPWD	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	2	0	0	2	0	2	2	0	0	1	9
Sheepshead	Sport	0	0	0	1	0	2	0	0	0	0		3
	Commercial	0	0	1	0	0	0	0	0	0	1		2
	TPWD	0	0	0	0	0	0	0	0	0	0		0
	Unknown	0	0	0	0	1	0	0	0	0	0		1
	Total	0	0	1	1	1	2	0	0	0	1		6
Gulf flounder[a]	Sport	0	0	1	0	0	0	0	1	0	1		3
Atlantic croaker[a]	Sport	0	0	0	0	0	0	0	1	0	0		1
Spotted seatrout[a]	Sport	0	0	0	0	0	1	1	0	2	3		7

[a]Tag returns reported by sport fishermen only.

Table 6 . Number of returned tagged fish moving from site of tagging on the Texas coast.

Species	Minimum distance traveled (km)								Number with movement data available
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	> 35	
Red drum	81	24	11	13	7	7	4	6	153
Black drum	26	7	4	1	2	3	2	4	49
Southern flounder	7	1	0	0	1	0	0	0	9
Sheepshead	1	0	0	2	0	0	0	3	6
Gulf flounder	2	1	1	0	0	0	0	0	4
Atlantic croaker	1	0	0	0	0	0	0	0	1
Spotted seatrout	2	0	0	2	0	0	1	1	6

Table 7 . Direction of travel and size of fishes traveling > 10 km from site of tagging on the Texas coast.

Species	North		South		East		West	
	Number	Mean total length (mm) ± 1 SE	Number	Mean total length (mm) ± 1 SE	Number	Mean total length (mm) ± 1 SE	Number	Mean total length (mm) ± 1 SE
Red drum	8	464 ±45	31	453 ±17	7	489 ±48	2	592 ±8
Black drum	8	409 ±33	3	413 ±52	4	344 ±32	0	-

Table 8 . Mean growth rate for fishes tagged on the Texas coast during November 1975 - September 1976.

Species	Mean growth rate ± 1 S E			
	Number measured	Total length per day (mm/day)	Number weighed	Weight per day (g/day)
Red drum	110	0.43 ± 0.08	72	2.4 ± 2.3
Black drum	28	0.73 ± 0.25	13	0.1 ± 1.6
Southern flounder	5	1.05 ± 0.24	7	4.6 ± 8.7
Sheepshead	3	-0.57 ± 0.25	2	-0.2 ± 1.0
Gulf flounder	4	0.27 ± 0.15	1	4.4
Spotted seatrout	4	-0.55 ± 0.82	3	1.6 ± 1.2

Table 9 . Number of tagged red drum returned by month on the Texas coast by sport (S), commercial (C) and all (T) fishermen during November 1975 - September 1976.

Month	Number tagged	Nov. S C T	Dec. S C T	Jan. S C T	Feb. S C T	Mar. S C T	April S C T	May S C T	June S C T	July S C T	Aug. S C T	Sept. S C T
Nov.	126	1 0 1	1 0 1	0 1 1	0 0 1	1 0 1	0 1 3[a]	0 0 0	0 0 1	0 0 0	2 1 3	1 0 1
Dec.	262		1 1 2	3 2 6[a]	2 1 3	0 1 3[a]	1 1 2	1 0 3[a]	1 1 2	3 0 3	2 1 3	0 0 0
Jan.	296			1 0 1	3 3 6	1 4 6[a]	1 1 2	4 2 6	3 3 7[a]	5 3 8	2 1 3	2 5 7
Feb.	134				1 0 1	1 1 2	0 4 5[a]	2 0 2	0 1 1	1 0 1	1 1 2	1 0 1
Mar.	138					0 0 0	0 3 3	0 1 2[a]	1 3 5[a]	0 0 0	5 0 5	1 0 1
April	183						0 2 2	2 2 6[a]	2 5 7	5 0 5	1 0 1	2 2 4
May	184							0 0 0	3 1 6[a]	2 0 2	3 0 3	6 0 6

[a]Totals include tag returns by TPWD personnel and unknown type fishermen.

Table 10. Number of tagged black drum returned by month on the Texas coast by sport (S), commercial (C) and all (T) fishermen during November 1975 - September 1976.

Month	Number tagged	Nov. S C T	Dec. S C T	Jan. S C T	Feb. S C T	Mar. S C T	April S C T	May S C T	June S C T	July S C T	Aug. S C T	Sept. S C T
Nov.	183	0 1 1	0 0 0	0 0 0	1 0 1	0 0 1[a]	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0
Dec.	262		1 0 1	0 0 0	2 0 2	1 0 1	0 0 0	0 0 0	0 0 0	1 1 2	2 0 2	0 1 1
Jan.	309			0 1 1	3 1 4	1 1 2	0 0 0	1 1 2	1 1 3[a]	1 0 1	0 0 0	1 0 1
Feb.	273				2 1 3	1 2 3	0 0 0	0 1 1	1 0 1	0 3 3	0 0 0	1 0 1
Mar.	215					1 0 1	3 2 5	1 0 1	0 0 0	2 1 3	0 0 0	0 0 0
April	78						0 0 0	0 0 0	1 0 1	0 0 0	0 0 0	0 0 0
May	210							0 0 0	0 0 0	1 0 1	0 0 0	1 0 1

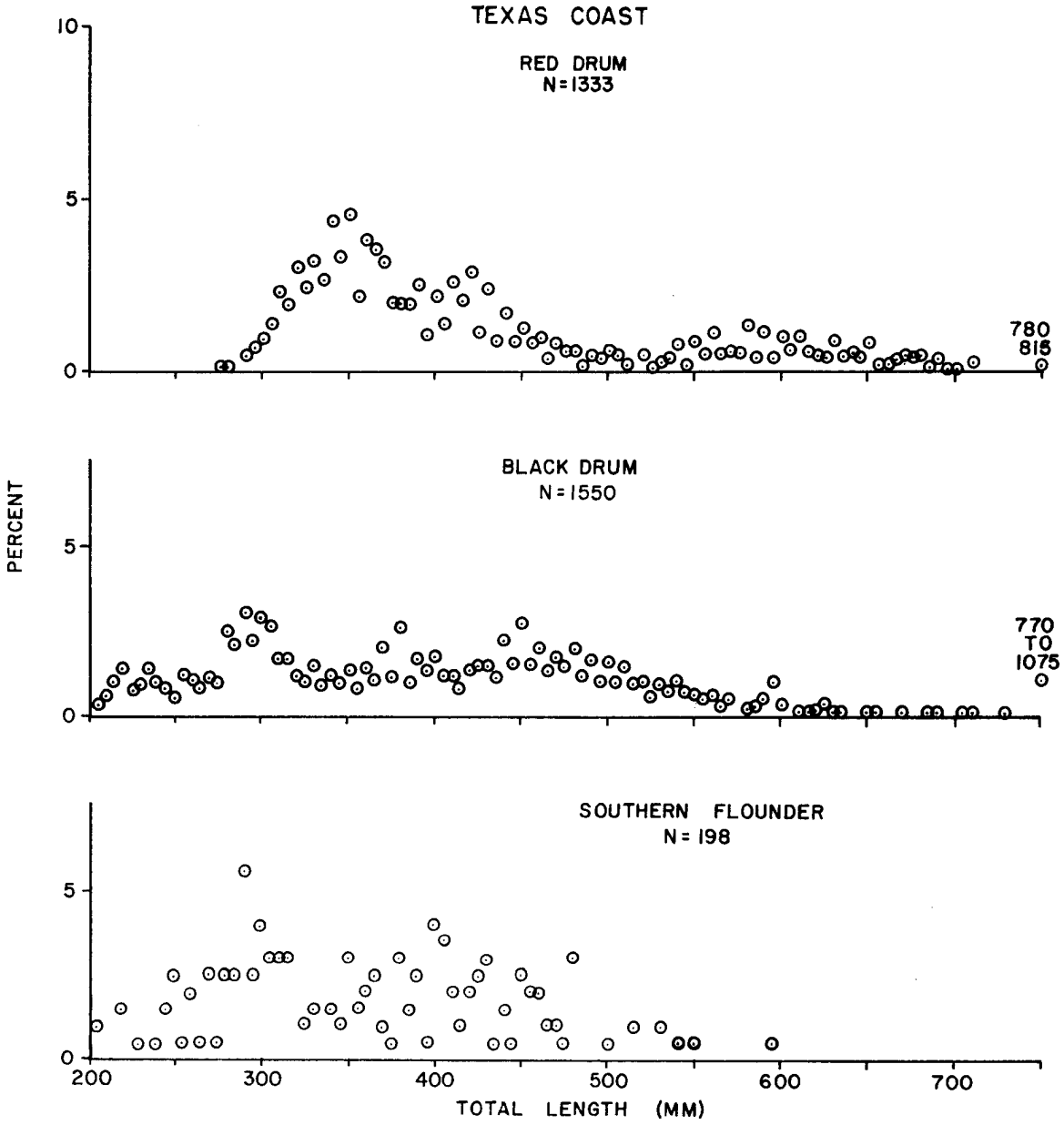
[a]Totals include tag returns by TPWD personnel and unknown type fishermen.

Table 11. Minimum distance traveled through time for southern and gulf flounder, sheepshead, Atlantic croaker and spotted seatrout tagged on the Texas coast during November 1975 - September 1976.

Species	Days free	Minimum distance traveled (km)
Southern flounder	3	0
	8	0
	39	10
	51	2
	63	0
	85	0
	125	2
	137	0
	140	23
Gulf flounder	54	15
	114	2
	120	6
	140	0
Sheepshead	41	2
	52	19
	80	88
	83	163
	84	71
	219	17
Atlantic croaker	53	3

Table 11 . (Cont'd.)

Species	Days free	Minimum distance traveled (km)
Spotted seatrout	5	0
	100	43
	165	18
	183	18
	187	0
	196	33



igure 1. Size of red drum, black drum and southern flounder tagged on the Texas coast during November 1975 - September 1976.

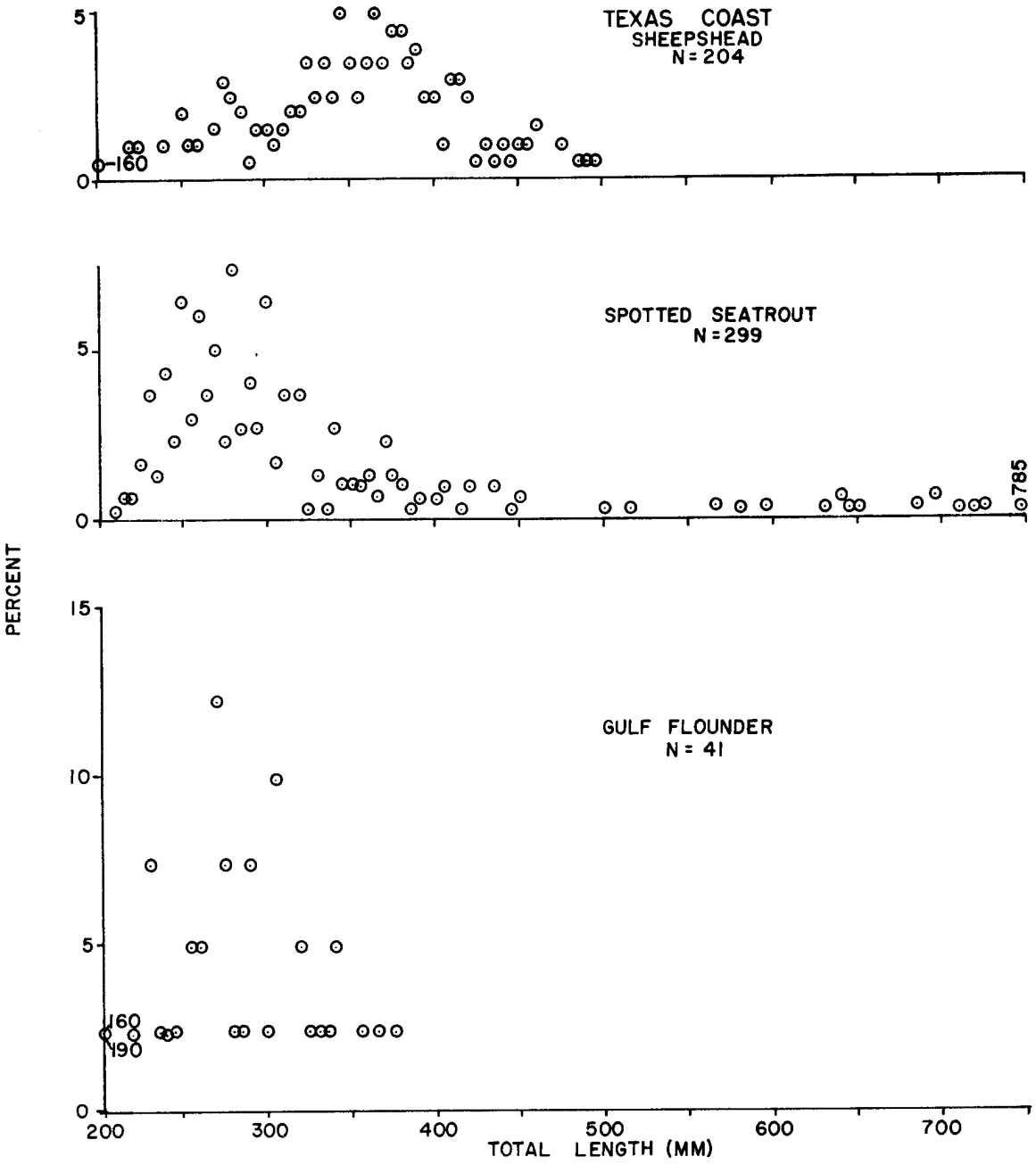


Figure 2. Size of sheepshead, spotted seatrout and gulf flounder tagged on the Texas coast during November 1975 - September 1976.

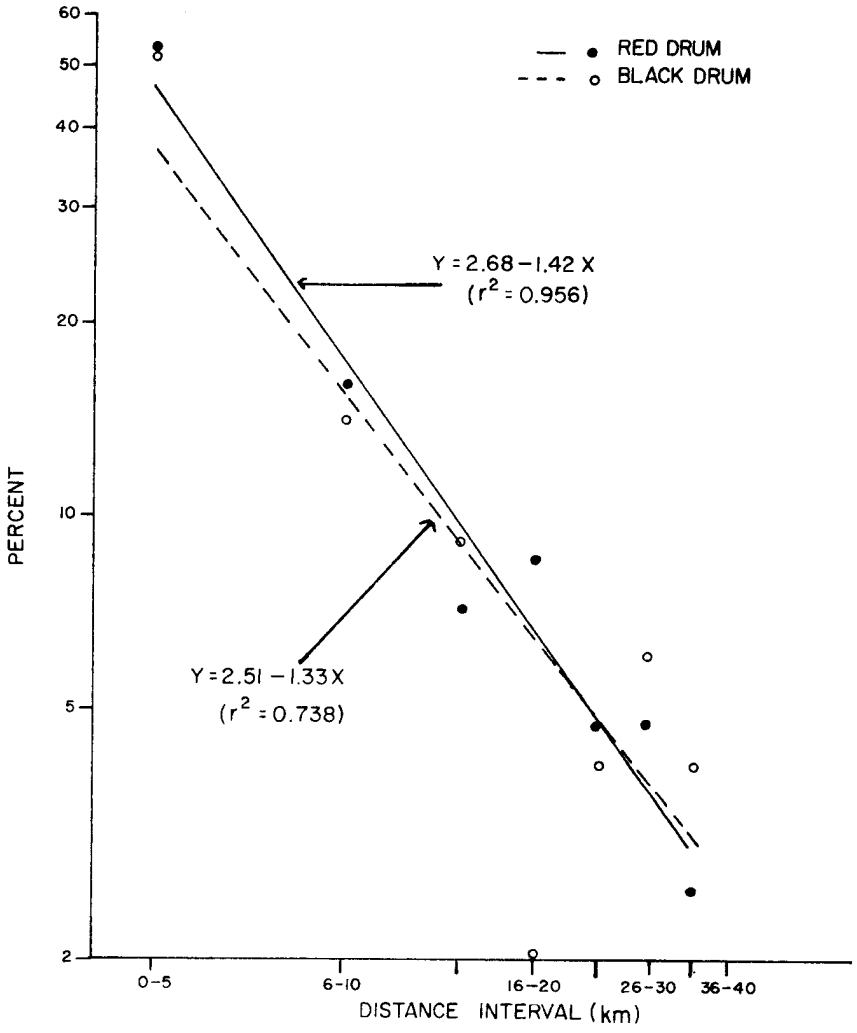


Figure 3. Percent of tagged red drum travelling from site of tagging expressed in 5 km increments.

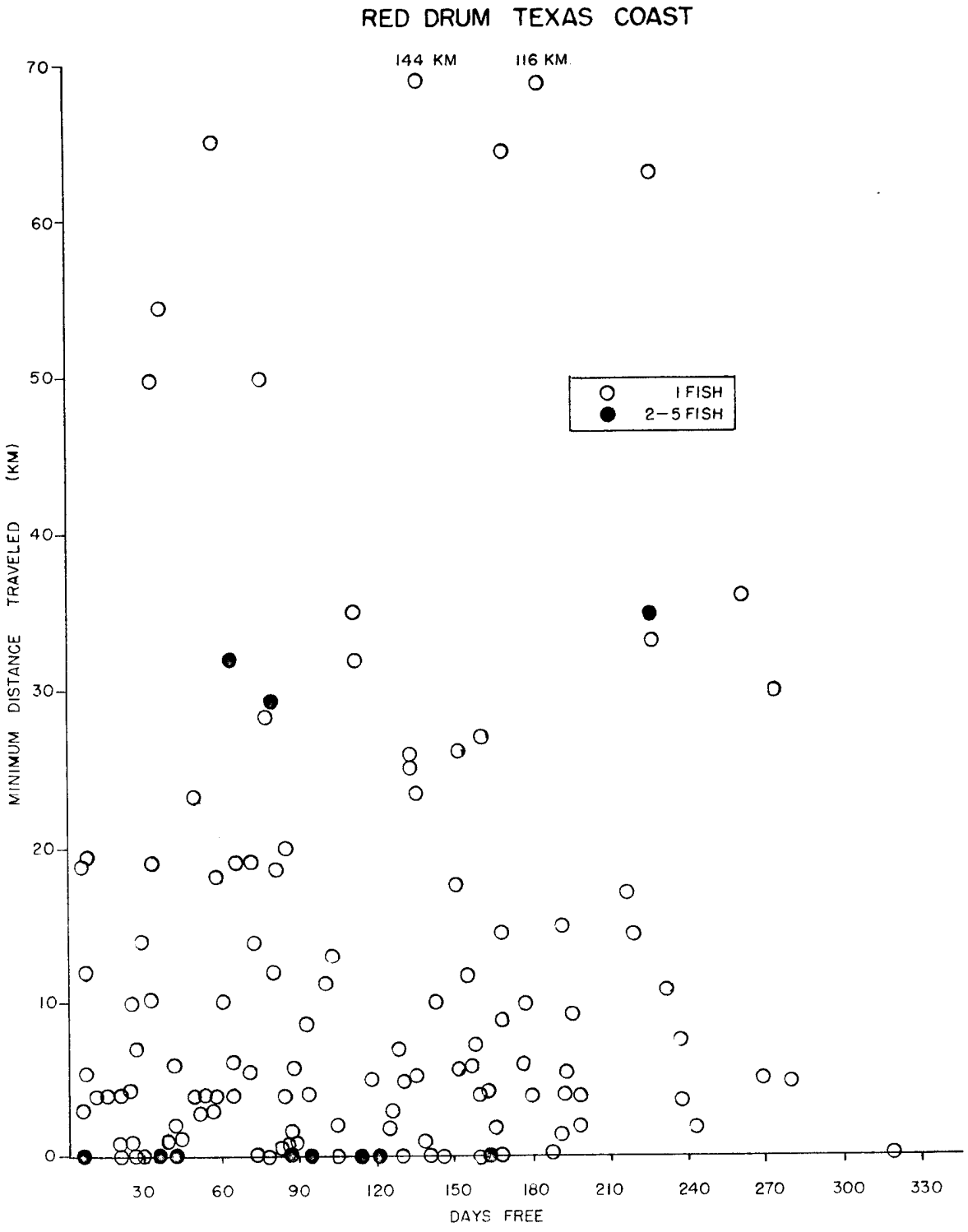


Figure 4 . Relationship between minimum distance traveled and days free for red drum tagged on the Texas coast.

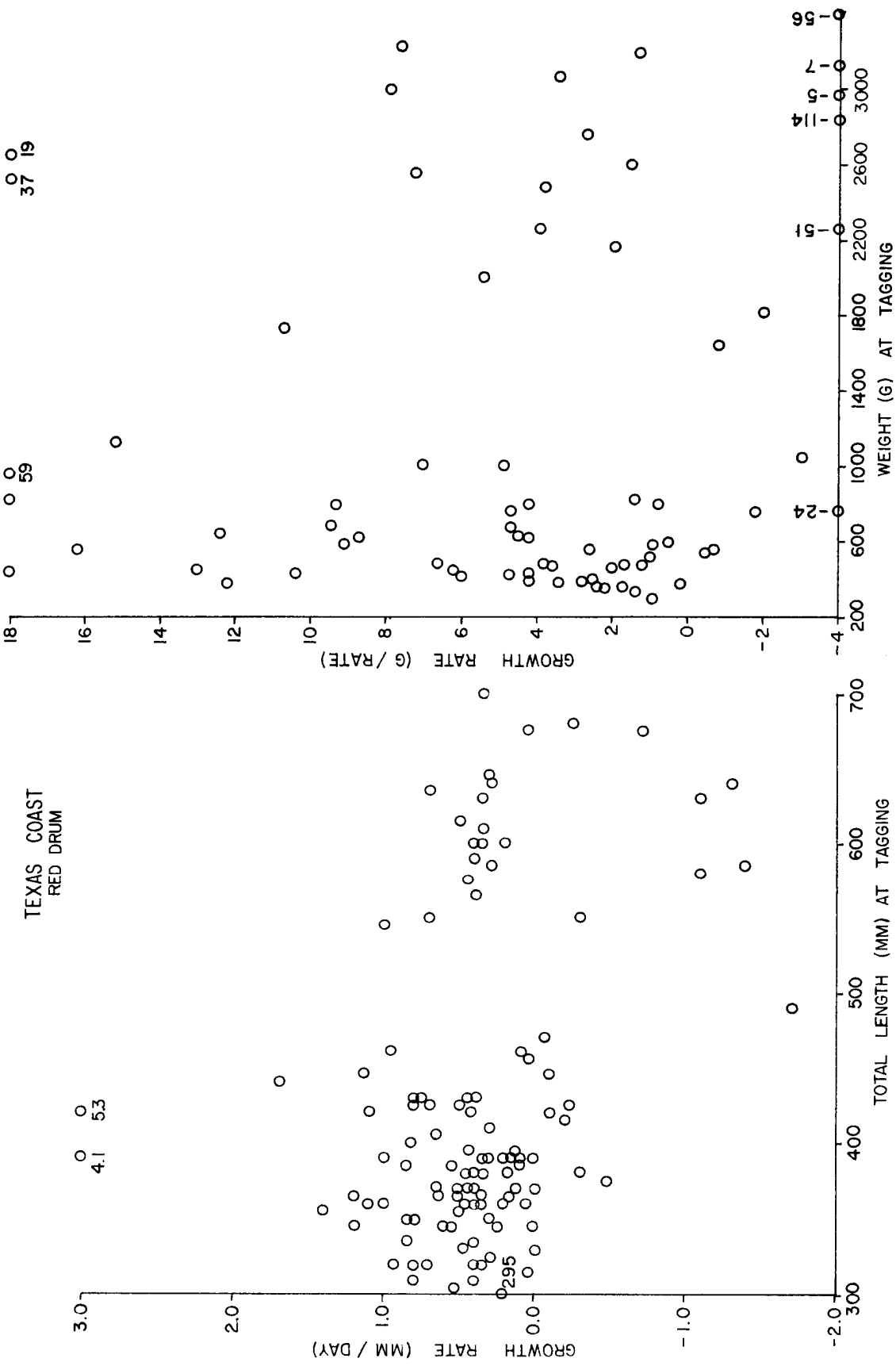


Figure 5. Relationship between size and growth rate of tagged red drum on the Texas coast during November 1975 - September 1976.

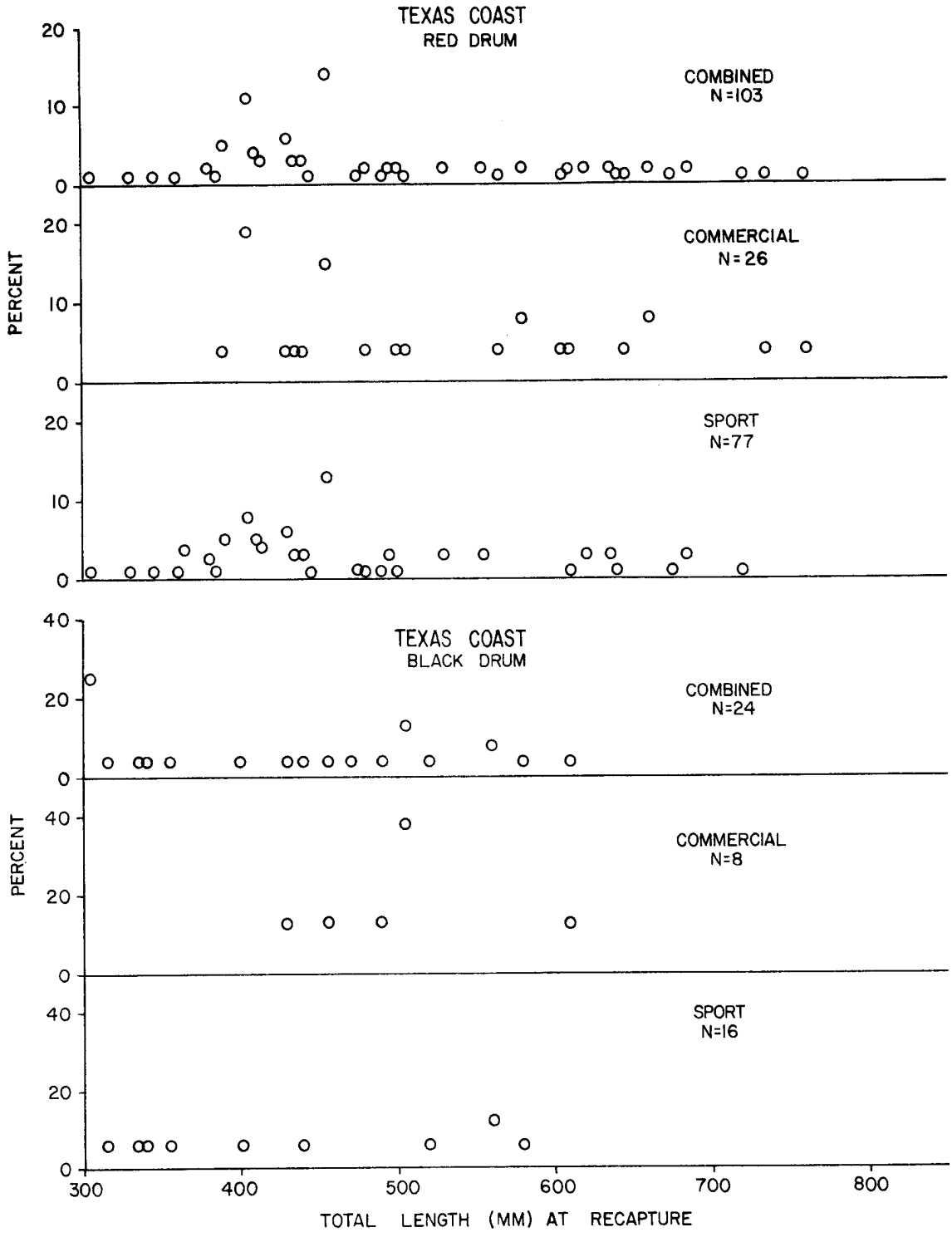


Figure 6. Size of red and black drum returned from the Texas coast by sport and commercial fishermen, individually and combined during November 1975 - September 1976.

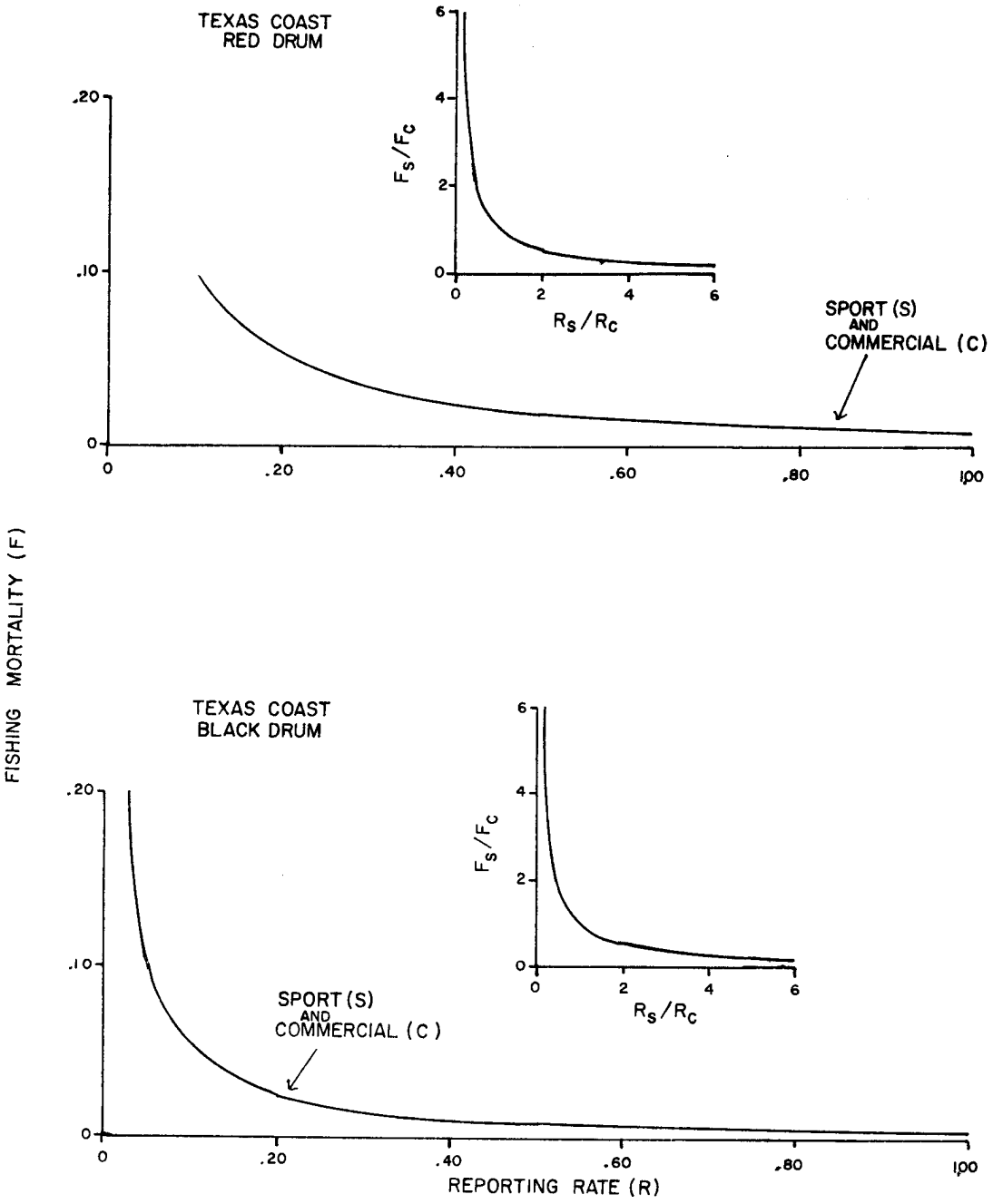


Figure 7. Effect of reporting rate (percentage of recapture rate) on monthly fishing mortality (percentage of population) estimate of red drum and black drum by sport and commercial fishermen on the Texas coast for November 1975 - September 1976.

