Comparison of Volunteer Angler-supplied Fisheries Catch and Population Structure Data with Traditional Data

John A. Prentice, *Texas Parks and Wildlife Department, Heart of the Hills Research Station, HC7, Box 62, Ingram, TX 78025*

Bobby W. Farquhar, *Texas Parks and Wildlife Department, Inland Fisheries, 6200 Hatchery Road, Ft. Worth, TX 76114*

Wilbur E. Whitworth,[1] *Texas Parks and Wildlife Department, Inland Fisheries, 4200 Smith School Road, Austin, TX 78744*

Abstract: A volunteer angler diary program was evaluated as a data source compared to traditional fisheries census techniques (i.e., electrofishing, gill netting, and on site creel surveys). Anglers were supplied fishing diaries and asked to record lengths of fishes caught, location, and time fished in Texas public waters, 1986–1988. Volunteer angler-supplied (ANG) length and catch-per-unit-effort (CPUE) data were then compared to traditional fisheries census data for the same season and water body. Although ANG data were reported for 4,581 trips, 144 reservoirs, and 10 species or species groups, sufficient data for analysis was obtained only for largemouth bass (*Micropterus salmoides*). Regression analysis of ANG and traditional data indicated significant but variable relations existed for PSD ($r^2 = 0.28$; $P = 0.0159$), RSD ($r^2 = 0.56$; $P = 0.0002$), and CPUE ($r^2 = 0.42$; $P = 0.0050$). Cost of ANG data on a per fish basis was about one-third that of traditional methods. Anglers were supportive of the program. ANG data could be useful to a fisheries management agency as supplemental data, or as a warning system so agency data can be collected to determine action when ANG data indicate problems.

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Angler catch data are generally easier to obtain and less costly than data obtained from sources such as electrofishing or gill nets (Weiss-Glanz and Stanley 1984, Green et al. 1986, Willis and Hartmann 1986). For this reason, anglers have been used to help assess various population parameters. Such parameters have included estimates of population abundance using mark-recapture (Ricker 1975) or depletion techniques (DeLury 1947, Mottley 1949), mortality rate estimates using

[1]Present address: 210 Arikara Drive, Buda, TX 78610.

catch curve analysis (Farman et al. 1982), and population structure indices such as Proportional or Relative Stock Density (PSD or RSD; Anderson 1978, Reynolds and Babb 1978, Wege and Anderson 1978) for managing freshwater sport fishes, especially largemouth bass (Weiss-Glanz and Stanley 1984, Green et al. 1986, Ebbers 1987).

A number of studies to determine the usefulness of voluntarily supplied angler catch data have provided mixed results. Green et al. (1986) evaluated a program in which anglers kept their catch records in a fishing diary and reported results to the New York fisheries conservation agency. In that program, electrofishing and diary length-frequency distributions, PSDs, and catch rates from the same lakes and years generally compared favorably. McEachron et al. (1986) found anglers accurately reported fishing trip durations on creel surveys along the Texas coast. Ferguson et al. (1984) found angler reported fish length estimates were comparable to measurements taken by biologists; however, the angler estimates were biased toward whole English units, which increased variance. Bryant and Jones (1991) also found anglers biased fish length by reporting to the nearest half or whole English unit. Gabelhouse and Willis (1986) found good correlation between angler supplied and electrofishing largemouth bass population data, but catch rates varied by angler type (bass tournament angler, non-tournament bass angler, or non-bass angler).

Some states routinely collect size and catch data from tournament fishing (Shupp 1978) to help assess largemouth bass stocks. A program established in Kansas to collect data from largemouth bass tournaments (Willis and Hartmann 1986) produced biased but usable data (Gabelhouse and Willis 1986). In that program, tournament anglers consistently reported higher proportions of larger fish than electrofishing. Except for large fish, data from anglers and electrofishing generally compared favorably. Ebbers (1987) found angler-supplied data from tournaments and diaries closely matched data from spring electrofishing. Alexander and Holbrook (1978) found tournament catch rates were not different from creel census catch rates on 3 Tennessee reservoirs, while mean fish weights from the creel were smaller. Similarly, largemouth bass tournament fishing and creel survey harvest rates and mean weights from 6 Texas reservoirs were not found different by direct comparison (Dolman 1991). Weiss-Glanz and Stanley (1984) used tournament and non-tournament angler-supplied data to calculate PSD and RSD values; however, they did not compare angler data to electrofishing or other traditional data collection. Likewise, Van Horn and Birchfield (1981) collected catch data from North Carolina largemouth bass tournaments to monitor trends in bass relative abundance but did not validate angler data with other traditional estimates of relative abundance.

