Increasing Creel Interview Efficiency Through Early Survey Termination

HAL R. OSBURN and MIKE G. WEIXELMAN

Introduction

The Texas saltwater recreational sport-boat fishery is a biologically and economically important segment of the total Texas coastal fishery. Nearly 2.2 million fish were landed by Texas saltwater sport-boat anglers in 1984–85 (Osburn and Ferguson, 1986). Ferguson and Green (1987) estimated there were over 1.4 million saltwater fishing boat trips in Texas in 1982. Direct expenditures by these fishermen translated into over $1 billion of economic value annually to the State of Texas (Anonymous, 1985; Grubb, 1973).

The Texas Parks and Wildlife Department has monitored the sport-boat fishery in seven major bay systems of Texas since May 1974 using on-site creel interview methods (Osburn and Ferguson, 1986; Heffernan et al.,

ABSTRACT—Operational modifications based on recreational angler activity patterns can be successfully formulated to increase creel survey efficiency without a significant loss of information. This study was conducted to estimate the amount of Texas marine sport-boat angler interview and retained fish data (bay and Gulf) that would be missed both coastwide and within each bay system if surveys were terminated early when no angler interviews were conducted by a specified time. Using this method, <3 percent of the total interviews and retained fish would be missed coastwide by terminating surveys at 1400 hours on weekends and 1600 hours on weekdays throughout the survey year. This would result in the early termination of 14 percent of the weekend surveys and 23 percent of the weekday surveys, thus allowing an annual redirection of 440 work-hours and $6,063 in operating expenses.

1976; Green et al., 1978). However, all boating activities were not monitored until September 1977 and all boat ramps with significant Gulf of Mexico (Gulf) fishing pressure were not monitored until May 1978. Since September 1979, all surveys at boat access sites have been conducted on both weekends and weekdays from 1000 to 1800 hours regardless of the amount of fishing activity. The efficiency of the monitoring program was improved in November 1984 by terminating weekend surveys at 1400 hours if no angler interviews had been conducted between 1000 and 1400 hours. Weixelman and Green (1984) found that this procedure would result in a coastwide loss of <4 percent of all angler interview and retained fish data. However, that study did not include weekday surveys, and areas fished (bay and Gulf) were not analyzed as separate effects. Fishing-trip characteristics of weekday anglers and Gulf anglers in Texas differ from those of weekend anglers and bay anglers, respectively (Osburn and Ferguson, 1986).

The purpose of this study was to evaluate the feasibility of terminating weekday surveys early and to re-evaluate weekend surveys using a larger data set. The objectives were to: 1) Determine if the percent of bay and of Gulf sport-boat angler interviews and retained fish missed in each season (high-use and low-use) was signifi-

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cantly different among termination times, day types (weekend and weekday), and bay systems; 2) estimate the percent of sport-boat angler interviews and retained fish that would be missed for each termination time by day type, season, area fished (bay and Gulf), and bay system; 3) determine if the number of survey days that could have been terminated early was significantly different among day types, seasons, and bay systems for each termination time; and 4) estimate the percent of days on which early termination can be expected to occur by termination time, day type, season, and bay system.

Methods

Data for this study were collected from 15 May 1978 through 14 May 1985 (Osburn and Ferguson, 1986) on 4,397 randomly selected days on weekends and weekdays in the Galveston, Matagorda (including East Matagorda), San Antonio, Aransas, Corpus Christi, and upper and lower Laguna Madre bay systems. Each year consisted of a high-use season (15 May to 20 November) and a low-use season (21 November to 14 May). Methods used to survey sport-boat anglers (including private, party, and tournament) are described in Osburn and Ferguson (1986), Heffernan et al. (1976), and Green et al. (1978). Landings data were collected by interviewing sport-boat anglers as they completed a trip.

