Computer Assisted Techniques for Standardized Fisheries Data Collection and Analysis

William M. Bivin, *Arkansas Game and Fish Commission, No. 2 Natural Resource Drive, Little Rock, AR 72205*

Michael L. Armstrong, *Arkansas Game and Fish Commission, No. 2, Natural Resource Drive, Little Rock, AR 72205*

Stephen P. Filipek, *Arkansas Game and Fish Commission, No. 2 Natural Resource Drive, Little Rock, AR 72205*

Abstract: Fisheries personnel of the Arkansas Game and Fish Commission have developed a standardized system of collecting, analyzing, and reporting electrofishing and rotenone sample data. The system utilizes microcomputers and custom written Microsoft QuickBasic Version 4.0 programs and dBASE files to compile sample data, generate reports, and store information in a statewide database. This system provides fish managers with a quick method for processing data with in-depth analysis while relieving them of time consuming manual processing of sample data. Processing of data is performed by a centralized computer staff for storage in a statewide database that is easily accessed by non-programmers.

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Collection, compilation, and analysis of fishery data in a way which allows quick storage and retrieval, comparisons across time, and timely processing of information to aid management decision making is a problem faced by many fishery managers. In the past, biologists with the Arkansas Game and Fish Commission operated within a rather loosely organized framework of sampling procedures and reporting. Cove-rotenone sampling procedures were fairly uniform but data reports varied in content, and electrofishing was conducted with little standardization in procedures or reporting. In addition, compilation of data and computation of necessary population statistics often took days. A single .4-ha (1-acre) cove-rotenone sample that took 2 days in the field to conduct often took 3–4 man-days to compile and analyze. Also, in-depth treatment of data such as the Available Prey/Predator Model (Jenkins and Morais 1978) and the Fish Biomass Model (Ploskey and Jenkins 1982) were not possible. With the need for better efficiency in sampling in the field and more comparable analysis by management and administrative personnel, a faster and more uniform method for sampling and reporting was needed.

To solve these problems, the Fisheries Division staff of the Arkansas Game and Fish Commission developed a computer assisted standardized sampling system capable of producing detailed analysis of fishery populations. The goal of this project was to aid the field biologist with fishery data compilation and analysis, reduce report writing time, and aid fisheries administrators with report analyses. The system is composed of 2 principal components: methods and analysis. The methods component includes obtaining and compiling fisheries data in a consistent, standardized manner that is easily replicated. This permits standardization of data collection from biologist to biologist as well as allowing a single computer program to obtain similar analysis from sample to sample. The analysis component was built around a data management system utilizing computers to expedite analysis and presentation.

Methods

Electrofishing and cove-rotenone data are collected using standard sampling procedures (Armstrong 1988). Field data include physical, descriptive, and numerical fishery data, and are recorded on field sheets that resemble the data entry computer screens to facilitate data transfer into the computer. Field sheets are mailed to the Fisheries Division computer operator who is responsible for entering, editing, and processing all field data (Fig. 1). Processing is performed by an IBM PC compatible microcomputer with 640 kilobytes random access memory, 40 megabyte hard disk, and an EGA or VGA monitor. A dot matrix printer is used to print reports, tables, and graphs. Optionally, a Hewlett Packard 6 pen plotter (HP 7475A) is used to plot some graphs. Programs used to input and analyze data are written in Microsoft Quickbasic, Version 4.0. This programming language was chosen because it allows multidimensional (up to 256) arrays, array sizes up to memory limits, modular program design, and graphics capabilities. Programs utilize pop-up menus with on-screen explanations of each menu choice to guide the operator in entering data and retrieving results. Data are stored in dBASE III+ files to allow access by non-programmers. Printed output is returned to the field biologist for evaluation and report writing (Fig. 1).

Electrofishing

Electrofishing equipment has been standardized statewide following an evaluation of various electrofishing systems and has tended to follow the specifications of Novotny and Priegel (1974). Basic boat design is an aluminum hulled, 16–18 foot flatbottom boat with a 20–40 horsepower outboard motor. A 4,000–5,000 watt, 220 volt A.C. gasoline powered generator is used to produce an electrical current that is rectified to a 3–5 amp direct current at 60 pulses per second by a Smith-Root Variable Voltage Pulsator Model VIIA. Anode design varies from simple electrode drops of flexible metal conduit to multiple drops in a ring array (Novotny and Priegel