Fishing diary programs have provided inexpensive and useful data for some fish populations (Green et al. 1986, Ebbers 1987), but not for others (Jones and Van Horn 1985, Bryant and Jones 1991). These programs typically recruit volunteer anglers to record basic statistics such as fish length, number of fish caught, trip duration, and trip frequency data for 1 or selected species and waters. The ob-

jectives of this study were to evaluate 1) similarity of angler-supplied data to traditional fisheries agency data and therefore usefulness of a volunteer angler diary program for collecting catch-per-unit-effort (CPUE) and size structure data for multiple fish species in Texas fresh waters, and 2) attitudes of anglers toward the program and the fishing diary used.

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Methods

Volunteer Angler Recruitment

Volunteer anglers were recruited by TPWD in 1986–1987 by publishing news releases in newspaper sporting sections statewide, by biologists attending fishing club meetings, and by arranging special meetings of biologists and anglers through bait shops in various parts of the state. Initial recruitment efforts were directed at fishing clubs (primarily largemouth bass anglers) due to the efficiency of reaching many anglers with minimal effort. All volunteers were required to attend a training seminar. Most training seminars were held in conjunction with fishing club meetings and consisted of a biologist explaining the purpose of the program, what the data would be used for, how to measure a fish, and how to record data. Volunteers were then asked to record information on all fishing trips they took on Texas public waters.

Two incentives were used to increase volunteer interest and participation. Volunteers periodically received a newsletter which informed them of results from the data and of any developments or problems in the program, and the diaries were returned to the volunteers after TPWD recorded the data to provide the volunteers with a record of their catch.

Data Collection

Volunteer Angler Data.—Methods were patterned after Green et al. (1986) using a fishing diary system. A preliminary version of the fishing diary was developed and pretested on 50 anglers. Wording and format were revised according to angler suggestions and TPWD needs to create the final diary form (Fig. 1). The diary was designed with 3 objectives: 1) create an accurate instrument for recording data, 2) make the diary as easy to use as possible and 3) make the diary as useful to the volunteer angler as possible to encourage participation. Diary size (10.5×17.5 cm) was convenient for storage in a tackle box or clothing pocket. Each diary contained pages for 7 fishing trips. Required information was listed on the left page and optional information on the right (Fig. 1). All optional data were for angler use only and were not included in analyses. Each diary also contained instructions in the front explaining how to measure a fish, species abbreviations for diary use, general

