COMPARISON BETWEEN REPORTED AND ESTIMATED COMMERCIAL FINFISH LANDINGS FROM THE CENTRAL TEXAS COAST

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Management Data Series Number 20
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Texas Parks and Wildlife Department
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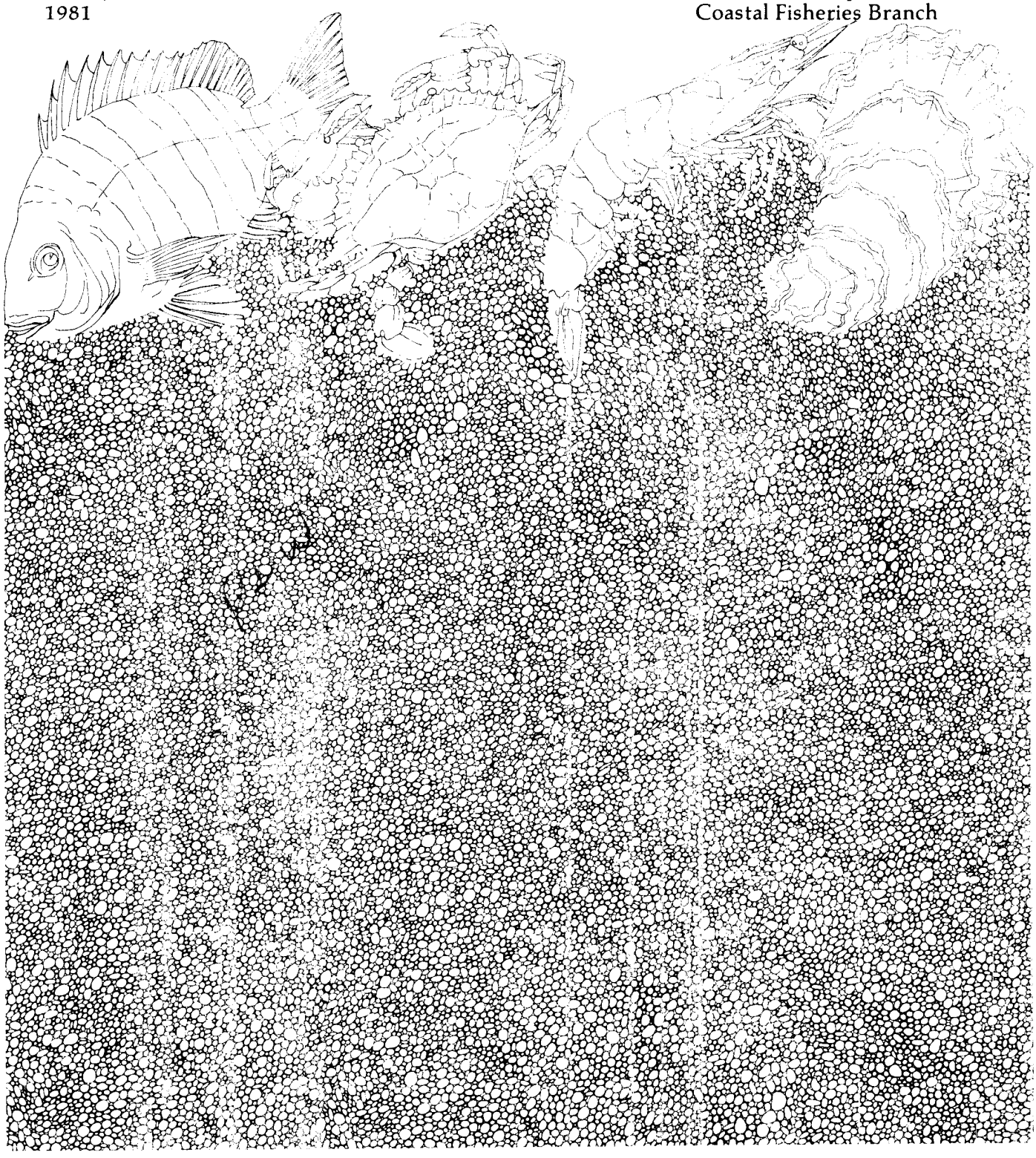