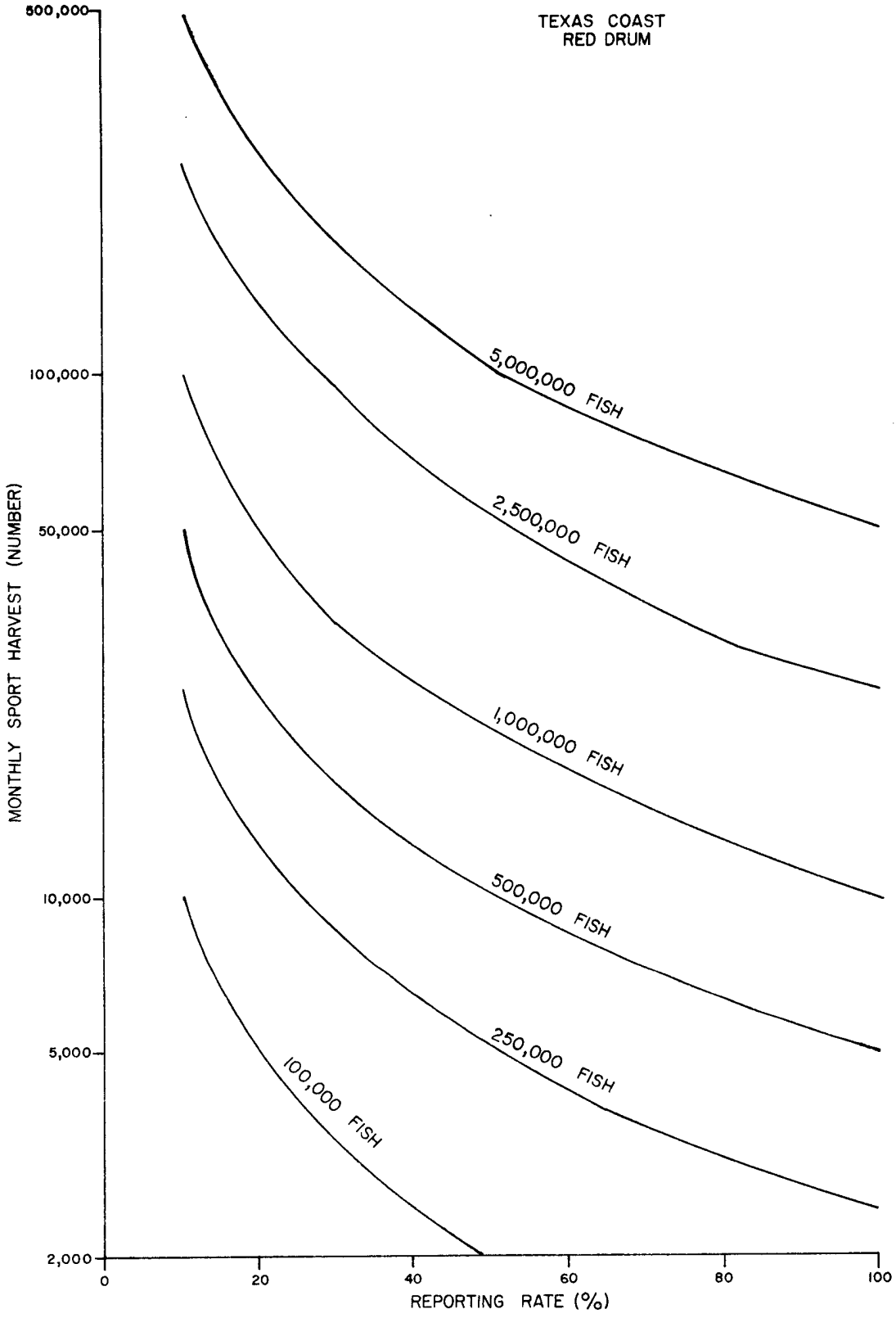


Figure 8. Estimates of red drum abundance in Texas bays using monthly reporting rates and harvest by sport fishermen.

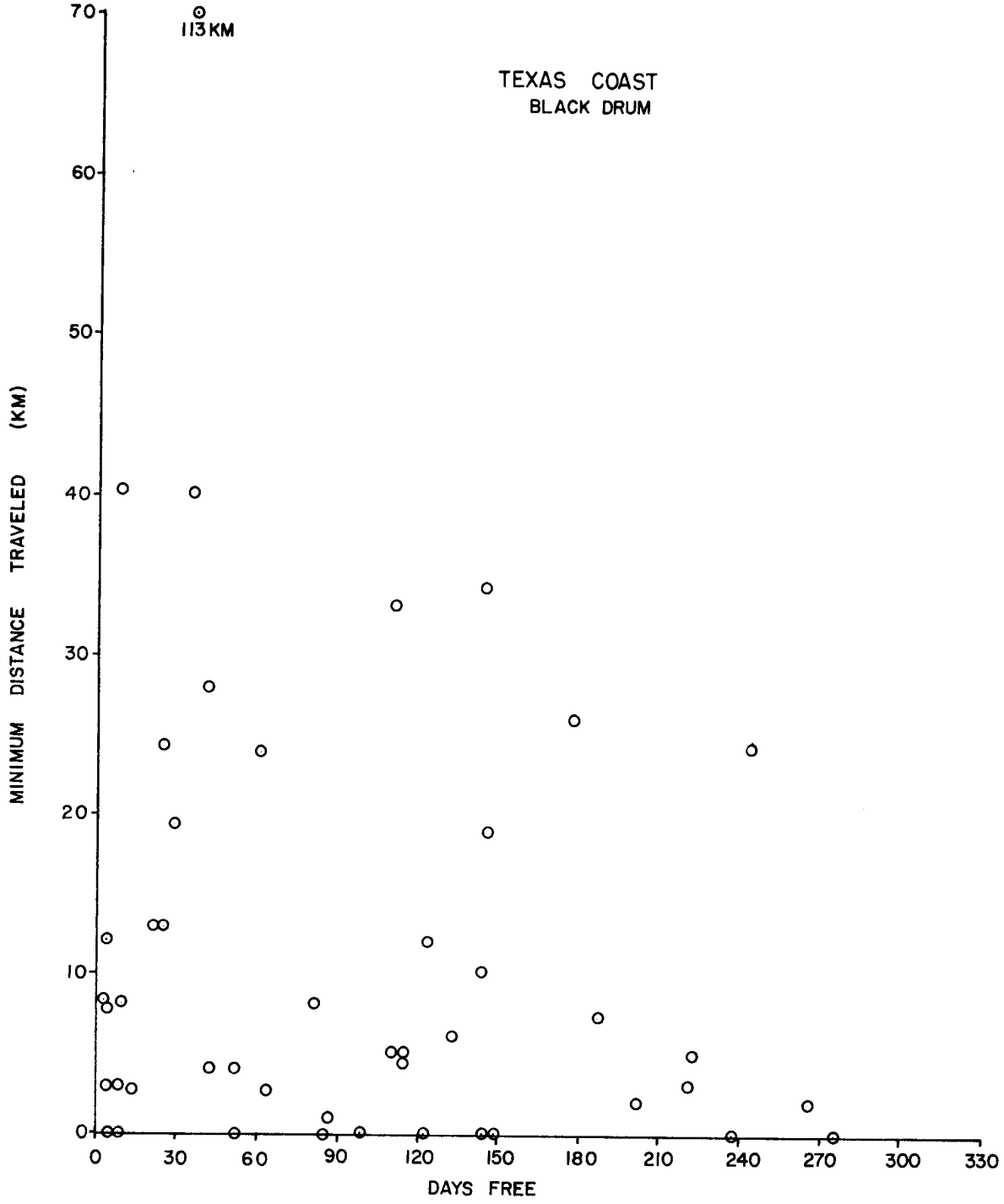


Figure 9. Relationship between minimum distance traveled and days free for black drum tagged on the Texas coast.

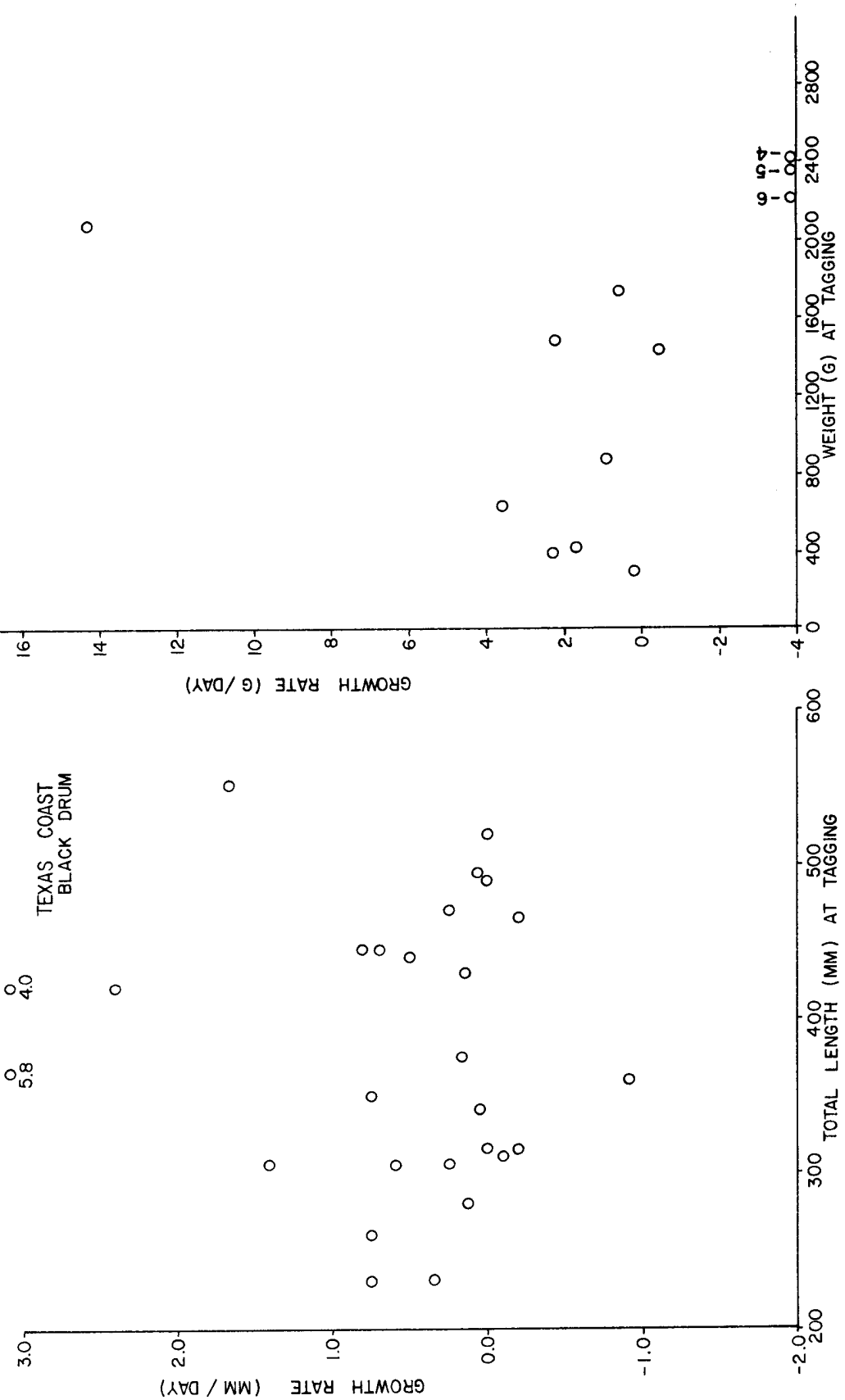


Figure 10. Relationship between size and growth rate of tagged black drum on the Texas coast during November 1975 - September 1976.

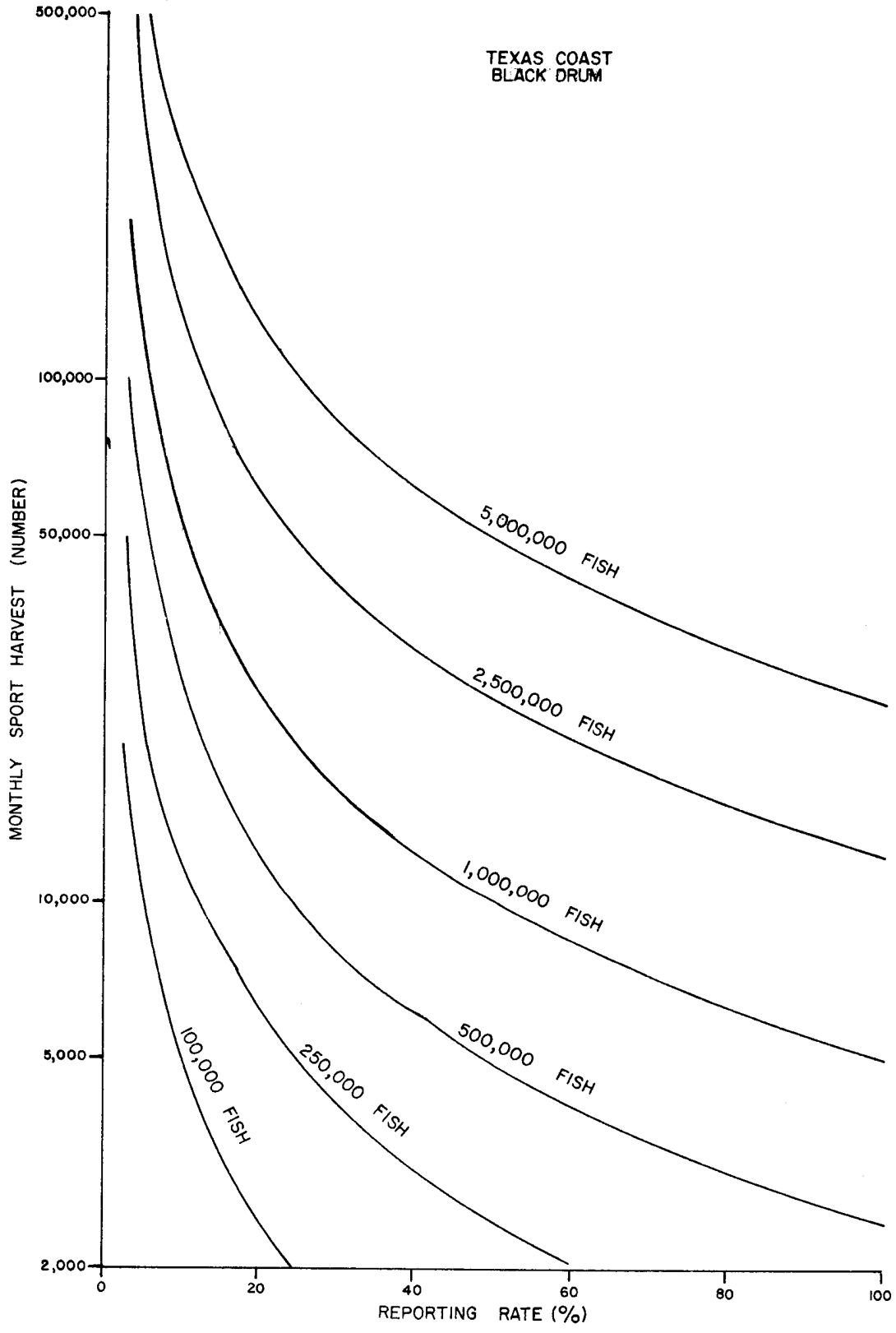


Figure 11. Estimates of black drum abundance in Texas bays using monthly reporting rates and harvest by sport fishermen.

APPENDIX A Number of Fish Tagged With Internal Abdominal Tags in Each Bay System During November 1975 - September 1976

Table 1 . Number of fish tagged with internal abdominal tags during November 1975 - September 1976 in the Galveston Bay system.

Species	1975		1976									Total
	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	
Red drum	47	33	39	2	34	2	99	2	0	0	0	258
Black drum	14	32	27	14	7	7	129	0	0	0	2	232
Southern flounder	2	0	2	1	2	1	30	0	0	0	0	38
Sheepshead	2	6	5	1	0	2	18	0	0	0	0	34
Spotted seatrout	0	0	0	80	91	2	0	0	0	0	100	273
Atlantic croaker	0	0	0	0	0	1	18	0	0	0	0	19
Striped mullet	0	0	0	0	0	3	1	0	0	0	0	4
Sea catfish	0	0	0	0	0	6	0	0	0	0	0	6
Gizzard shad	0	0	0	0	0	1	0	0	0	0	0	1
Tripletail	0	0	0	0	0	0	1	0	0	0	0	1
All species	65	71	73	98	134	25	296	2	0	0	102	866

Table 2 . Number of fish tagged with internal abdominal tags during November 1975 - September 1976 in the Matagorda Bay system.

Species	1975		1976									Total
	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	
Red drum	2	65	69	75	8	7	46	0	0	0	1	273
Black drum	0	29	93	55	5	9	44	0	0	0	6	241
Southern flounder	0	9	0	1	0	1	27	0	0	0	0	38
Sheepshead	0	0	0	0	0	4	5	0	0	0	0	9
Spotted seatrout	0	0	0	0	0	1	0	0	0	0	0	1
Sea catfish	0	0	0	0	0	1	0	0	0	0	0	1
Gulf flounder	0	0	0	0	0	0	2	0	0	0	0	2
Gulf kingfish	0	0	0	0	0	0	1	0	0	0	0	1
All species	2	103	162	131	13	23	125	0	0	0	7	566

Table 3 . Number of fish tagged with internal abdominal tags during November 1975 - September 1976 in the San Antonio Bay system.

Species	1975		1976									Total
	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	
Red drum	24	73	66	17	26	0	39	0	1	0	3	249
Black drum	23	54	51	6	22	0	35	0	1	1	4	197
Southern flounder	3	3	2	0	5	0	0	0	0	0	0	13
Sheepshead	0	0	22	0	3	0	44	0	0	0	3	72
Gulf flounder	0	0	0	0	1	0	5	0	0	0	0	6
All species	50	130	141	23	57	0	123	0	2	1	10	537

Table 4 . Number of fish tagged with internal abdominal tags during November 1975 - September 1976 in the Aransas Bay system.

Species	1975		1976									Total
	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	
Red drum	8	28	46	5	32	55	0	1	1	1	1	178
Black drum	19	42	36	52	73	48	0	2	4	4	8	288
Southern flounder	3	0	5	0	4	8	0	0	0	1	1	22
Spotted seatrout	0	0	0	0	0	7	0	0	0	0	0	7
Gulf flounder	0	0	0	0	0	0	0	2	0	0	0	2
All species	30	70	87	57	109	118	0	5	5	6	10	497

Table 5 . Number of fish tagged with internal abdominal tags during November 1975 - September 1976 in the Corpus Christi Bay system.

Species	1975		1976									
	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Total
Red drum	21	39	20	18	21	3	0	0	1	6	0	129
Black drum	26	28	17	26	19	0	0	0	1	5	0	122
Southern flounder	12	27	0	3	7	1	0	0	0	4	1	55
Sheepshead	9	19	16	15	13	0	0	0	2	2	0	76
Gulf flounder	1	7	0	5	4	9	0	0	1	0	0	27
Atlantic croaker	1	0	0	0	0	3	0	0	0	0	0	4
Sea catfish	0	0	0	0	0	4	0	0	0	0	0	4
Spot	0	0	0	0	0	1	0	0	0	0	0	1
All species	70	120	53	67	64	21	0	0	5	17	1	418

Table 6 . Number of fish tagged with internal abdominal tags during November 1975 - September 1976 in the upper Laguna Madre system.

Species	1975		1976									Total
	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	
Red drum	11	20	32	14	16	7	0	0	0	0	0	100
Black drum	85	44	26	42	78	0	2	0	0	0	0	277
Southern flounder	5	1	1	1	1	0	0	0	0	0	0	9
Gulf flounder	0	0	0	1	0	4	0	0	0	0	0	5
Spotted seatrout	0	0	0	0	0	7	0	0	0	0	0	7
All species	101	65	59	58	95	18	2	0	0	0	0	398

Table 7 . Number of fish tagged with internal abdominal tags during November 1975 - September 1976 in the lower Laguna Madre system.

Species	1975		1976									
	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Total
Red drum	13	4	24	3	1	109	0	0	0	0	0	154
Black drum	16	33	59	82	11	14	0	0	0	0	0	215
Southern flounder	4	4	2	1	1	12	0	0	0	0	0	24
Sheepshead	0	0	0	10	4	0	0	0	0	0	0	14
Gulf flounder	0	0	0	0	1	0	0	0	0	0	0	1
Spotted seatrout	0	0	0	0	0	15	0	0	0	0	0	15
Striped mullet	0	0	0	0	0	3	0	0	0	0	0	3
Sea catfish	0	0	0	0	0	17	0	0	0	0	0	17
Spot	0	0	0	0	0	3	0	0	0	0	0	3
Atlantic croaker	0	0	0	0	0	2	0	0	0	0	0	2
All species	33	41	85	96	18	175	0	0	0	0	0	448

APPENDIX B Size of Fishes Tagged in Each Bay System During November 1975 - September 1976

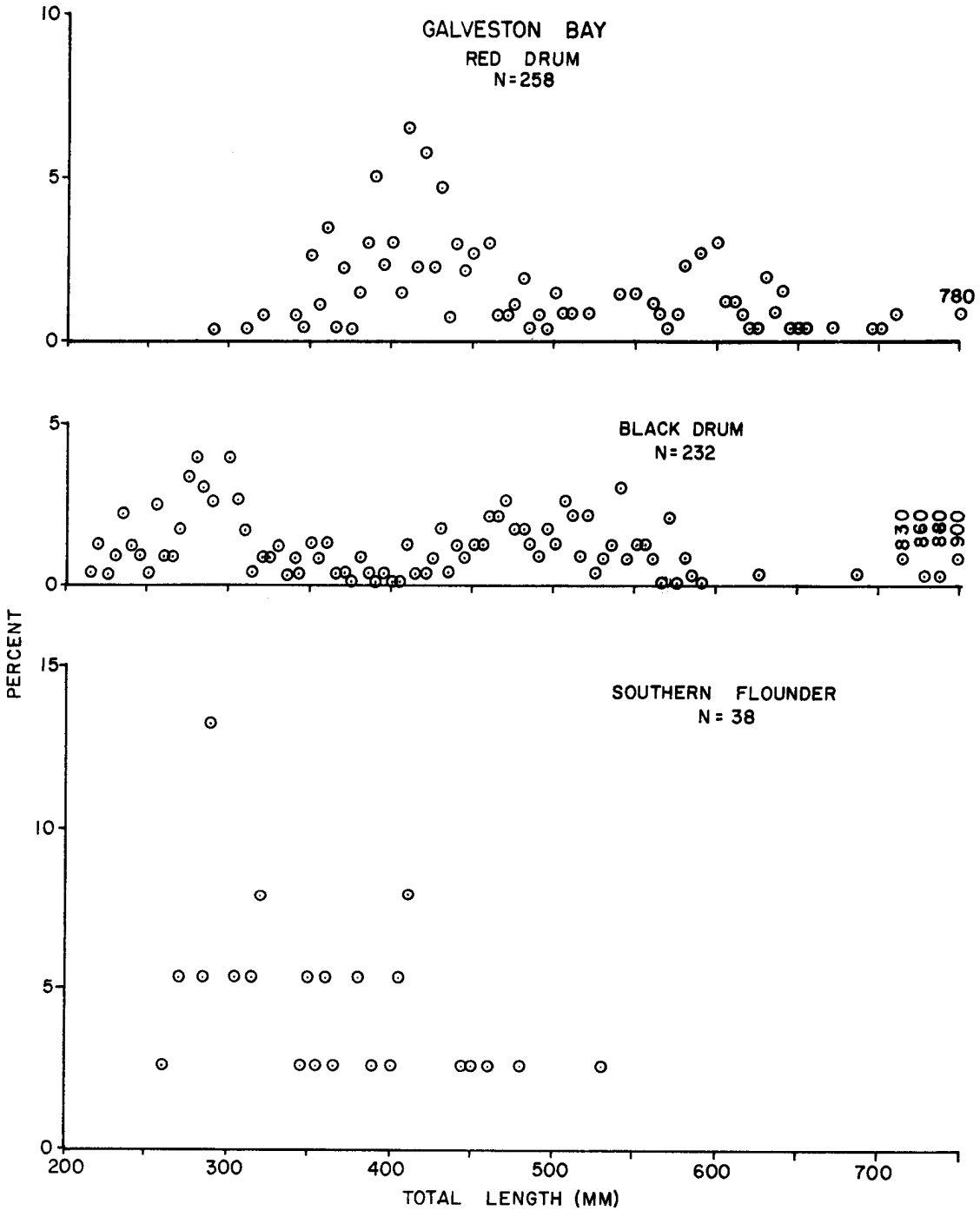


Figure 1. Size of red drum, black drum and southern flounder tagged in the Galveston Bay system during November 1975 - September 1976.

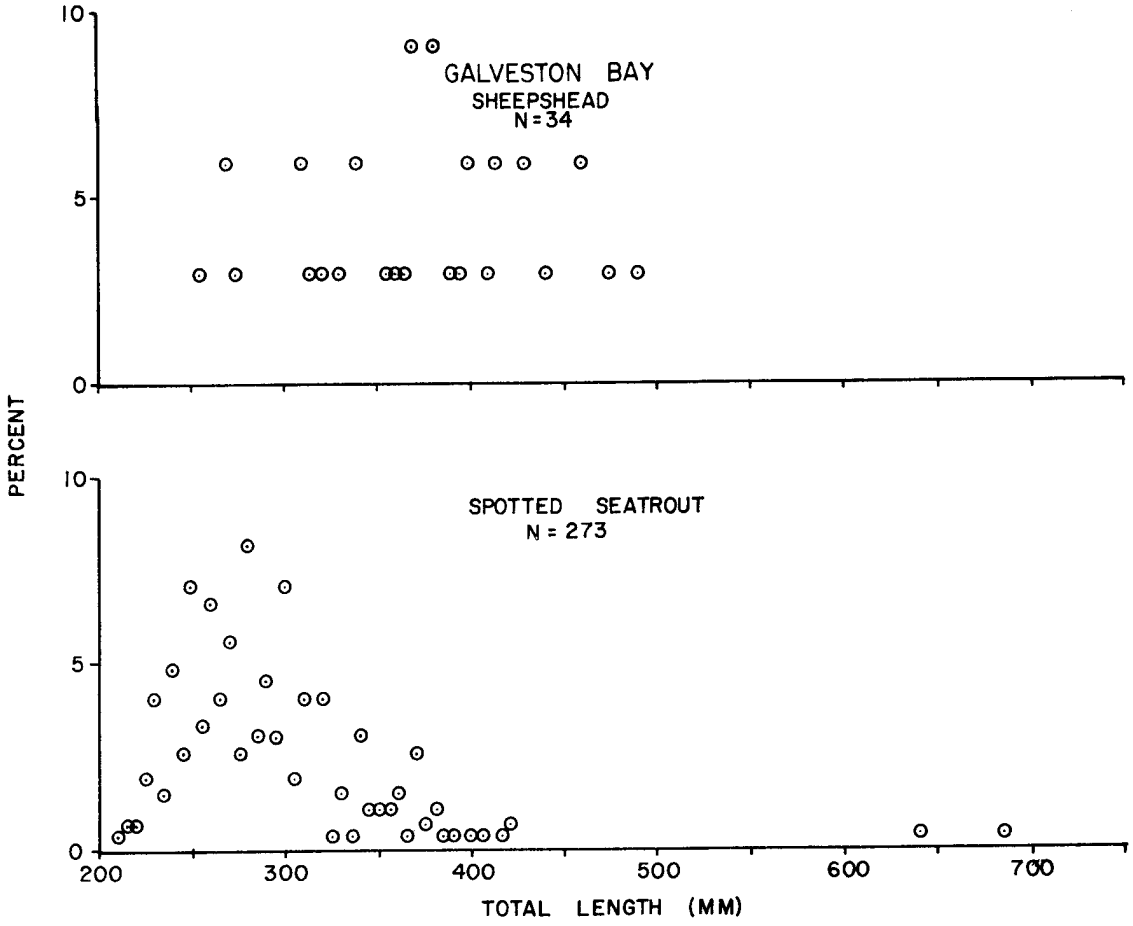


Figure 2. Size of sheepshead and spotted seatrout tagged in the Galveston Bay system during November 1975 - September 1976.

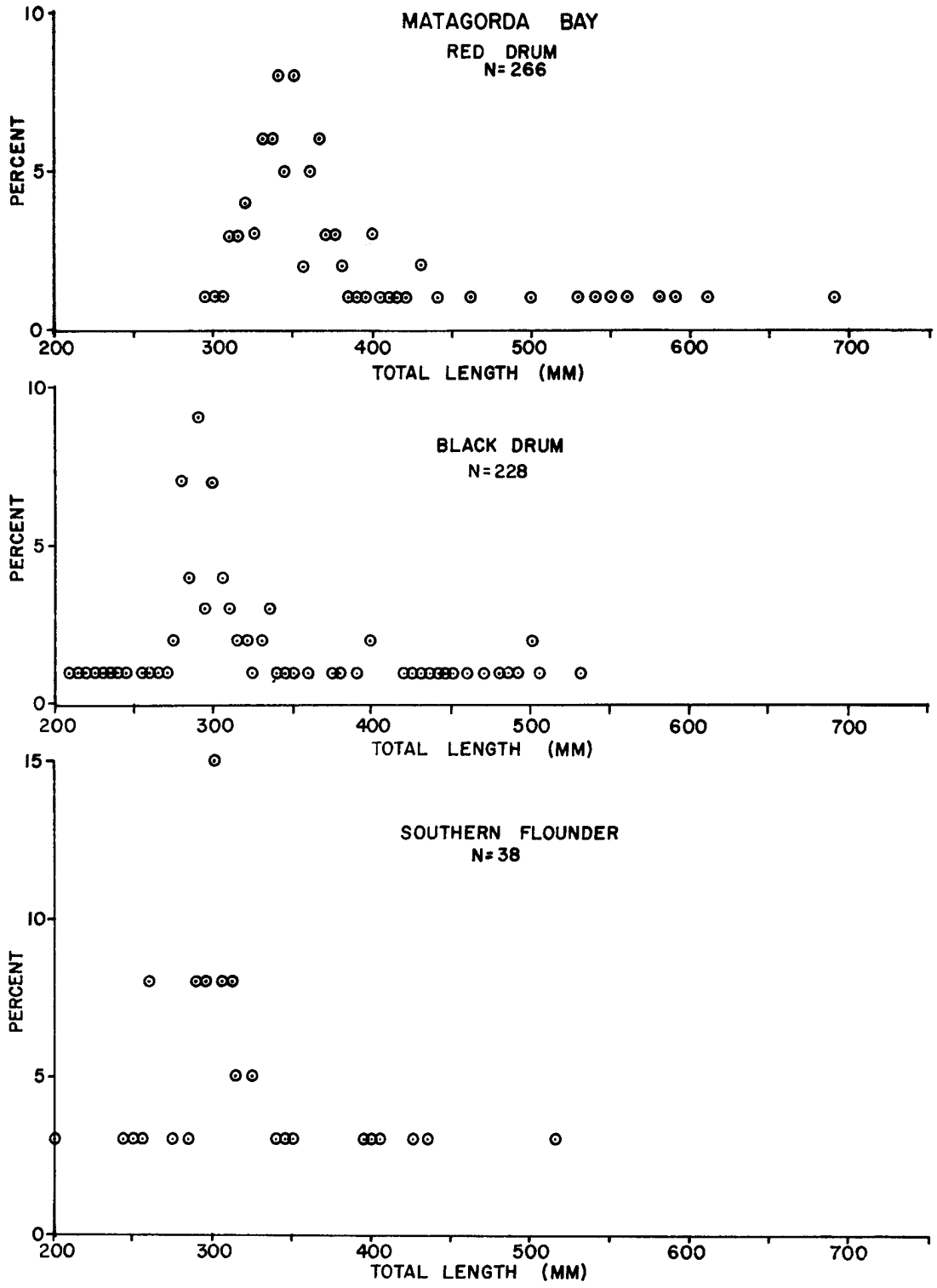


Figure 3. Size of red drum, black drum and southern flounder tagged in the Matagorda Bay system during November 1975 - September 1976.