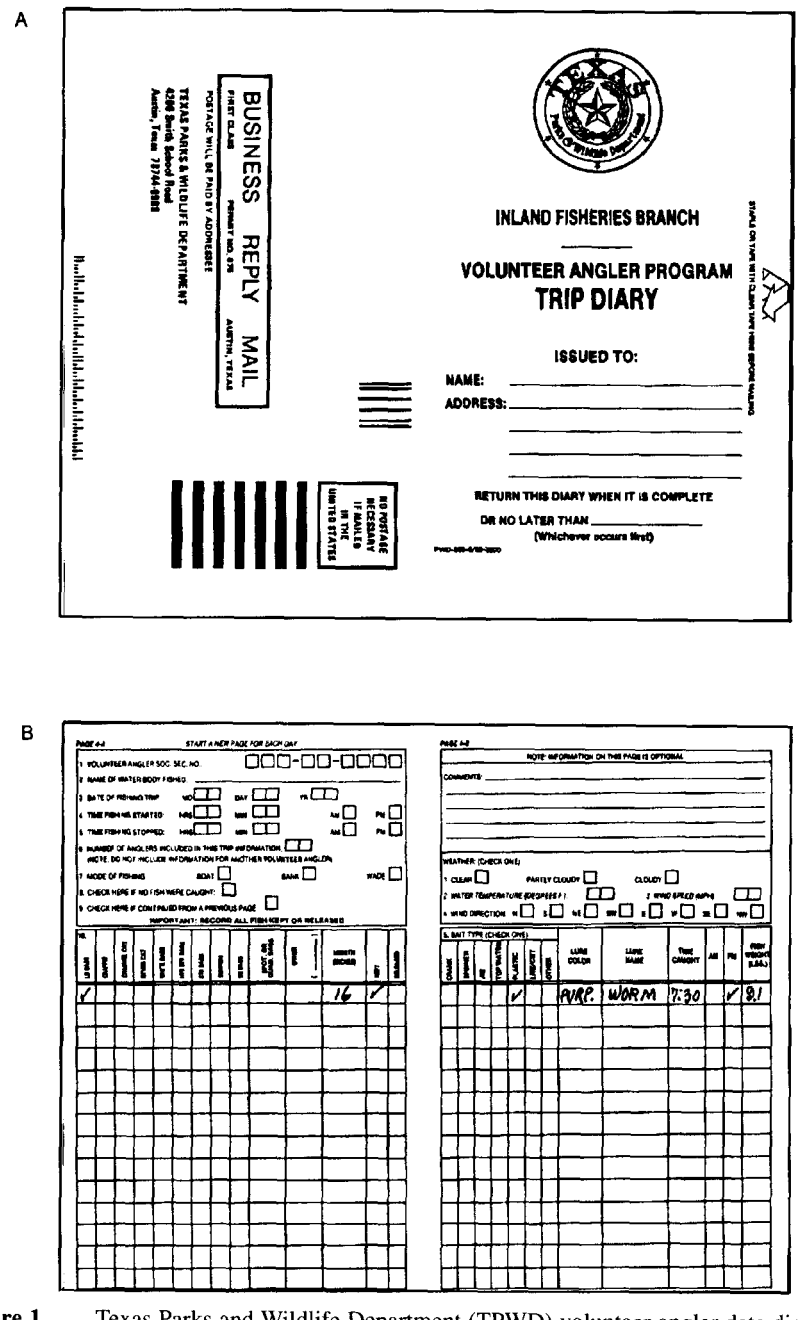

Figure 1. Texas Parks and Wildlife Department (TPWD) volunteer angler data diary format, 1986–1988. Top half of figure (A) is the diary cover, back (with prepaid postage for return to TPWD address), and front (with angler name and address and return date). Bottom half of figure (B) is the diary opened to pages 4-A and 4-B for recording data for a fishing trip with an example entry on the first line.

instructions on important diary aspects, and instructions on how to complete specific items. Diaries were issued 2 at a time so anglers would always have at least 1 diary in their possession. Anglers returned a diary to TPWD (diaries were printed with a return address and were postage paid) when completed or after 6 months and were furnished replacement diaries. Upon receipt, diaries were edited by TPWD for completeness, legibility, and errors. If any problem was found with a returned diary, the reporting volunteer was contacted and the problem resolved. Data from completed diaries were entered into a computer for analyses.

Traditional Data.—Electrofishing, frame netting, and gill netting are the primary TPWD data-collecting techniques for fish population surveys. Fixed-access, stratified random creel survey is the TPWD data collection technique for angler resource use and catch (fish harvested plus fish caught and released) and harvest measurements. Data for this study were taken from all fish populations census and creel survey data taken routinely or for special projects, 1986–1988. All data were collected from Texas public waters using standardized procedures as described by TPWD (1989).

Statistical Analysis

Statistical analyses were conducted to determine similarity of volunteer angler-supplied (ANG) fish length distribution and abundance data to independently collected TPWD data. For each species, ANG and TPWD data were searched to find water bodies and seasons where ≥20 individuals of a species were reported. A sample size of 20 fish was selected as a minimum number to produce fishery management indices or decisions as discussed by Anderson and Gutreuter (1983) and Gustafson (1988). ANG data were then cross-referenced with appropriate TPWD data to obtain data pairs for both data sources from the same water body during the same year and season. These data pairs were compared for similarities in size structure indices and CPUE.

