Job Report

E. G. Simmons
Marine Biologist

Project No. M-8-R-3 Date March 12, 1962

Project Name: Biological Survey and Developmental Experiments in the Waters of Region M-8, Upper Laguna Madre

Period Covered: August 1, 1960 to July 31, 1961 Job No. A-4

Life History of Adult Commercial Fishes

Abstract: Catch per unit effort was calculated for gill net catches from 1952 to 1961. These show that the c.p.u. for drum has declined in recent years, while that for redfish has increased. The method was tested by comparing it with commercial landings. There was good agreement for redfish and less pronounced agreement for drum.

Relative abundance was calculated from returns of tagged fish. The results indicate an increase of about 33 percent in redfish populations and a corresponding increase for trout. Too little of the drum population was tagged to allow calculation.

Redfish returns were tested to determine if significant differences occurred when schools of fish were tagged and when scattered fish were tagged. The results indicate that there is no significant difference between returns from numerous scattered taggings and single mass tagging.

Checks were made of total mortality and sexual dimorphism of sea trout. Total mortality averages about 50 percent, or about ten times fishing mortality. Males suffered higher mortality than females.

Objectives: To determine relative abundance of adult fishes. To determine natural and fishing mortality rates for the various species and to evaluate the factors which cause these mortalities. To establish parameters for determining absolute or relative abundance.

Procedure: The tagging program was continued with major emphasis placed on percent recovery rather than on movement or growth of fish. A standard was established whereby a catch per unit of effort could be derived. In this instance, 300 feet of gill net set 12 hours equaled one net unit. All net catches from 1952 to the present time were then compiled into these standard units for drum and for other species. Commercial catch for two years was obtained from landing reports. Sports catch was obtained by creel census in 1959-60 and from proration of this census in 1960-61. Relative abundance was determined from these data and from the percentage return of tagged fish. Late in the year a program was initiated to give information on population per unit area, but data are still too meager to analyze.

Sea trout and redfish were measured, by sex, at fish houses and at fishing camps. Information was gained on the degree of sexual dimorphism, total mortality, fishing mortality and mortality by age and sex of fish. The findings were compared with other sections of the Texas coast and with the east coast of Florida.

Standard methods were established for sampling juvenile and forage species.

Results:

Relative abundance - Figure 1 shows the catch per unit of effort for 5-inch stretch gill nets from late 1952 until middle of 1961. The total population of the upper Laguna Madre has declined fairly steadily since 1955, although there was an upsurge in the fall of 1960. This decline can be attributed directly to a corresponding decline in drum which, in turn, can be attributed to changes in weather, salinity and food supply. This decline in numbers of drum has been accompanied by an increase in the numbers of desirable species, particularly redfish.

A test of the validity of catch per unit effort data is to compare them with commercial landings. Figure 2 shows that the two are in good agreement for redfish and in fair agreement for drum and thus may be considered valid. Too few trout were caught in standard nets to allow comparison.

In summation, catch per unit effort values indicate that redfish were 20 percent more abundant in 1960-61 than in 1959-60; 100 percent more abundant than in 1953-54; and 400 percent more abundant than in 1954-55, the low year. Drum were 22 percent less abundant than in 1959-60 and 330 percent less abundant than in 1954-55, the peak year. However, the drum values are misleading since September 1960 had an average abundance 300 percent greater than the preceding September, and this abundance was reflected in the commercial catch.

Calculations of relative populations by tag returns -

Redfish - As noted, the catch per unit of effort for redfish was 20 percent above the previous year. This suggests an increase in total populations. In spite of an extra large number of tag returns, the percent return declined slightly. This also indicates an increased population. Finally, commercial landings increased for the year although they declined sharply late in the year.

Rough estimates of population may be derived from the formula: where N = population, C = catch, T = number of tagged fish, and Tc = number of tagged fish recovered.

$$N = \frac{C}{Tc/T}$$

The calculated population of redfish for each year is as follows:

Year	Tagged	Recovered	Per Cent	Catch (fish)	N
1959-60	63	14	22.0	75,500	363,000
1960-61	122	21*	17.0*	78,500*	460,000

*10 months only

This shows a 33 percent increase in population.

Several factors determine the validity of deriving population estimates from tag returns. One of these, failure to turn in recovered tags, cannot be evaluated. Another is the question of whether tagged fish can be evaluated as indicative of the population. A test of this is to compare the percent return from large schools with percent of returns from small groups or individuals and percent of returns from all groups. These factors are evaluated below.