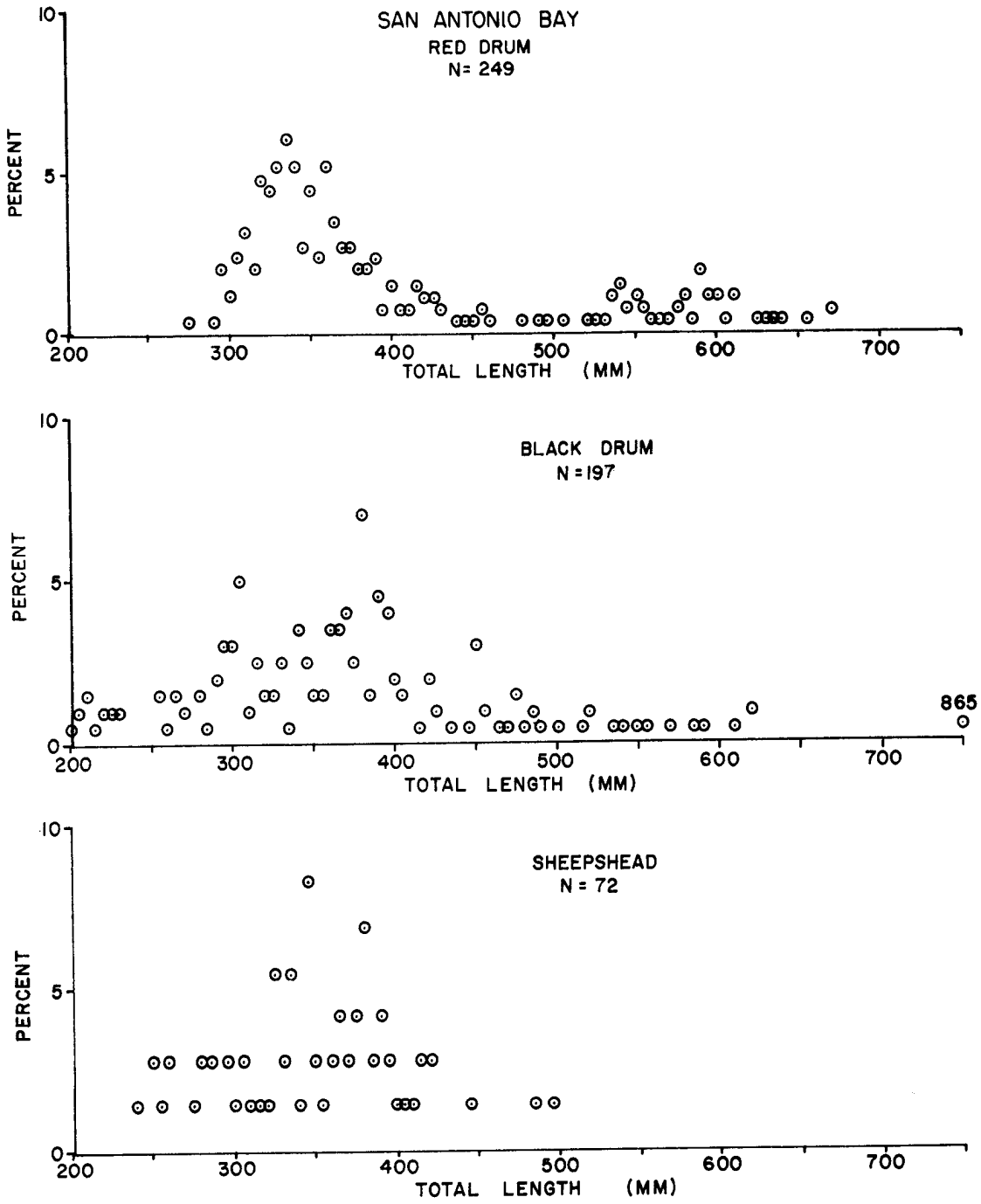


Figure 4 . Size of red drum, black drum and sheepshead tagged in the San Antonio Bay system during November 1975 - September 1976.

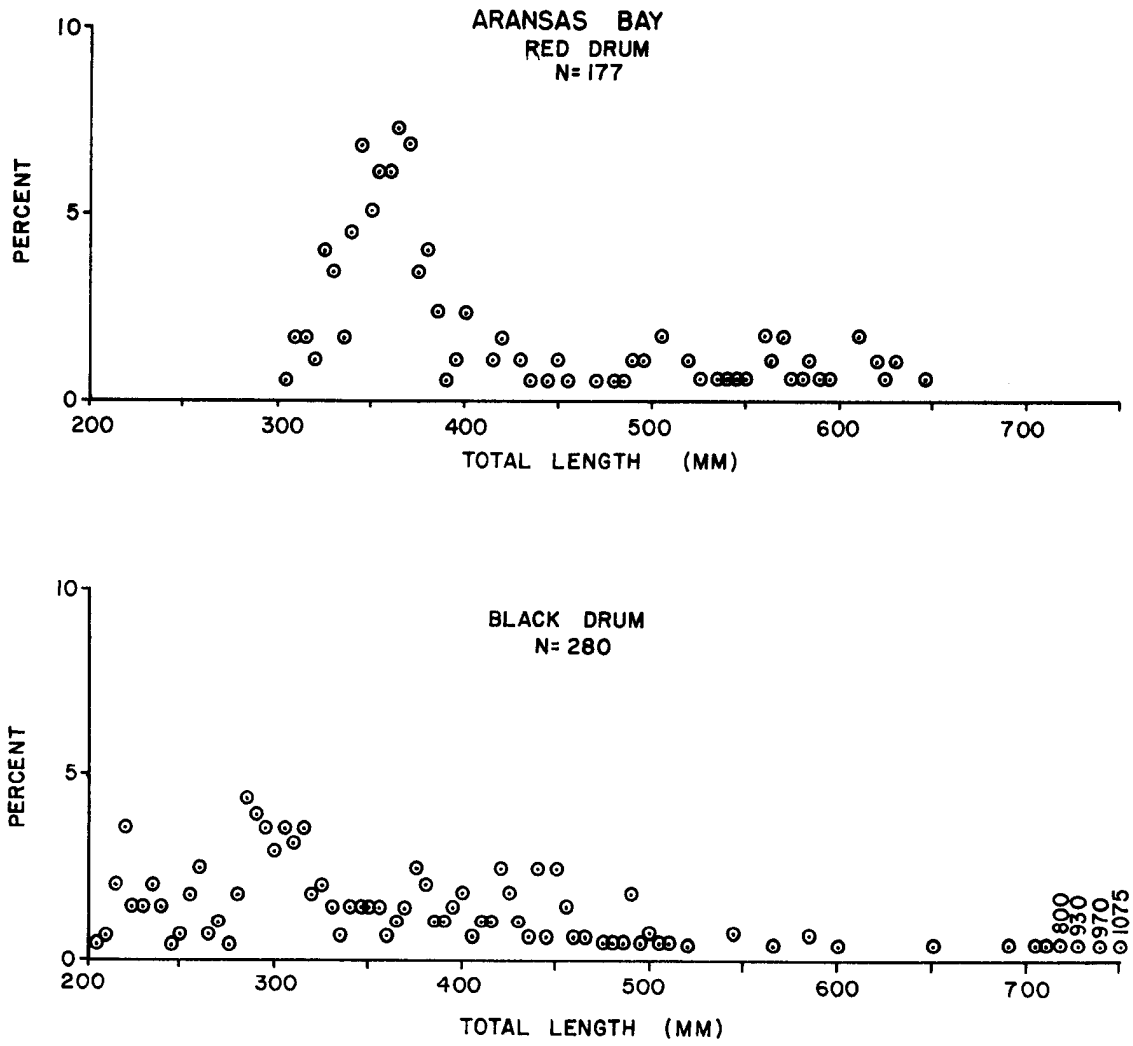


Figure 5. Size of red drum and black drum tagged in the Aransas Bay system during November 1975 - September 1976.

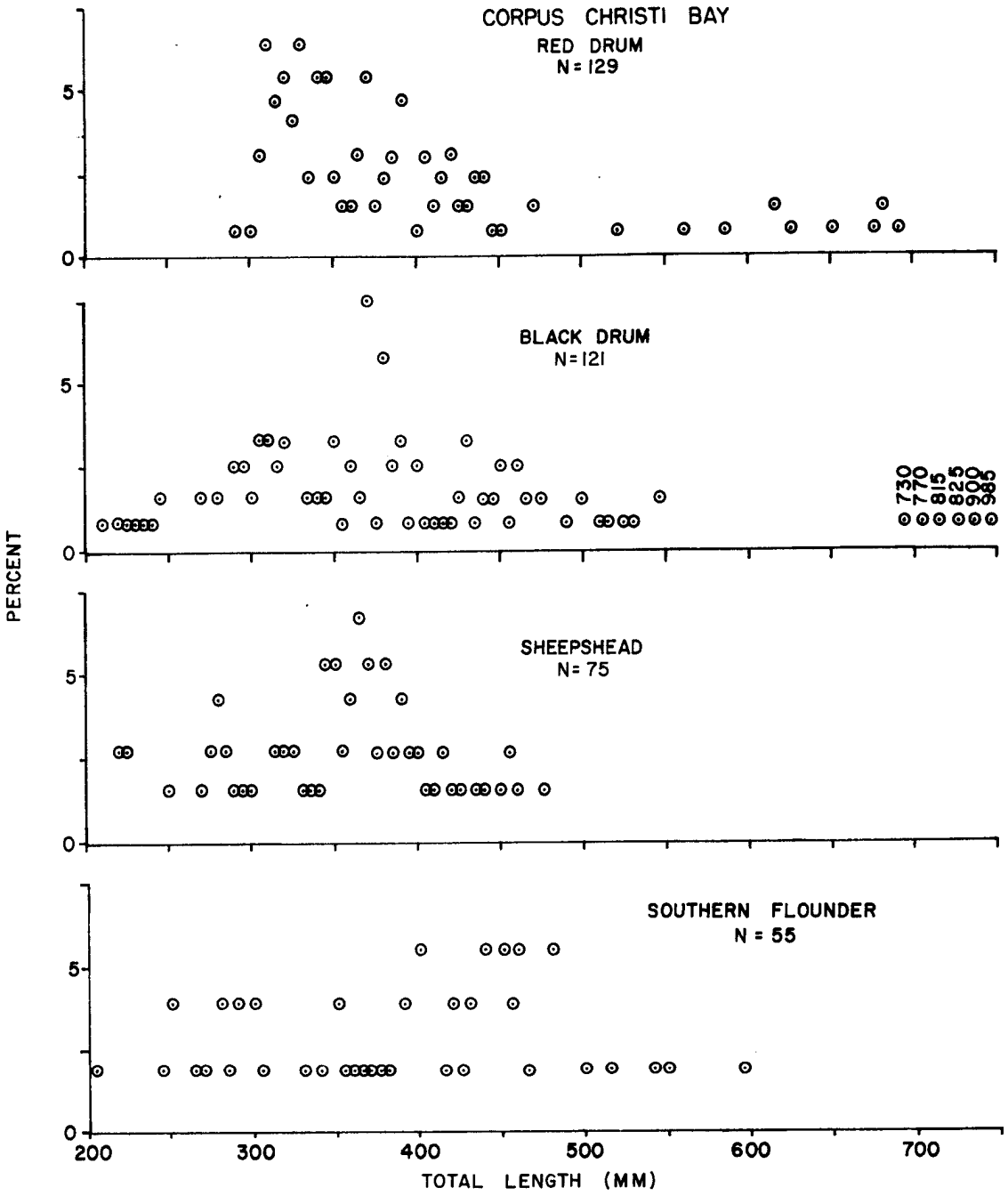


Figure 6. Size of red drum, black drum, sheepshead and southern flounder tagged in the Corpus Christi Bay system during November 1975 - September 1976.

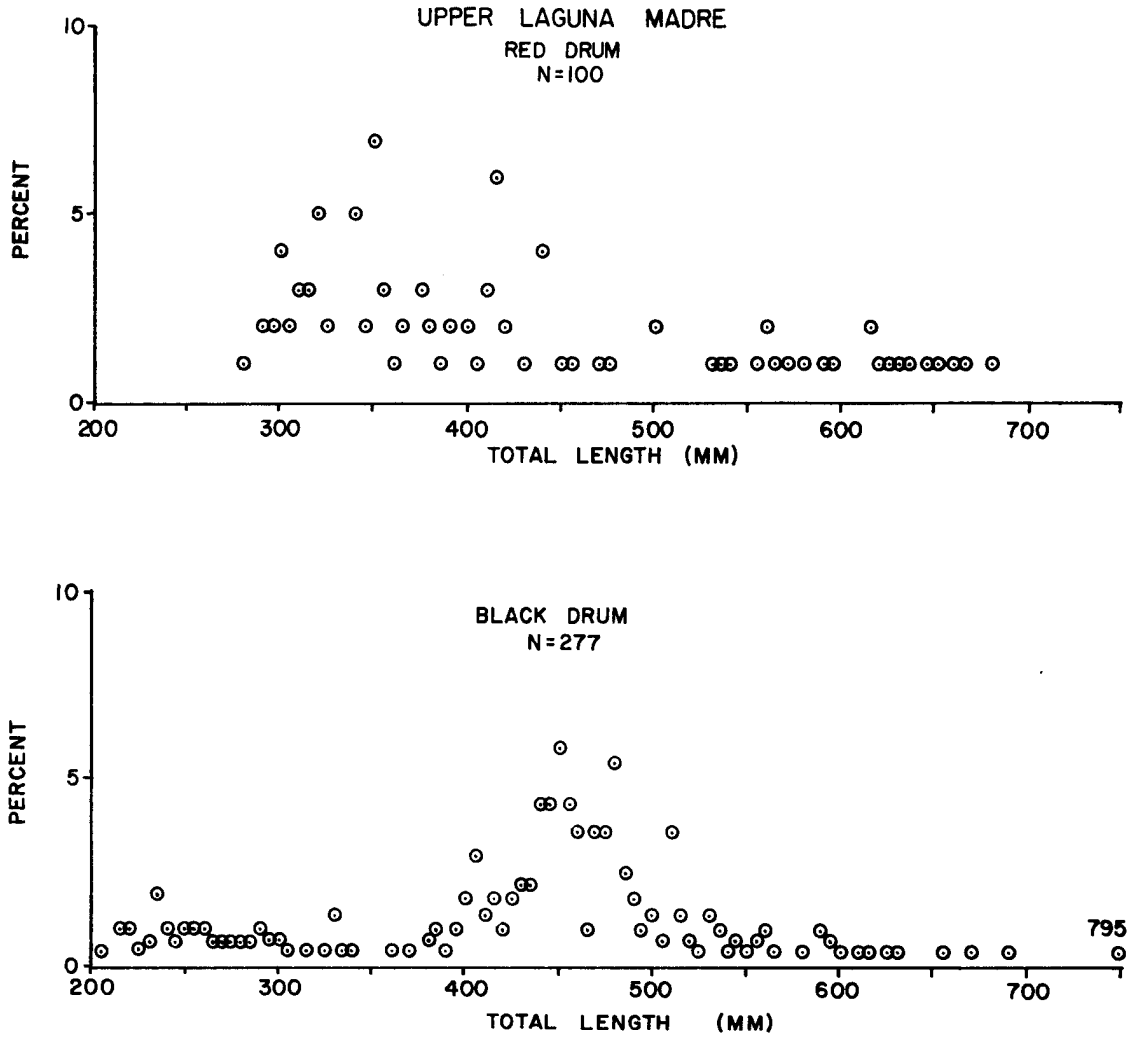


Figure 7. Size of red drum and black drum tagged in the upper Laguna Madre system during November 1975 - September 1976.

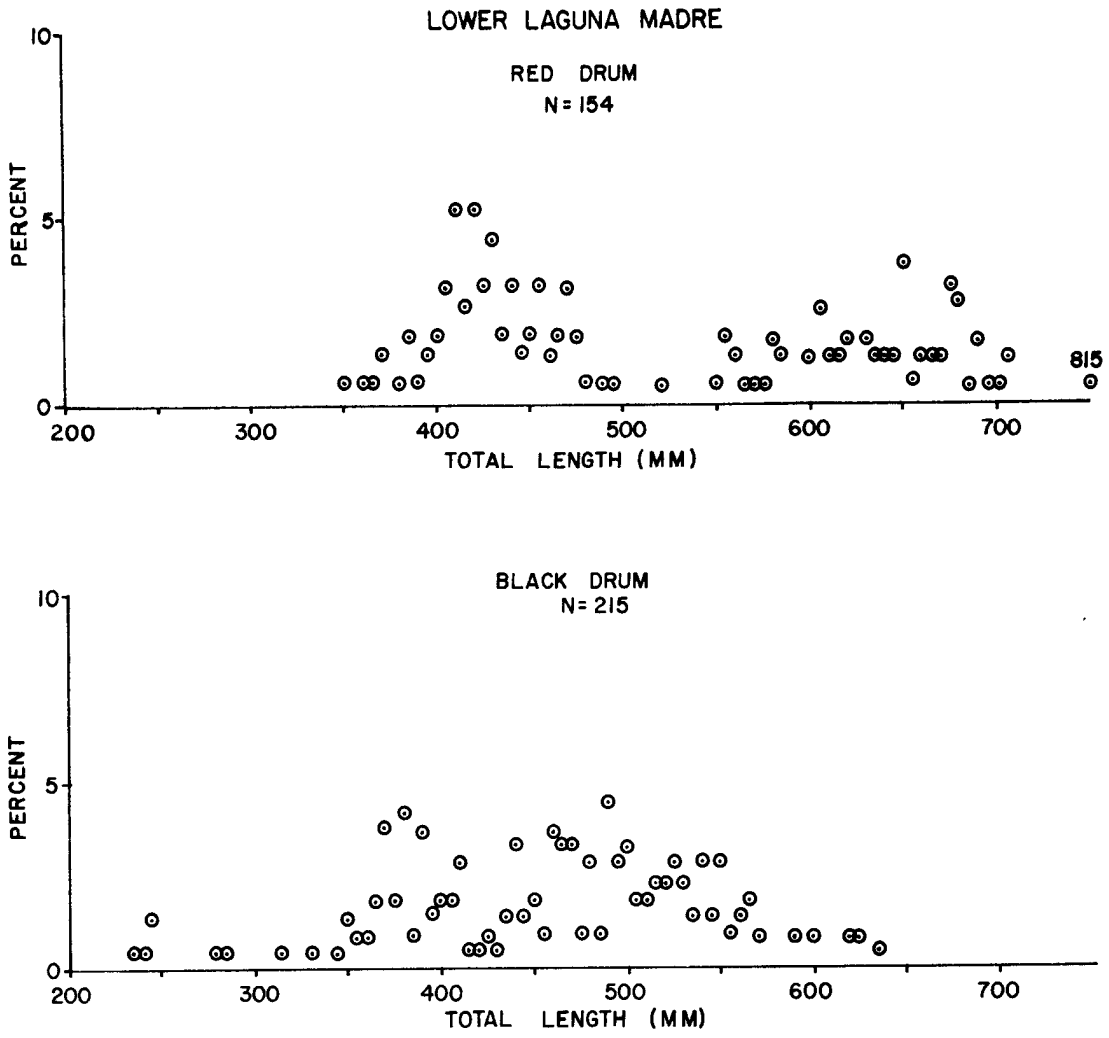


Figure 8. Size of red drum and black drum tagged in the lower Laguna Madre system during November 1975 - September 1976.

APPENDIX C Percent of Fishes Tagged in Each Bay System and Returned During November 1975 - September 1976

Table 1. Percent of fishes tagged in the Galveston Bay system and returned during November 1975 - September 1976.

Species	Number tagged	Total returned		Returned from same bay system		Returned from other bay system	
		Number	Percent of total tagged	Number	Percent of total returned	Number	Percent of total returned
Red drum	258	17	6.6	16	94.1	1	5.9
Black drum	232	4	1.7	4	100.0	0	0.0
Southern flounder	38	1	2.7	1	100.0	0	0.0
Spotted seatrout	273	7	2.3	5	83.3	1	16.7
Atlantic croaker	19	1	5.3	1	100.0	0	0.0

Table 2 . Percent of fishes tagged in the Matagorda Bay system and returned during November 1975 - September 1976.

Species	Number tagged	Total returned		Returned from same bay system		Returned from other bay system	
		Number	Percent of total tagged	Number	Percent of total returned	Number	Percent of total returned
Red drum	273	24	8.8	23	95.8	1	4.2
Black drum	241	9	3.7	9	100.0	0	0
Southern flounder	38	2	5.3	2	100.0	0	0
Gulf flounder	2	1	50.0	1	100.0	0	0

Table 3. Percent of fishes tagged in the San Antonio Bay system and returned during November 1975 - September 1976.

Species	Number tagged	Total returned		Returned from same bay system		Returned from other bay system	
		Number	Percent of total tagged	Number	Percent of total returned	Number	Percent of total returned
Red drum	249	17	6.8	16	94.1	0	0.0
Black drum	197	3	1.5	3	100.0	0	0.0
Sheepshead	72	3	4.2	1	33.3	2	66.7
Gulf flounder	6	2	33.3	2	100.0	0	0.0

Table 4. Percent of fishes tagged in the Aransas Bay system and returned during November 1975 - September 1976.

Species	Number tagged	Total returned		Returned from same bay system		Returned from other bay system	
		Number	Percent of total tagged	Number	Percent of total returned	Number	Percent of total returned
Red drum	178	31	17.4	29	93.5	2	6.5
Black drum	288	16	5.6	15	93.8	1	6.3
Southern flounder	22	1	4.5	1	100.0	0	0.0

Table 5 . Percent of fishes tagged in the Corpus Christi Bay system and returned during November 1975 - September 1976.

Species	Number tagged	Total returned		Returned from same bay system		Returned from other bay system	
		Number	Percent of total tagged	Number	Percent of total returned	Number	Percent of total returned
Red drum	129	26	20.2	21	80.8	5	19.2
Black drum	122	4	3.3	4	100.0	0	0
Southern flounder	55	3	5.5	2	66.7	1	33.3
Gulf flounder	27	1	3.7	1	100.0	0	0
Sheepshead	76	3	3.9	2	66.7	1	33.3

Table 6 . Percent of fishes tagged in the upper Laguna Madre and returned during November 1975 - September 1976.

Species	Number tagged	Total returned		Returned from same bay system		Returned from other bay system	
		Number	Percent of total tagged	Number	Percent of total returned	Number	Percent of total returned
Red drum	100	15	15.0	10	71.4	4	28.6
Black drum	277	6	2.2	6	100.0	0	0.0
Southern flounder	9	2	22.2	1	50.0	1	50.0

Table 7. Percent of fishes tagged in the lower Laguna Madre system and returned during November 1975 - September 1976.

Species	Number tagged	Total returned		Returned from same bay system		Returned from other bay system	
		Number	Percent of total tagged	Number	Percent of total returned	Number	Percent of total returned
Red drum	154	29	18.8	29	100.0	0	0.0
Black drum	215	11	5.1	11	100.0	0	0.0

APPENDIX D Total Number of Fish Returned From Each Bay System By Fishermen During November 1975 - September 1976

Table 1 . Total number of tagged fish returned from the Galveston Bay system by fishermen during November 1975 - September 1976.

Species	Fishing interest	1975		1976									Nov-Sept
		N	D	J	F	M	A	M	J	J	A	S	
Red drum	Sport	1	1	0	0	1	0	0	2	1	3	6	15
	Commercial	0	0	1	0	0	0	0	0	0	0	0	1
	TPWD*	0	0	0	1	0	0	0	0	0	0	0	1
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	1	1	1	1	1	0	0	2	1	3	6	17
Black drum	Sport	0	0	0	1	0	0	0	0	1	0	1	3
	Commercial	0	0	0	0	0	0	0	0	0	0	0	0
	TPWD	0	0	0	0	1	0	0	0	0	0	0	1
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	0	0	1	1	0	0	0	1	0	1	4
Southern flounder	Sport	0	0	0	0	0	0	0	1	0	0	0	1
	Commercial	0	0	0	0	0	0	0	0	0	0	0	0
	TPWD	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	1	0	0	0	1
Atlantic croaker	Sport	0	0	0	0	0	0	0	0	1	0	0	1
	Commercial	0	0	0	0	0	0	0	0	0	0	0	0
	TPWD	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0	1	0	0	1
Spotted seatrout	Sport	0	0	0	0	0	0	1	1	0	2	3	7
	Commercial	0	0	0	0	0	0	0	0	0	0	0	0
	TPWD	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	1	1	0	2	3	7

*Texas Parks and Wildlife Department personnel.

Table 2 . Total number of tagged fish returned from the Matagorda Bay system by fishermen during November 1975 - September 1976.

Species	Fishing interest	1975 N	1975 D	1976 J	F	M	A	M	J	J	A	S	Nov-Sept
Red drum	Sport	0	1	0	4	0	0	2	1	4	3	0	15
	Commercial	0	0	0	0	1	3	0	0	0	1	0	5
	TPWD*	0	0	0	0	1	0	2	1	0	0	0	4
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	1	0	4	2	3	4	2	4	4	0	24
Black drum	Sport	0	0	0	3	3	0	1	0	1	0	0	8
	Commercial	0	0	0	0	1	0	0	0	0	0	0	1
	TPWD*	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	0	0	3	4	0	1	0	1	0	0	9
Southern flounder	Sport	0	0	0	0	1	0	0	0	0	0	1	2
	Commercial	0	0	0	0	0	0	0	0	0	0	0	0
	TPWD*	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	0	0	0	1	0	0	0	0	0	1	2
Gulf flounder	Sport	0	0	0	0	0	0	0	0	1	0	0	1
	Commercial	0	0	0	0	0	0	0	0	0	0	0	0
	TPWD*	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0	1	0	0	1

*Texas Parks and Wildlife Department personnel.

Table 3 . Total number of tagged fish returned from the San Antonio Bay system by fishermen during November 1975 - September 1976.

Species	Fishing interest	1975		1976									Nov-Sept
		N	D	J	F	M	A	M	J	J	A	S	
Red drum	Sport	0	0	0	1	1	0	1	0	1	5	2	11
	Commercial	0	0	1	1	0	0	0	1	0	0	1	4
	TPWD*	0	0	0	0	0	0	1	0	0	0	0	1
	Unknown	0	0	1	0	0	0	0	0	0	0	0	1
	Total	0	0	2	2	1	0	2	1	1	5	3	17
Black drum	Sport	0	1	0	1	0	0	0	0	0	0	0	2
	Commercial	0	0	0	1	0	0	0	0	0	0	0	1
	TPWD	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	1	0	2	0	0	0	0	0	0	0	3
Sheepshead	Sport	0	0	0	0	0	2	0	0	0	0	0	2
	Commercial	0	0	0	0	0	0	0	0	0	1	0	1
	TPWD	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	2	0	0	0	1	0	3
Gulf flounder	Sport	0	0	1	0	0	0	0	0	0	0	1	2
	Commercial	0	0	0	0	0	0	0	0	0	0	0	0
	TPWD	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	0	1	0	0	0	0	0	0	0	1	2

*Texas Parks and Wildlife Department personnel.

Table 4 . Total number of tagged fish returned from the Aransas Bay system by fishermen during November 1975 - September 1976.

Species	Fishing interest	1975 N	1975 D	1976 J	1976 F	1976 M	1976 A	1976 M	1976 J	1976 J	1976 A	1976 S	Nov-Sept
Red drum	Sport	0	0	1	1	1	1	1	3	4	3	4	19
	Commercial	0	0	0	2	1	2	1	0	1	0	3	10
	TPWD*	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	1	0	0	1	0	0	0	2
	Total	0	0	1	3	3	3	2	4	5	3	7	31
Black drum	Sport	0	0	0	1	1	1	1	3	2	1	2	12
	Commercial	0	0	1	0	1	1	0	0	0	0	0	3
	TPWD	0	0	0	0	0	0	0	0	0	0	1	1
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	0	1	1	2	2	1	3	2	1	3	16
Southern flounder	Sport	0	0	0	0	1	0	0	0	0	0	0	1
	Commercial	0	0	0	0	0	0	0	0	0	0	0	0
	TPWD	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	0	0	0	1	0	0	0	0	0	0	1

*Texas Parks and Wildlife Department personnel.

Table 5 . Total number of tagged fish returned from the Corpus Christi Bay system by fishermen during November 1975 - September 1976.

Species	Fishing interest	1975		1976									Nov-Sept
		N	D	J	F	M	A	M	J	J	A	S	
Red drum	Sport	0	0	2	0	0	1	0	2	0	1	0	6
	Commercial	0	1	1	1	0	2	1	5	0	1	1	13
	TPWD*	0	0	0	0	1	0	2	0	0	0	0	3
	Unknown	0	0	0	0	0	3	0	1	0	0	0	4
	Total	0	1	3	1	1	6	3	8	0	2	1	26
Black drum	Sport	0	0	0	2	0	0	0	0	1	0	0	3
	Commercial	0	0	0	0	0	0	0	0	0	0	1	1
	TPWD	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	0	0	2	0	0	0	0	1	0	1	4
Sheepshead	Sport	0	0	0	1	0	0	0	0	0	0	0	1
	Commercial	0	0	1	0	0	0	0	0	0	0	0	1
	TPWD	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	1	0	0	0	0	0	0	1
	Total	0	0	1	1	1	0	0	0	0	0	0	3
Southern flounder	Sport	0	0	0	0	0	0	1	1	0	0	0	2
	Commercial	0	1	0	0	0	0	0	0	0	0	0	1
	TPWD	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	1	0	0	0	0	1	1	0	0	0	3
Gulf flounder	Sport	0	0	0	0	0	0	0	0	0	0	0	0
	Commercial	0	0	0	0	0	0	0	0	1	0	0	1
	TPWD	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0	1	0	0	1

*Texas Parks and Wildlife Department personnel.

Table 6 . Total number of tagged fish returned from the upper Laguna Madre system by fishermen during November 1975 - September 1976.

Species	Fishing interest	1975 N	1975 D	1976 J	F	M	A	M	J	J	A	S	Nov-Sept
Red drum	Sport	0	0	1	0	0	0	4	0	1	1	1	8
	Commercial	0	0	0	0	0	1	0	0	2	2	0	5
	TPWD*	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	0	0	0	2	0	0	0	2
	Total	0	0	1	0	0	1	4	2	3	3	1	15
Black drum	Sport	0	0	0	0	0	0	0	0	0	1	0	1
	Commercial	0	0	0	1	1	1	0	0	1	0	0	4
	TPWD	0	0	0	0	0	0	0	1	0	0	0	1
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	0	0	1	1	1	0	1	1	1	0	6
Southern flounder	Sport	0	0	0	0	0	0	1	0	0	0	0	1
	Commercial	0	1	0	0	0	0	0	0	0	0	0	1
	TPWD	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	1	0	0	0	0	1	0	0	0	0	2

*Texas Parks and Wildlife Department personnel.

Table 7 . Total number of tagged fish returned from the lower Laguna Madre by fishermen during November 1975 - September 1976.

Species	Fishing interest	1975		1976									Nov-Sept
		N	D	J	F	M	A	M	J	J	A	S	
Red drum	Sport	0	0	0	0	0	0	1	2	5	0	0	8
	Commercial	0	0	0	0	4	4	4	7	0	0	2	21
	TPWD*	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	0	0	0	4	4	5	9	5	0	2	29
Black drum	Sport	0	0	0	0	0	2	0	0	0	0	0	2
	Commercial	1	0	0	0	0	0	2	1	4	0	1	9
	TPWD	0	0	0	0	0	0	0	0	0	0	0	0
	Unknown	0	0	0	0	0	0	0	0	0	0	0	0
	Total	1	0	0	0	0	2	2	1	4	0	1	11

*Texas Parks and Wildlife Department personnel.

APPENDIX E Number of Fishes Tagged and Recovered From Each Bay Within Each Bay System During November 1975 - September 1976

Table 1. Number of fishes tagged and recovered from each bay within the Galveston Bay system during November 1975 - September 1976.