Stock structure indices from ANG and TPWD data were compared using least-squares linear and logistic (Agresti 1990) regression analyses. Results from the 2 regression techniques were concordant; therefore, we present results from least-squares regression only. Measures of abundance were compared by least-squares regression of ANG with TPWD CPUE. Two-tailed t-tests were used to determine if intercepts or slopes of significant relations were significantly different from 0.0 or 1.0, respectively. Probability level was set at $P \leq 0.05$ to identify significant differences.

Determination of Data Costs

Costs to obtain total data sets were determined for both ANG and TPWD systems during calendar year 1987. ANG system costs included diaries (materials, printing, and mailing), labor (TPWD personnel time to recruit, train, and communicate with volunteers as well as to receive, edit, and transcribe data from diaries to computer storage) and computer analysis/report generation. TPWD systems costs included (for fall/spring electrofishing, fall frame netting, and spring/summer gill

netting) labor (TPWD personnel time to prepare equipment, travel time to and from collection site, time performing sampling, and data recording), meals, lodging, and vehicle fuels. Capital equipment (boats, computers, trucks, collection gear, etc.) was not included in ANG or TPWD costs. Total cost of each data set was then divided by number of target fishes collected that were usable (≥20 individuals of a species per water body per season) to get cost per fish for comparison. Because of the low number of waters with TPWD creel surveys conducted annually, creel survey costs were not included.

Evaluation of the Program by Volunteer Anglers

Volunteers were mailed a 25-question evaluation questionnaire to determine attitudes about the program, why they enrolled in the program, willingness to participate in the future, and the volunteer's opinion of the diary. The questionnaire was mailed near the end of the study (fall 1988).

Results

Basic Statistics

The volunteer angler program interested 1,155 anglers. Of these, 648 (56%) attended a training seminar and received diaries. The 648 volunteer anglers were fishing club members (84.3%), non-club anglers (10.3%), and fishing guides (5.4%). One or more diaries were returned to TPWD by 277 (43%) of those anglers

Table 1. Volunteer angler catch totals (*N*) for all reported fish species from Texas public reservoirs and number of volunteer angler and Texas Parks and Wildlife Department (TPWD) data sets, 1986–1988. ANG column represents the number of reservoirs for which volunteer angler data sets contained ≥20 individuals per season. TPWD columns represent the number of reservoirs for which there were comparable data sets from various collecting gears.

			TPWD reservoirs			
Species[a]	*N*	ANG reservoirs	Electrofishing	Gill netting	Frame netting	Creel survey[b]
Channel catfish	176	2	0	0	0	
Other catfishes[c]	38	0	0	0	0	
White bass	1,172	15	0	3	0	
Striped bass	912	2	0	1	0	
Palmetto bass	230	4	0	2	0	
Lepomis spp[d]	632	8	0	0	0	
Smallmouth bass	97	1	0	0	0	
Spotted bass	631	6	0	0	0	
Largemouth bass	18,033	76	20	2	0	17
Pomoxis spp[e]	1,790	10	0	0	0	
Fish species unknown	293	3	0	0	0	

[a] Common species names are from Robins et al. (1991).
[b] ANG and TPWD creel survey corresponding data sets were selected only for largemouth bass.
[c] Includes blue catfish, black bullhead, yellow bullhead and flathead catfish.
[d] Includes redbreast sunfish, green sunfish, warmouth, bluegill, longear sunfish, and redear sunfish.
[e] Includes white crappie and black crappie.

who had received them. Anglers returned 981 diaries which reported 4,581 fishing trips from 144 reservoirs. During 1986, 1987, and 1988, 178, 204, and 45 anglers expended 8,929, 26,204 and 5,805 angler-hours on 94, 135, and 61 reservoirs, respectively. Anglers reported catches of several species, with the most frequently caught being largemouth bass (Table 1). However, usable ANG data sets, ≥ 20 fish per season per reservoir, were obtained for 9 species or species groups from 124 reservoirs. Fewer data pairs were available when ANG and TPWD data sets were matched to obtain comparable reservoir and season data for both data sets (Table 1).