Sport-boat angler interviews conducted on each survey day were divided into 1-hour time periods (1000–1059, 1100–1159, 1200–1259, 1300–1359, 1400–1459, 1500–1559, 1600–

1659, and 1700–1800 hours) by day type, season, area fished, and bay system. On those days when no angler interviews were conducted from 1000 hours to each termination time (i.e., 1100, 1200, 1300, 1400, 1500, 1600 or 1700 hours), any interviews conducted after the termination times were assumed missed. The percents of interviews and retained fish that would have been missed had surveys been terminated early were calculated for each early termination time by dividing these missed data by all respective data collected. The percents were calculated for both areas fished on both day types during both seasons in each bay system (e.g., the number of Gulf angler interviews conducted after 1700 hours on weekends during the high-use season in the Galveston Bay system were divided by the total number of Gulf angler interviews conducted from 1000–1800 hours on weekends during the high-use season in the Galveston Bay system). The percents of missed information were also calculated on a coastwide basis because this corresponds to harvest estimation methodology used in presenting sport-boat landings in Osburn and Ferguson (1986).

Analyses of variance were conducted to determine if the mean percent of angler interviews missed and the mean percent of retained fish missed were significantly different among termination times, day types, and bay systems (Sokal and Rohlf, 1981). The effect of bay systems on the percent of missed information was examined to identify those areas where a coastwide application of an early termination time would cause the most bias in harvest estimates. There was no analyses of years because the purpose of this study was to evaluate the feasibility of terminating surveys early for all future years of the survey program and it was decided that analyzing the data with all years combined gave the most representative results that could be applied to future years. Analyses were performed for each season on bay angler interviews missed, bay retained fish missed, Gulf angler interviews missed, and Gulf retained fish missed. A

posteriori testing of means was not possible since there were no replicate measures within cells. Analyses of variance were performed using arcsine transformed percents to assure a more normal distribution and equal variances. When differences among bay systems occurred, the data were visually examined and bay systems that appeared to be different were removed; the analysis of variance was then rerun. This procedure was repeated in a stepwise fashion until similar bay system groups were identified. Data from similar bay system groups were pooled and the percents of angler interviews and retained fish missed were recalculated (e.g., if there was no significant difference between percents of bay angler interviews missed during high-use weekend surveys in the Galveston and Matagorda Bay systems, then the high-use weekend data sets for these two bay systems were pooled and the percent of bay angler interviews missed was recalculated).

Survey days were placed into four categories based on the time interviews were conducted with respect to a proposed termination time. The categories were: 1) Days with all angler interviews from 1000 hours to a proposed termination time, 2) days with all angler interviews from a proposed termination time to 1800 hours, 3) days with angler interviews before and after the proposed termination time, and 4) days with no angler interviews.

For each termination time, the number of days in each category was analyzed for significant differences among day types, seasons, and bay systems using a test of independence (Sokal and Rohlf, 1981). When differences among bay systems occurred the data were visually examined and bay systems that appeared to be different were removed; the test of independence was then reran. This procedure was repeated in a stepwise fashion until similar bay system groups were identified. The percent of days on which early termination can be expected to occur (2nd and 4th categories) was calculated by dividing the appropriately grouped data by the total number of survey days in the corresponding day type, season and bay system group.

Results

Coastwide and for any season, <3 percent of bay and Gulf angler interviews and retained fish would be missed by terminating surveys at 1400 hours on weekends and at 1600 hours on weekdays (Table 1). The earlier the termination time, the greater the amount of missed information. For any given termination time, less information was missed on weekends compared with weekdays and during the high-use season compared with the low-use season. For any given termination time during the high-use season, the amounts of bay and Gulf angler information missed were sim-

Table 1.—Percent of angler interviews and retained fish that would have been missed coastwide by terminating a survey early when no angler interviews were conducted by a specified termination time by day type, season, and area fished.

| Season | Termination time | Weekend | | | | Weekday | | | |
| | | Bay | | Gulf | | Bay | | Gulf | |
		Interviews	Fish	Interviews	Fish	Interviews	Fish	Interviews	Fish
High-use	1100h	18.0%	18.4%	16.8%	17.5%	43.9%	42.0%	40.2%	37.6%
	1200	4.4	4.5	4.5	5.9	15.1	14.9	13.9	16.4
	1300	1.3	1.1	1.7	4.2	5.9	5.6	4.8	6.6
	1400	0.4	0.3	0.4	1.9	3.3	2.9	3.0	4.9
	1500	0.2	0.2	0.2	0.8	1.6	1.1	1.8	3.1
	1600	0.1	0.1	0.1	0.7	0.7	0.5	0.9	1.9
	1700	<0.1	<0.1	<0.1	0.0	0.3	0.2	0.2	0.4
Low-use	1100	40.6	38.9	39.2	47.4	64.2	62.2	78.8	75.4
	1200	13.5	12.0	15.3	30.0	33.4	29.6	42.3	39.7
	1300	5.6	5.3	5.3	5.1	15.8	13.4	23.1	18.0
	1400	2.9	2.9	2.1	2.8	9.5	7.7	17.3	14.4
	1500	1.5	1.9	2.1	2.8	5.8	3.6	13.5	14.2
	1600	0.4	0.3	0.0	0.0	2.5	1.5	1.9	0.5
	1700	1.0	0.0	0.0	0.0	0.6	0.4	0.0	0.0