Date	No. Tagged	Recovered	Per Cent
4/24/58	5	1	20.0
7/23/58	6	1	16.6
8/ 4/58	5	0	00.0
9/10/58	1	0	00.0
9/10/58	1	0	00.0
10/ 3/58	1	0	00.0

10/23/58	3	1	33.3
11/14/58	6	1	16.6
11/26/58	3	1	33.3
12/ 4/58	12	3	25.0
2/ 9/59	1	0	00.0
3/11/59	1	0	00.0
4/20/59	3	1	33.3
6/ 5/59	2	0	00.0
6/11/59	1	0	00.0
7/ 6/59	2	0	00.0
7/27/59	2	0	00.0
8/ 7/59	1	1	100.0
8/19/59	1	0	00.0

		Variance from overall average
Average return where five or more fish tagged	17.6%	+00.1
Average return where less than five fish tagged	17.4	-00.1
Average return where only one fish tagged	12.5	- 5.0
Average return where all fish considered	17.5	

Date	Tagged	Recovered	Per Cent
9/ 2/59	6	2	33.3
9/ 8/59	3	0	00.0
9/16/59	7	0	00.0
11/ 7/59	1	0	00.0
11/16/59	3	1	33.3
11/19/59	1	0	00.0
12/ 8/59	1	1	100.0
12/10/59	2	1	50.0
12/11/59	1	0	00.0
12/30/59	3	1	33.3
1/ 2/60	22	4	18.0
3/30/60	1	0	00.0
4/ 6/60	2	0	00.0
6/15/60	1	0	00.0
6/29/60	4	0	00.0
5/31/60	1	1	100.0
8/30/60	4	2	50.0

		Variance
Average return where five or more fish tagged	17.1%	-3.5
Average return where less than five fish tagged	25.0	+4.4
Average return where only one fish tagged	28.1	+7.5
Average return of all fish considered	20.6	

Date	Tagged	Recovered	Per Cent
9/21/60	7	1	14.5
10/ 6/60	2	0	00.0
10/26/60	15	1	7.0
11/ 3/60	6	0	00.0
11/15/60	1	0	00.0
11/18/60	1	0	00.0
11/29/60	1	1	100.0
12/22/60	1	1	100.0
1/10/61	21	5	24.0

1/16/61	4	0	00.0
2/ 9/61	25	4	16.0
2/15/61	20	3	15.0
4/25/61	12	4	33.0
4/26/61	6	1	16.6

		Variance
Average return where five or more fish tagged	16.9%	-00.3
Average return where less than five fish tagged	20.0	+ 2.8
Average return where only one fish tagged	50.0	+32.8
Average return all fish considered	17.2	

The distribution of returns is actually a Poisson distribution. This, however, yields a deviation about equal to the mean and is less valuable than a simple average.

The above computations indicate that percentage return can be based on large numbers of individual taggings but not on small numbers. Average returns from schools vary, but the mean of returns from several schools closely approximates the general overall average. Any bias may be removed by tagging at scattered points and on several dates.

Other factors to be considered are loss of tags by fish and effects of tags on fish. In the first instance there will be a decline in percentage returns with passage of time. Findings thus far indicate that some fish retain tags for at least three years; but since 90 percent of recoveries occur within one year, it appears that some tags are lost. In the second instance, if the tags affect the fish, there will be a lag period before any are recovered. This factor may be tested by comparing tagging dates with recovery dates.

Date Tagged	First Recovery	Second Recovery	Third Recovery	Fourth Recovery	Fifth Recovery	Sixth Recovery	Seventh Recovery	Eighth Recovery
12/ 4/58	4/24/59	7/ 1/60	9/ 9/60					
1/ 2/60	6/17/60	7/ 1/60	8/19/60	8/24/60				
1/10/60	4/12/61	6/15/61	6/27/61	6/29/61	7/ 3/61			
2/ 9/61	5/11/61	5/16/61	5/31/61	6/ 1/61	6/ 9/61	6/27/61	7/12/61	8/19/61
2/14/61								
4/25/61	4/27/61	5/25/61	5/25/61	5/26/61	7/22/61			

The first four cases indicate there is a lag period before recovery. However, the last example shows no lag and suggests the fish moved out of the fishing area and returned at a later date.

Trout - Only 106 trout were tagged during the year and 16 of these were noted to be in poor condition and may be assumed to have died. This leaves a fishing rate of 0.044 = Tc/T. A comparison between 1959-60 and 1960-61 follows.