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ABSTRACT

Two different types of surveys--a fixed survey during which a biologist stayed at one fish house and a roving survey during which a biologist traveled from one fish house to another according to a prearranged schedule--were used to investigate the reliability of commercial fish landings reported to the Texas Parks and Wildlife Department (TPWD). The geographical area investigated was the Texas Coast between Port O'Connor and Corpus Christi. The survey involved 41 different fish houses and took place from October 1977 through August 1978. The total landings and the species composition (by weight) estimated by the fixed survey were similar to those reported on the Marine Monthly Products Report (MMPR) and Individual Sales Transaction (IST) to TPWD; however, landings revealed by individual interviews did not correspond to IST reports. This inconsistency was probably caused by the fish house operators reporting more than one purchase on a report form, thus decreasing the amount of paperwork. None of the data collection systems accurately reflect total commercial harvest since only fish house operators were involved. Sales occurring during "closed" hours and sales made to individuals other than the surveyed fish houses were not included in this study. Since fishery management requires estimates of catch per effort, fishing mortality and size composition for management decisions, it is recommended that commercial landing statistics be collected by survey.

INTRODUCTION

In 1934, the Texas Legislature enacted Article 978f-1 of the Texas Penal Code giving the Texas Parks and Wildlife Department (TPWD) the authority to gather statistical information on the harvest or catch of fish, shrimp, oysters and other edible forms of marine life from Texas coastal waters. The law required TPWD to prepare and distribute forms for obtaining the quantity of fish (number and weight), shrimp, oysters or other marine products taken; the specific waters from which they were taken; and the type of gear used. All commercial fish dealers were required to complete and submit this form once a month. Since 1935 this information has been collected and reported on the Monthly Marine Products Report (MMPR). This system of reporting commercial landings was the only one used by Texas until 1977.

In 1977 the 65th Texas Legislature passed Senate Bill 624 (Red Drum Conservation Act). This law required each initial sale (sale by a commercial fisherman) of red drum to be recorded separately. A record of each transaction must be supplied to TPWD by the 10th of each month. These records are used to determine when a bay system has attained 90% of its allowable red drum harvest. At that time TPWD is required to close the bay system to any further commercial harvest of red drum. This same law established lower and upper commercial harvest limits (635,600 kg-726,400 kg) within which the TPWD Commission can set the maximum weight of red drum to be taken commercially in a 12-mo period.

In October 1977 TPWD created the Individual Sales Transaction (IST) form (using the Red Drum Conservation Act as its authority). TPWD required the reporting of each initial sale of all finfish species on this form. Some wholesale fish dealers along the coast challenged this requirement; many refused to fill out any of the forms except when red drum were sold. Additionally, circumstantial evidence indicated that some wholesale fish dealers were ignoring the requirement for red drum.

The confusion caused by the passage of the Red Drum Conservation Act and new interpretations of the old law under Article 978f-1 created doubts as to the reliability of the statistics reported by either system. Therefore, TPWD initiated a program (beginning October 1977 and ending August 1978) which permitted an independent evaluation of these two reporting methods.

Phase I of the evaluation program involved the development of a statistical sampling design (independent of the two reporting programs) to estimate the finfish harvest and species composition of that harvest for a known geographical region. Phase II of the program involved the estimation of the finfish harvest and species composition using the selected sampling design. Finally, these estimates were compared with the statistics obtained from the MMPR and the IST (Red Drum Conservation Act) reports.

MATERIALS AND METHODS

The survey area included 41 fish houses (identified using the MMPR inventory) in a coastal area from Port O'Connor to Corpus Christi, Texas. This 6-county area included the San Antonio, Aransas, Corpus Christi and part of the upper Laguna Madre Bay systems. This area was chosen because of the concentration of large wholesale fish dealers in the area and the extensive background knowledge available from resident biologists to guide the investigation.