Species	Bay	Total tagged	Sport recoveries		Commercial recoveries		All recoveries	
			Introduced into recovery bay	Introduced into different bay	Introduced into recovery bay	Introduced into different bay	Introduced into recovery bay	Introduced into different bay
Red drum	Bastrop	40	2	0	0	0	2	0
	Chocolate	60	4	0	0	0	4	0
	Christmas	6	0	0	0	0	0	0
	Dickinson	11	0	0	0	0	0	0
	Dollar	15	0	0	0	0	1	0
	East	39	1	0	0	0	1	0
	Galveston	1	0	2	0	0	0	2
	Jones Lake	17	0	0	0	0	0	0
	Moses Lake	9	1	0	0	0	1	0
	Swan Lake	1	0	0	0	0	0	0
	Tabbs	3	0	0	0	0	0	0
	Trinity	18	0	0	0	0	0	0
	West	38	2	2	1	0	3	2
Black drum	Bastrop	65	0	0	0	0	0	0
	Chocolate	53	1	0	0	0	1	0
	Christmas	3	0	0	0	0	0	0
	Dickinson	17	0	0	0	0	0	0
	Dollar	3	0	0	0	0	0	0
	East	26	0	0	0	0	1	0
	Galveston	12	0	0	0	0	0	0
	Moses Lake	11	0	0	0	0	0	0
	Tabbs	17	0	0	0	0	0	0
	Trinity	11	0	0	0	0	0	0
	West	14	1	1	0	0	1	1

Table 1. (Cont'd.)

Species	Bay	Total tagged	Sport recoveries		Commercial recoveries		All recoveries	
			Introduced into recovery bay	Introduced into different bay	Introduced into recovery bay	Introduced into different bay	Introduced into recovery bay	Introduced into different bay
Southern flounder	Bastrop	10	1	0	0	0	1	0
	Chocolate	17	0	0	0	0	0	0
	Christmas	1	0	0	0	0	0	0
	Dollar	2	0	0	0	0	0	0
	East	1	0	0	0	0	0	0
	Moses Lake	4	0	0	0	0	0	0
	Swan Lake	1	0	0	0	0	0	0
	Trinity	2	0	0	0	0	0	0
Spotted seatrout	Bastrop	271	3	0	0	0	3	0
	East	2	0	0	0	0	0	0
	West	0	0	3	0	0	0	3
Atlantic croaker	Bastrop	3	0	0	0	0	0	0
	Dickinson	3	0	0	0	0	0	0
	East	1	0	0	0	0	0	0
	Moses Lake	12	0	1	0	0	0	1

Table 2. Number of fishes tagged and recovered from each bay within the Matagorda Bay system during November 1975 - September 1976.

Species	Bay	Total tagged	Sport recoveries		Commercial recoveries		All recoveries	
			Introduced into recovery bay	Introduced into different bay	Introduced into recovery bay	Introduced into different bay	Introduced into recovery bay	Introduced into different bay
Red drum	Carancahua	25	2	1	0	2	2	3
	Cox	31	0	0	0	0	0	0
	Keller	65	3	0	0	0	3	0
	Lavaca	18	0	1	0	1	0	2
	Oyster Lake	1	0	0	0	0	0	0
	Powderhorn Lake	73	2	0	0	0	6	0
	Tres Palacios	37	1	0	0	0	1	0
	Turtle	7	0	2	0	0	0	2
	Matagorda	16	0	2	2	0	2	2
Black drum	Carancahua	31	2	1	1	0	3	1
	Cox	49	0	0	0	0	0	0
	Keller	40	0	0	0	0	0	0
	Lavaca	48	2	0	0	0	2	0
	Powderhorn Lake	3	0	0	0	0	0	0
	Tres Palacios	58	2	0	0	0	2	0
	Turtle	5	1	0	0	0	1	0
	Matagorda	7	0	0	0	0	0	0
Southern flounder	Carancahua	1	0	0	0	0	0	0
	Cox	2	0	0	0	0	0	0
	Keller	1	0	0	0	0	0	0
	Powderhorn Lake	30	2	0	0	0	2	0
	Matagorda	4	0	0	0	0	0	0
Gulf flounder	Powderhorn Lake	2	1	0	0	0	1	0

Table 3 . Number of fishes tagged and recovered from each bay within the San Antonio Bay system during November 1975 - September 1976.

Species	Bay	Total tagged	Sport recoveries		Commercial recoveries		All recoveries	
			Introduced into recovery bay	Introduced into different bay	Introduced into recovery bay	Introduced into different bay	Introduced into recovery bay	Introduced into different bay
Red drum	Espiritu Santo	133	10	0	3	0	14	0
	Hynes	3	0	0	0	0	0	0
	San Antonio	113	1	0	1	0	3	0
Black drum	Espiritu Santo	148	1	0	1	0	2	0
	Hynes	1	0	0	0	0	0	0
	San Antonio	52	1	0	0	0	1	0
Sheepshead	Espiritu Santo	72	0	0	0	0	0	0
	San Antonio	0	0	0	0	1	0	1
Gulf flounder	Espiritu Santo	6	2	0	0	0	2	0

Table 4. Number of fishes tagged and recovered from each bay within the Aransas Bay system during November 1975 - September 1976.

Species	Bay	Total tagged	Sport recoveries		Commercial recoveries		All recoveries	
			Introduced into recovery bay	Introduced into different bay	Introduced into recovery bay	Introduced into different bay	Introduced into recovery bay	Introduced into different bay
Red drum	Aransas	21	0	2	0	2	0	4
	Copano	64	3	0	2	0	5	0
	Redfish	28	5	0	4	0	11	0
	St. Charles	65	7	0	0	0	7	0
	Sundown	0	0	0	0	1	0	1
Black drum	Aransas	46	0	1	0	1	0	2
	Copano	163	5	1	1	0	6	1
	Port	24	1	0	0	0	2	0
	Redfish	3	0	1	0	0	0	1
	St. Charles	52	2	0	0	0	2	0
	Sundown	0	0	0	0	1	0	1
Southern flounder	Aransas	3	0	0	0	0	0	0
	Copano	9	0	0	0	0	0	0
	Redfish	3	1	0	0	0	1	0
	St. Charles	7	0	0	0	0	0	0

Table 5 . Number of fishes tagged and recovered from each bay within the Corpus Christi Bay system during November 1975 - September 1976.

Species	Bay	Total tagged	Sport recoveries		Commercial recoveries		All recoveries	
			Introduced into recovery bay	Introduced into different bay	Introduced into recovery bay	Introduced into different bay	Introduced into recovery bay	Introduced into different bay
Red drum	Corpus Christi	86	4	0	7	0	13	0
	Nueces	5	0	0	0	1	0	1
	Redfish	38	1	0	1	0	6	1
Black drum	Corpus Christi	70	0	0	0	1	0	1
	Nueces	6	3	0	0	0	3	0
	Redfish	46	0	0	0	0	0	0
Southern flounder	Corpus Christi	42	2	0	1	0	3	0
	Nueces	3	0	0	0	0	0	0
	Redfish	10	0	0	0	0	0	0
Sheepshead	Corpus Christi	33	0	0	0	0	0	0
	Nueces	3	0	0	0	0	0	0
	Redfish	40	1	0	0	1	1	1
Gulf flounder	Corpus Christi	16	0	0	1	0	1	0
	Nueces	1	0	0	0	0	0	0
	Redfish	10	0	0	0	0	0	0

Table 6. Number of fishes tagged and recovered from each bay within the upper Laguna Madre system during November 1975 - September 1976.

Species	Bay	Total tagged	Introduced into recovery bay	Introduced into different bay	Introduced into recovery bay	Introduced into different bay	Introduced into recovery bay	Introduced into different bay
Red drum	Alazan	10	0	0	0	0	0	0
	Cayo del Grullo	1	0	0	0	0	0	0
	Laguna Salada	18	1	0	0	0	1	0
	Upper Laguna Madre	71	4	0	3	0	9	0
Black drum	Alazan	8	0	0	0	1	0	1
	Baffin	3	0	0	0	1	0	1
	Cayo del Grullo	10	0	0	0	0	0	0
	Laguna Salada	80	0	0	0	0	1	0
	Upper Laguna Madre	176	0	1	2	0	1	2
Southern flounder	Laguna Salada	1	0	0	0	0	0	0
	Upper Laguna Madre	8	1	0	0	0	1	0

APPENDIX F Number of Returned Tagged Fish Moving From Site of Tagging in Each Bay System

Table 1. Number of returned tagged fish moving from site of tagging in the Galveston Bay system.

Species	Minimum distance traveled (km)								Number with movement data available
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	>35	
Red drum	14	0	2	0	0	0	1	0	17
Black drum	2	1	1	0	0	0	0	0	4
Southern flounder	1	0	0	0	0	0	0	0	1
Atlantic croaker	1	0	0	0	0	0	0	0	1
Spotted Seatrout	2	0	0	2	0	0	1	1	6

Table 2 . Number of tagged fish moving from site of tagging in the Matagorda Bay system.

Species	Minimum distance traveled (km)								Number with movement data available
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	>35	
Red drum	11	3	2	3	4	0	0	1	24
Black drum	3	3	0	0	0	1	0	1	8
Southern flounder	2	0	0	0	0	0	0	0	2

Table 3 . Number of returned tagged fish moving from site of tagging in the San Antonio Bay system.

Species	Minimum distance traveled (km)								Number with movement data available
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	≥ 35	
Red drum	11	3	1	1	0	0	0	0	16
Black drum	2	1	0	0	0	0	0	0	3
Sheepshead	0	0	0	1	0	0	0	2	3
Gulf flounder	0	1	1	0	0	0	0	0	2

Table 4 . Number of returned tagged fish moving from site of tagging in the Aransas Bay system.

Species	Minimum distance traveled (km)								Number with movement data available
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	≥35	
Red drum	16	5	2	1	0	2	2	1	29
Black drum	8	2	2	1	0	0	1	1	15
Southern flounder	1	0	0	0	0	0	0	0	1

Table 5. Number of returned tagged fish moving from site of tagging in the Corpus Christi Bay system.

Species	Minimum distance traveled (km)								Number with movement data available
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	>35	
Red drum	17	5	0	2	0	1	0	1	26
Black drum	4	0	0	0	0	0	0	0	4
Southern flounder	2	0	0	0	1	0	0	0	3
Gulf flounder	1	0	0	0	0	0	0	0	1
Sheepshead	1	0	0	1	0	0	0	1	3

Table 6. Number of returned tagged fish moving from site of tagging in the upper Laguna Madre system.

Species	Minimum distance traveled (km)								Number with movement data available
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	>35	
Red drum	7	0	1	1	1	1	0	3	14
Black drum	2	0	1	0	1	1	0	1	6
Southern flounder	1	1	0	0	0	0	0	0	2

Table 7 . Number of returned tagged fish moving from site of tagging in the lower Laguna Madre system.

Species	Minimum distance traveled (km)								Number with movement data available
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	>35	
Red drum	8	5	3	5	2	4	0	0	27
Black drum	5	1	0	0	0	1	1	1	9

APPENDIX G Directions of Movement of Fishes Tagged in Each Bay System for Individuals Traveling > 10 km

Table 1 . Directions of movement of fishes tagged in the Galveston Bay system for individuals traveling >10 km.

Species	Total length (mm) at tagging	Month tagged	Month returned	Distance traveled (km)	Direction traveled	Bay system of recapture
Red drum	420	November	November	12	South	Galveston
Red drum	390	November	December	14	North	Galveston
Red drum	590	May	September	35	South	Gulf of Mexico
Black drum	520	May	September	12	North	Galveston
Spotted seatrout	290	February	June	43	North	Galveston
Spotted seatrout	310	February	August	18	East	Galveston
Spotted seatrout	265	February	August	18	East	Galveston
Spotted seatrout	300	February	September	33	South	Gulf of Mexico

Table 2 . Directions of movement of fishes tagged in the Matagorda Bay system for individuals traveling >10 km.

Species	Total length at tagging (mm)	Month tagged	Month returned	Distance traveled (km)	Direction traveled	Bay system of recapture
Red drum	605	December	December	17	South	Matagorda
Red drum	610	December	February	22	South	Matagorda
Red drum	360	December	May	14	South	Matagorda
Red drum	580	December	July	25	East	Matagorda
Red drum	440	December	July	25	East	Matagorda
Red drum	350	December	August	15	South	Matagorda
Red drum	460	January	February	55	South	San Antonio
Red drum	320	February	April	17	East	Matagorda
Red drum	345	February	April	17	East	Matagorda
Red drum	335	February	July	24	East	Matagorda
Black drum	305	February	March	25	East	Matagorda
Black drum	305	February	March	25	East	Matagorda

Table 3. Directions of movement of fishes tagged in the San Antonio Bay system for individuals traveling > 10 km.

Species	Total length at tagging (mm)	Month tagged	Month returned	Distance traveled (km)	Direction traveled	Bay system of recapture
Red drum	600	January	May	13	West	San Antonio
Red drum	670	January	February	19	East	San Antonio
Sheepshead	345	January	August	17	West	San Antonio
Sheepshead	390	January	April	88	South	Aransas
Sheepshead	400	January	April	71	South	Aransas
Gulf flounder	305	April	June	15	North	San Antonio

Table 4 . Directions of movement of fishes tagged in the Aransas Bay system for individuals traveling > 10 km.

Species	Total length (mm) at tagging	Month tagged	Month returned	Distance traveled (km)	Direction traveled	Bay system of recapture
Red drum	585	January	March	28	West	Aransas
Red drum	430	January	May	11	South	Aransas
Red drum	345	January	September	33	South	Aransas
Red drum	325	January	September	35	South	Aransas
Red drum	455	March	April	19	East	Aransas
Red drum	360	March	August	26	South	Aransas
Red drum	380	March	September	116	North	Matagorda
Red drum	350	April	September	11	South	Aransas
Black drum	325	January	June	19	East	Aransas
Black drum	305	March	April	13	North	Aransas
Black drum	420	March	April	13	North	Aransas
Black drum	305	March	May	113	North	Matagorda
Black drum	325	March	July	33	South	Aransas

Table 5. Directions of movement of fishes tagged in the Corpus Christi Bay system for individuals traveling > 10 km.

Species	Total length (mm) at tagging	Month tagged	Month returned	Distance traveled (km)	Direction traveled	Bay system of recapture
Red drum	425	November	April	26	North	Corpus Christi
Red drum	585	December	January	65	South	Upper Laguna Madre
Red drum	575	December	February	20	East	Aransas
Red drum	680	March	June	19	North	Corpus Christi
Southern flounder	460	December	May	24	West	Corpus Christi
Sheepshead	385	December	January	19	South	Corpus Christi
Sheepshead	390	January	March	163	North	Gulf of Mexico

Table 6 . Directions of movement of fishes tagged in the upper Laguna Madre system for individuals traveling > 10 km.

Species	Total length (mm) at tagging	Month tagged	Month returned	Distance traveled (km)	Direction traveled	Bay system of recapture
Red drum	647	November	June	17	North	Corpus Christi
Red drum	375	November	August	30	South	Upper Laguna Madre
Red drum	390	January	May	24	South	Upper Laguna Madre
Red drum	360	January	May	144	North	Matagorda
Red drum	355	January	July	15	North	Upper Laguna Madre
Red drum	385	January	August	63	South	Lower Laguna Madre
Red drum	415	February	May	50	South	Gulf of Mexico
Black drum	440	December	August	24	East	Upper Laguna Madre
Black drum	315	February	February	12	North	Upper Laguna Madre
Black drum	410	February	March	40	South	Upper Laguna Madre
Black drum	505	March	April	28	South	Upper Laguna Madre

Table 7. Directions of movement of fishes tagged in the lower Laguna Madre system for individuals traveling > 10 km.

Species	Total length (mm) at tagging	Month tagged	Month returned	Distance traveled (km)	Direction traveled	Bay system of recapture
Red drum	400	November	April	18	South	Lower Laguna Madre
Red drum	415	January	March	23	South	Lower Laguna Madre
Red drum	600	January	March	19	South	Lower Laguna Madre
Red drum	434	January	March	19	South	Lower Laguna Madre
Red drum	440	January	May	25	South	Lower Laguna Madre
Red drum	580	January	June	12	South	Lower Laguna Madre
Red drum	475	February	April	18	North	Lower Laguna Madre
Red drum	430	April	April	19	South	Lower Laguna Madre
Red drum	644	April	June	14	South	Lower Laguna Madre
Red drum	472	April	June	29	South	Lower Laguna Madre
Red drum	605	April	June	29	South	Lower Laguna Madre
Red drum	480	April	June	29	South	Lower Laguna Madre
Red drum	422	April	June	12	South	Lower Laguna Madre
Red drum	458	April	September	27	South	Lower Laguna Madre

Table 7 . (Cont'd.)

Species	Total length (mm) at tagging	Month tagged	Month returned	Distance traveled (km)	Direction traveled	Bay system of recapture
Black drum	465	February	July	26	North	Lower Laguna Madre
Black drum	535	February	July	34	North	Lower Laguna Madre
Black drum	405	March	April	40	North	Lower Laguna Madre

APPENDIX H Relationship Between Minimum Distance Traveled and Days Free for Red Drum and Black Drum Tagged in Each Bay System

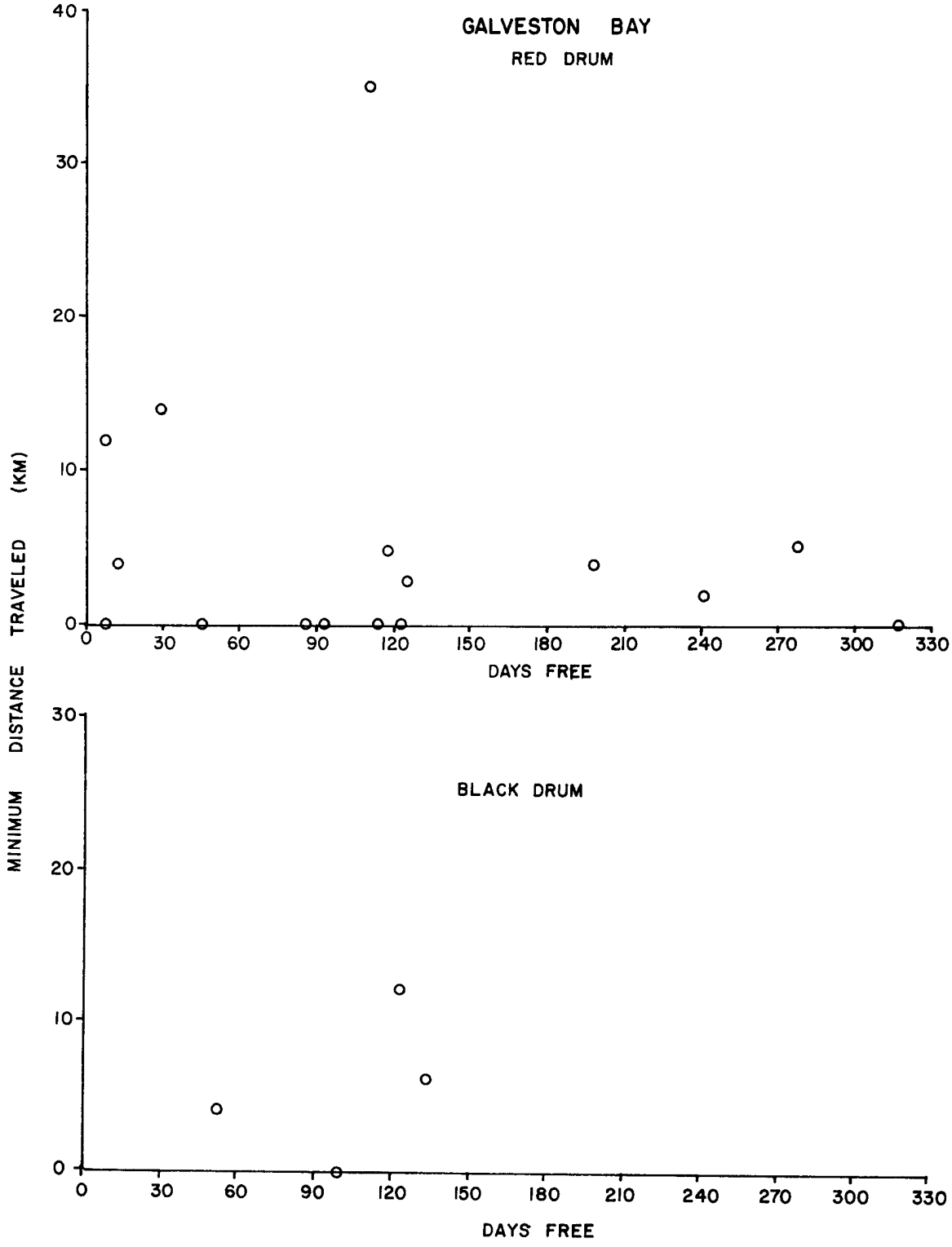


Figure 1. Relationship between minimum distance traveled and days free for red drum and black drum tagged in the Galveston Bay system.

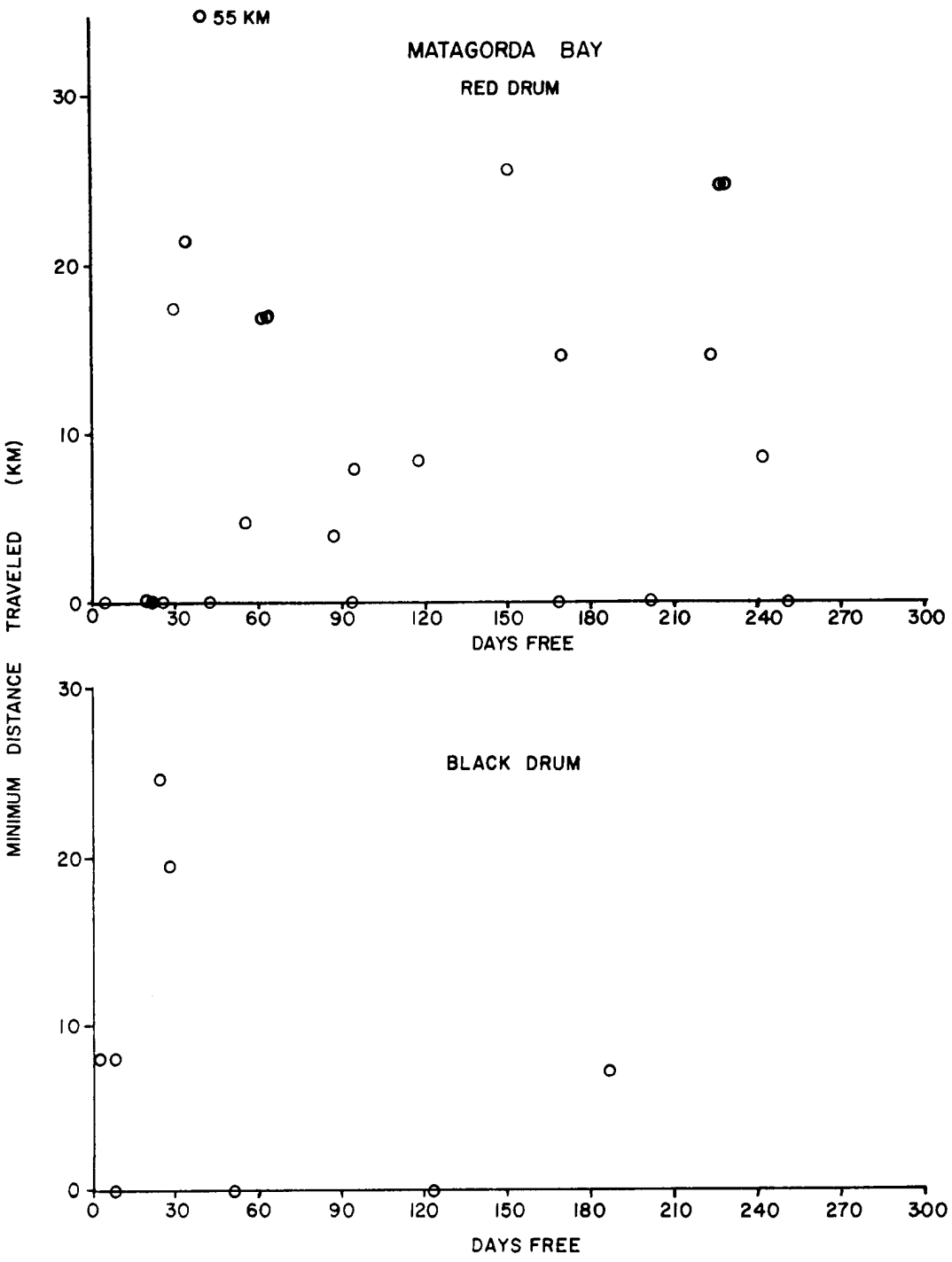


Figure 2. Relationship between minimum distance traveled and days free for red drum and black drum tagged in the Matagorda Bay system.

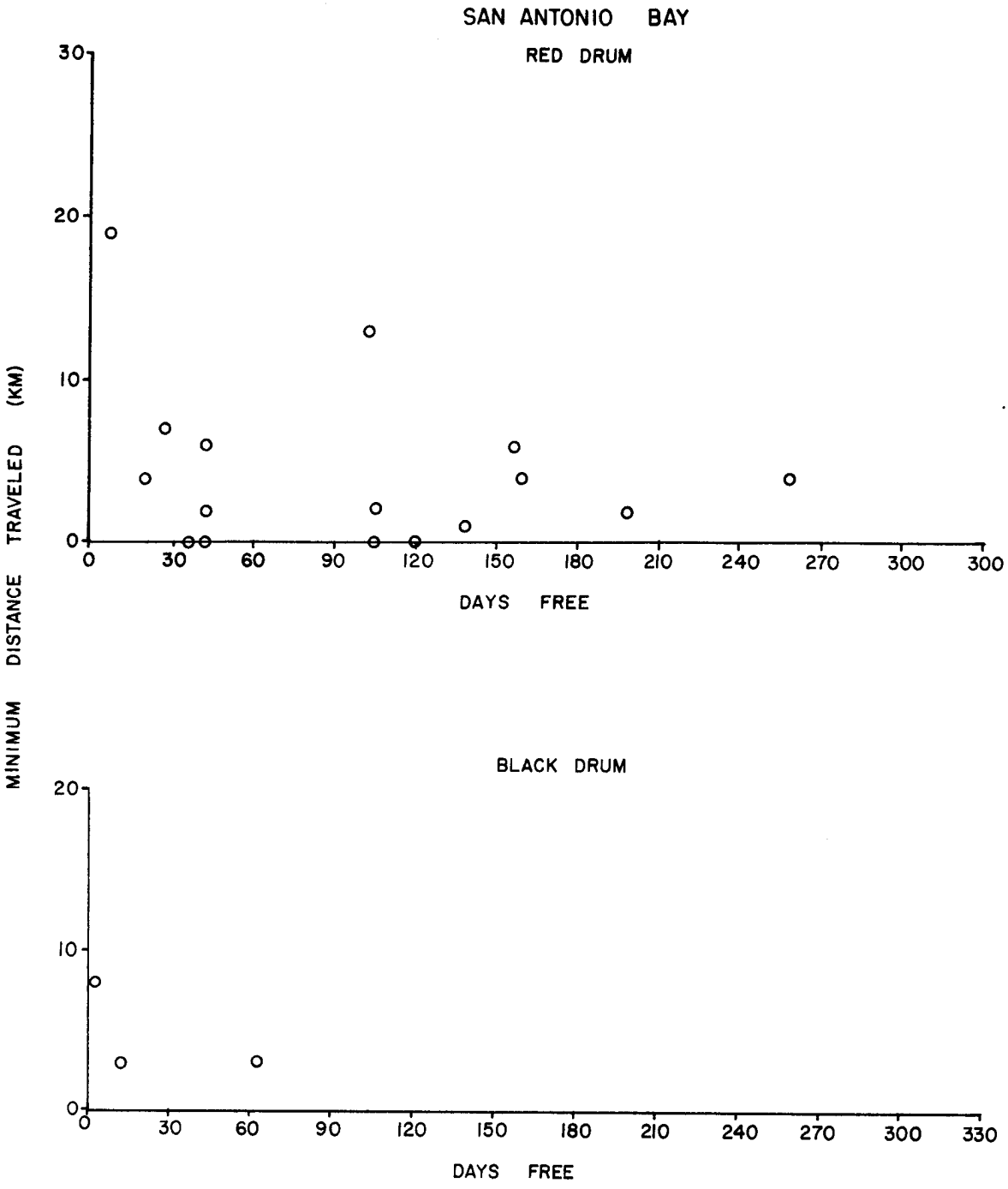


Figure 3. Relationship between minimum distance traveled and days free for red drum and black drum tagged in the San Antonio Bay system.

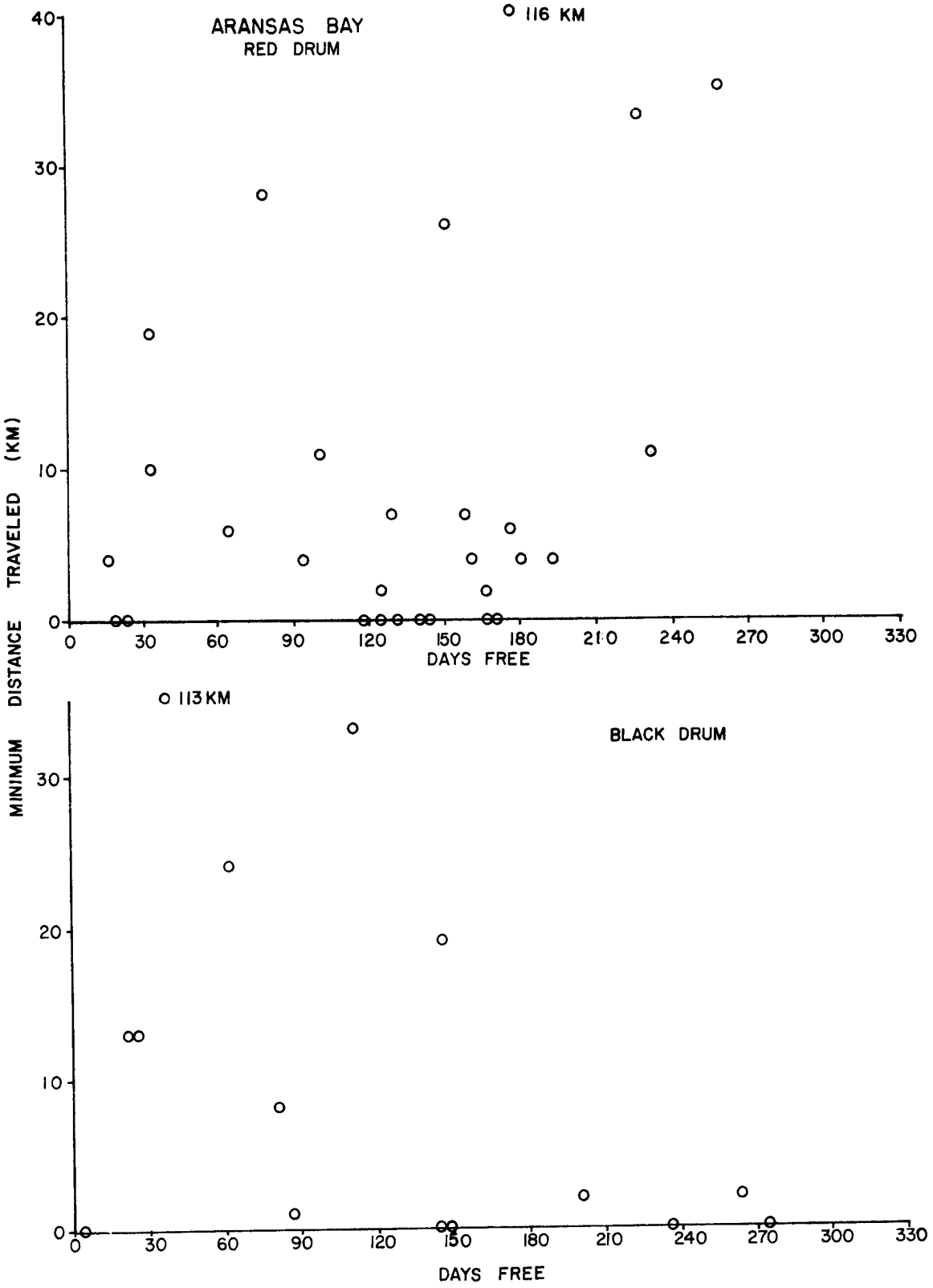


Figure 4. Relationship between minimum distance traveled and days free for red drum and black drum tagged in the Aransas Bay system.