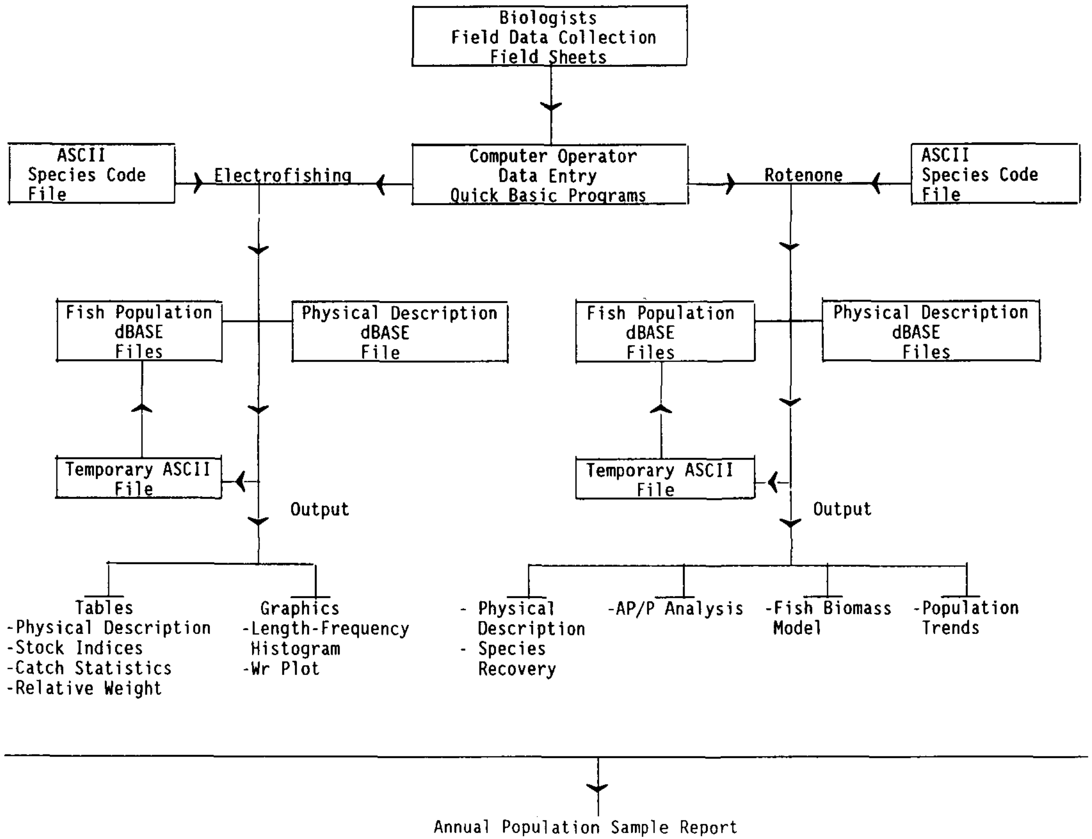

Figure 1. Flow chart illustrating processing procedures, simplified file structure, and standard printed output provided for electrofishing and cove-rotenone fish population samples.

1974). Specific design employed depends on habitat being sampled and water conductivity. Largemouth bass, spotted bass, and smallmouth bass are collected in sufficient numbers to allow computation of several commonly used structural and condition indices: proportional and relative stock densities (Anderson 1976, 1980; Anderson and Weithman 1978; Gabelhouse 1984), relative weight (Wege and Anderson 1978), young-adult ratios, percent frequency of occurrence, and catch-per-unit-effort. Species, length, and weight information collected during from 1 to 10 30-minute electroshocking replicates on 1 date and from 1 discreet body of water or defined lake section is considered a sample.

Two dBASE files are used for storing electrofishing data from each reservoir (Fig. 1). A unique 6-character name for each reservoir is used for the primary name of the data file which contains information on fish populations. This fishery data file has 6 fields (sample number, replicate number, species code number, length, weight, and age.) and each fish requires 1 record. A second file with 43 fields contains the physical and descriptive information on the lake and sample area, and each sample constitutes 1 record in this file.

The opening menu presents the operator with the option to input data or output reports. The input portion of the program first presents the operator with a screen image of the field sheet containing physical descriptive data. Information is entered directly from the field sheet with the keyboard. Upon completion, the input program enters a mode which allows entry of fish data. The input program first reads an ASCII species code file which contains a record for each fish species found in Arkansas. Information in this file includes the common name, sizes for the young-adult ratio, stock, quality, and preferred sizes (Gabelhouse 1984), and length-weight coefficients. A second ASCII file is then read containing t-values that are used to calculate 95% confidence intervals of the relative weights (Wr). The program then prompts the operator for the replicate number from the field sheet followed by species code number, length, and weight of each fish. The program cycles through prompts for length and weight data until a new replicate or species code number is required. Experience has shown that an operator can easily learn a species code number for each fish, thereby eliminating reference tables. This information is automatically printed as each fish is entered. For each entry, the program calculates an estimated weight for the length of the species being entered. If the observed and estimated weights differ more than 20%, the estimated weight is also printed to help identify mistakes made in the field or during data entry. Field data are written to a temporary ASCII file upon completion of data entry. Field sheets are then compared to the hardcopy and a full screen ASCII editor is used to correct any mistakes. The input model also writes a dBASE command file which uploads the corrected data into a dBASE file.