Size Structure Indices Analysis

Data pairs for 20 largemouth bass populations were found between ANG and TPWD electrofishing sources (Table 1, 2), while 3 or less data pairs for white bass (*Morone chrysops*), striped bass (*M. saxatilis*), palmetto bass (*M. chrysops* x *M. saxatilis*), or largemouth bass were found between ANG and TPWD gill netting sources (Table 1). Regression analysis performed on largemouth bass data from ANG and TPWD electrofishing sources (Table 2) indicated significant relations existed for PSD (r^2 = 0.28; P = 0.0159) and RSD (r^2 = 0.56; P = 0.0002), but variability, especially for PSD, made confidence in predictability by these models (Fig. 2A, 2B) low. The PSD relation (dependent variable = ANG PSD; intercept±SE = 41.1±12.03; slope±SE = 0.61±0.23) had an intercept significantly

Table 2. Voluntary angler (ANG) and Texas Parks and Wildlife Department (TPWD) electrofishing sample size of stock (S), preferred (P) and quality (Q)[a] length largemouth bass and calculated Proportional (PSD) and Relative (RSD) Stock Densities for various Texas reservoirs and seasons.

			ANG					TPWD				
Reservoir	Year	Season	S	P	Q	PSD	RSD	S	P	Q	PSD	RSD
Amistad	1986	Fall	82	42	5	51	6	33	12	3	36	9
Bastrop	1986	Fall	100	72	20	72	20	41	23	2	56	5
Choke Canyon	1986	Fall	89	70	29	79	33	68	22	5	32	7
Conroe	1987	Spring	27	22	7	81	26	112	61	27	54	24
Fayette County	1986	Fall	70	64	45	91	64	76	57	35	75	46
Fayette County	1987	Spring	80	76	61	95	76	99	80	60	81	61
Gibbons Creek	1986	Fall	23	7	2	30	9	127	61	44	48	35
Jacksonville	1986	Fall	27	14	4	52	15	32	10	3	31	9
Livingston	1986	Fall	26	15	6	58	23	88	40	16	45	18
Martin Creek	1986	Fall	146	98	14	67	10	57	15	3	26	5
Monticello	1986	Fall	99	94	69	95	70	75	35	23	47	31
Monticello	1987	Spring	24	24	15	100	63	77	71	46	92	60
Palestine	1986	Fall	45	19	4	42	9	48	21	8	44	17
Palestine	1987	Spring	31	27	11	87	35	46	21	9	46	20
Proctor	1986	Fall	45	33	8	73	18	27	14	2	52	7
Sam Rayburn	1987	Winter	281	203	60	74	21	64	30	8	47	13
Texoma	1987	Spring	122	84	30	69	25	24	11	5	46	21
Toledo Bend	1986	Fall	60	33	7	55	12	73	39	16	53	22
Toledo Bend	1987	Winter	135	113	51	84	38	104	51	12	49	12
Whitney	1986	Fall	52	41	15	79	29	21	8	2	38	10

[a] Stock, prefered and quality lengths are ≥20.3 cm, ≥30.5 cm, and ≥38.1 cm, respectively.