Phase I began during the last week of October 1977 and continued until the end of January 1978. During this time two different types of surveys were conducted. A "fixed" survey involved stationing a biologist in a randomly selected fish house from opening until closing. A "roving" survey involved a biologist visiting several different fish houses at designated times during the day for a 1-h time period. The houses and sequence of visits were randomly determined. In addition, the roving survey took place during an early (0600-1300) or late (1300-1900 CST) time period. Only one of these time periods was sampled on a given day; the number of samples taken during each time period was equally distributed.

The two survey types were used to determine the most efficient (considering time and precision of the estimates) method of survey and to provide a way of detecting fishermen avoidance (i.e., fishermen may have avoided coming into a fish house because a TPWD biologist was there conducting interviews). Avoidance, if it was occurring, was expected to be reflected in lower mean landings per hour in the fixed survey when compared with corresponding estimates in the roving survey. In order to find out if fishermen were able to detect the presence of the biologist in a very short time, the landings intercepted during the roving survey were divided into thirds of an hour and compared to see if landings seen towards the end of the survey hour were less than landings seen at the beginning of the survey hours. A decline in landings would be evidence that fishermen had detected the biologist's presence and were avoiding the fish house.

The fixed survey technique was selected for fish house sampling during phase II. However, a major change was made in the sampling scheme, i.e., fish houses were assigned to strata (Appendix A). These strata were determined subjectively by asking the interviewing biologists to rank the fish houses into three categories: 1) fish houses that purchased a relatively large number of finfish, 2) fish houses that purchased very few finfish and 3) fish houses that did not purchase finfish.

A total of 106 sample days was planned for this project (36 days for phase I and 70 days for phase II). Ten of the 36 sample days allocated to phase I were used for weekend sampling and 26 days for weekday sampling. The 26 weekday samples were divided between fixed (8) and roving (18) surveys. The 10 weekend samples were divided bewteen fixed (4) and roving (6) samples.

Biologists conducting the surveys recorded the following information when they encountered a fisherman selling fish: fish house code number, business name, dealer's license number, date, time that the fish house

opened and closed (fixed survey), time the biologist entered and left the fish house (roving survey), time an interview was initiated (the fish house operator weighing a fisherman's catch was used to indicate that fish were being sold and that an interview would be initiated), the fisherman's commercial license number, the gear used to capture the fish, the name of each species caught and the total number and weight, and price per pound by species that the fish house paid the fisherman.

The data collected during phase I were compared with the effort it took to collect the data. Landing data were expressed as landings (sales or purchases) per hour within each survey type and day type and examined for statistical differences using analysis of variance. At the completion of phase II harvest estimates were made from the survey data for the five major species caught--red drum (Sciaenops ocellata), black drum (Pogonias cromis), spotted seatrout (Cynosion nebulosus), flounder (Paralichythys lethostigma and P. albigutta) and sheepshead (Archosargus probatocephalus). These estimates were compared with the MMPR and IST reports for agreement as to total weight harvested and species composition (percent by weight). The total landings from the MMPR and IST reports were adjusted so that they would be comparable to the survey estimate. The total landings for the MMPR were obtained by taking the fiscal landings (September 1977-August 1978) for Espiritu Santo, San Antonio, Aransas, Copano, Corpus Christi, Nueces and upper Laguna Madre Bays and subtracting the comparable September 1977 landings from the total. The total landings for the IST were obtained by summing all the reported landings from the fish houses that were in the survey list.

Data collected during both phases were examined for evidence of reliability and avoidance. IST reports were checked for accuracy by comparing them with corresponding interviews using dates, species and weights. Avoidance was investigated by comparing the mean landings per hour obtained during the two survey types and by comparing mean daily landings obtained during the fixed survey with mean daily landings reported on IST on the days immediately before and immediately after the survey. Lower mean landings per hour in the fixed survey than in the roving survey would indicate avoidance. Lower mean daily landings from the fixed survey data compared with mean daily landings reported on IST on the day before and after the survey would also indicate avoidance.