Date	Tc/T	Catch Commercial	Catch Sports	N (fish)
1959-60	0.054	53,000		980,000
	0.054		257,000	4,800,000
1960-61	0.044	80,000		1,818,000
	0.044		257,000	5,900,000
				7,718,000 fish

488

Commercial catch is separated from sports catch as the former consists of larger older fish with changed habits. The sports catch was derived from the creel census. This sports catch value may not be accurate; superficial examination indicated a reduction in rod and reel catch. In a final evaluation natural mortality may remove most of the tagged fish from the population within one year.

Drum - There was a heavy harvest of drum during fall and winter months, but the population declined rapidly in the spring. Another peak of abundance occurred during spawning migrations. The rate of recovery of tagged drum was very low, only 7 out of 517 tagged. This gives a Tc/T of 0.013. The commercial catch was 365,000 pounds, representing approximately 130,000 fish. The accumulated population would then be 10,000,000 fish, a large increase over the previous year. It should be re-emphasized that this was a seasonal population and that the standing crop became very low in the summer. It should also be noted that much larger numbers should be tagged to give a more accurate estimation since drum are not randomly distributed.

Conclusions on the method - For redfish this method agrees well with calculations of relative abundance using catch per unit effort (+20% and +33%). For drum the methods were not in agreement; catch per unit effort indicated a 22 percent increase, while tag returns indicated a 100 percent increase. This latter, of course, is the result of the seasonal abundance.

Sexual dimorphism and mortality rates -

Trout - It is known that female trout grow at a more rapid rate and live longer than males. Tabb (1961) examined scales and found that on the east coast of Florida the growth rates were as follows:

Year Class	Males Mode	Males Growth	Females Mode	Females Growth
I	130 mm.		130 mm.	
		70 mm.		100 mm.
II	200		230	
		60		70
III	260		300	
		55		60
IV	315		360	
		70		55
V	385		415	
		25		55
VI	410		470	

These growth rates seem realistic except for age IV and V males, where a growth of 70 mm. is indicated, compared to 55 mm. the previous year and also where males outgrew females. In plotting data for the upper and lower Laguna Madre, no better results could be obtained. For females, peaks were found roughly at points indicated by Tabb's scale readings; for males, there was so much overlapping that only one major peak existed. Attempts to read scales have been fruitless; and it seems, in this area, foreknowledge of actual growth is necessary for accurate readings. The few valid returns of tagged trout (with growth) indicate sexual dimorphism exists and that a fifth year class exists, for males, at about 360 mm.

Since Tabb's (Op. Cit.) findings otherwise agree well with these results, the following growth rates are postulated.

Age	Males Mode	Males Growth	Females Mode	Females Growth
I	130 mm.		130 mm.	
		70 mm.		100 mm.
II	200		230	
		60		70
III	260		300	
		55		60
IV	315		360	
		45		55
V	360		415	
		25		55
VI	385		470	
		25		50
VII	410		520	

When trout are presented by size and by sex (Figure 3), it becomes apparent that the more rapid growing females soon outnumber corresponding males. However, when trout are presented by age (Figure 3), a totally different picture emerges. Within limits, there is little difference in percentage composition until after Year Class VI when most males die. This figure is derived from data from the lower Laguna Madre and closely resembles that from the upper Laguna. Year Class I is probably invalid since males at this age are just enough smaller than females to prevent their being brought into the landing points.

It is possible to compute mortality of either sex by size and by age, with the exception of the first two year classes. All values given are from the Laguna Madre, with those from the upper area in parenthesis.

Size	Number Males	% Mortality	Number Females	% Mortality
255-300	163(140)		78(36)	
		18		
305-350	134(155)		112(50)	
		79(90)		17(28)
355-400	31(15)		93(36)	
		70(40)		66(64)
405-450	9(9)		31(13)	
		100(60)		47(40)
455-500	0(4)		16(8)	
		---(100)		------
505-550	---(0)		---(16)	
				--(25)
555-600	---(0)		---(12)	
				--(42)
605-650	---(0)		---(7)	
				--(86)
655-700	---(0)		---(1)	

Age	Number Males	% Mortality	Number Females	% Mortality
III	205(103)		112(63)	
		56(12.6)		28(64)
IV	89(90)		80(27)	
		83(82)		66(55)

Age	Number Males	% Mortality	Number Females	% Mortality
V	15(16)		27(12)	
		40(50)		66(--)
VI	9(8)		9(15)	
		66(50)		66(27)
VII	3(4)		4(11)	
		100(100)		100(73)
VIII	0(0)		0(3)	

In both areas there is heavy mortality by age and by size. In each area the heaviest male mortality is between the sizes 305-350 and 355-400, while the heaviest female mortality is between the sizes 355-400 and 405-450. Where age is concerned the heaviest male mortality occurs between year classes IV and V, and mortality of females is fairly uniform.