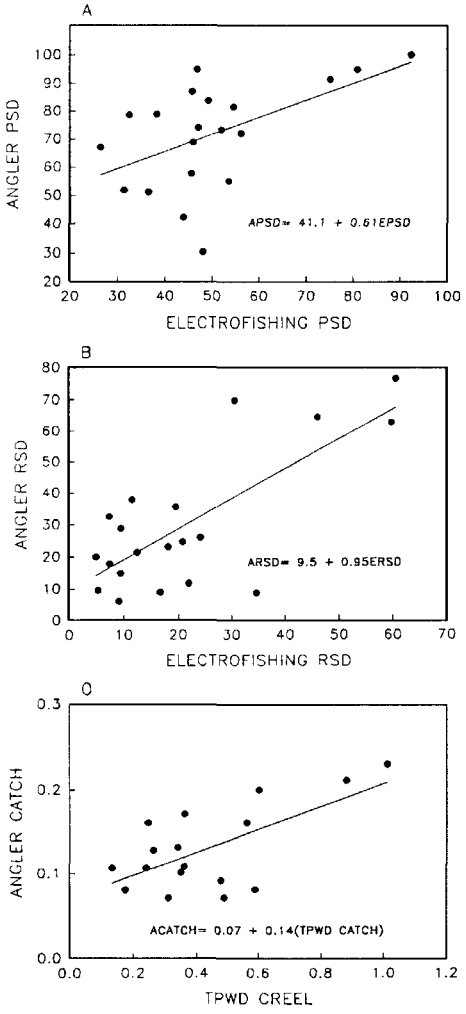

Figure 2. Scatter plot and best fit regressions between volunteer angler (ANG) and Texas Parks and Wildlife Department (TPWD) data sources for Proportional and Relative Stock Density (PSD and RSD) population structure indices and catch-per-unit-effort (CPUE) for largemouth bass. Regression A is between ANG PSD (APSD) and TPWD electrofishing PSD (EPSD) ($r^2 = 0.28$; $P = 0.0159$). Regression B is between ANG RSD (ARSD) and TPWD electrofishing RSD (ERSD) ($r^2 = 0.56$; $P = 0.0002$). Regression C is between ANG (ACATCH) and TPWD creel census catch rates (TPWD CATCH) ($r^2 = 0.42$; $P = 0.0050$).

greater than 0.0 but no difference from 1.0 in slope was found. However, no significant differences were found from 0.0 intercept or 1.0 slope in the RSD relation (dependent variable = ANG RSD; intercept±SE = 9.5±5.41; slope±SE = 0.95±0.20). PSD and RSD relations showed volunteers tended to catch a higher proportion of large individuals from a population than TPWD.

Catch Rates Analysis

Data pairs for CPUE were found for 20 and 17 largemouth bass populations between ANG and TPWD electrofishing sources and between ANG and TPWD creel survey sources, respectively (Tables 1,3). Regression analysis of ANG and TPWD electrofishing CPUE data indicated no significant relation existed. Regres-

Table 3. Voluntary angler (ANG) and Texas Parks and Wildlife Department (TPWD) catch-per-unit-of-effort (CPUE; hours) for largemouth bass including all (CPUE-A) and only stock[a] (CPUE-S) lengths from ANG and TPWD electrofishing data and harvest[b] (CPUE-H) and catch[c] (CPUE-C) from creel survey data for various Texas reservoirs and seasons. Blanks indicate no corresponding data are available.

					TPWD			
			ANG		Electrofishing		Creel survey	
Reservoir	Year	Season	CPUE-A	CPUE-S	CPUE-A	CPUE-S	CPUE-H	CPUE-C
Amistad	1986	Fall	0.252	0.250	18.40	13.20		
Bastrop	1986	Fall	0.055	0.054	93.00	49.00		
Choke Canyon	1986	Fall	0.174	0.174	60.00	31.00		
Conroe	1987	Spring	0.308	0.308	46.00	33.33		
Fayette County	1986	Fall	0.093	0.092	85.60	60.00		
Fayette County	1987	Winter	0.160	0.160			0.025	0.247
Fayette County	1987	Spring	0.130	0.128	68.37	51.69	0.021	0.263
Gibbons Creek	1986	Fall	0.074	0.074	44.00	38.77		
Jacksonville	1986	Fall	0.189	0.186	26.00	20.00		
Livingston	1986	Fall	0.802	0.802	29.38	20.59		
Martin Creek	1986	Fall	0.127	0.126	57.33	36.67		
Monticello	1986	Fall	0.106	0.106	56.67	50.00	0.034	0.242
Monticello	1987	Winter	0.110	0.107			0.027	0.135
Monticello	1987	Spring	0.081	0.081	65.60	61.60	0.067	0.590
Monticello	1987	Summer	0.131	0.131			0.025	0.339
Monticello	1987	Fall	0.071	0.071			0.046	0.310
Palestine	1986	Summer	0.108	0.108			0.101	0.361
Palestine	1986	Fall	0.167	0.160	34.23	18.26	0.061	0.563
Palestine	1987	Winter	0.081	0.081			0.062	0.175
Palestine	1987	Spring	0.101	0.101	29.50	22.50	0.141	0.351
Palestine	1987	Summer	0.075	0.071			0.043	0.489
Palestine	1987	Fall	0.091	0.091			0.084	0.479
Proctor	1986	Fall	0.258	0.215	58.67	46.67		
Sam Rayburn	1987	Winter	0.170	0.170	27.44	22.44	0.074	0.362
Sam Rayburn	1987	Spring	0.213	0.210			0.092	0.880
Sam Rayburn	1987	Summer	0.230	0.229			0.127	1.011
Sam Rayburn	1987	Fall	0.215	0.199			0.126	0.602
Texoma	1987	Spring	0.139	0.133	18.33	11.67		
Toledo Bend	1986	Fall	0.122	0.113	26.40	22.48		
Toledo Bend	1987	Winter	0.156	0.156	38.29	30.98		
Whitney	1986	Fall	0.113	0.109	15.43	10.86		