The statistical techniques used during this investigation are commonly used; only one deserves special mention. The special factorial analysis Overall and Spiegel (1969) was necessary because of unequal cell sizes. All analyses of variance utilized log (data +1) transformation in order to make the treatment variances equal. The estimation of the finfish harvest and its variance (made with mean daily landings) utilized stratified population estimators (Mendenhall et al. 1971). A description of the single classification analysis of variance and the simultaneous sums of squares used to test strata means for statistical differences are found in Sokal and Rohlf (1969).

RESULTS

Of the 36 samples allocated to phase I, only 27 were usable in the analyses because of faulty equipment (car breakdown) with no time to take additional samples, lost samples and times not entered properly. Three (1 weekend day, 2 weekdays) fixed survey samples and six roving survey samples (1 weekend day, 5 weekdays) could not be used.

The fixed survey did not require the interviewers to travel to more than one fish house for a sample; thus less gasoline was consumed than during the roving survey. A comparison of the data collected by the two different surveys (October 1977-January 1978) showed that the fixed survey was more efficient (resulting in more data per sample day) for collecting data than the roving survey. During 27 sample days (9 fixed surveys, 18 roving surveys) 28 fish sales (interviews) involving 1345.6 kg of fish were recorded. Fixed surveys resulted in a mean of 2.11 interviews per sample day (0.22 interviews/h); roving surveys resulted in a mean of 0.50 interviews per sample day (0.11 interviews/h) (Table 1). The mean daily landings of finfish intercepted per fixed survey sample were 76.1 kg; the mean daily landings for the roving survey were 36.7 kg/day. Mean landings per hour between survey types did not differ ($F_s = 0.132$; df = 1,23) nor did mean weekend hourly landings differ from mean weekday hourly landings ($F_s = 1.083$; df = 1,23). The mean landings were 7.6 $\pm$ 4.1 kg/h from the fixed survey and 7.9 $\pm$ 3.8 kg/h from the roving survey (Table 2).

The fixed survey sampling efforts for the entire investigation (October 1977-August 1978) resulted in a total of 77 samples (9 days from phase I and 68 days from phase II). One sample was missed because it was left off the sampling schedule; one sample was taken from the wrong strata which caused the intended sample size of high volume fish houses sampled on weekdays to be increased by one and the sample size of low volume fish houses sampled on weekdays to be decreased by one. Thus, there were 43 weekday and 9 weekend high-volume fish house samples and 23 weekday and 2 weekend low-volume fish house samples.

A total of 6265.6 kg of finfish was observed by biologists while conducting fixed surveys (684.6 kg during phase I, 5581.0 kg during phase II). There was a large difference in the mean landings obtained from the different strata ($F_s = 6.244$; df = 2,72; P 0.01). Mean landings were highest for high volume fish houses sampled on weekdays (130.7 $\pm$ 34.2 kg/day) and lowest for low volume fish houses sampled on weekends (0.0 $\pm$ 0 kg/day) (Table 3). However, since the mean daily landings for low volume fish houses on weekends was based on only two samples, the value reported here is not realistic. Mean landings at high volume fish houses on weekends (33.7 $\pm$ 20.7 kg/day) were higher than mean landings at low volume fish houses on weekdays (14.9 + 7.6 kg/day), but this difference was not significant based on a simultaneous sums of squares comparison.

The strata means and variances and the strata sampling units (number of fish houses x number of days in survey period) were expanded to obtain total landings and standard errors (Table 4). Bay landings accounted for 97% of the total landings estimated (636,223 $\pm$ 145,401 kg). The five

major species accounted for 95% of the total landings. Black drum had the highest estimated landings (220,547 ± 85,973 kg); flounder had the lowest (45,838 ± 17,878 kg). The standard error of the total finfish estimated landings was 23% of the estimate; the standard errors for the different species landings ranged from 24% (red drum) to 39% (flounder).