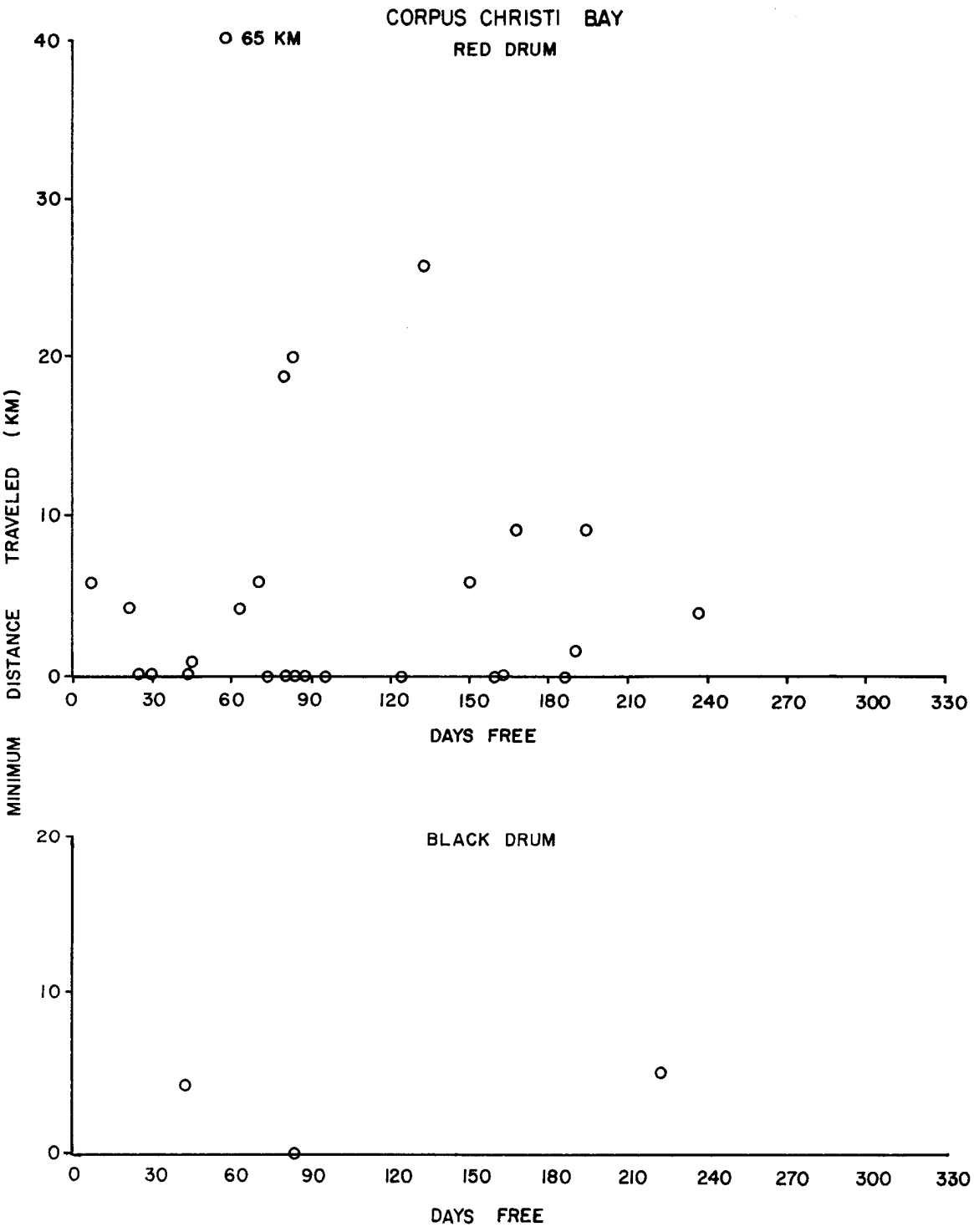


Figure 5. Relationship between minimum distance traveled and days free for red drum and black drum tagged in the Corpus Christi Bay system.

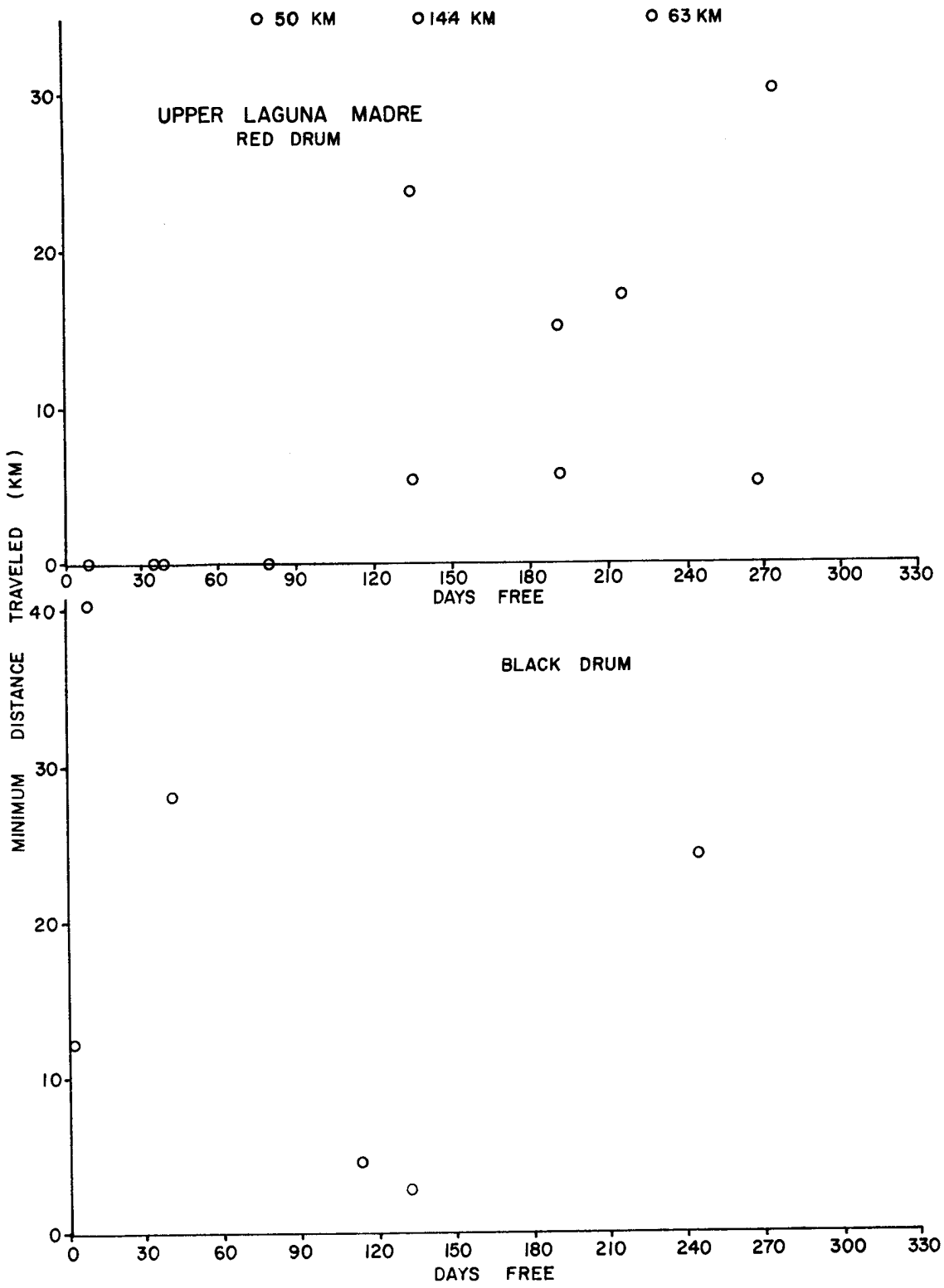


Figure 6. Relationship between minimum distance traveled and days free for red drum and black drum tagged in the upper Laguna Madre system.

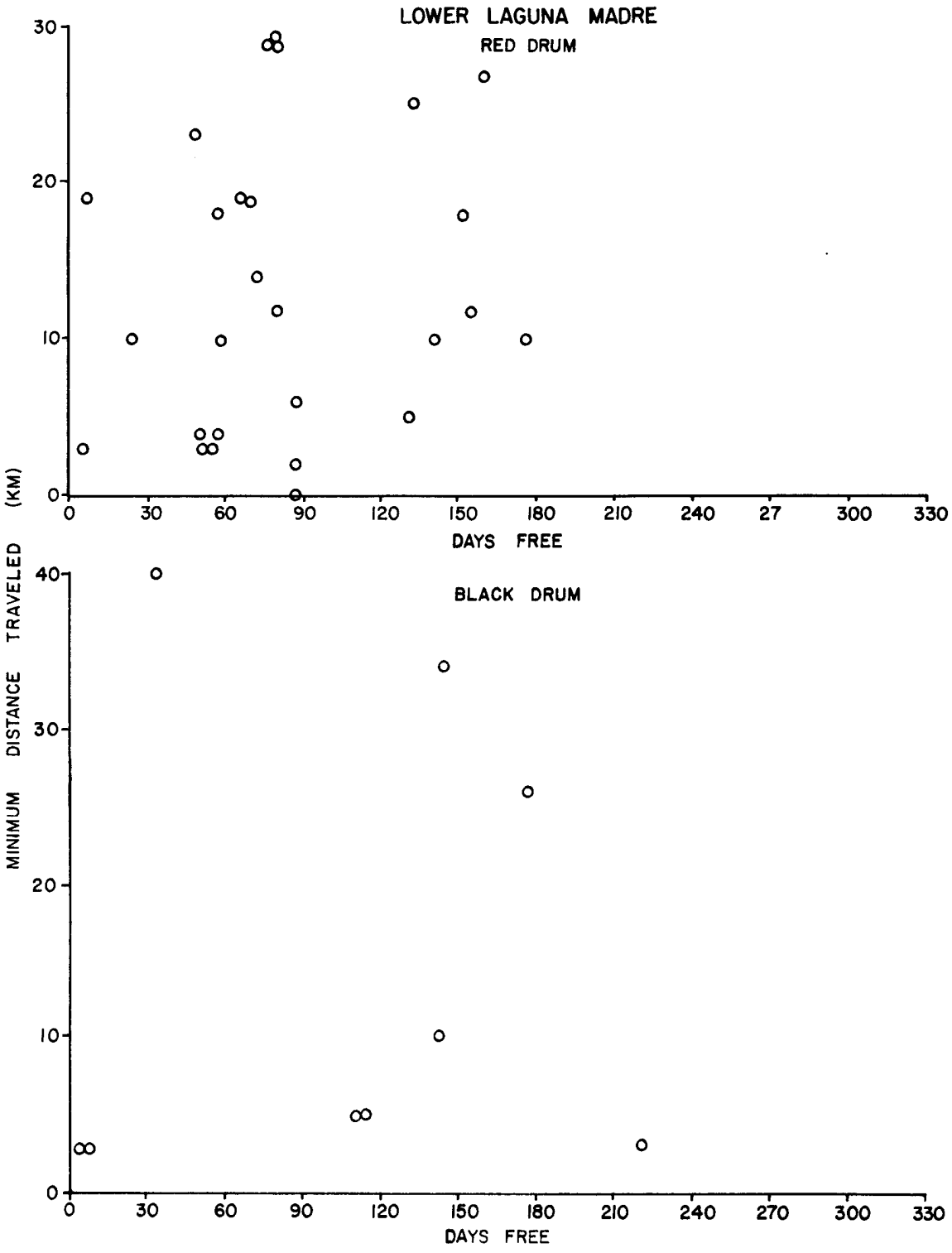


Figure 7. Relationship between minimum distance traveled and days free for red drum and black drum tagged in the lower Laguna Madre system.

APPENDIX I Mean Growth Rates for Fishes Tagged in Each Bay System During November 1975 - September 1976

Table 1 . Mean growth rates for fishes tagged in the Galveston Bay system during November 1975 - September 1976.

Species	Mean growth rate ± 1 S.E.			
	Number measured	Total length per day (mm/day)	Number weighed	Weight per day (g/day)
Red drum	14	0.85 ± 0.47	11	13.8 ± 5.4
Black drum	4	0.00 ± 0.07	0	
Southern flounder	1	1.75	1	16.8
Spotted seatrout	4	-0.55 ± 0.82	3	1.6 ± 0.6

Table 2 . Mean growth rates for fishes tagged in the Matagorda Bay system during November 1975 - September 1976.

Species	Mean growth rate ± 1 S.E.			
	Number measured	Total length per day (mm/day)	Number weighed	Weight per day (g/day)
Red drum	16	0.31 ± 0.12	13	-1.0 ± 4.4
Black drum	2	1.41 ± 1.79	2	1.3 ± 1.1
Southern flounder	0		1	. 5.3
Gulf flounder	1	0.12	1	1.7

Table 3 . Mean growth rates for fishes tagged in the San Antonio Bay system during November 1975 - September 1976.

Species	Mean growth rate ± 1 S.E.			
	Number measured	Total length per day (mm/day)	Number weighed	Weight per day (g/day)
Red drum	14	0.40 ± 0.20	8	-9.5 ± 31.4
Black drum	1	-0.90 ± 0.00	0	
Sheepshead	0		1	0.8 ± 0.0
Gulf flounder	2	0.40 ± 0.80	1	4.4 ± 0.0

Table 4 . Mean growth rates for fishes tagged in the Aransas Bay system during November 1975 - September 1976.

Species	Mean growth rate ± 1. S.E.			
	Number measured	Total length per day (mm/day)	Number weighed	Weight per day (g/day)
Red drum	25	0.31 ± 0.08	4	3.4 ± 0.4
Black drum	11	0.85 ± 0.34	0	

Table 5 . Mean growth rates for fishes tagged in the Corpus Christi Bay system during November 1975 - September 1976.

Species	Mean growth rate ± 1 S.E.			
	Number measured	Total length per day (mm/day)	Number weighed	Weight per day (g/day)
Red drum	21	0.30 ± 0.11	12	4.1 ± 1.7
Black drum	2	3.08 ± 2.74	1	1.7
Southern flounder	3	0.31 ± 0.17	3	1.5 ± 1.1
Sheepshead	3	-0.57 ± 0.25	1	-1.2
Gulf flounder	1	0.27	0	

Table 6 . Mean growth rates for fishes tagged in the upper Laguna Madre Bay system during November 1975 - September 1976.

Species	Mean growth rate ± 1 S.E.			
	Number measured	Total length per day (mm/day)	Number weighed	Weight per day (g/day)
Red drum	12	0.68 ± 0.13	4	8.0 ± 3.3
Black drum	3	0.17 ± 0.17	2	-4.2 ± 0.6
Southern flounder	1	0.90	2	2.6 ± 11.2

Table 7 . Mean growth rates for fishes tagged in the lower Laguna Madre Bay system during November 1975 - September 1976.

	Mean growth rate ± 1 S.E.			
Species	Number measured	Total length per day (mm/day)	Number weighed	Weight per day (g/day)
Red drum	8	0.39 ± 0.19	20	0.3 ± 3.4
Black drum	5	0.51 ± 0.32	8	0.7 ± 2.5

APPENDIX J Relationship Between Size and Growth Rate of Tagged Red Drum in Each Bay System During November 1975 - September 1976

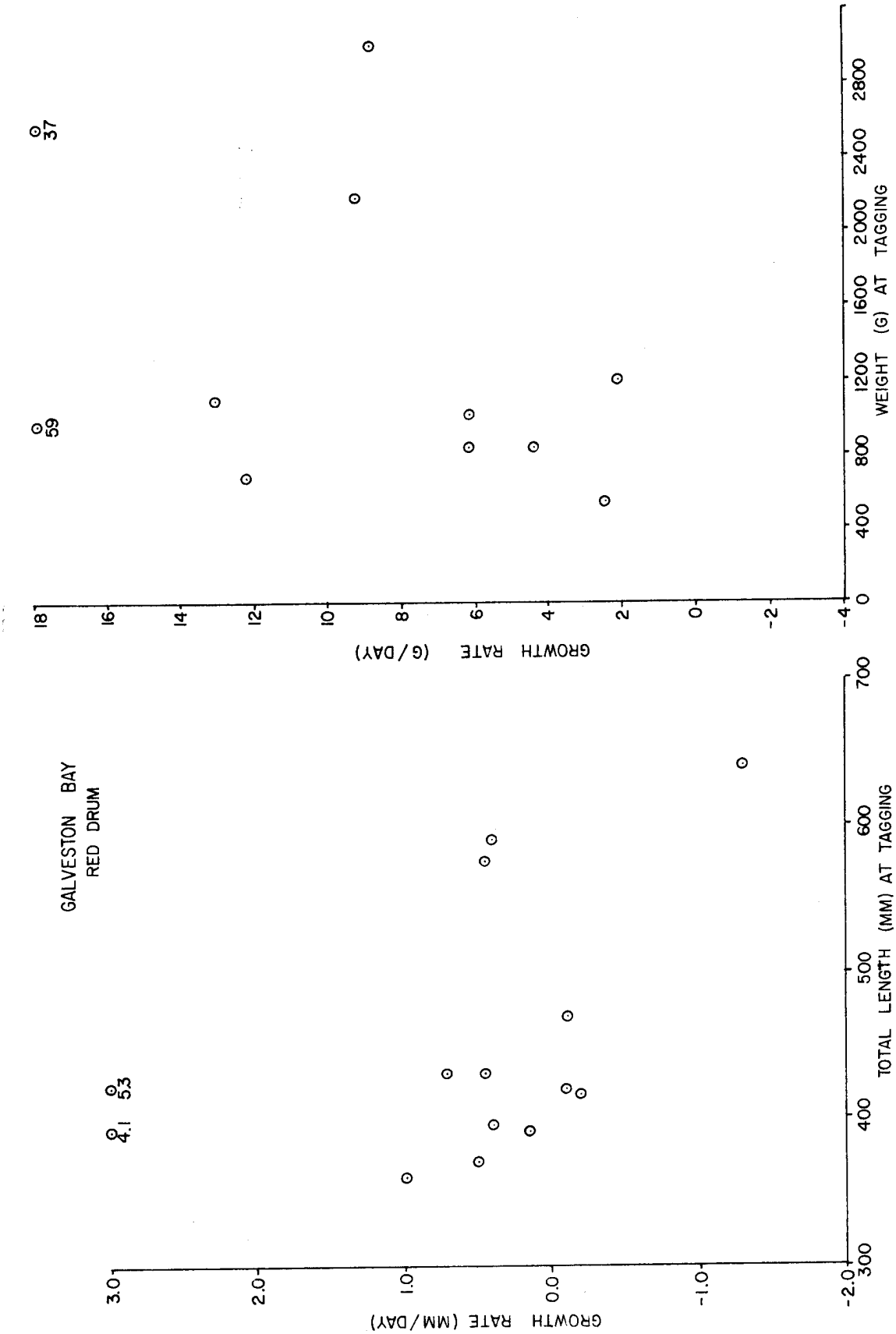


Figure 1. Relationship between size and growth rate of tagged red drum in the Galveston Bay system during November 1975 - September 1976.

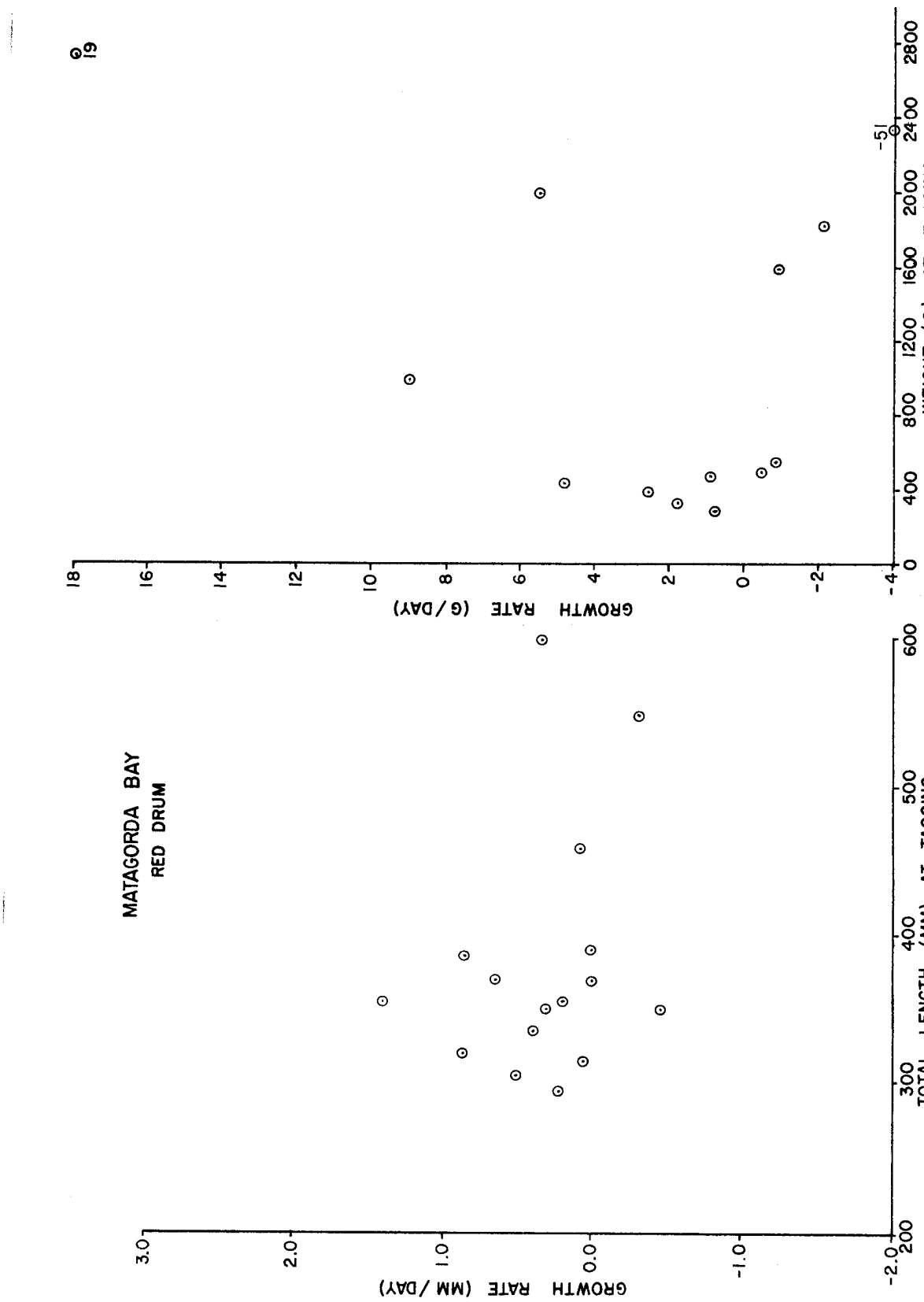


Figure 2. Relationship between size and growth rate of tagged red drum in the Matagorda Bay system during November 1975 - September 1978.

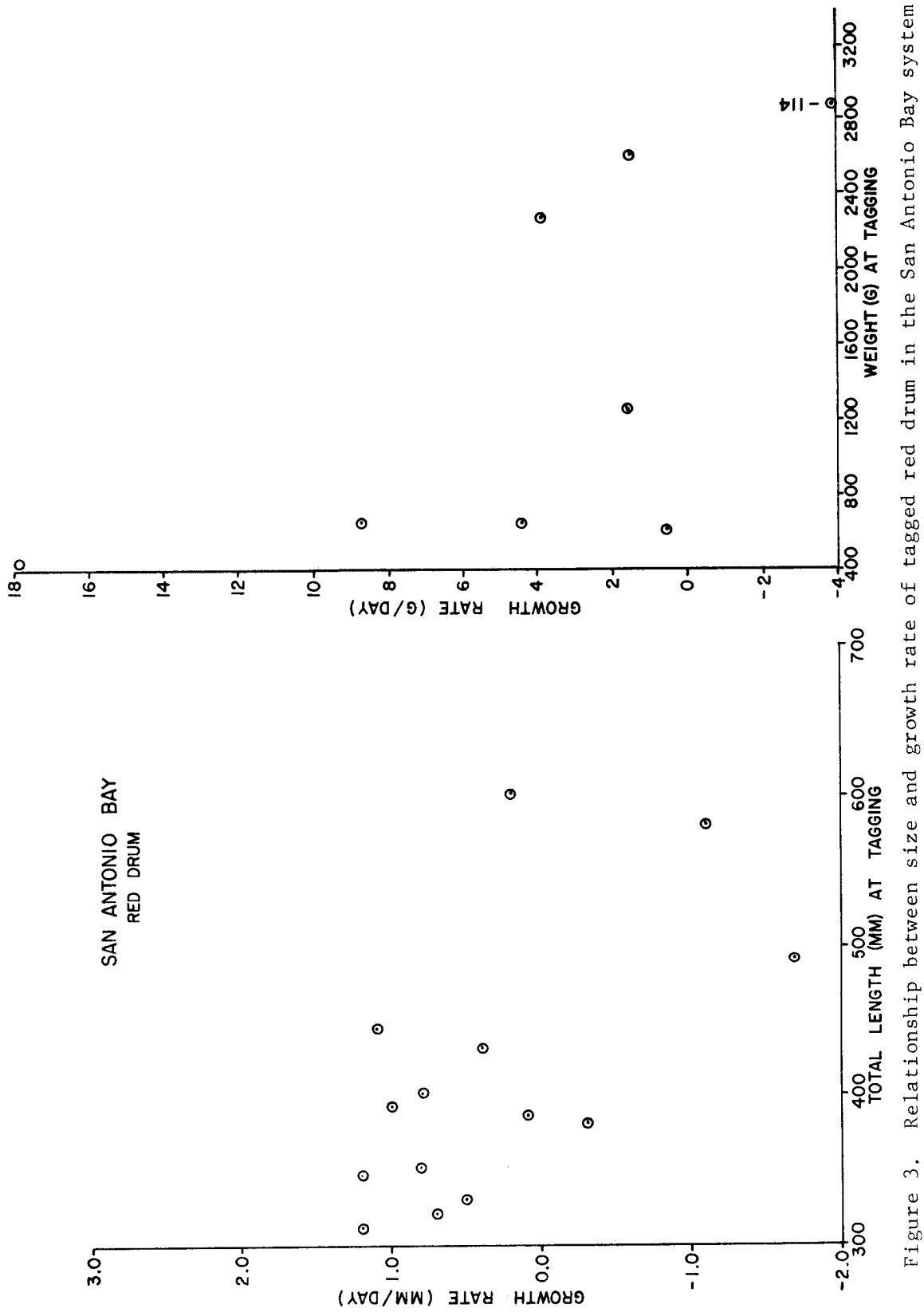


Figure 3. Relationship between size and growth rate of tagged red drum in the San Antonio Bay system during November 1975 - September 1976.

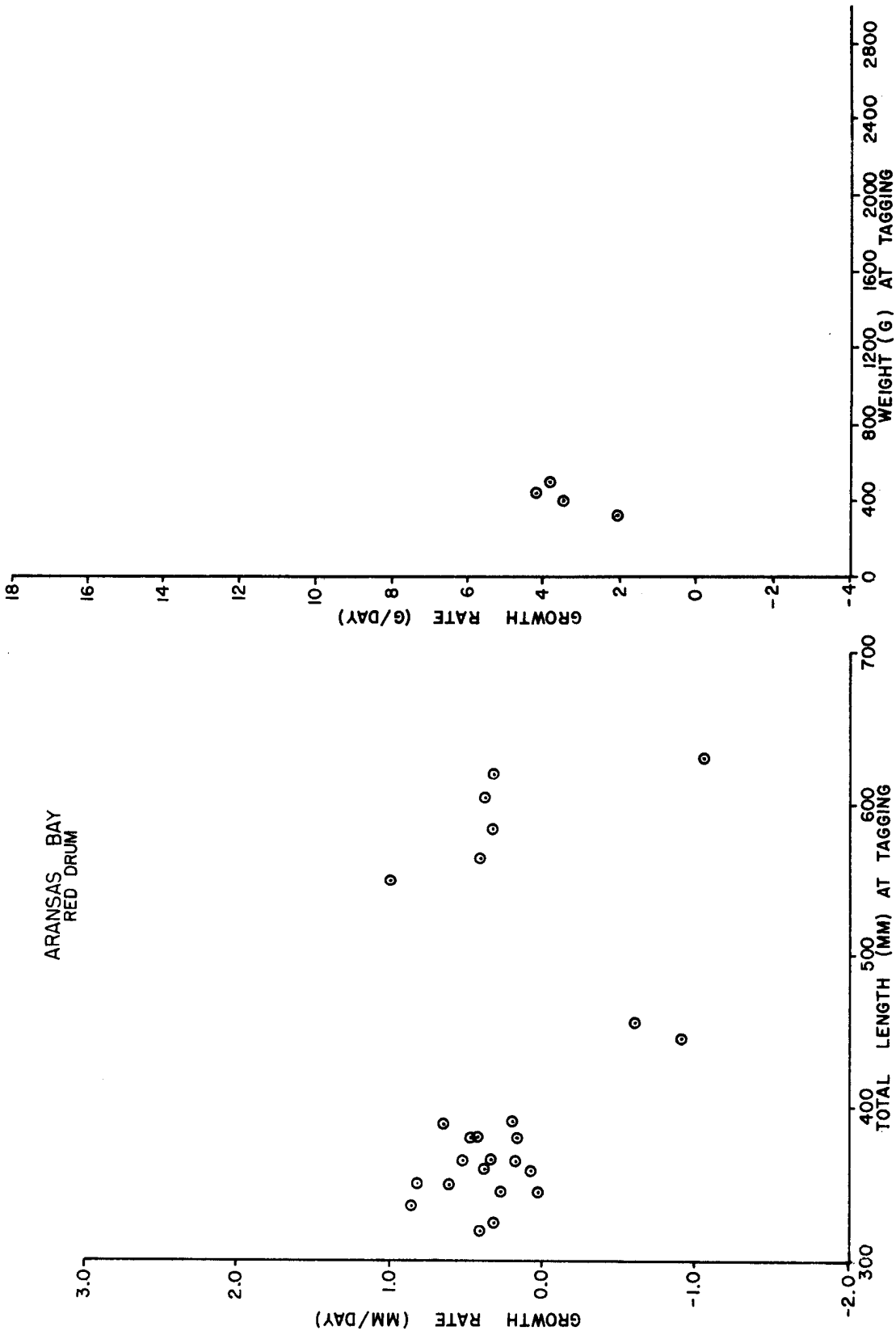


Figure 4. Relationship between size and growth rate of tagged red drum in the Aransas Bay system during November 1975 - September 1976.