ilar; however, during the low-use season, less information was normally missed on bay anglers.

The percent of angler interviews and retained fish that would be missed if surveys were terminated early (before 1800 hours) varied significantly ($P < 0.05$) among day types, seasons, areas fished, and bay systems (Table 2), although some bay systems were similar ($P \geq 0.05$) and these bay systems were grouped accordingly (Tables 3 and 4). During the high-use season, the bay system groups that missed the most bay angler information varied by day type and type of information missed (interview vs. retained fish); however, for missed Gulf angler information, the Galveston Bay system was always the highest (Table 3). During the low-use season, the bay system groups that missed the most bay angler information varied by day type and type of information missed, except that both the Matagorda and Aransas Bay systems were always in those groups with only one exception each (Table 4). For missed Gulf angler information in the low-use season, all bay systems were similar.

Applying a coastwide termination time of 1400 hours on weekends and 1600 hours on weekdays, during the high-use season the greatest survey bias would occur in the Galveston Bay system where 6.6 percent and 7.9 percent of the Gulf retained fish would be missed on weekends and weekdays, respectively. During the low-use season, the Matagorda and Aransas Bay systems would be most out of line with the coastwide average loss of information; on weekends, 7.2 percent of the bay retained fish would be missed in both bay systems while on weekdays 5.1 percent of the bay angler interviews would be missed in the Matagorda Bay system.

Coastwide, 14 percent of all weekend surveys could be terminated at 1400 hours and 23 percent of all weekday surveys could be terminated at 1600 hours (Table 5). The earlier the termination time the greater the proportion of survey days that could be terminated early. For any given termination time, a greater proportion of surveys days could be terminated on weekdays compared with weekends

Table 2.—Summary of results of three-way analyses of variance of the percent of interviews and of retained fish missed by termination time, day type, and bay system for bay and for Gulf anglers in the high- and in the low-use season.

Group and season	Source of variation	Degrees of freedom	Sum of squares	F value	Group and season	Source of variation	Degrees of freedom	Sum of squares	F value
Bay interviews High-use	Total	97	13,056.69		Gulf interviews High-use	Total	55	7,701.36	
	Time	6	10,602.44	632.54*		Time	6	5,266.21	161.68*
	day type	1	1,412.72	505.70*		day type	1	737.95	135.94*
	Bay	6	256.58	15.31*		Bay	3	895.78	55.00*
	Time×Day type	6	499.31	29.79*		Time×Day type	6	316.14	9.71*
	Time×Bay	36	127.36	1.27NS		Time×Bay	18	326.09	3.34*
	Day type×Bay	6	57.71	3.44*		Day type×Bay	3	61.48	3.78*
	Error	36	100.57			Error	18	97.71	
Low-use	Total	97	24,372.24		Low-use	Total	55	26,198.33	
	Time	6	20,516.37	693.90*		Time	6	18,349.13	36.75*
	Day type	1	1,915.89	388.79*		Day type	1	1,295.67	15.57*
	Bay	6	562.53	19.03*		Bay	3	121.25	0.49NS
	Time×Day type	6	285.86	9.67*		Time×Day type	6	690.49	1.38NS
	Time×Bay	36	595.91	3.36*		Time×Bay	18	2,347.04	1.567NS
	Day type×Bay	6	318.28	10.77*		Day type×Bay	3	1,896.69	7.60*
	Error	36	177.40			Error	18	1,498.06	
Bay fish High-use	Total	97	13,239.44		Gulf fish High-use	Total	55	9,065.28	
	Time	6	10,750.30	533.78*		Time	6	5,308.03	132.45*
	Day type	1	1,356.56	404.14*		Day type	1	664.30	99.46*
	Bay	6	305.71	15.18*		Bay	3	2,106.48	105.13*
	Time×Day type	6	473.50	23.51*		Time×Day type	6	214.15	5.34*
	Time×Bay	36	171.34	1.42NS		Time×Bay	18	614.91	5.11*
	Day type×Bay	6	61.19	3.04*		Day type×Bay	3	37.19	1.86NS
	Error	36	120.84			Error	18	120.22	
Low-use	Total	97	24,610.23		Low-use	Total	55	31,168.21	
	Time	6	20,676.43	286.78*		Time	6	21,962.20	25.36*
	Day type	1	1,310.80	109.08*		Day type	1	630.58	4.37NS
	Bay	6	710.30	9.85*		Bay	3	545.33	1.26NS
	Time×Day type	6	354.12	4.91*		Time×Day type	6	1,212.89	1.40
	Time×Bay	36	710.16	1.64NS		Time×Bay	18	3,418.89	1.32NS
	Day type×Bay	6	415.82	5.77*		Day type×Bay	3	800.75	1.85NS
	Error	36	432.60			Error	18	2,597.59	