Landings for the five major species estimated from on-site interviews conducted during regular business hours did not differ greatly from the landings reported by MMPR or IST. All statistics derived from MMPR and IST fell within the 95% confidence intervals for the estimated landings (Table 5). The difference between the lowest landings reported (IST: 590,731 kg) and the highest landings reported (MMPR: 659,536 kg) was only 68,805 kg (10%). Landings estimated by the survey were 2% higher than landings reported by IST and 8% lower than landings reported by MMPR. The species composition was also very similar. Reported landings of red drum did not differ by more than 3% (20-23% of total landings). The greatest difference (a range of 7%) was found for black drum. Inspection of the percentage composition of all three systems indicated that the survey estimates were numerically more similar to MMPR landings than to IST landings.

Landings reported on IST tickets did not correspond to interview landings, indicating inaccuracies in the tickets. Biologists encountered one or more fishermen on 37 of 77 sample days. IST tickets dated on the same day as a survey were found on only 11 days; on 2 days IST bore dates on which no encounters with commercial fishermen occurred. Landings reported by IST and by interview were the same on only 7 days (excluding days when no landings were reported). In addition, only 53 IST tickets were dated on the same day as a survey and only 31 of these matched any of the interviews.

Although there were three instances when interviewing biologists were told by fish house operators that fishermen were not entering the fish house because of the survey, avoidance during the period when biologists were in the fish houses was not detected statistically. There was no difference in the mean landings (kg/h) observed during the first 20 min of a roving survey sample and those during the second or third 20 min ($F_s = 0.026$; df = 2,18). However, the mean daily landings reported on IST on the day before and the day after a survey differed from the mean daily landings observed by the biologists on the day of the survey ($F_s = 4.035$; df = 2,30; P 0.05) (Table 6). According to the transformed means, the landings reported on IST on the day before or after a survey were less than the landings observed by the biologists while conducting the survey. However, the mean daily landings calculated from the untransformed data did not show the same pattern. The mean daily landings from IST reports dated the day before and after the survey were respectively, 124.4 ± and 138.9 ± 58.1 kg/day while the survey data showed 127.1 ± 38.1 kg/day. Thus, the differences found in the transformed means probably reflected differences in the distribution of reported landings (i.e., IST showed fewer days having landings than did the survey but when landings were reported they were greater on IST than those found during the survey).

DISCUSSION

Landing statistics (total landings and species composition) obtained from MMPR and IST were expectedly similar since the report forms used in both systems are usually filled out by the same individual (i.e., fish house operator). Landing statistics based on survey data were also found to be similar to MMPR and IST statistics. This similarity exists despite the lack of correspondence found between survey interviews and individual IST reports and the warnings from some fish house operators to TPWD biologists that fishermen were not entering the fish houses when surveys were conducted. Some operators reported incorrect numbers of transactions. For example, some landings were reported as having occurred during four transactions on two different days when in fact they occurred during six or eight transactions on three or four different days. This procedure resulted in the same total landings but fewer sales. Although avoidance probably did occur, this study did not detect it statistically. Either avoidance was not extensive or it was offset exactly by under reporting or nonreporting on MMPR and IST. Otherwise, landings reported on MMPR and IST would have differed greatly from landings estimated from the survey interviews.

This study was not designed to address two additional types of transactions that probably occurred. The first involves the failure of the fish house operator to report purchases of fish made during "closed" hours (i.e. before or after the biologist visited the house) on either the MMPR or the IST. For example, fish could have been landed during one night, and cash payment left for the fishermen the next night. The biologist would not have been aware of this type of transaction, nor would a record of it have existed. This survey did not include landings that were a result of direct sales of fish from fishermen to someone other than a licensed fish house operator (e.g. restaurant, final consumers, etc). Again, these types of purchasers were not surveyed by the biologists. The reporting of these types of transactions on the MMPR is not required by law; reporting is required on the IST by law. Personal interviews with several restaurant owners showed this type of sale was occurring; therefore total landings on the IST should have exceeded those on the MMPR. Landings reported on the IST and the MMPR were similar. This would indicate the commercial fishing industry was not reporting total landings. The proportion of landings not reported is unknown, and could not be determined from this study.