With sexes combined the structure of mortality varies little from bay to bay. Figure 4 shows this structure in the lower Laguna Madre, upper Laguna Madre, Cedar Bayou Pass and the Galveston Bay region. In all areas there is heavy mortality at smaller sizes, reduced mortality in the mid-range, and heavy mortality at larger sizes.

Natural mortality is much greater than fishing mortality. Figure 5 shows, for combined sexes, the total mortality versus the fishing mortality in the upper Laguna Madre (where trotline fishing is intense), Cedar Bayou Pass (where sports fishing is intense) and on the east coast of Florida, where all pressure is intense. Seldom is fishing mortality greater than 20 percent of the natural mortality.

Redfish - Little is known of the mortality rate of redfish. Some data is available from non-selective gear used in the Galveston area. These show that in three instances where fairly large numbers of redfish were caught the mortality rate was 71 to 82 percent between year classes I and II. Fishing mortality is about 20 percent. It is possible that this loss of redfish is actually emigration rather than mortality. This fish grows at a rapid rate, requires more space, and spends a portion of its life in the Gulf. Its natural enemies are not known; and while some may be consumed by other fish, it is generally too large to be considered a food item.

Drum - Although many drum have been tagged, most of these have been taken in non-selective gill nets and the data are not useful for determination of mortality rates. This can be corrected by intense sampling with selective nets.

During the coming year permanent stations will be established in each area for the purpose of sampling adult fish populations. These stations will be worked with relatively non-selective trammel nets and drag seines. At the same time, sampling for juveniles will be put on a routine basis. These methods will afford, over a long period, a measure of absolute abundance, a relationship between juvenile abundance and adult abundance, and mortality rates of smaller individuals.