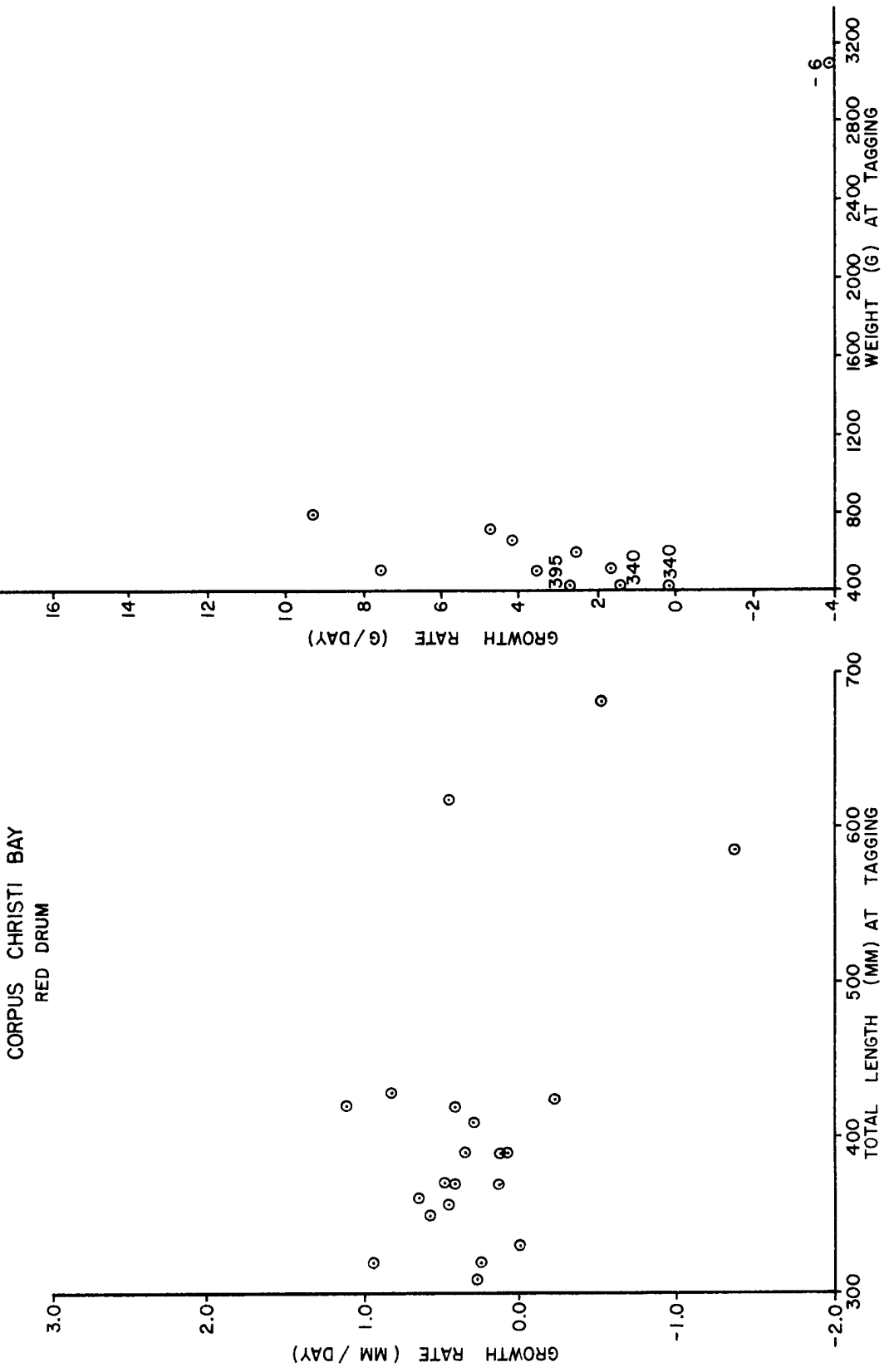


Figure 5. Relationship between size and growth rate of tagged red drum in the Corpus Christi Bay system during November 1975 - September 1976.

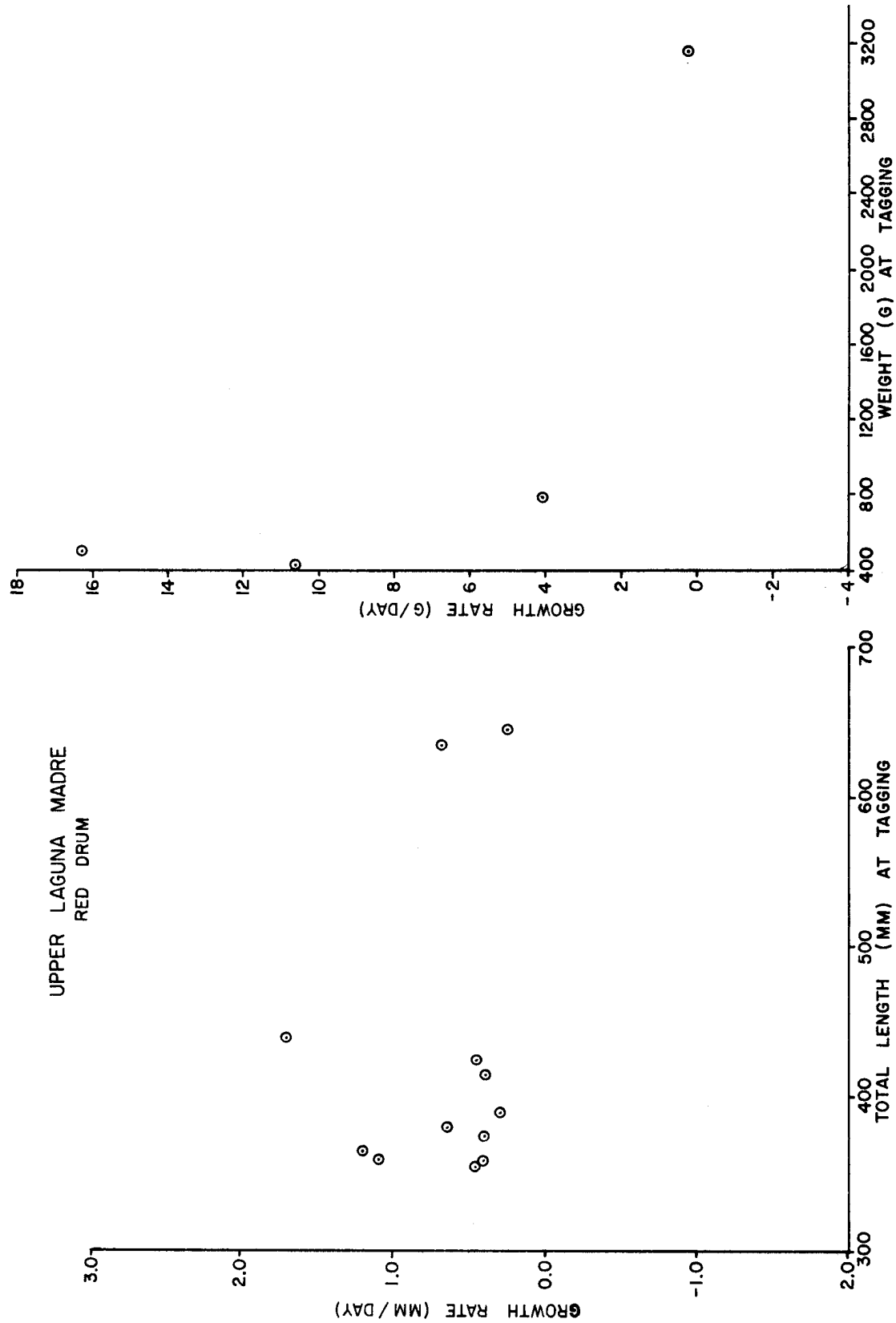


Figure 6. Relationship between size and growth rate of tagged red drum in the upper Laguna Madre system during November 1975 - September 1976.

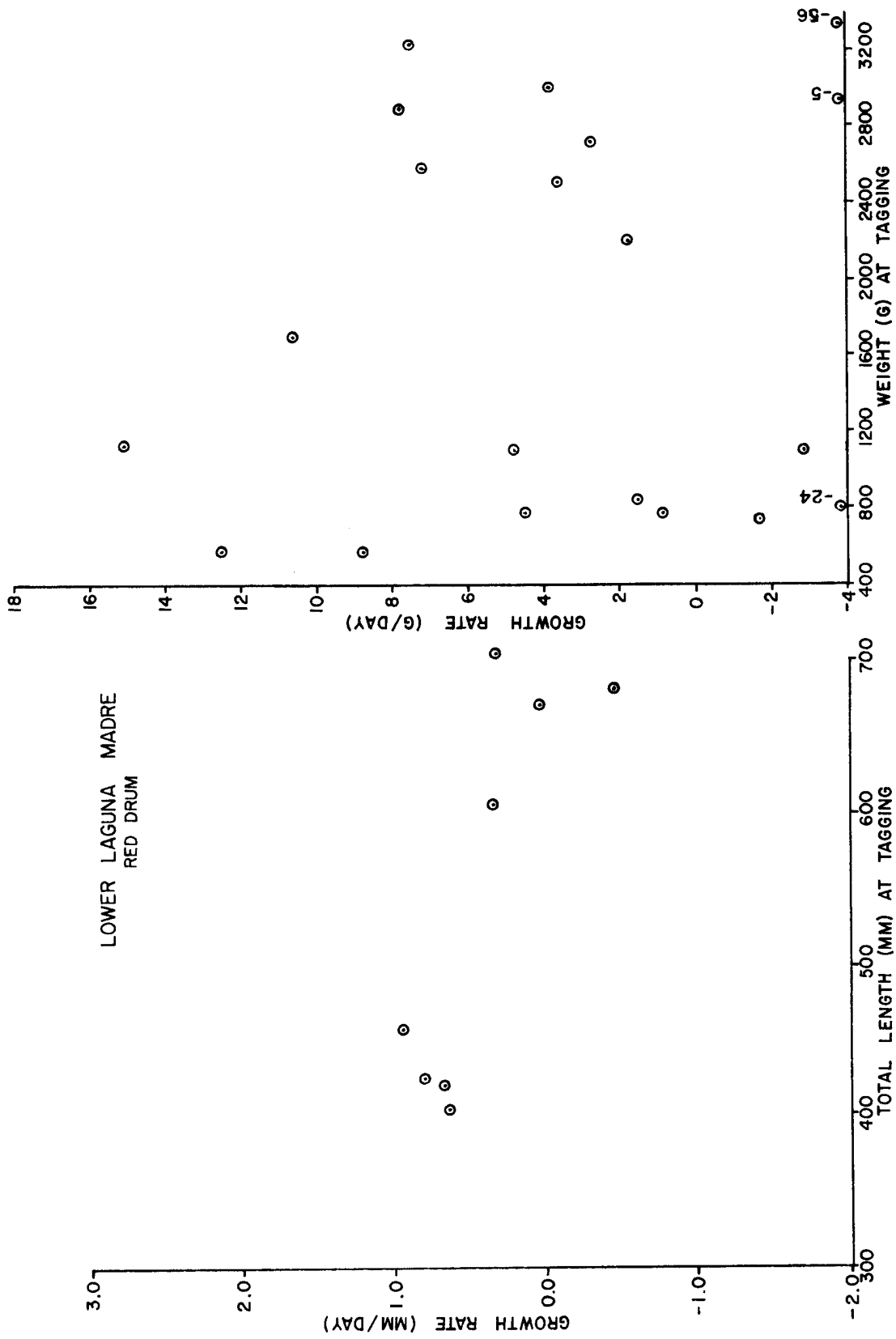


Figure 7. Relationship between size and growth rate of tagged red drum in the lower Laguna Madre system during November 1975 - September 1976.

APPENDIX K Effect of Reporting Rate (Percentage of Recapture Rate) on Fishing Mortality (Percentage of Population) Estimate of Red Drum By Sport and Commercial Fishermen in Each Bay System for November 1975 - September 1976

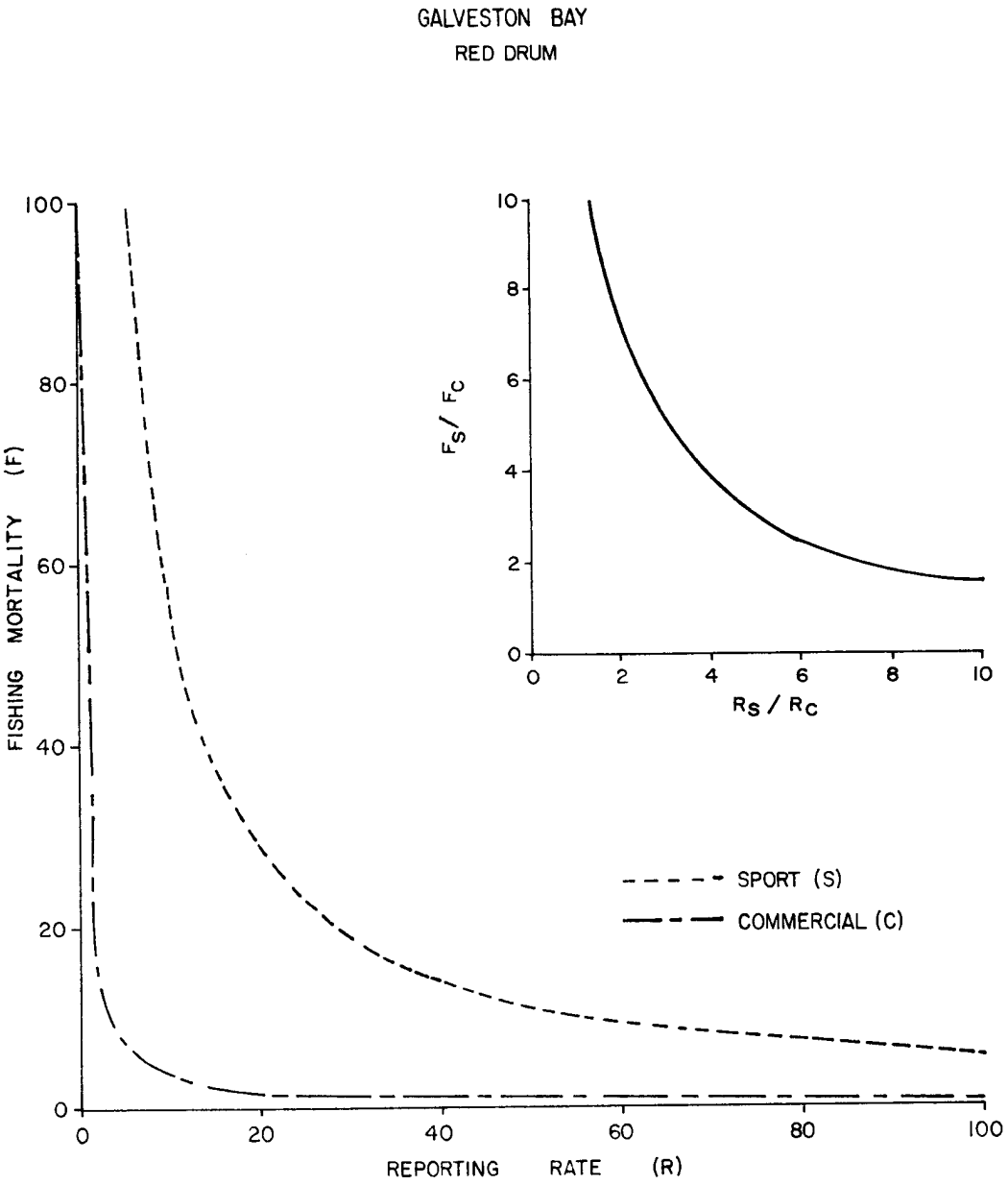


Figure 1. Effect of reporting rate (percentage of recapture rate) on fishing mortality (percentage of population) estimate of red drum by sport and commercial fishermen in the Galveston Bay system for November 1975 - September 1976.

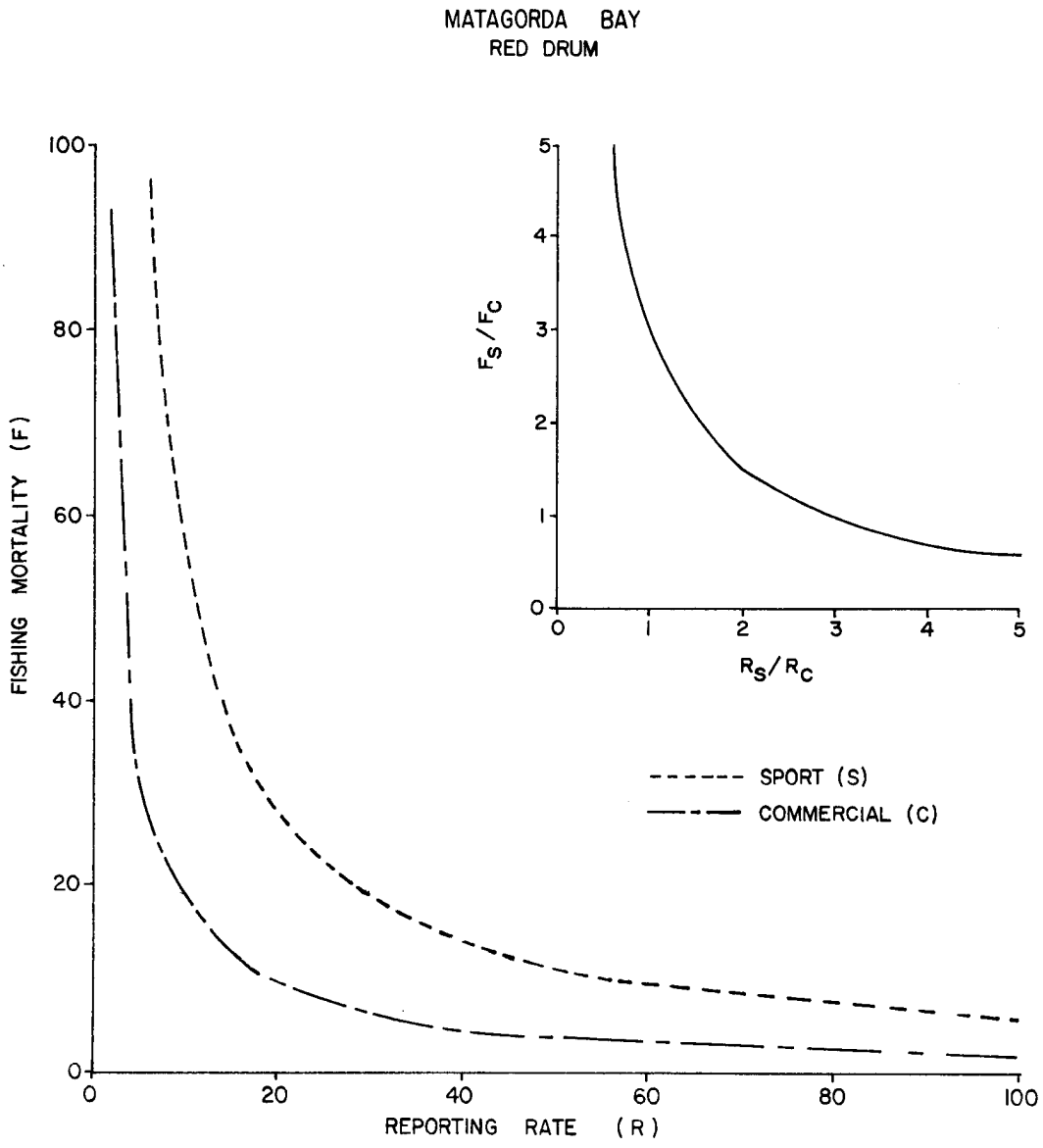


Figure 2. Effect of reporting rate (percentage of recapture rate) on fishing mortality (percentage of population) estimate of red drum by sport and commercial fishermen in the Matagorda Bay system for November 1975 - September 1976.

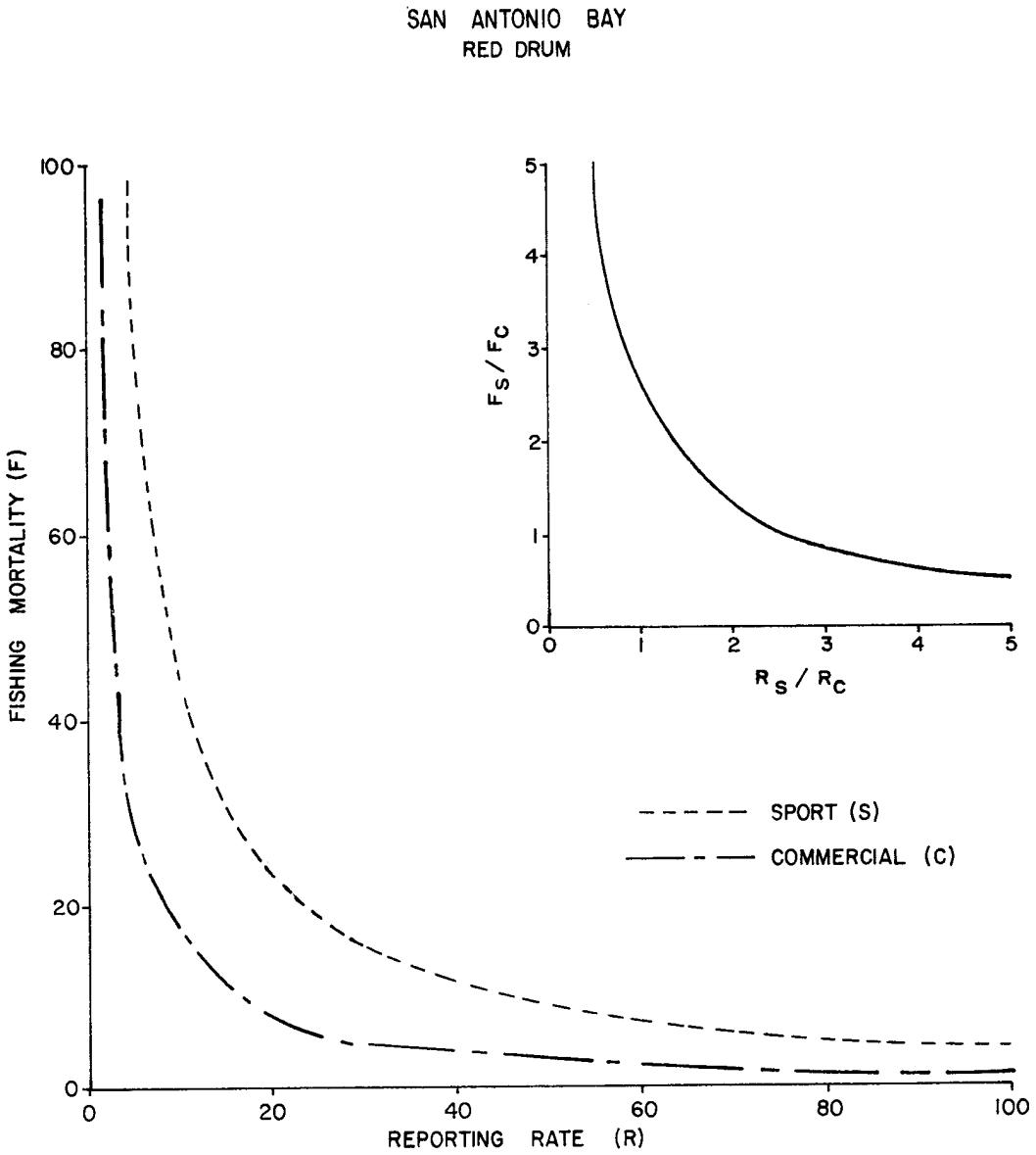


Figure 3. Effect of reporting rate (percentage of recapture rate) on fishing mortality (percentage of population) estimate of red drum by sport and commercial fishermen in the San Antonio Bay system for November 1975 - September 1976.

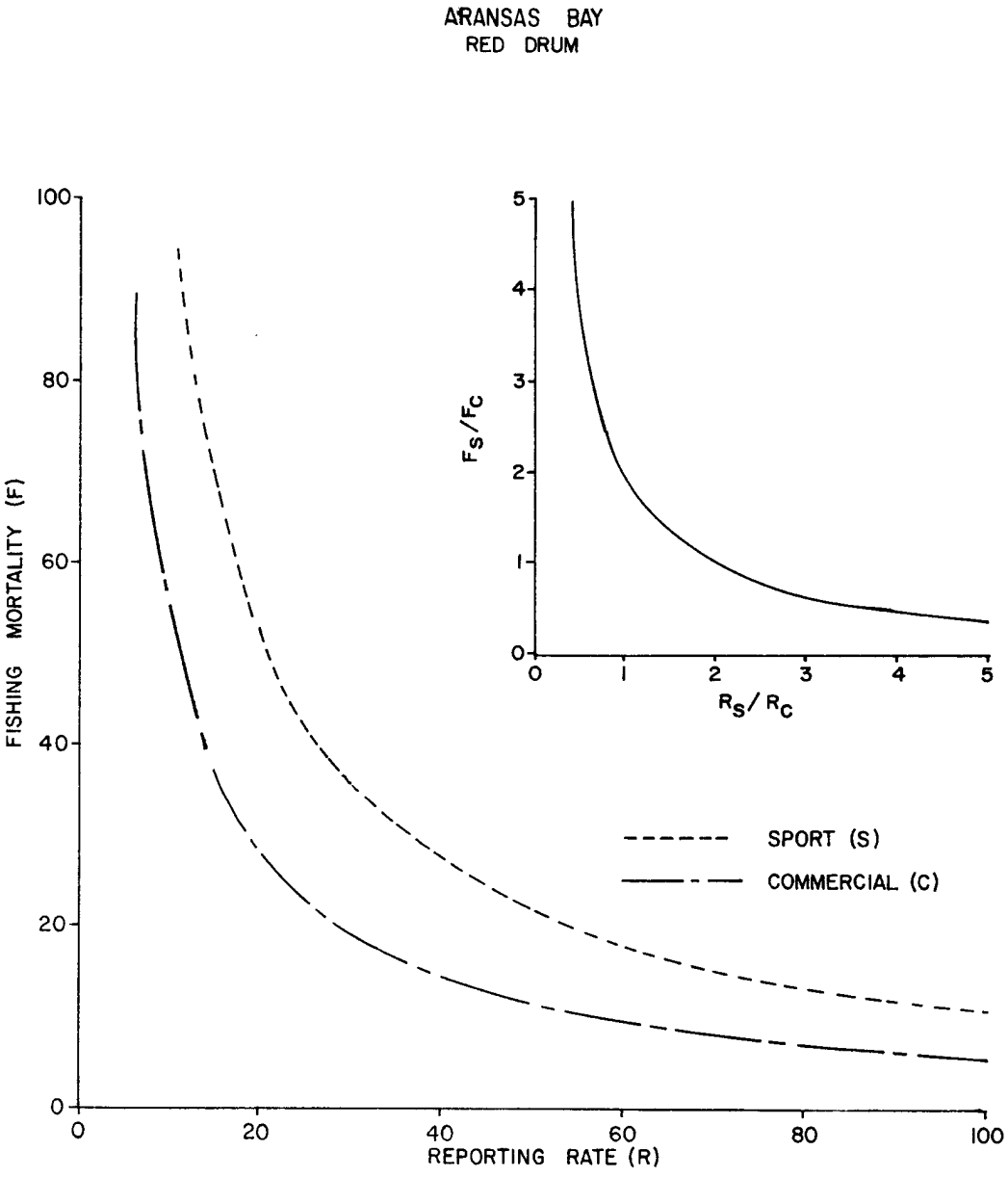


Figure 4. Effect of reporting rate (percentage of recapture rate) on fishing mortality (percentage of population) estimate of red drum by sport and commercial fishermen in the Aransas Bay system for November 1975 - September 1976.

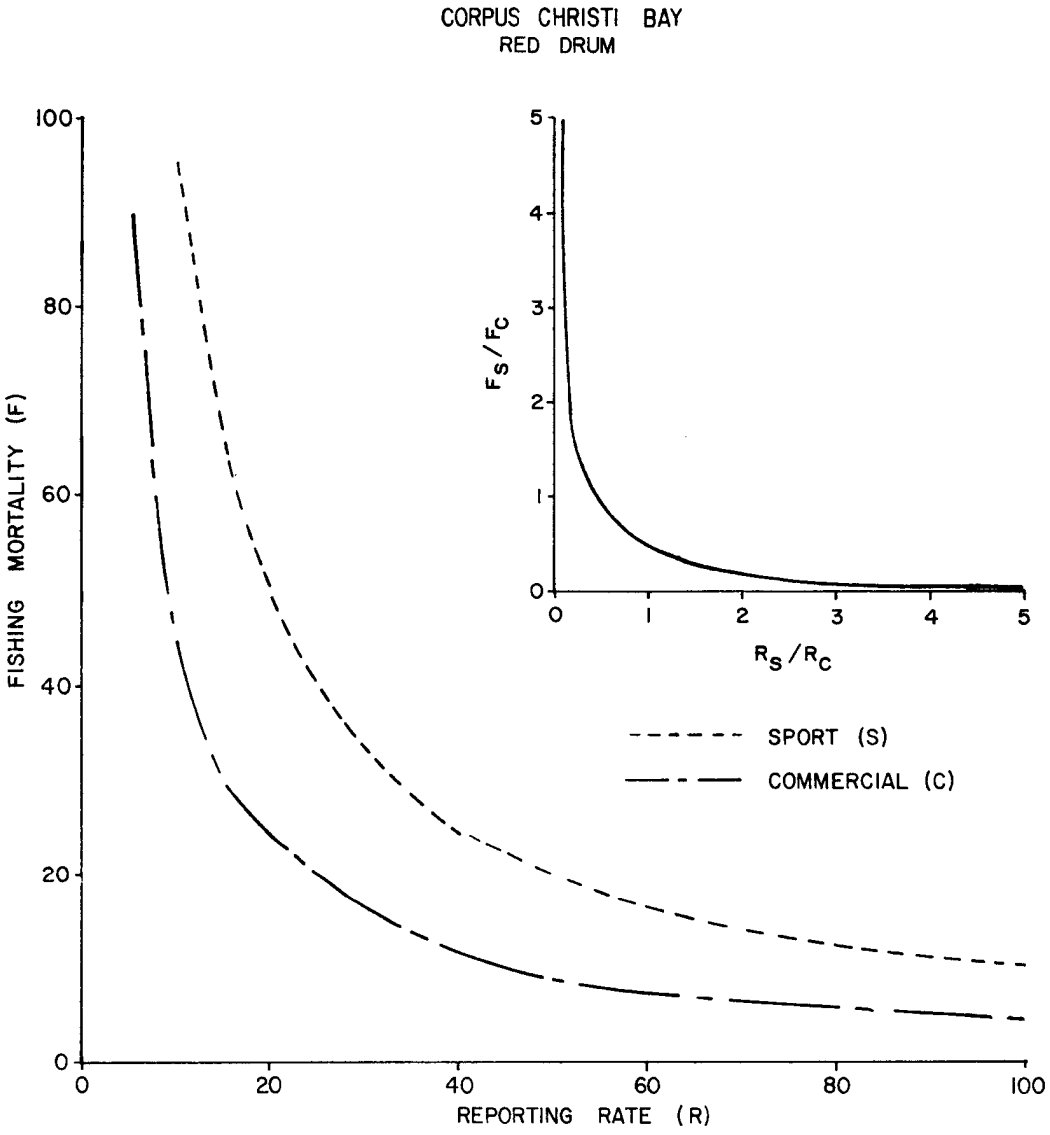


Figure 5. Effect of reporting rate (percentage of recapture rate) on fishing mortality (percentage of population) estimate of red drum by sport and commercial fishermen in the Corpus Christi Bay system for November 1975 - September 1976.

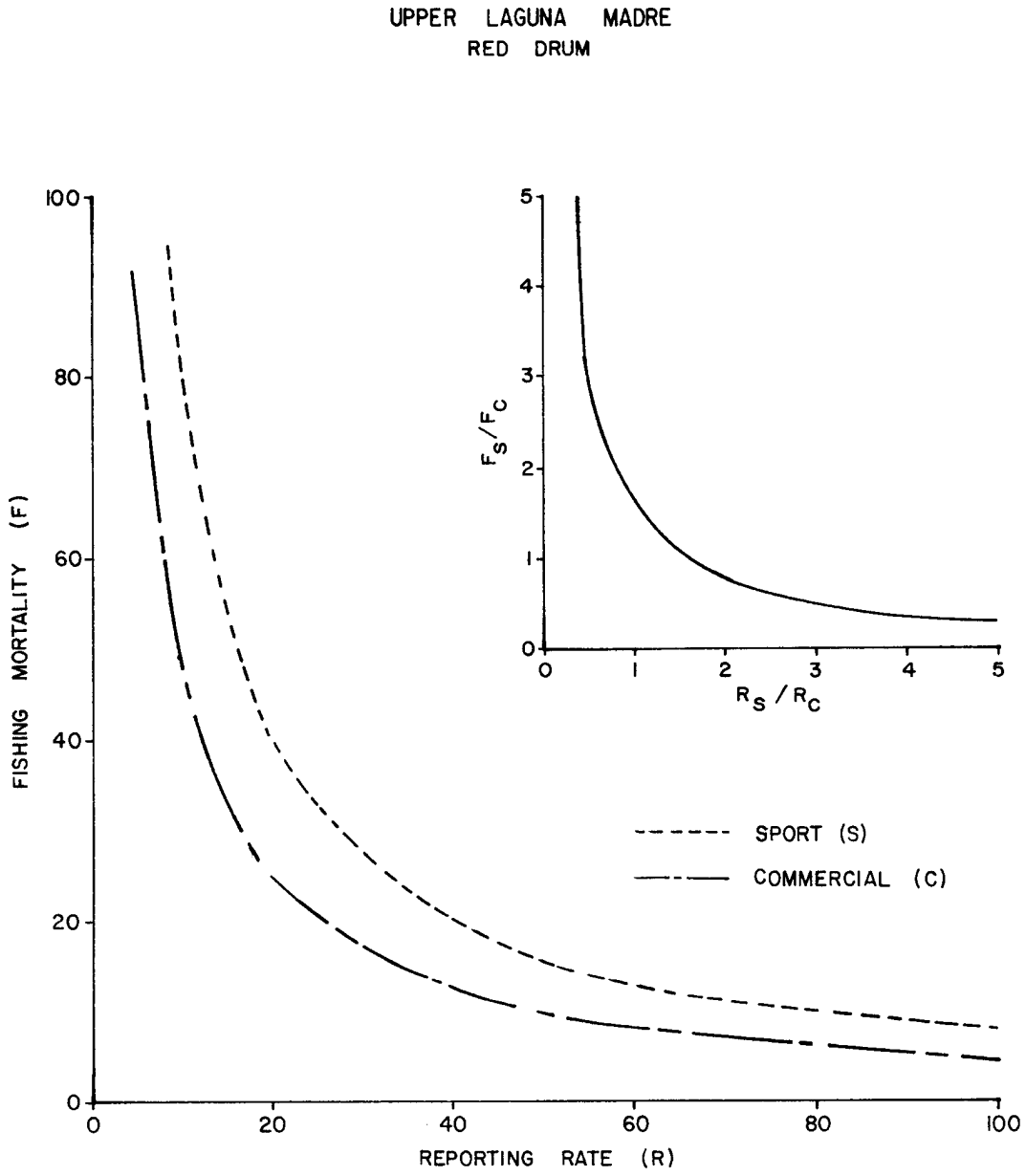


Figure 6. Effect of reporting rate (percentage of recapture rate) on fishing mortality (percentage of population) estimate of red drum by sport and commercial fishermen in the upper Laguna Madre for November 1975 - September 1976.