If the management of the Texas finfish fishery could be accomplished with weight landed and species composition data only, any one of the three reporting methods would suffice. However, the growing demand for marine fishery resources requires more sophisticated data (Roedel 1975). Catch per effort by gear type, gear selectivity and fishing mortality by age or size class are needed to calculate yield equations (Gulland 1977) or for use in the more sophisticated population simulation models that are currently being developed (Walters 1969, Van Winkle et al. 1978). Considering these requirements, the logical method of collecting commercial landings statistics is by survey.

The survey was the only method that permitted the size of fish to be recorded. It was also the only method that permitted accurate recordings of catch per effort (landings per sale). Fish house operators do not willingly provide biological data to state agencies and consequently may

report more than one sale per ticket. This simple expedience leads to overestimates of catch per effort and distorts patterns of fishing activity. Some fishermen may make more than one fishing trip before going to a fish house. If this were reported as one sale, as it probably is, catch per effort would again be overestimated. Interviewers, however, can ask fishermen if their catch was the result of one or more trips and this information can be incorporated into the estimating procedure.

There are two problems involved with gathering landings data by survey. Sample sizes must be large enough to permit a precise estimate of the total landings and the public must be convinced that valid decisions can be made from survey statistics. The results of this study indicated that sample sizes required to make reliable estimates would not be unreasonable (approximately 500 man days, Appendix B), but an optimization study would be required to substantiate this. The acceptance of survey data by the public as a decision making tool remains the major problem.

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Table 1. Total sampling effort and data collected during the fixed and roving fish house surveys, October 1977-January 1978.

Survey type	Day type	Total man-hours	Total sample days	Total interviews	Interviews per survey hour	Interviews per sample day	Total landings observed (kg)
Fixed	Weekday	54.5	6	17	0.31	2.83	519.4
	Weekend	28.5	3	2	0.07	0.67	165.2
Roving	Weekday	61.0	13	8	0.13	0.62	648.3
	Weekend	21.0	5	1	0.05	0.20	12.7
Fixed	Combined	83.0	9	19	0.22	2.11	684.6
Roving	Combined	82.0	18	9	0.11	0.50	661.0

Table 2. Mean landings (kg/h), standard errors and sample sizes (n) for the fixed and roving surveys by day type.

Survey type	Weekday	Weekend	Combined
Fixed	8.4 ± 6.9	5.8 ± 5.8	7.6 ± 4.1
n	6	3	9
Roving	10.7 ± 5.0	0.6 + 0.6	7.9 ± 3.8
n	13	5	18

Table 3. Observed landings (kg), mean daily landings (kg/day ± 1 SE) and sample sizes from the fixed survey, by strata, October 1977-August 1978.

Day type	Sampling[a] units in strata	Strata[b]	Sample size	Total observed landings	Mean landings	Standard error
Weekday	4,063	1	43	5,619.6	130.7	34.2
	3,346	2	23	342.3	14.9	7.6
Weekend	1,632	1	9	303.7	33.7	20.7
	1,344	2	2	0.0	0.0	0.0

[a] = Number of fish houses in strata total number of days available for sampling.

[b] Strata 1 = high volume fish houses; Strata 2 = low volume fish houses.

Table 4. Total estimated landings (kg) and standard errors of the estimates for total finfish and five major species, October 1977-August 1978.

	Total	Standard error
Total finfish[a]	636,223	145,401
Total bay finfish	617,319	145,206
Red drum	140,970	45,954
Spotted seatrout	115,442	33,171
Black drum	220,547	85,973
Sheepshead	80,405	30,184
Flounder	45,838	17,878

[a]Bay and Gulf landings combined; all other estimates are for bay landings only.