Prepared by: E. G. Simmons
Marine Biologist

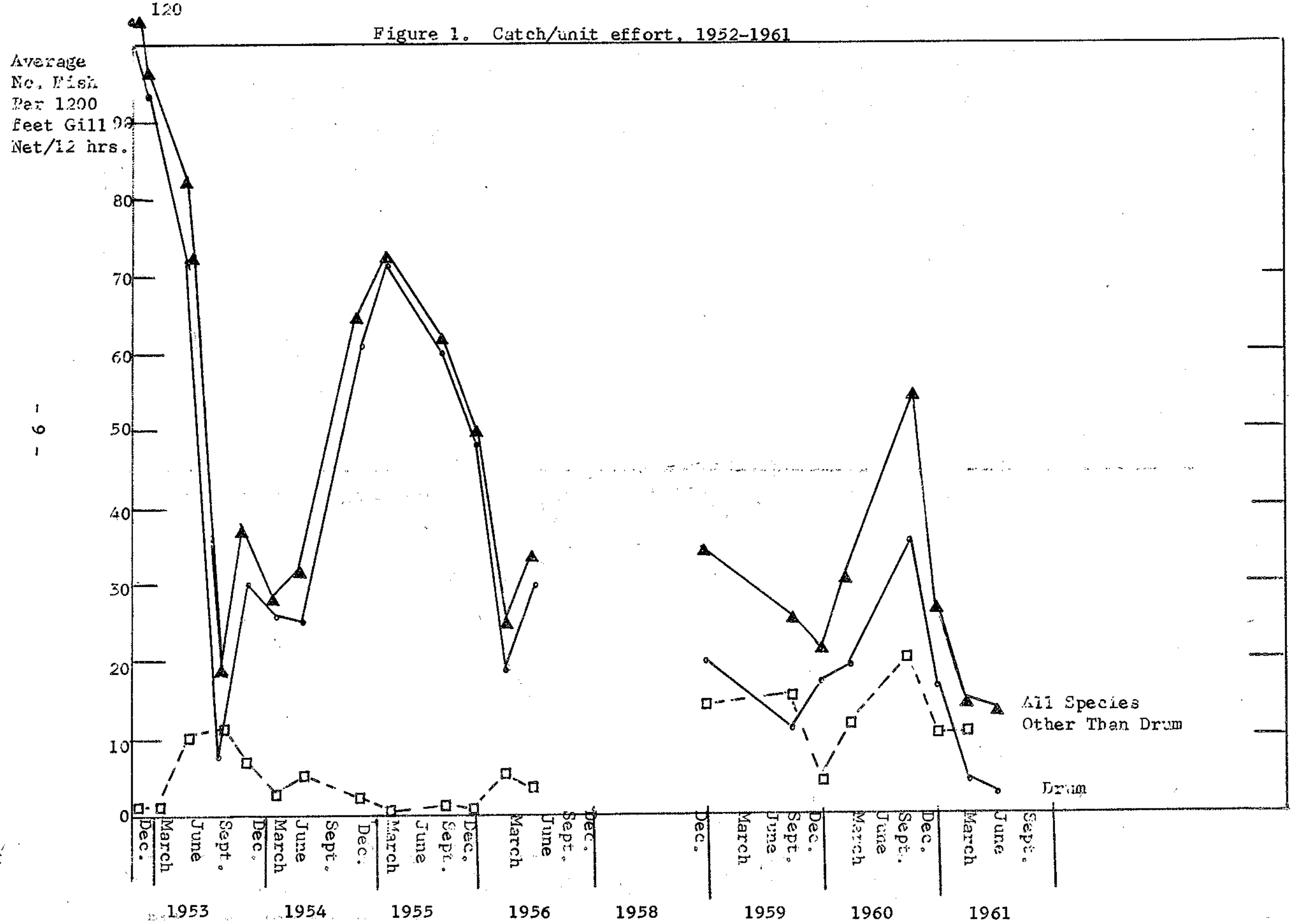
Robert G. Mauermann
Regional Director

Approved by
Coordinator

LITERATURE CITED

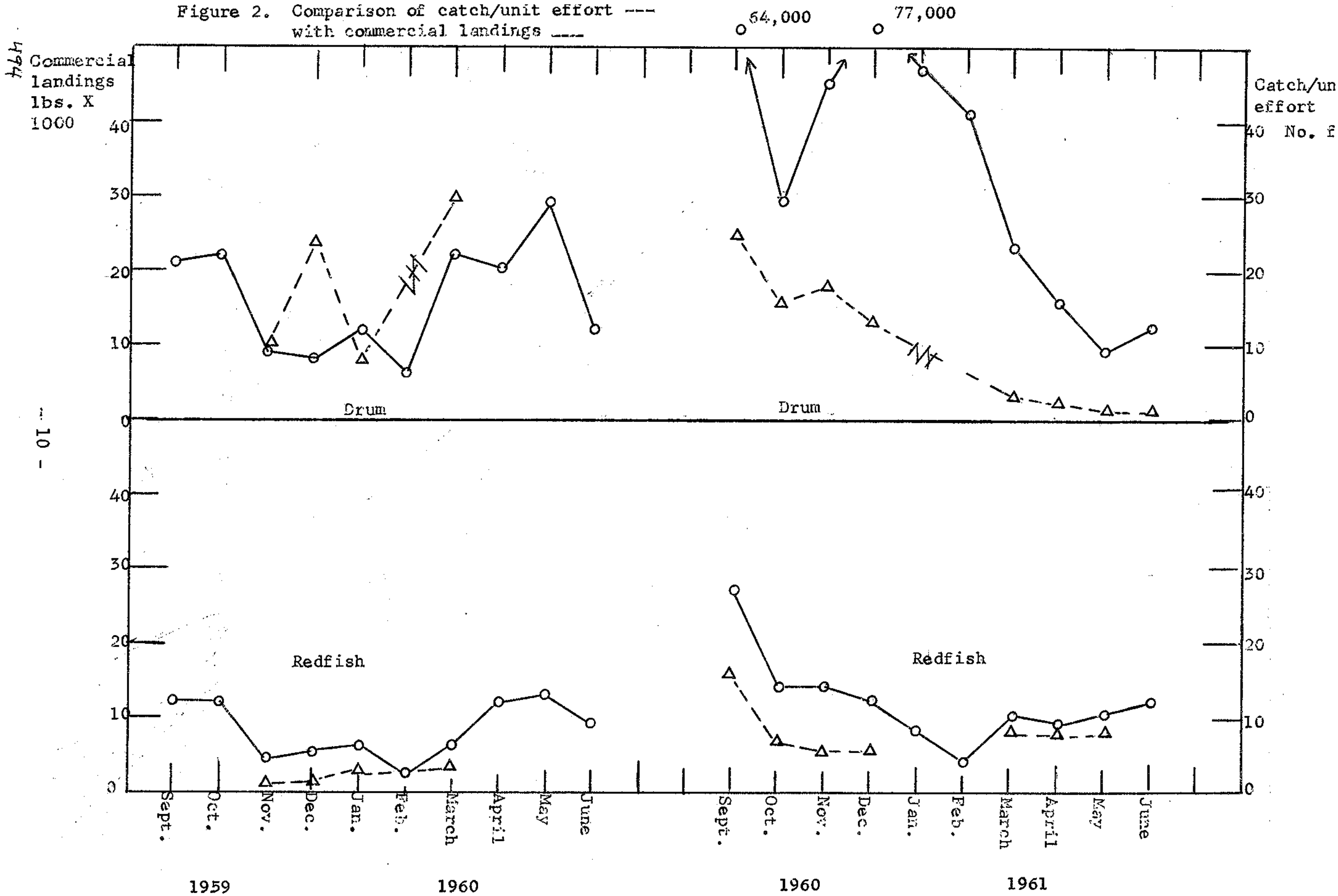
Tabb, Durbin C., 1961. A contribution to the biology of the spotted seatrout, Cynoscion nebulosus (Cuvier) of east-central Florida. Florida State Board of Conservation, Tech. Series No. 35.