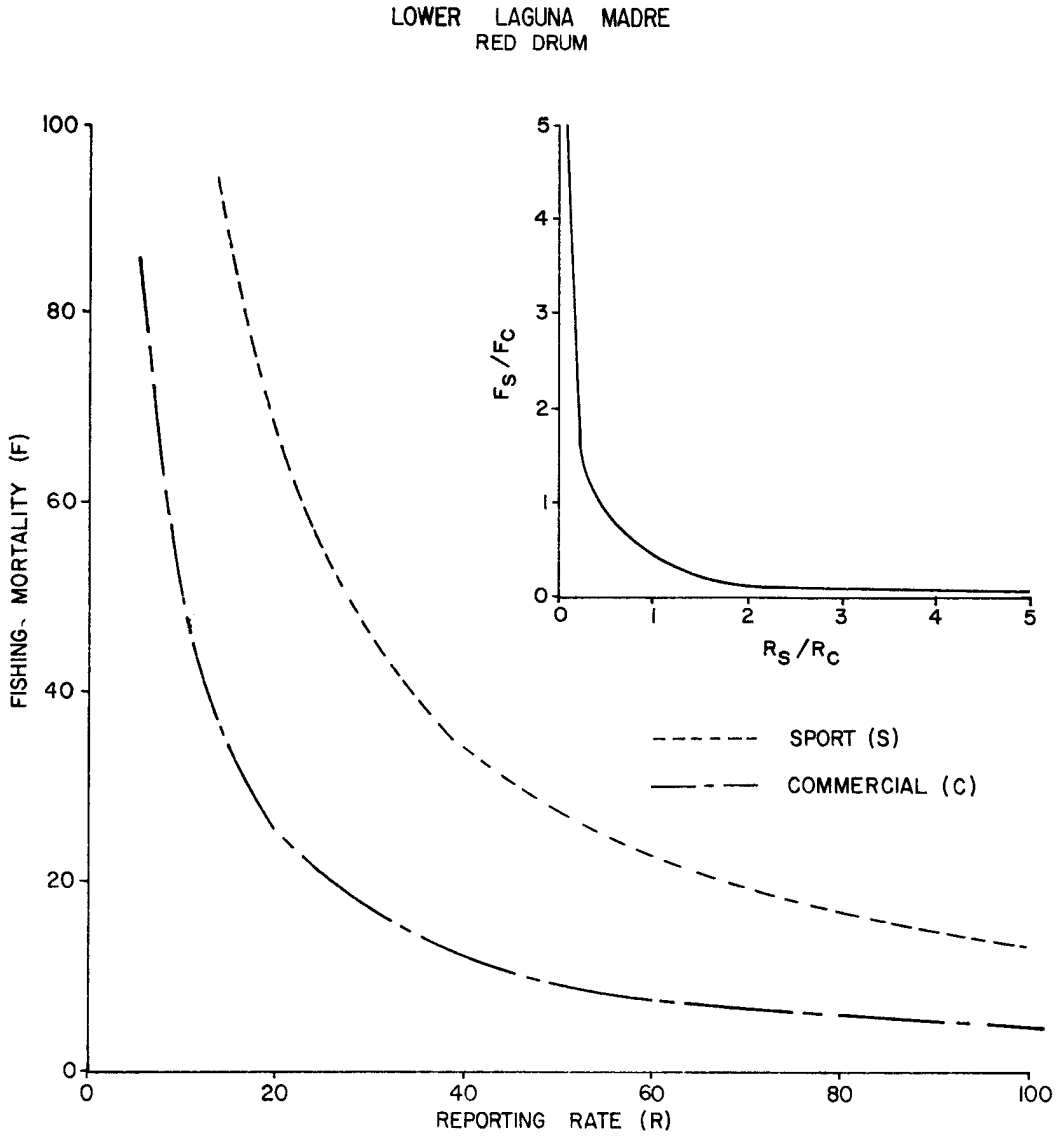


Figure 7. Effect of reporting rate (percentage of recapture rate) on fishing mortality (percentage of population) estimate of red drum by sport and commercial fishermen in the lower Laguna Madre system for November 1975 - September 1976.

APPENDIX L Estimates of Red Drum Abundance in Each Bay System Using Reporting Rates and Harvest by Sport Fishermen

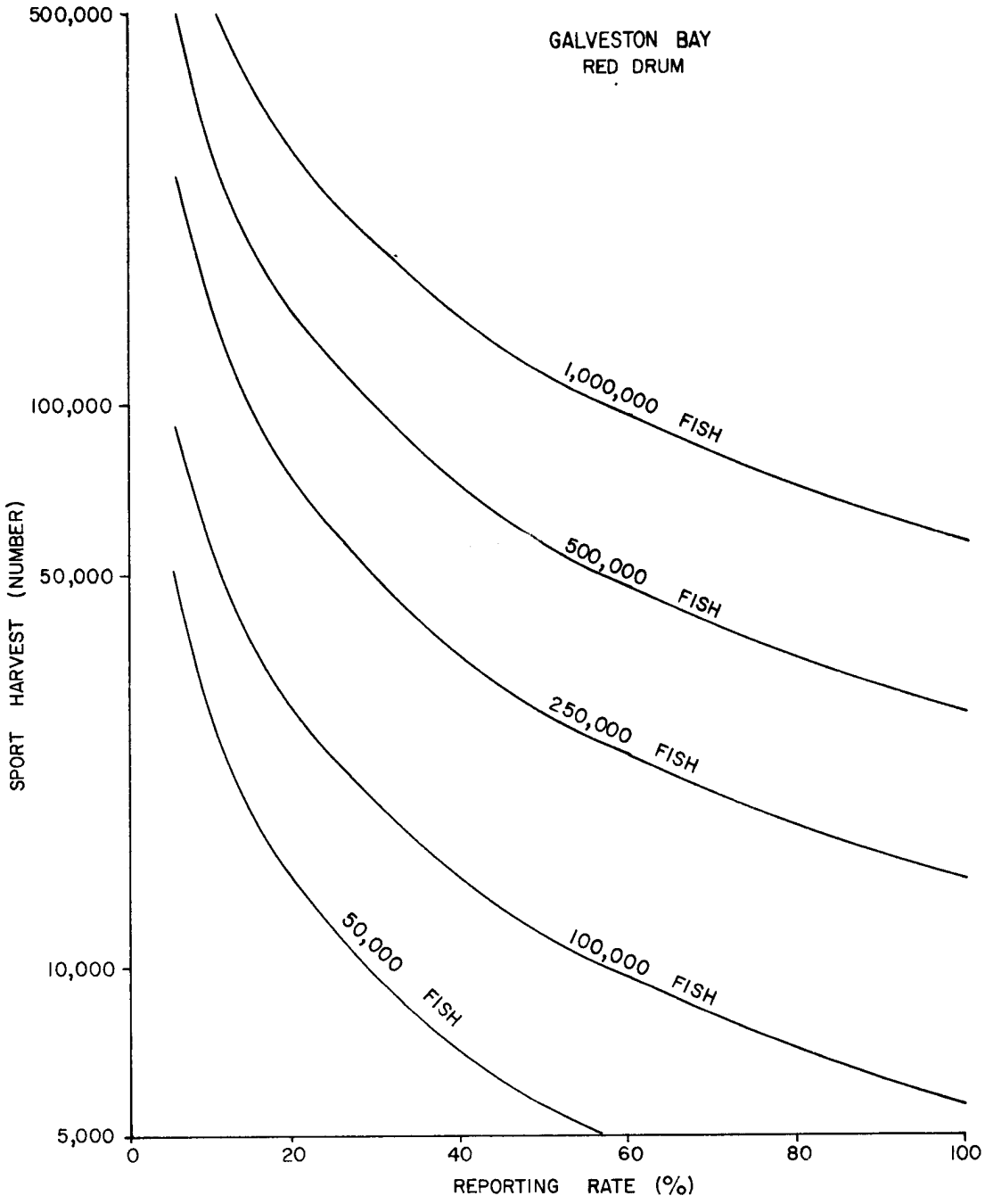


Figure 1. Estimates of red drum abundance in the Galveston Bay system using reporting rates and harvest by sport fishermen.

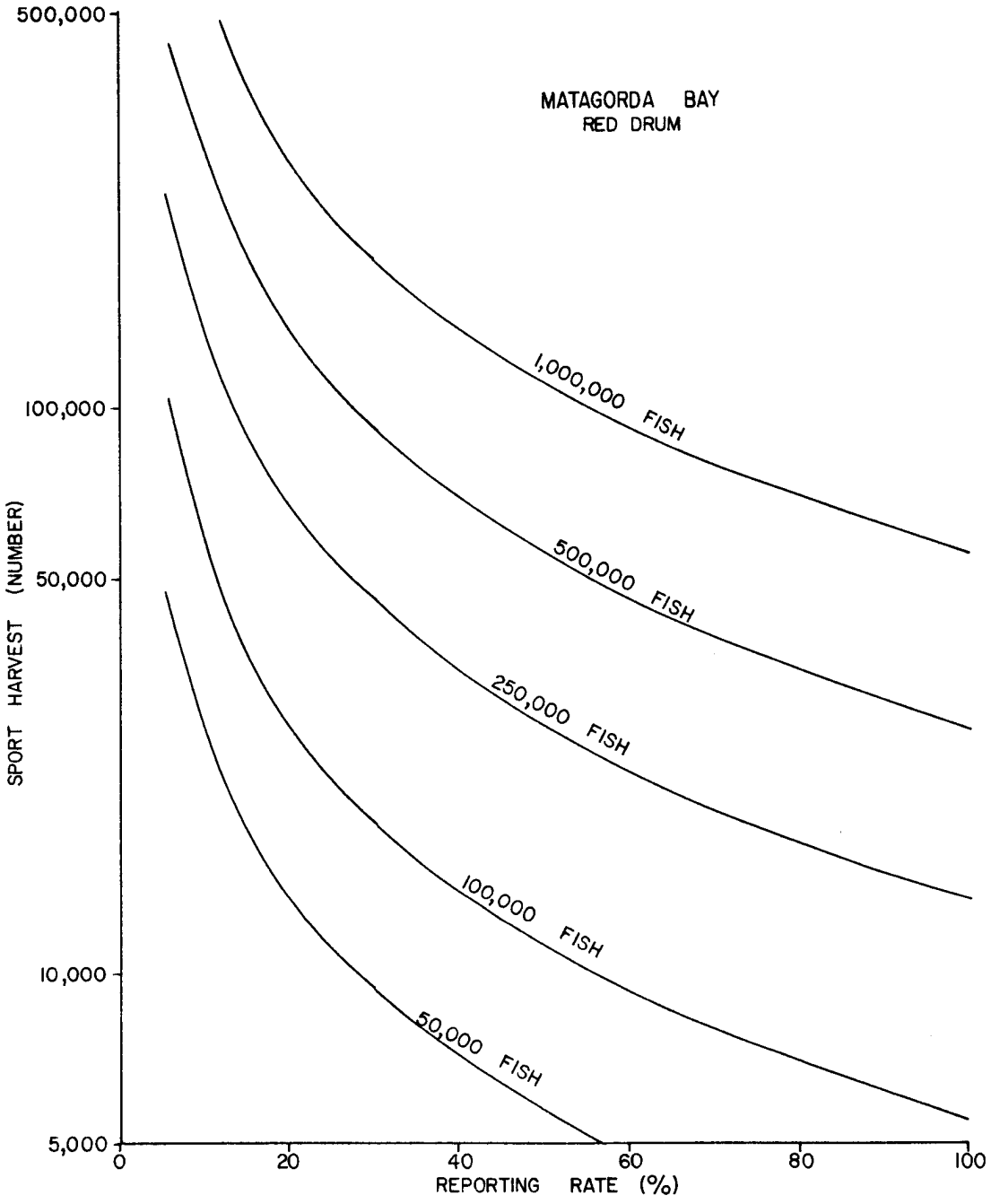


Figure 2. Estimates of red drum abundance in the Matagorda Bay system using reporting rates and harvest by sport fishermen.

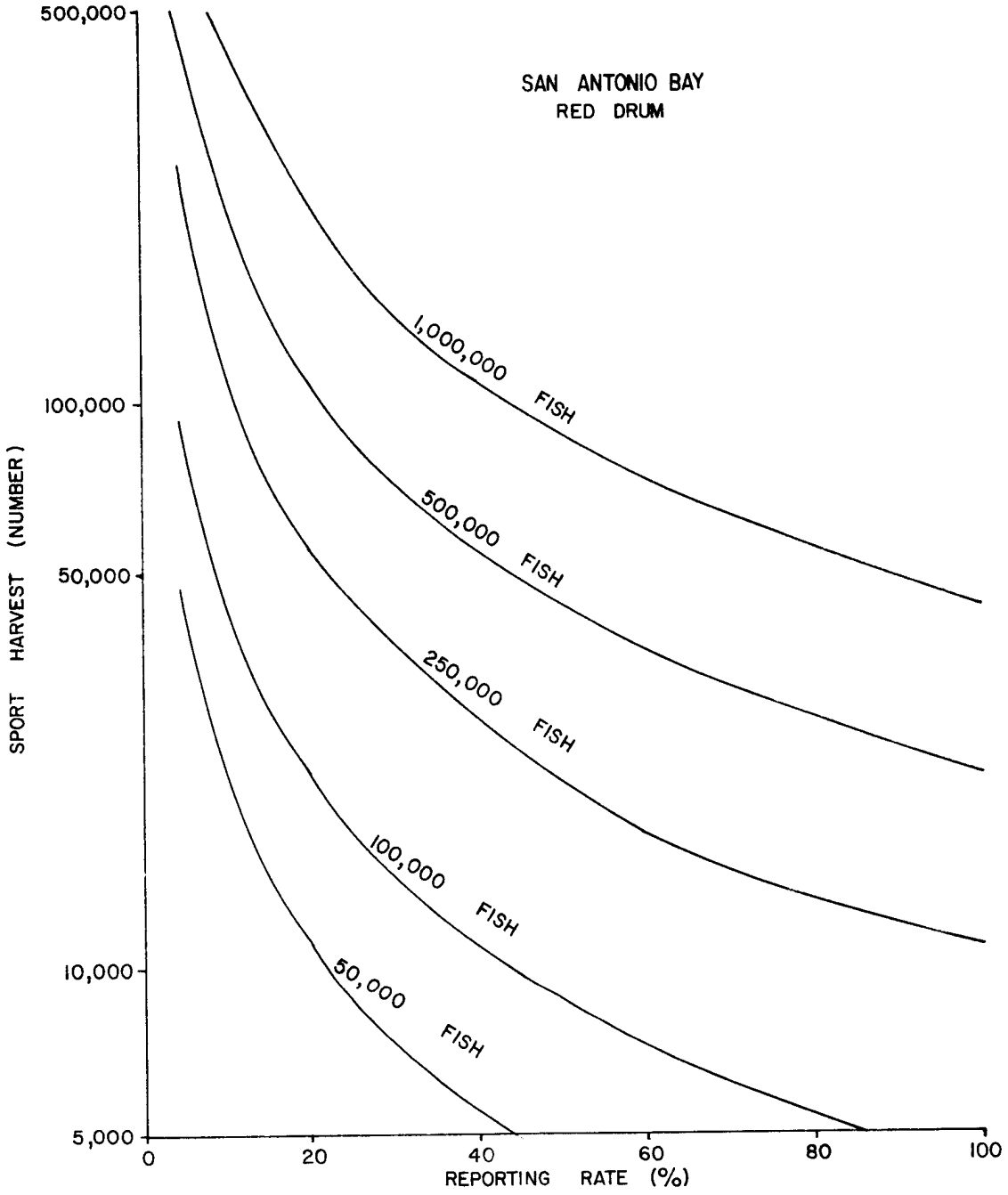


Figure 3. Estimates of red drum abundance in the San Antonio Bay system using reporting rates and harvest by sport fishermen.

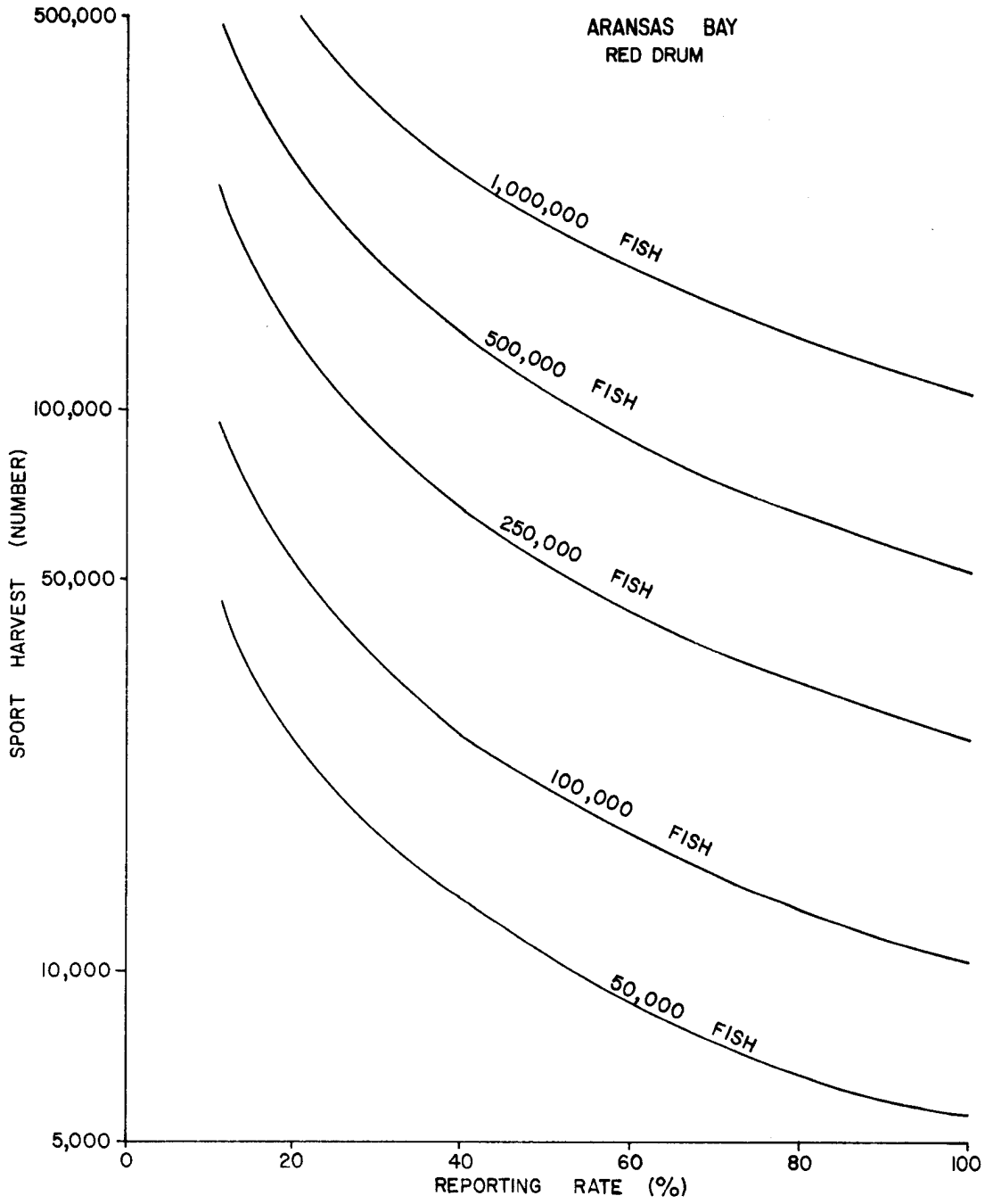


Figure 4. Estimates of red drum abundance in the Aransas Bay system using reporting rates and harvest by sport fishermen.

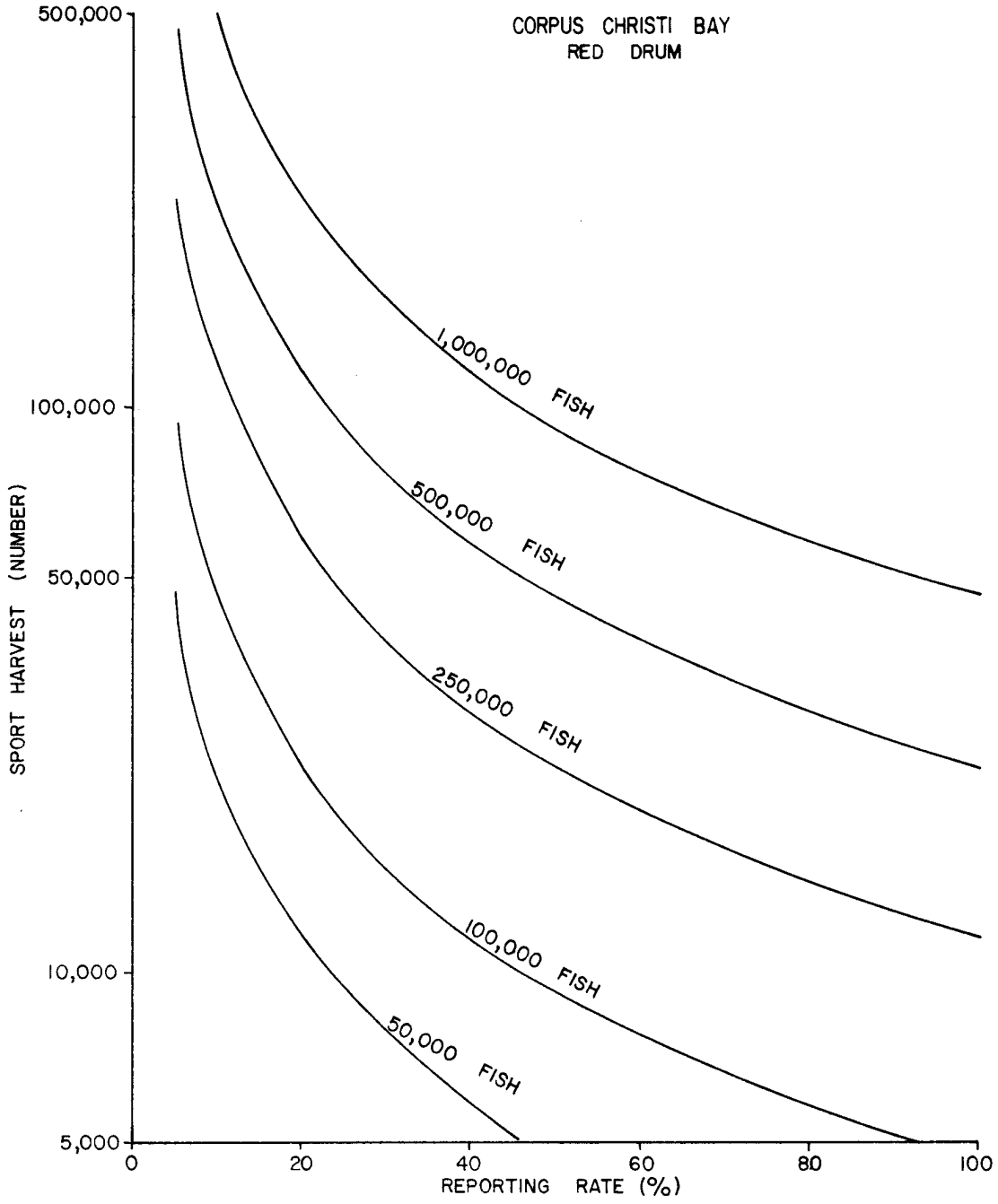


Figure 5. Estimates of red drum abundance in the Corpus Christi Bay system using reporting rates and harvest by sport fishermen.

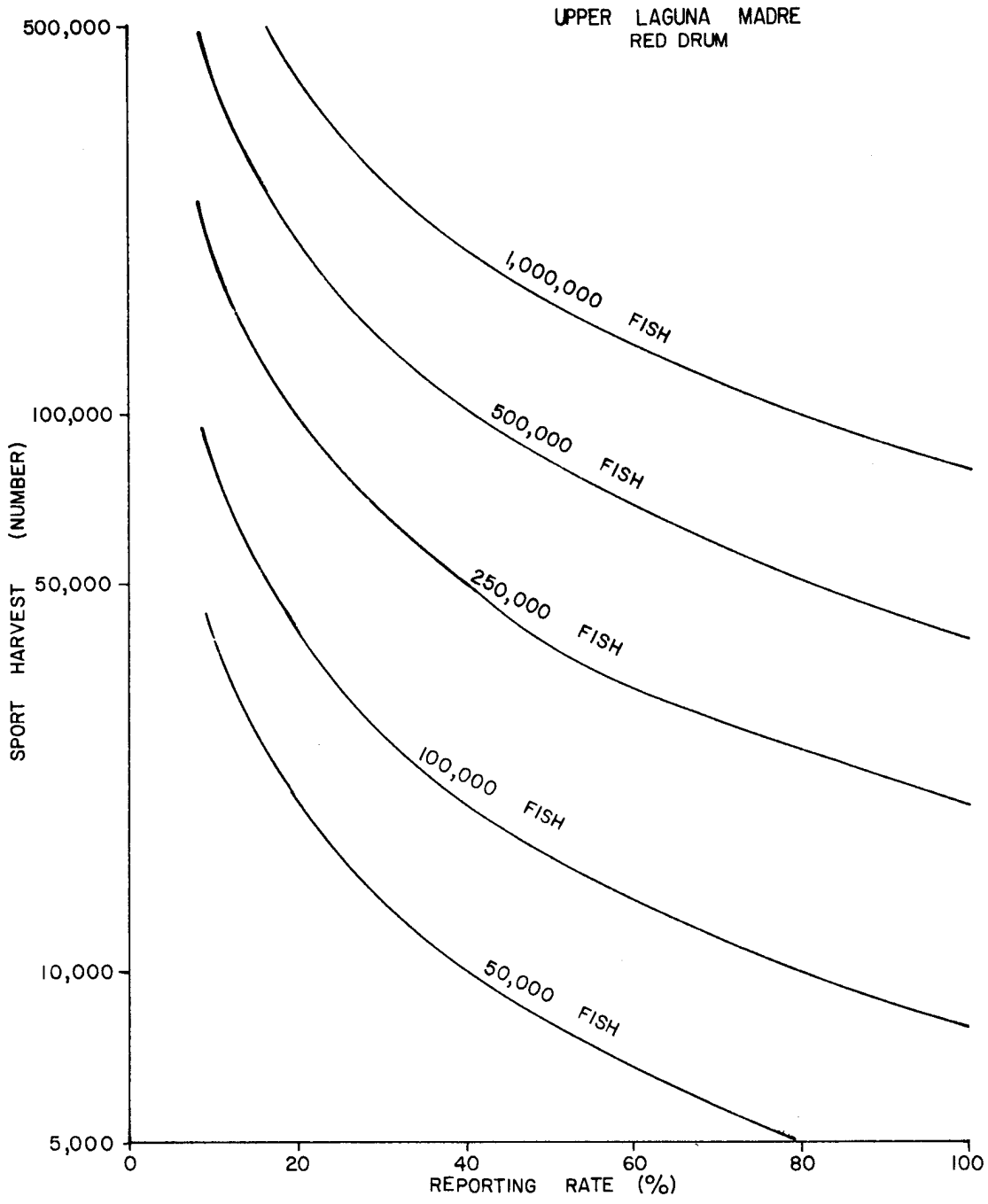


Figure 6. Estimates of red drum abundance in the upper Laguna Madre system using reporting rates and harvest by sport fishermen.

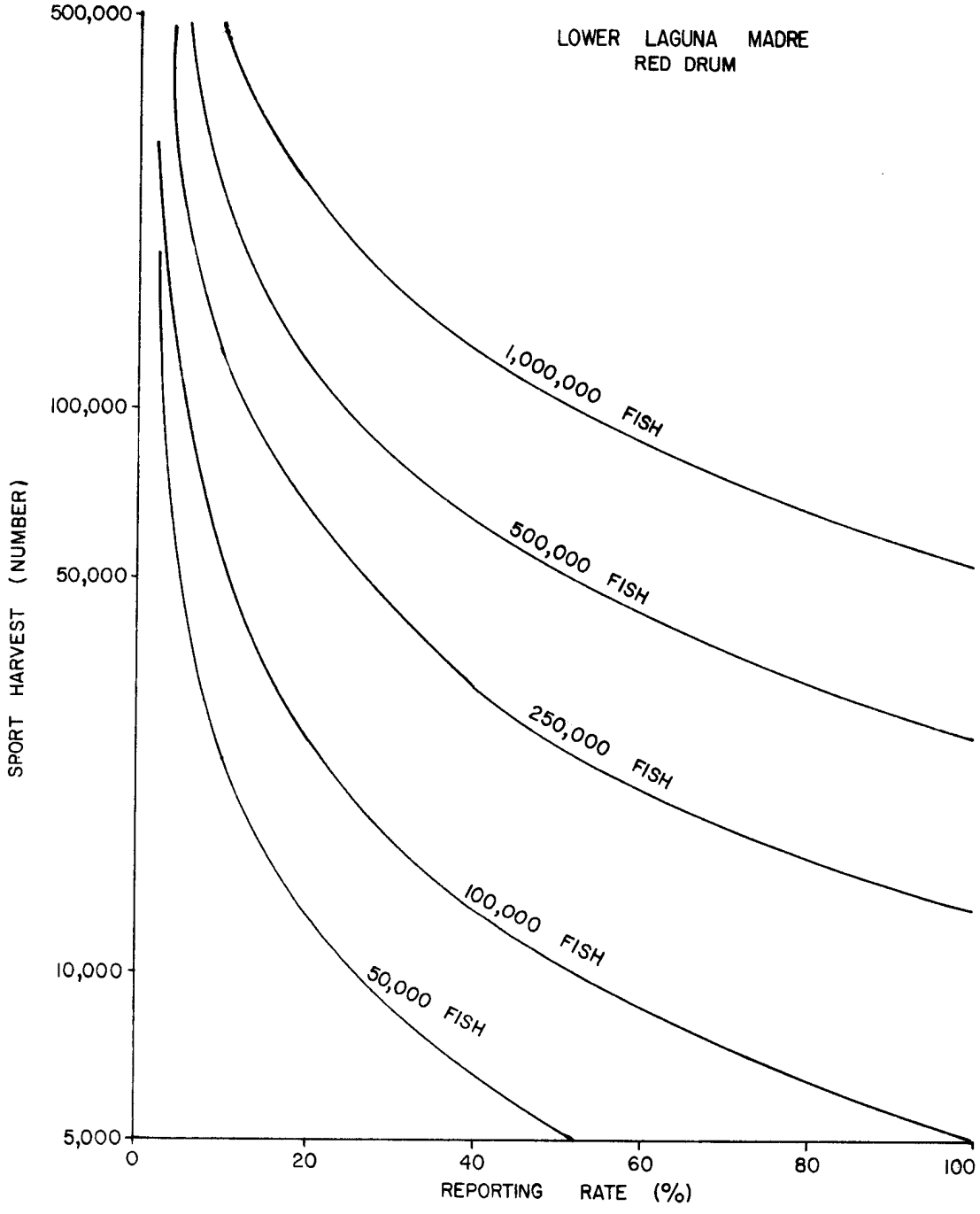


Figure 7. Estimates of red drum abundance in the lower Laguna Madre system using reporting rates and harvest by sport fishermen.