Table 5. Total bay commercial finfish landings (kg) and percent composition (by weight) for the five major species as reported by MMPR, IST and a sampling survey, October 1977-August 1978.

Report	Total (kg)	Red drum		Spotted seatrout		Black drum		Sheepshead		Flounder	
		kg	%	kg	%	kg	%	kg	%	kg	%
MMPR	659,536	133,167	(20)	157,793	(24)	244,269	(37)	69,849	(11)	54,458	(8)
IST	590,731	132,368	(22)	121,982	(21)	256,743	(43)	49,882	(8)	28,848	(5)
Survey	603,202	140,970	(23)	115,442	(19)	220,547	(36)	80,405	(13)	45,838	(8)

Table 6. Transformed (log (Data + 1)) and untransformed mean daily landings (kg) ± 1 SF resulting from the comparison of landings observed while conducting surveys and landings reported on IST on days immediately before and after a survey.

	IST		Observed
	Day before	Day after	in survey
Transformed	1.0 ± 0.3	1.1 ± 0.3	1.6 ± 0.2
Untransformed	124.4 ± 24.5	138.9 ± 58.1	127.1 ± 38.1

Appendix A: Fish house strata assignments and mean landings

Strata assignments for phase II of survey, samples sizes and observed mean landings (kg/day) for fish houses surveyed in the San Antonio, Aransas and Corpus Christi bay systems from October 1977 through August 1978.

Fish house code number	Strata[a]	No. days sampled	Mean	SE
5	1	2	1.8	1.8
6	1	5	0.0	0.0
7	1	1	4.1	0.0
8	1	5	206.8	61.9
15	1	3	154.5	72.9
16	1	1	0.0	0.0
24	1	3	262.7	74.9
26	1	2	18.2	18.2
27	1	6	26.0	10.6
28	1	3	15.3	10.0
30	1	2	123.0	17.7
33	1[b]	4	28.1	28.1
34	1	0		
35	1	4	267.2	237.6
36	1	2	0.0	0.0
38	1	3	44.6	27.7
39	1	3	491.2	250.9
40	1	2	206.8	147.3
1	2	1	0.0	0.0
2	2	3	0.0	0.0
3	2	2	0.0	0.0
9	2	3	0.0	0.0
10	2	1	0.0	0.0
11	2	0		
12	2	2	0.0	0.0
13	2	0		
14	2	0		
20	2	2	45.8	45.8
23	2	0		
25	2	3	60.9	43.9
31	2	2		0.0
32	2	4	12.5	12.5
17	3			
18	3			
19	3			
21	3			
29	3			
37	3			
4	Closed			
41	Closed			

[a] 1 - High volume fish house.
2 - Low volume fish house.
3 - Indicates one that doesn't purchase finfish at all.

[b] Fish houses 33 and 34 were owned by the same person and all business with commercial fishermen was conducted at site 33.

Appendix B: Sample size analysis

Sample size (number of survey days per year) required to obtain a specified precision (%) in estimated commercial landings based on different stratifications.

Stratification	Day type	No sampling units	Mean kg/day	Variance of X	Number of sample days required to obtain stated level of precision			
					10%	15%	20%	30%
Based on Interview Survey								
High volume	Weekday	4,063	131	224.3	599	408	143	78
Low volume	Weekday	3,346	15	36.4	80	54	32	10
High volume	Weekend	1,632	34	62.2	54	37	22	7
Total		9,041	-	-	733	499	297	95
Based on IST								
High volume	Weekday	2,349	163	219	548	280	159	73
Intermediate volume	Weekday	2,088	60	228	358	183	104	48
Low volume	Weekday	2,610	7	17	51	26	15	6
High volume	Weekend	936	121	61	61	31	18	8
Total		7,983	-	-	1,018	520	296	135

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