* = Significant at $P<0.05$.
NS = Not significant at $P=0.5$.

Table 3.—Percent of high-use season angler interviews and retained fish that would have been missed by terminating a survey early when no angler interviews were conducted by a specified termination time by day type, area fished and bay system group[1]. (Number in parentheses is mean number of interviews or retained fish for respective survey period and area fished.)

	Weekend								Weekday							
	Bay				Gulf				Bay				Gulf			
	Interviews		Fish		Interviews		Fish		Interviews		Fish		Interviews		Fish	
Termination time	G-M-A (1,314)	S-C-U-L (2,091)	G-M (6,040)	S-A-C-U-L (15,667)	G (32)	M-S-A-C-U-L (545)	G (141)	M-S-A-C-U-L (2,886)	G-S-C-L (1,475)	M-A-U (972)	M (1,958)	G-S-A-C-U-L (17,072)	G (11)	M-S-A-C-U-L (242)	G (86)	M-S-A C-U-L (1,414)	L (203)
1100h	25.5%	13.5%	27.5%	14.1%	20.5%	16.4%	34.5%	15.1%	41.2%	49.6%	56.8%	40.8%	45.8%	39.8%	50.4%	38.3%	29.1%
1200	5.6	3.7	5.6	4.0	13.5	3.5	22.1	3.6	13.4	18.6	27.4	13.9	39.6	11.8	43.2	15.3	8.5
1300	2.2	0.7	2.1	0.6	10.9	0.7	20.6	1.9	4.7	8.5	11.0	5.2	25.0	3.2	33.7	5.0	0.6
1400	0.7	0.2	0.6	0.1	2.0	0.2	6.6	1.3	2.5	4.7	7.8	2.5	13.5	2.1	17.7	4.5	0.6
1500	0.4	0.1	0.5	0.1	1.3	0.1	6.3	0.0	1.1	2.5	1.8	1.0	10.4	1.1	15.3	2.4	0.0
1600	0.2	0.1	0.1	0.1	0.7	0.1	5.3	0.0	0.4	1.3	1.3	0.5	2.1	0.8	7.9	1.6	0.0
1700	0.1	0.1	0.1	0.0	0.3	0.0	0.0	0.0	0.2	0.7	1.1	0.1	1.0	0.1	0.0	0.5	0.0

[1]G = Galveston Bay system, M = Matagorda Bay system, S = San Antonio Bay system, A = Aransas Bay system, C = Corpus Christi Bay system.
U = upper Laguna Madra system, and L = lower Laguna Madre system.

Table 4.—Perent of low-use season angler interviews and retained fish that would have been missed by terminating a survey early when no angler interviews were conducted by a specified termination time by day type, area fished and bay system group[1]. (Number in parentheses is mean number of interviews or retained fish for respective survey period and area fished.)