[a] Stock length largemouth bass are ≥20.3 cm.
[b] Harvest is all fish removed from a water body.
[c] Catch is fish harvested and fish caught but released.

sion comparison of ANG and TPWD creel survey catch data sources indicated a significant, although variable, relation existed ($r^2 = 0.42$; $P = 0.0050$; Fig. 2C). This relation (dependent variable = ANG CPUE; intercept±SE = 0.07±0.021; slope± SE = 0.14±0.04) had an intercept significantly greater than 0.0 and a slope significantly less than 1.0. This relation shows volunteers had a lower catch rate than anglers interviewed at TPWD creel censuses. However, regression analysis of ANG and TPWD creel survey harvest data sources found no significant relation existed.

Data Costs

Total 1987 ANG system cost was $10,517 while TPWD system cost (25 reservoirs excluding creel survey costs) was $78,465. Cost of data per usable fish was $0.85 for ANG and $2.57 for TPWD systems.

Angler Participation and Motivation

Of the 648 volunteers mailed evaluation questionnaires, 200 (31%) responded. Of these respondents, 170 (85%) reported at least 1 fishing trip in a diary. Therefore, 61% of the 277 volunteers returning diaries to TPWD responded to the questionnaire. Volunteers tended to be very experienced anglers. One-half reported ≥29 years and 75% reported ≥20 years fishing experience. One-half of the respondents also indicated they fished ≥45 days in the previous year.

Respondents were generally enthusiastic about the program. Only 7.5% indicated they were not interested in continuing participation, while 83.5% were somewhat or very interested in continuing. Also, half of those not interested said they no longer fished. Helping TPWD was the principle motivation for 75% of the respondents to participate. Recording data in the diary interfered with fishing only a little or not at all for 56% of the respondents. When responding to an open-ended question asking for general comments, 27.5% indicated the program was a good idea and 31.5% thought the diary was a good personal reference.

Assessment of the diary was also generally favorable. Instructional material in the front of the diary received almost no comments, meaning respondents were generally satisfied, and 58% either had no opinion or disagreed with the statement that a separate instructional manual would be useful. Also, 81% of respondents had no comments about changes in the optional page for angler use. Thirty-eight respondents (19%) did recommend changes to the optional page which were: add space for water clarity notes (52.6%) and add more comments space (42.1%). Although size of the diary and print was acceptable, 74.5% of respondents either had no opinion or agreed that a larger page size diary would be helpful.

Discussion

Fisheries managers require data for continuing assessment of fish populations and resource use. Volunteer anglers in this study provided data sets with usable sample sizes for 124 reservoirs including 9 species or species groups (Table 1). Ninety-six of these 124 reservoirs were not sampled by TPWD during the study period, which represents additional data to potentially aid TPWD in management decisions. Texas inland fisheries resources are large and diverse, and TPWD manpower limitations currently prevent use of traditional sampling on all Texas public waters annually. Instead, fish populations and angler creels are surveyed on 12 or 13 reservoirs annually, while generally 160 of the more than 500 Texas public reservoirs are surveyed for fish populations every 3 years. Few Texas public reservoirs (<5%) ever have agency angler creel surveys conducted. Use of ANG catch data is one method to supplement traditional fisheries survey data and to pro-

vide fishery managers some estimation of angler catch rates where agency creel surveys are not conducted.