Figure 1. Catch/unit effort, 1952-1961



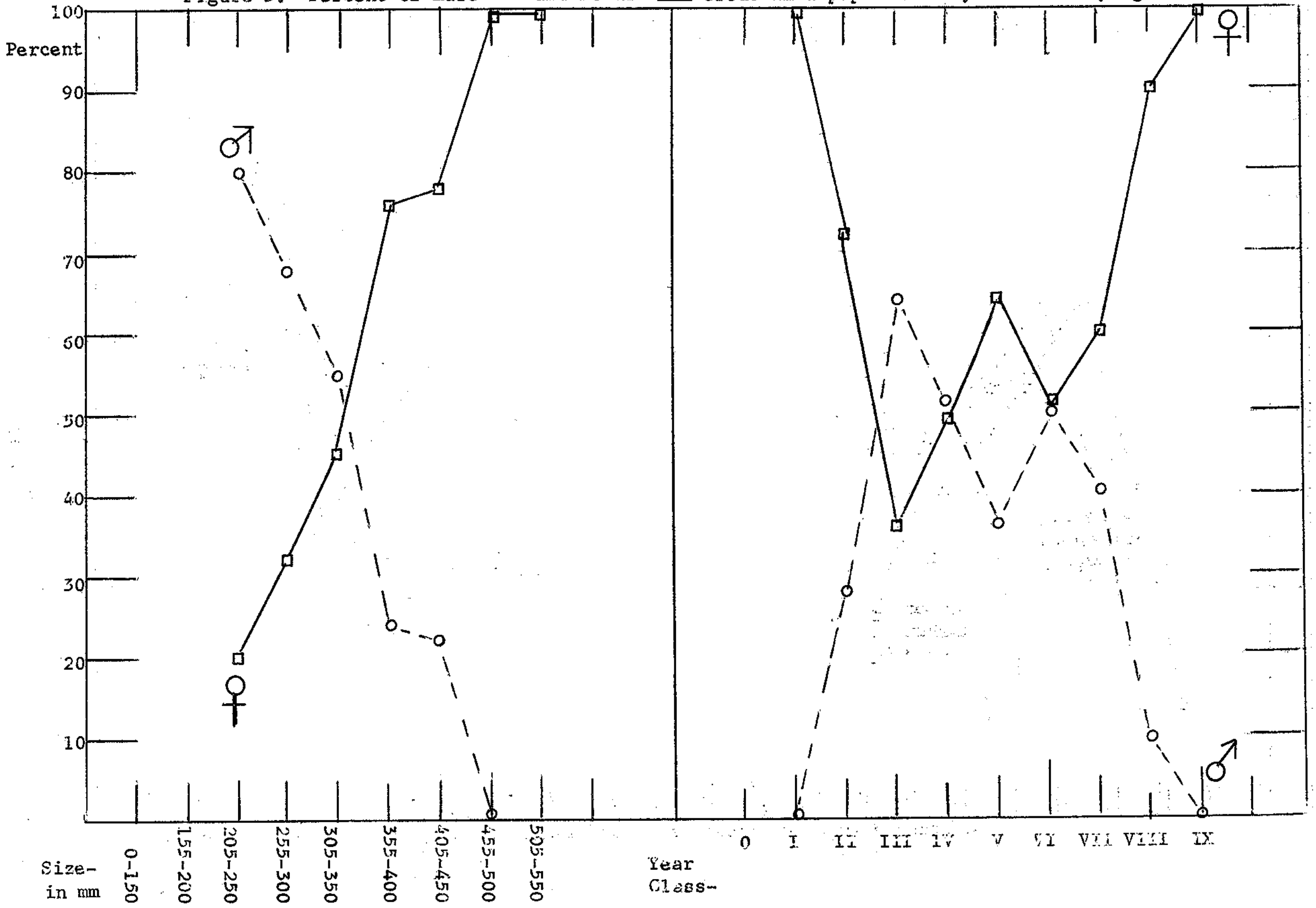
493

Figure 2. Comparison of catch/unit effort --- with commercial landings ___



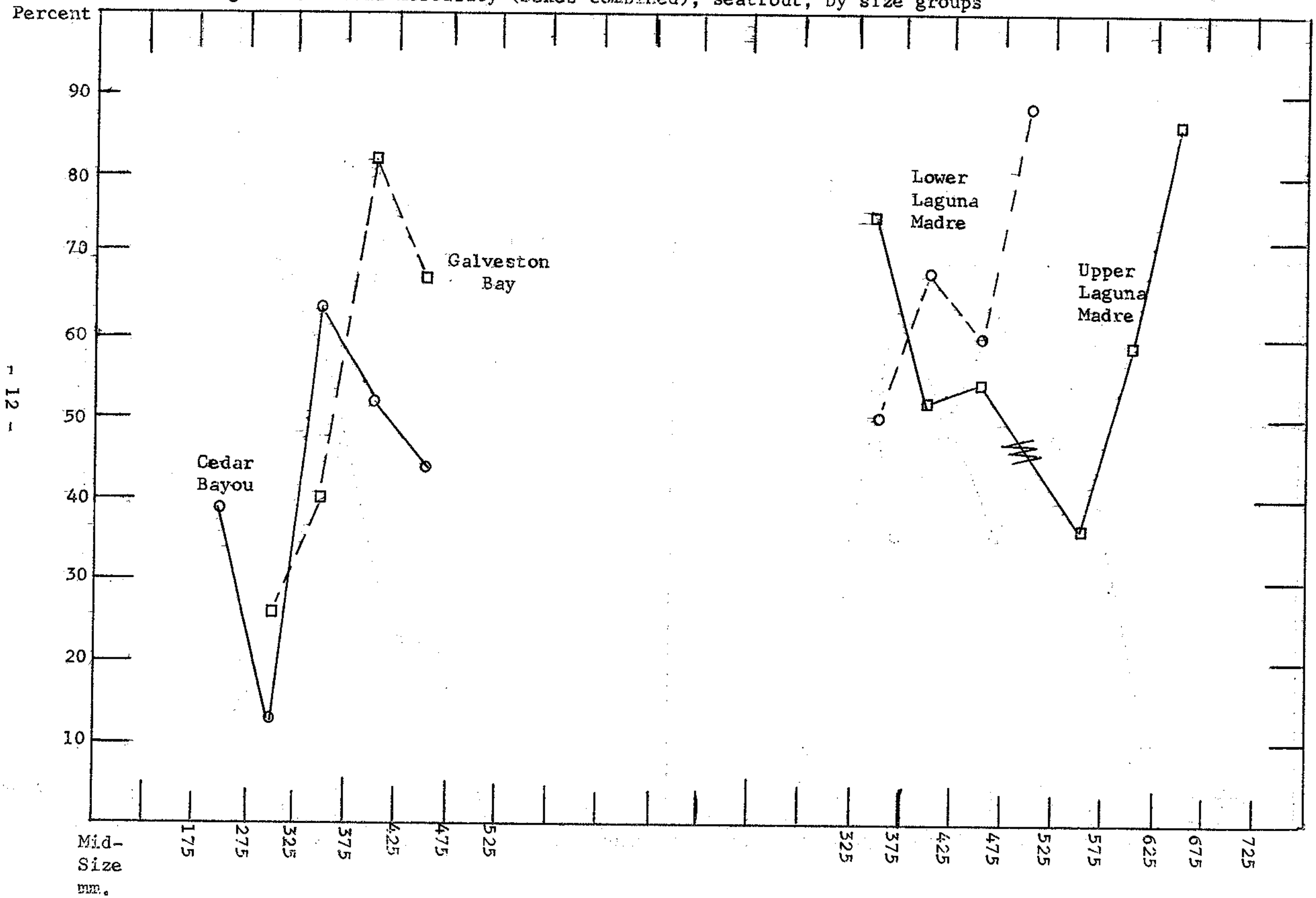
494

Figure 3. Percent of male --- and female ___ trout in a population by size and by age