	Weekend							Weekday							
	Bay					Gulf		Bay						Gulf	
	Interviews		Fish			Interviews	Fish	Interviews			Fish			Interviews	Fish
Termination time	G-M-A-L (387)	S-C-U (268)	G-U-L (983)	M-A (872)	S-C (535)	G-M-S-A-C-U-L (38)	G-M-S-A-C-U-L (975)	G-C-L (208)	M (63)	S-A-U (127)	G-C-L (1,885)	M (302)	S-A-U (747)	G-M-S-A-C-U-L (8)	G-M-S-A-C-U-L (155)
1100h	50.3	31.9	37.5	54.7	34.8	39.2	47.4	60.4	66.7	69.6	59.2	71.1	65.4	78.8	75.4
1200	18.7	8.9	14.0	22.8	4.6	15.3	30.0	29.2	47.2	36.7	24.6	48.5	34.4	42.3	39.7
1300	8.8	2.8	6.6	8.5	1.9	5.3	5.1	11.8	27.0	19.6	8.2	23.9	19.9	23.1	18.0
1400	3.8	2.0	3.1	7.2	0.8	2.1	2.8	6.3	18.6	12.4	4.6	22.2	10.0	17.3	14.4
1500	2.3	0.8	2.6	2.7	0.4	2.1	2.8	3.9	14.8	6.6	2.6	15.1	3.2	13.5	14.2
1600	0.4	0.3	0.1	0.8	0.4	0.0	0.0	1.6	5.1	3.3	1.0	3.2	2.1	1.9	0.5
1700	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.4	2.5	0.6	0.5	0.4	0.2	0.0	0.0

[1]G = Galveston Bay system, M = Matagorda Bay system, S = San Antonio Bay system, A = Aransas Bay system, C = Corpus Christi Bay system.
U = upper Laguna Madra system, and L = lower Laguna Madre system.

Table 5.—The number and percent of survey days coastwide that could have terminated early when no angler interviews were conducted by a specified termination time by day type and season.

| | Season | | | | | |
| | High-use | | Low-use | | Annual | |
Termination time	No.	%	No.	%	No.	%
Weekend						
1100h	84	39.6	57	67.9	141	47.6
1200	40	18.9	37	44.0	77	26.0
1300	25	11.8	28	33.3	53	17.9
1400	18	8.5	23	27.4	41	13.9
1500	14	6.6	20	23.8	34	11.5
1600	11	5.2	17	20.2	28	9.5
1700	9	4.2	15	17.9	24	8.1
Weekday						
1100	300	67.9	140	83.3	440	72.1
1200	190	43.0	114	67.9	304	49.8
1300	133	30.1	94	56.0	227	37.2
1400	109	24.7	82	48.8	191	31.3
1500	89	20.1	72	42.9	161	26.4
1600	76	17.2	62	36.9	138	22.6
1700	66	14.9	54	32.1	120	19.7

Table 6.—Number and percent of survey days that could have terminated early when no angler interviews were conducted by a specified termination time by day type, season and bay system group.

| Season and Day | Termination time | Bay system group | Survey days terminated early | | Season and Day | Termination time | Bay system group | Survey days terminated early | |
			percent	Number				percent	Number
High-use					Weekday				
Weekend	1100h	G-M-A	49.2%	46	(cont.)	1700	G-M-A-U	18.0	48
		S-C-U-L	31.6	38			S-C	13.8	15
	1200	G-M-A	25.0	23			L	5.1	3
		S-C-U-L	13.9	17	Low-use				
	1300	G	21.4	7	Weekend	1100	G-M-A	81.1	29
		M-S-A-C-U-L	9.9	18			S-C-U-L	58.3	28
	1400	G-M-S-A-C-L	9.2	17		1200	G-M-A	56.4	20
		U	2.4	1			S-C-U-L	35.3	17
	1500	G-M-S-A-C-L	7.2	13		1300	G-M-A	43.6	16
		U	2.4	1			S-C-U-L	24.2	12
	1600	G-M-S-A-C-U-L	5.2	11		1400	G-M-A	37.9	14
	1700	G-M-S-A-C-U-L	4.2	9			S-C-U-L	19.2	9
Weekday	1100	G-M-A-C-U	71.6	236		1500	G-M-A	32.9	12
		S	55.7	26			S-C-U-L	16.3	8
		L	57.8	38		1600	G-M-A	29.3	11
	1200	G-M-A-U	48.9	129			S-C-U-L	13.4	6
		S-L	31.6	35		1700	G-M-A-U	22.0	11
		C	38.8	26			S-C-L	12.2	4
	1300	G-S-C	31.4	56	Weekday	1100	G-M-S-A-C-U-L	83.6	140
		M-A-U	34.3	68		1200	G-S-A-C-U-L	65.1	94
		L	13.4	9			M	83.0	20
	1400	G-M-A-C-U	28.2	93		1300	G-S-A-C-U-L	53.8	77
		S	20.7	10			M	71.0	17
		L	9.1	6		1400	G-M-S-A-C-U-L	48.8	82
	1500	G-M-A-C-U	23.3	77		1500	G-M-S-A-C-U-L	42.7	72
		S-L	11.1	12		1600	G-M-S-A-C-U	38.8	56
	1600	G-M-A-U	20.5	54			L	24.0	6
		S-C	15.9	18		1700	G-M-S-A-C-U-L	32.1	54
		L	5.4	4					