APPENDIX M Effects of Reporting Rate (Percentage of Recapture Rate) on Fishing Mortality (Percentage of Population) Estimate of Selected Fishes by Sport and Commercial Fishermen in Selected Bays for November 1975 - September 1976 and the Estimate of Selected Fish Abundance in Selected Bays Using Reporting Rates and Harvest by Sport Fishermen

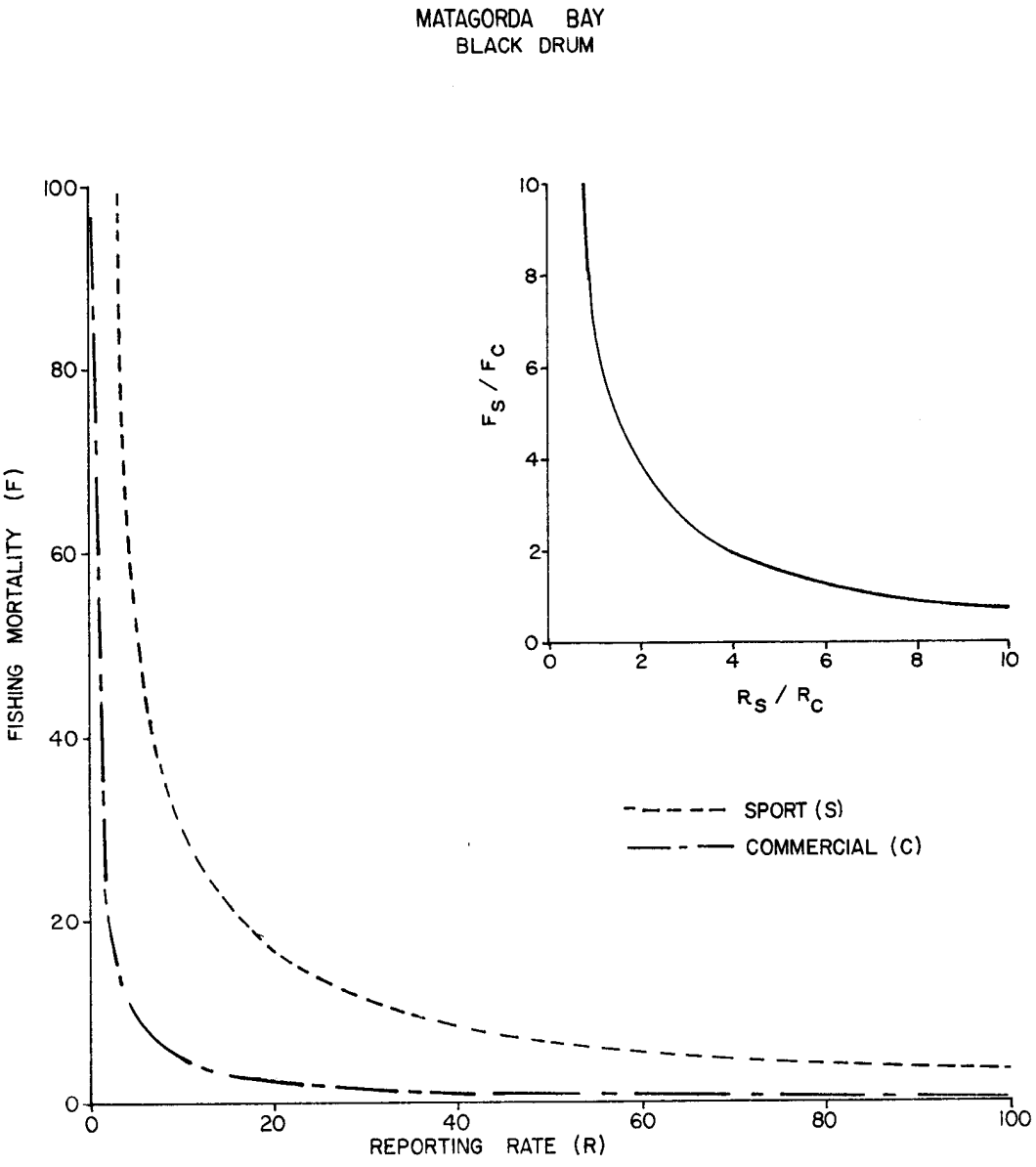


Figure 1. Effect of reporting rate (percentage of recapture rate) on fishing mortality (percentage of population) estimate of black drum by sport and commercial fishermen in the Matagorda Bay system for November 1975 - September 1976.

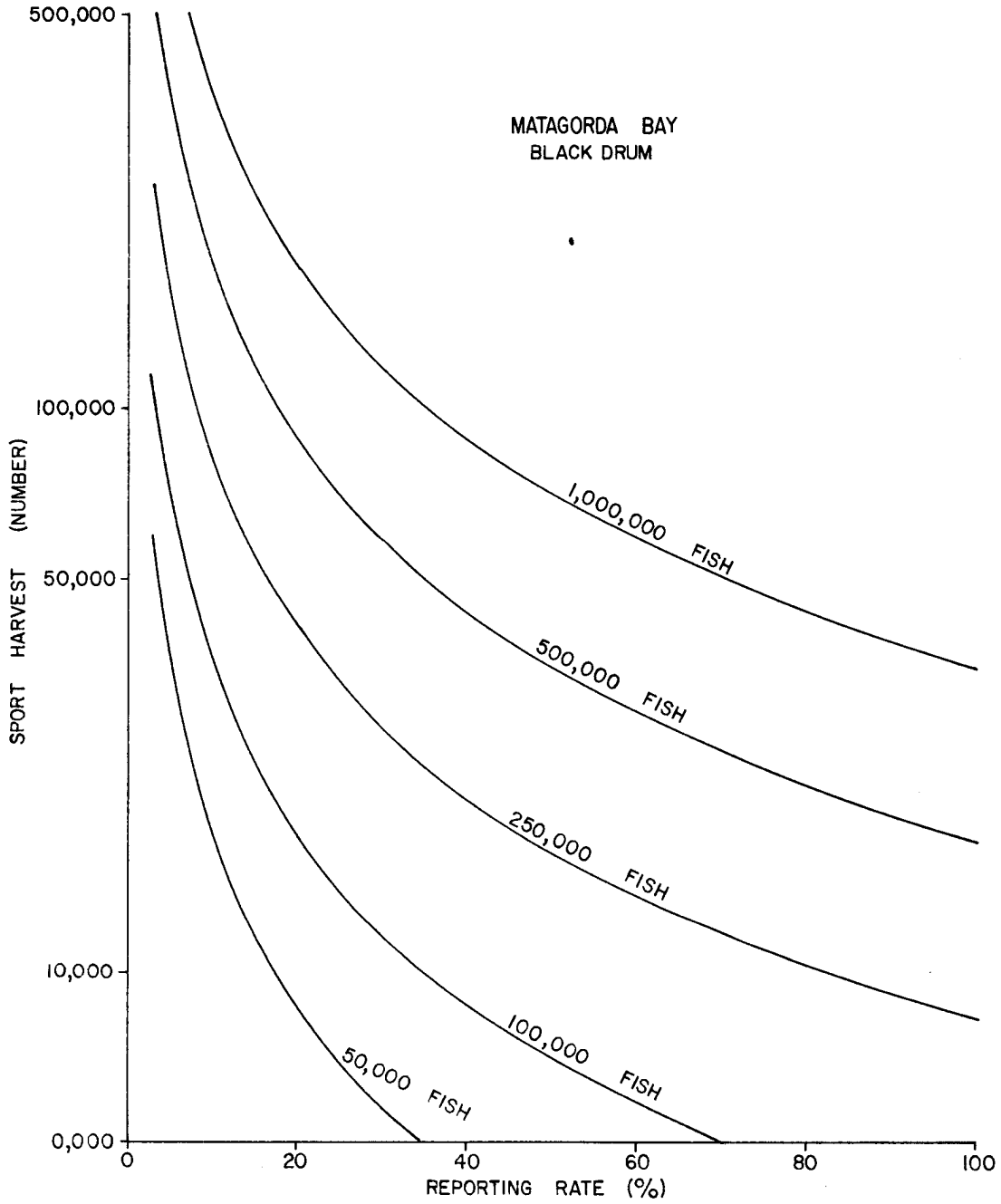


Figure 2. Estimates of black drum abundance in the Matagorda Bay system using reporting rates and harvest by sport fishermen.

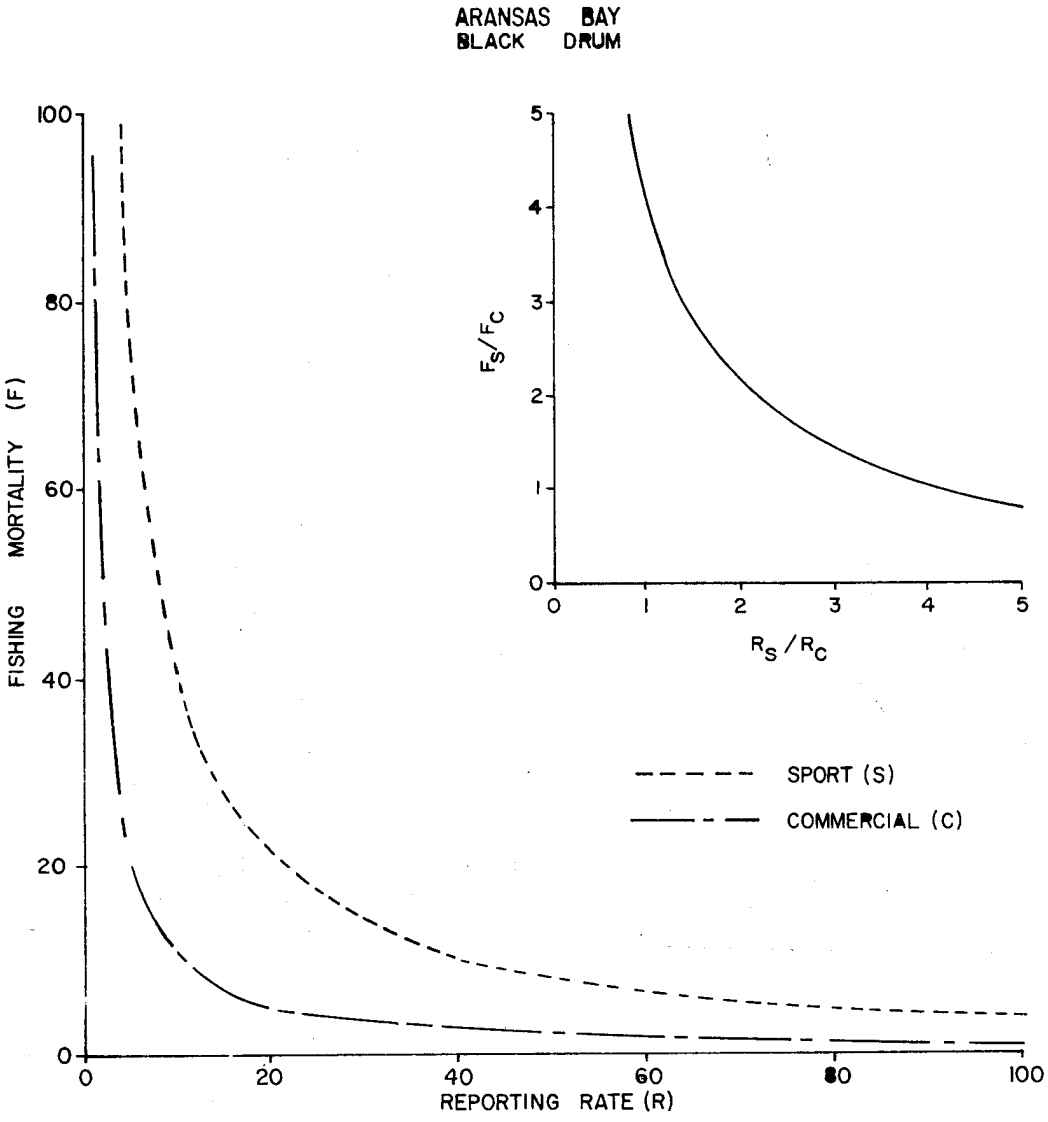


Figure 3. Effect of reporting rate (percentage of recapture rate) on fishing mortality (percentage of population) estimate of black drum by sport and commercial fishermen in the Aransas Bay system for November 1975 - September 1976.

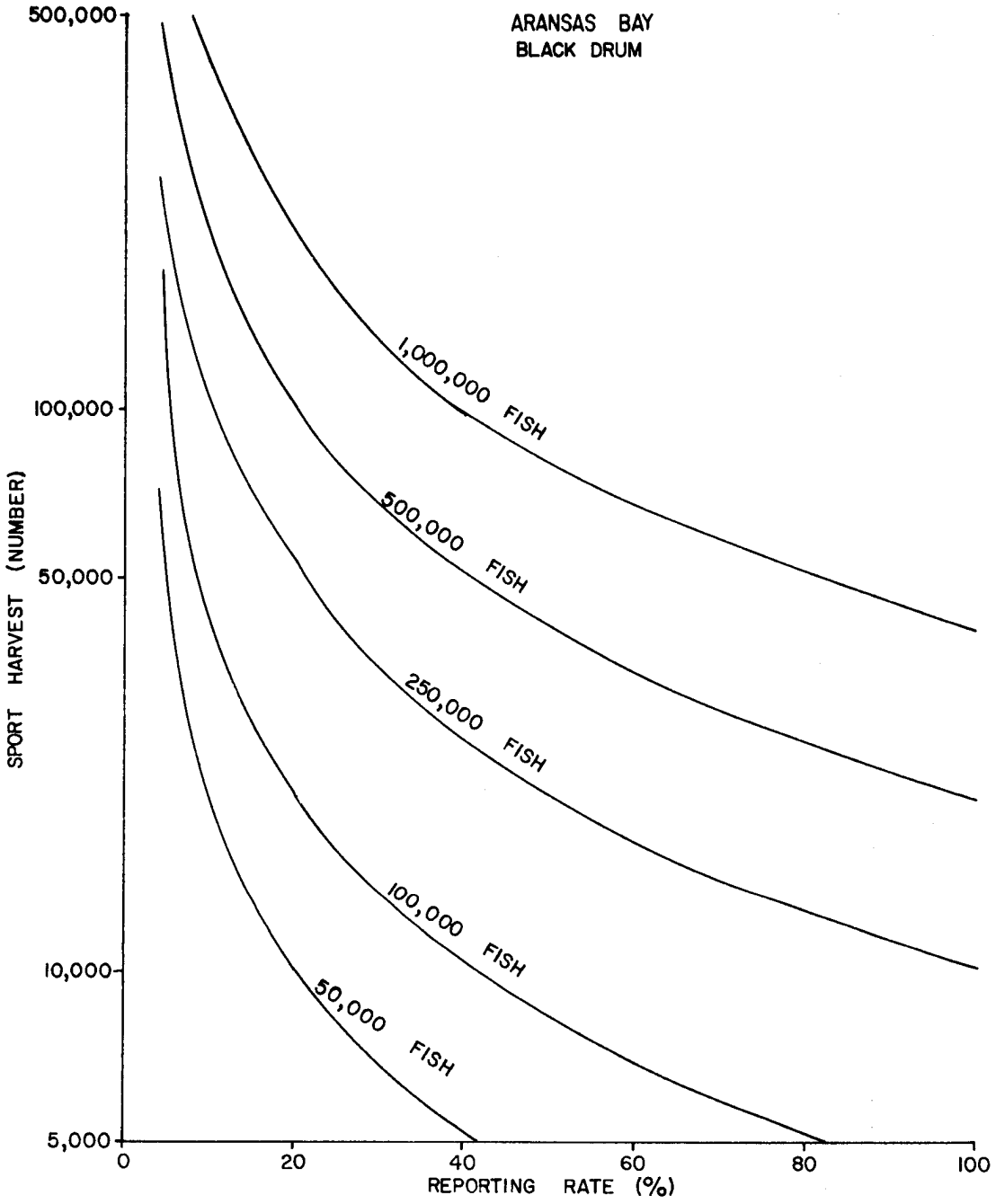


Figure 4. Estimates of black drum abundance in the Aransas Bay system using reporting rates and harvest by sport fishermen.

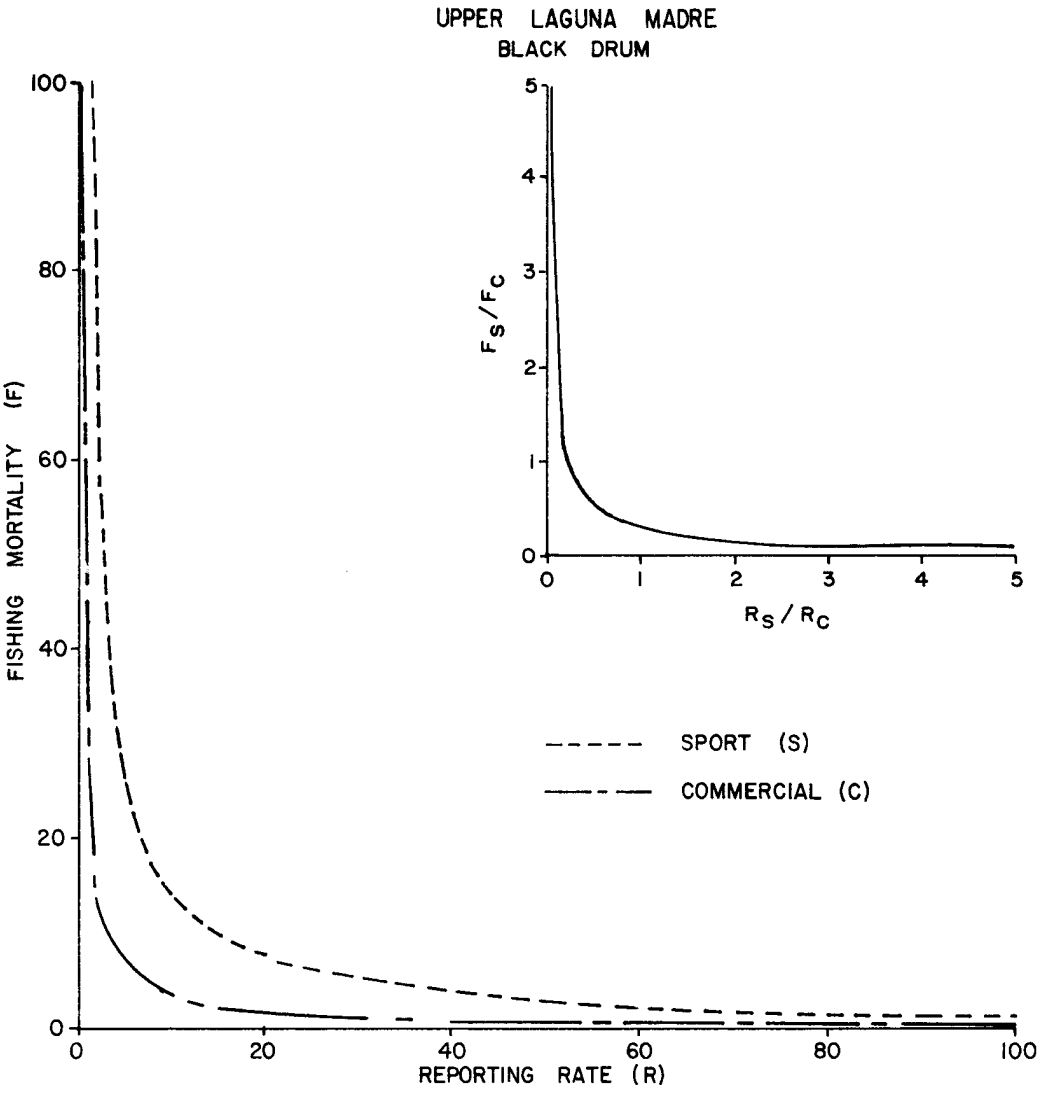


Figure 5. Effect of reporting rate (percentage of recapture rate) on fishing mortality (percentage of population) estimate of black drum by sport and commercial fishermen in the upper Laguna Madre system for November 1975 - September 1976.

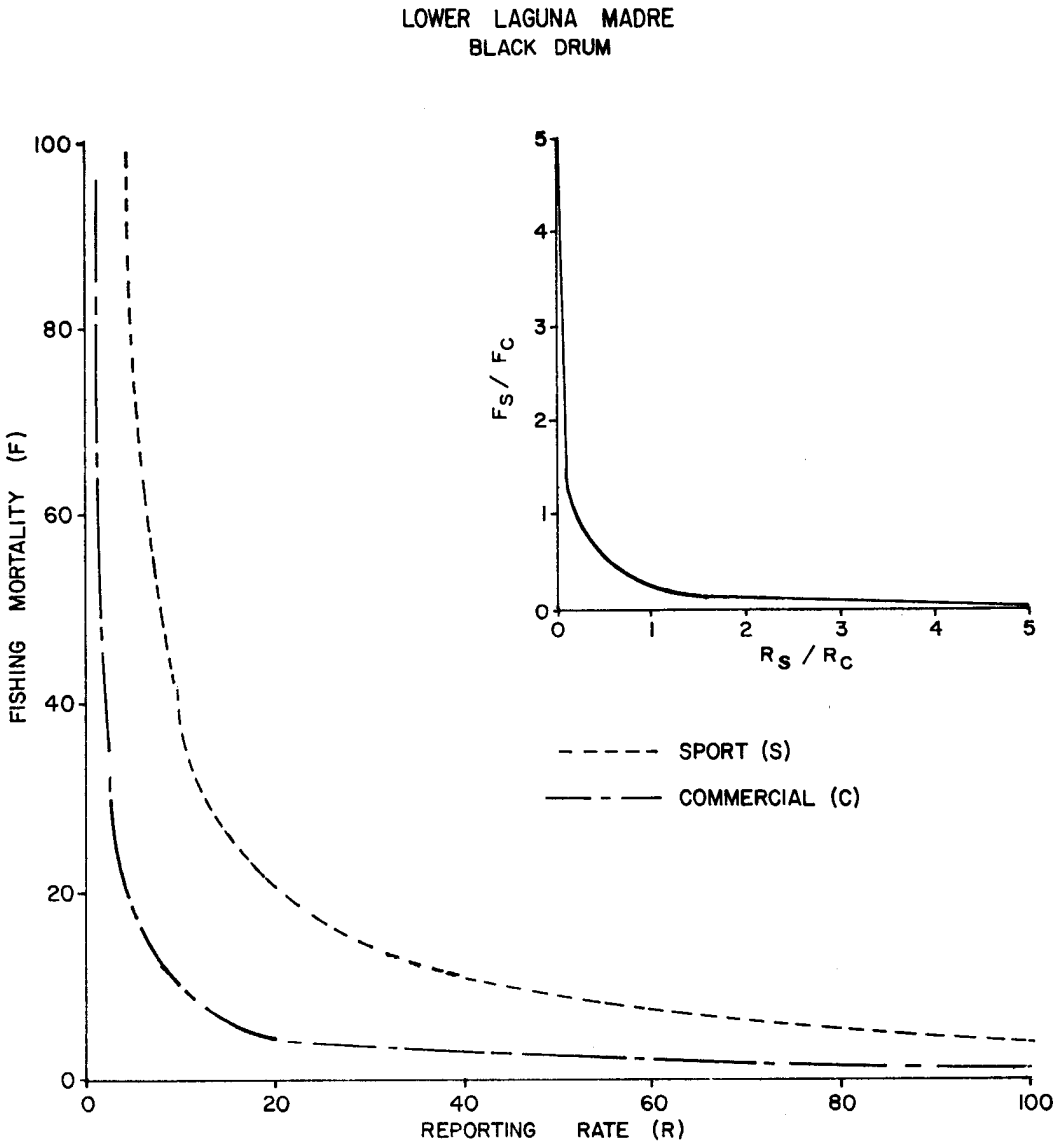


Figure 6. Effect of reporting rate (percentage of recapture rate) on fishing mortality (percentage of population) estimate of black drum by sport and commercial fishermen in the lower Laguna Madre system for November 1975 - September 1976.

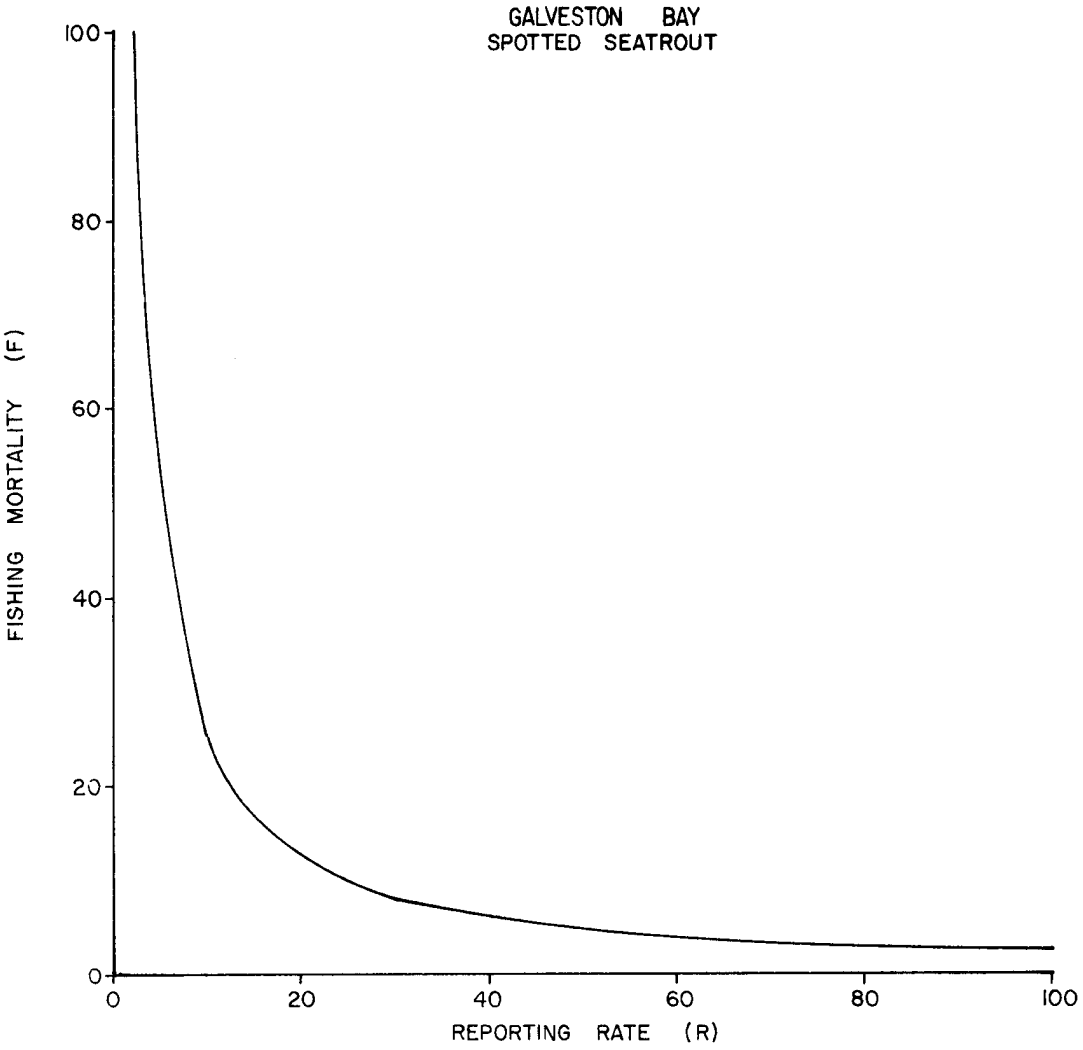


Figure 7. Effect of reporting rate (percentage of recapture rate) on fishing mortality (percentage of population) estimate of spotted seatrout by sport fishermen in the Galveston Bay system for November 1975 - September 1976.

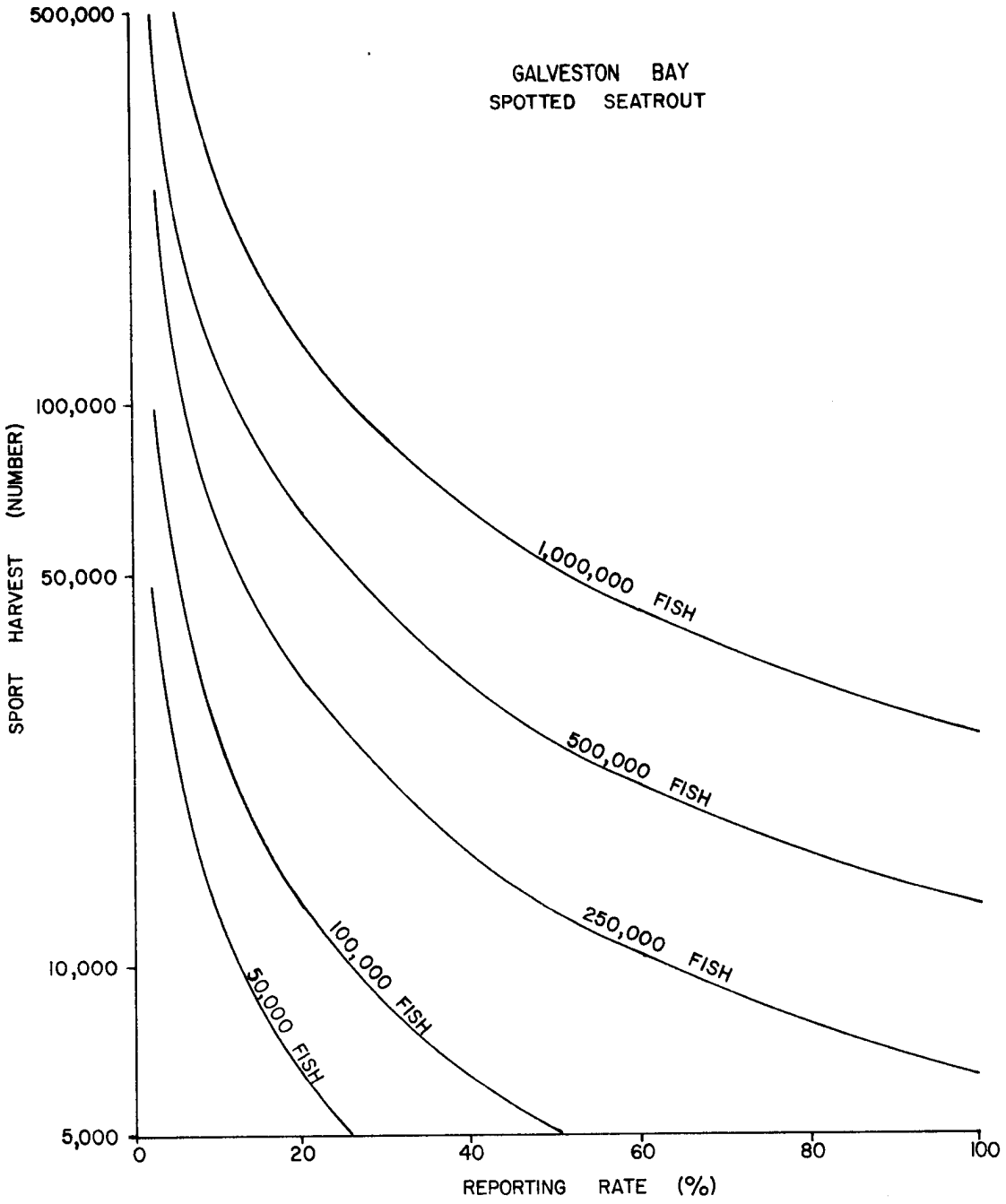


Figure 8. Estimates of spotted seatrout abundance in the Galveston Bay system using reporting rates and harvest by sport fishermen.