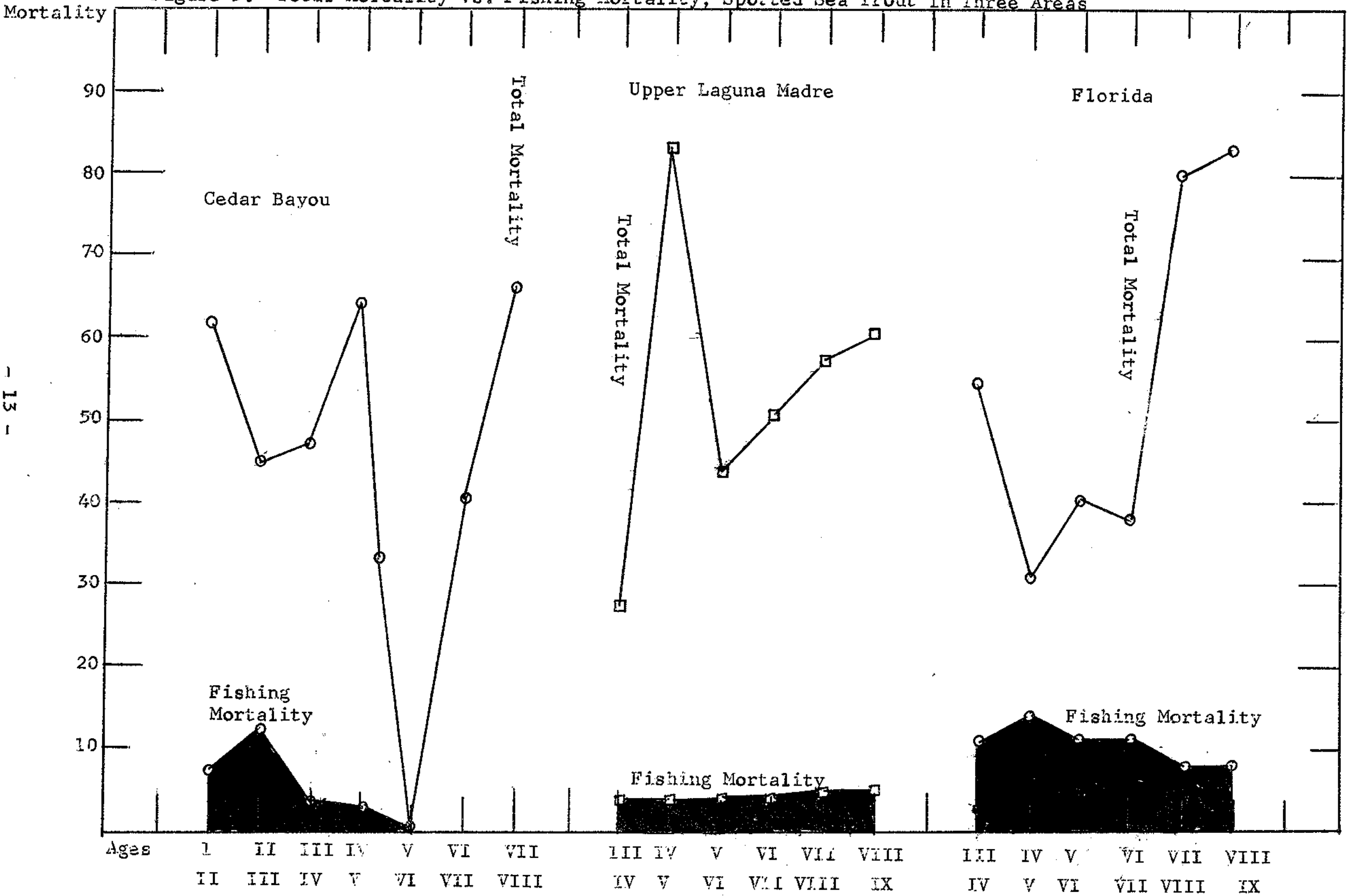
495

Figure 4. Total mortality (Sexes combined), seatrout, by size groups



496

Figure 5. Total Mortality vs. Fishing Mortality, Spotted Sea Trout in Three Areas



497