Comparison of ANG and TPWD data sets indicated significant relationships for population index (particularly RSD) and CPUE values existed (Fig. 2). These relationships indicated anglers tended to catch a higher proportion of large individuals than TPWD, similar to observations of others (Alexander and Holbrook 1978, Gabelhouse and Willis 1986). Also, predictabilities in relationships from this study were low (low r^2), similar to those reported from other studies (Gabelhouse and Willis 1986, Green et al. 1986). This highlights the need for care whenever ANG data are used to view fisheries. ANG data should be viewed not as a replacement for traditional fisheries data, but as a supplement providing additional information (Gabelhouse and Willis 1986, Green et al. 1986, Sztramko et al. 1991). Agency usefulness of ANG data could be increased by accumulating data from ANG and TPWD sources over time for the range of fish populations and angler types experienced, and thereby better account for data variability due to these factors, if a voluntary angler diary system were implemented.

Some errors in ANG data were present in spite of volunteer training and TPWD diary editing. Most noted among error types were fish identification (293 fishes were reported as unknowns, Table 1, and there may have been some confusion with similar species, e. g., temperate basses, *Morone* spp.) and locations where fish were caught (some anglers considered tailraces part of a reservoir rather than a separate water body). Agency experience with a volunteer program and continued feedback to volunteers should further reduce angler errors. Based on questionnaire responses and TPWD experience in this study, the diary would not be modified for future use.

This study operated similar to a pilot volunteer angler program with limited recruitment and volunteer participation incentive maintenance efforts. Recruitment and volunteer group maintenance would be a continuing concern if a decision were made to use this type of data for agency fisheries management. Even though many volunteers (83.5% of questionnaire respondents) reported interest in continuing participation with TPWD, rapid decline in number of reporting volunteers and reservoirs reported was observed from 1987 to 1988 after recruitment efforts by TPWD stopped. Similar observations of declining volunteer interest and need for regular agency contact and incentive development has been noted in other studies (Green et al. 1986, Willis and Hartmann 1986, Bryant and Jones 1991, Sztramko et al. 1991). Increase of volunteer diary program participation success by tailoring to specific objectives and time periods was suggested by Green et al. (1986). However, this approach would not provide continuous statewide fisheries monitoring and could increase costs by repeated recruitment of each volunteer group as various objective needs arise. Regardless of how a volunteer program is used, costs of recruitment, training, and maintaining motivation of volunteers might be reduced by using established self-interest groups such as fishing clubs or reservoir homeowner organization as suggested by Green et al. (1986).

Largemouth bass was the only species reported frequently enough by volunteers during this study to allow comparison of ANG and TPWD data sets because

most anglers were recruited through largemouth bass-oriented fishing clubs. Two considerations are highlighted by this. First, if multiple species ANG data is desired by a managing agency, volunteers must be recruited from various angler groups (groups seeking catfishes, *Ictalurus* spp., temperate basses, crappies, *Pomoxis* spp., etc.). Second, involving a diversity of angler groups would increase recruitment effort needed and heterogeneity of the volunteer group formed in terms of skill and interest. Other researchers point out the need to have homogeneous angler groups (Gabelhouse and Willis 1986) or large angler groups with low turnover (Green et al. 1986) supplying data for comparability to agency data. A possible approach to agency use of angler data, where maximum number of water bodies and species sampled is an annual objective, is to view angler data as a warning system. Angler data received by the agency could be compiled and distributed to personnel managing the appropriate water body. Agency personnel could thereby be alerted to problems and conduct traditional sampling to determine management actions. A system such as this could serve the functions of increased data-based resource management and continuous cross checks of angler and agency data.

Attractiveness of volunteer data as a supplement to agency data was highlighted by low costs per fish ($0.85) compared to that for TPWD ($2.57). However, until reliable relationships for the range of volunteer types and fish population types and densities are determined to compare volunteer to agency data, the volunteer data costs should be considered additive to current agency costs. Also, more data is typically taken per fish by agency techniques than that recorded by volunteers. The volunteer data system also carried value by involving anglers with agency work and creating an exchange of ideas and information toward improving or maintaining the fisheries resources they enjoy as noted in other studies (Van Horn and Birchfield 1981, Green et al. 1986, Willis and Hartmann 1986, Ebbers 1987, Bryant and Jones 1991, Sztramko et al. 1991).

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