[1]G = Galveston Bay system, M = Matagorda Bay system, S = San Antonio Bay system, A = Aransas Bay system, C = Corpus Christi Bay system, U = upper Laguna Madre system, and L = lower Laguna Madre system.

and during the low-use season compared with the high-use season.

The proportion of survey days that could be terminated early varied significantly ($P < 0.05$) among day types, seasons, and bay systems, although some bay systems were similar ($P \geq 0.05$) and these bay systems were grouped accordingly (Table 6). For each termination time, the bay system groups varied by day type and season; however, the Galveston, Matagorda, and Aransas Bay systems were nearly always in the groups with the highest percent of potential early termination days. Applying a coastwide termination time of 1400 hours on weekends and 1600 hours on weekdays, these

three bay systems would realize the greatest proportion of early terminated surveys with 9 percent and 30 percent, respectively, during the high-use season and 38 percent and 39 percent, respectively, during the low-use season. The lower Laguna Madre system was nearly always in the group with the least proportion of early terminated surveys.

Discussion

On-site creel surveys are used to estimate values, such as fishing pressure and landings, needed to assess fisheries and to formulate management strategies (Malvestuto, 1983). A basic disadvantage of this survey method, however, is that time spent surveying at low activity sites is not cost effi-

cient. Simply limiting the number of creel survey samples to lower costs could result in the precision of estimates being reduced (Best and Boles, 1956). Weixelman and Green (1984), however, found that weekend surveys of bay anglers could be terminated at 1400 hours when no angler interviews had been conducted and <4 percent of coastwide angler interview and retained fish data would be missed. This study confirmed those results for Gulf anglers and demonstrated that weekday surveys of both bay and Gulf anglers can also be terminated early when no angler interviews have been conducted by a specified time with a minimal loss of survey information.

According to Weixelman and Green (1984) the advantages of terminating unproductive creel surveys early are threefold: 1) More effective use of personnel time, 2) improved personnel morale, and 3) improved public relations. The disadvantage is missed information. In each creel survey program, the administrative agency must determine how much information can be missed and still maintain the statistical credibility of the study. For the current Texas Parks and Wildlife Department saltwater sport boat fishery monitoring program, a <3 percent loss of coastwide survey information would result in reductions in estimates of annual total finfish landings of approximately 2 percent (Osburn and Ferguson, 1986; TPWD[1]).

Assuming the tolerable loss of coastwide information for either bay or Gulf anglers is <5 percent for any day type and season, then maximum efficiency would result from early termination times of 1300 hours on weekends and 1400 hours on weekdays in the high-use season and 1400 hours on weekends and 1600 hours on weekdays in the low-use season. Consideration must be given, however, to the uniformity and ease of applying early termination procedures as well as to the effect on individual bay system estimates. We recommend that early termination times of 1400 on weekends and 1600 on weekdays be adopted coastwide throughout the survey year. This would allow an average of 179 surveys annually to be terminated early, thus resulting in the redirection of 440 survey personnel man-hours and $6,063 in operating expenses, including $5,413 in salaries and $650 in meal reimbursements.

Acknowledgments

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[1]TPWD Marine Laboratory, Rockport, Tex. Unpubl. data

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