Rotenone

Cove-rotenone sampling is used to monitor a reservoir's standing crop, fish species composition, and reproductive success of certain species. Annual sampling permits evaluation of year-to-year trends in relative abundance and biomass of certain key species in the population. Cove-rotenone in Arkansas follows the accepted methods of Surber (1959) and Hall (1974), and has specifications on sampling gear, frequency, effort, size, location, techniques, and data recording (Armstrong 1988).

As with electrofishing, data collected in the field by biologists is sent to a computer operator for processing. Rotenone field sheets are similar to electrofishing with a header sheet used to describe the sample site and data sheets for biological information. All fish observed are recovered over a 2-day period and sorted by species into 25 mm length groups. Biological data recorded on the first day are the numbers and weight for each species and length group. Weights of fish collected on the second day are generated by the computer using the first day's mean weights at each length group or from the length-weight relationship for each species.

The dBASE file structure per reservoir and the computer program operation are similar to that used in processing electrofishing sample data (Fig. 1). ASCII species code file is read for common names and length-weight coefficients. The opening menu presents the operator with the following options:

Input.—The operation of the input portion of the program resembles the electrofishing program. Biological data are stored as numbers and kilograms per hectare regardless of the surface area of the sample. The hardcopy which is printed and used for editing as the data is entered contains both the number and weight per sample and the number and weight per hectare. The standard weight computed from length-weight regressions is not used to compare with the observed weight because the 25 mm length groups are not considered accurate enough for this purpose. The operator is repeatedly prompted for the length group, number, and weight until a key sequence directs the program to prompt for a new species or second day lengths and numbers.

Output.—The output portion allows the operator to choose between a standard rotenone report, Available Prey/Predator (AP/P) analysis, Biomass Model, length-frequency plot based on number or weight of each selected species, and historical trends.

Average.—This subroutine is used to average selected samples. Usually, multiple samples performed on a reservoir during 1 year are averaged and then uploaded into dBASE files.

Upload.—This choice results in the uploading of the temporary data into the dBASE files. After uploading, the operator is given the opportunity to erase the temporary files.

Analysis

The analysis component of Arkansas' data management system provides printed output of sample statistics to be used for evaluation and report preparation. Printed output is produced by the computer operator immediately after entering sample data and mailed to the respective biologists.

Electrofishing

The single sample printout (1 day or night of electrofishing on 1 body of water) contains physical descriptive information and a summary of catch statistics and stock indices for each species. The tables include total number, total number stock size (Gablehouse 1984), PSD, RSD, young-adult ratio, median length range (50th percentile of total range), catch per hour per species for the sample, and catch per hour per species in each replicate (Fig. 2). For each species sampled, a separate table is printed listing the length range, frequency, percent frequency, mean weight, weight range, mean relative weight (Wr), 95% confidence intervals, and catch per hour for each length group (Fig. 3). The default length group size is 25 mm, but a menu option allows the operator to change this value. These data may be automatically or selectively dumped to the printer and displayed graphically. A

ELECTROFISHING SAMPLE SUMMARY

Samp. No.	Lake	Date	Zone	Site	Temp. Deg.C	Visibility (meters)
907	Bull Shoals	05/02/1988	Middle	Mt. Creek	17.0	2.10
908	Bull Shoals	05/03/1988	Lower	Jimmy Creek	17.0	3.40
909	Bull Shoals	05/05/1988	Lower	Howard Creek	18.0	2.10
910	Bull Shoals	05/06/1988	Upper	Lead Hill	18.0	1.90

County	Cond. (mmhos)	Lake Level (meters)	Gear Type	Day/ Night	Time (sec.)	Dist. (meters)
Marion	250	200.90 -Rising	DC	Nighttime	4599	
Marion	240	201.00 -Falling	DC	Nighttime	5617	
	240	200.70 -Falling	DC	Nighttime	2897	
Boone	255	200.60 -Falling	DC	Nighttime	5199	

Common Name	Total Number	Total Stock	PSD	RSD	YAR	Median Length Range
Largemouth Bass	348	288	80.2	34.8	0.1	251 - 400
Spotted Bass	247	188	48.9	9.0	0.3	176 - 325
Smallmouth Bass	35	21	28.6	14.3	0.7	151 - 275

Catch Per Hour

Largemouth Bass	68.41
Spotted Bass	48.56
Smallmouth Bass	6.88

Catch Per Hour Per Sample

Largemouth Bass

907.	908.	909.	910.
64.19	62.81	113.08	53.32

Spotted Bass

907.	908.	909.	910.
71.23	57.68	47.22	19.39

Smallmouth Bass

907.	908.	909.	910.
2.35	16.02	1.24	4.15

Figure 2. Computer generated output displaying electrofishing sample summary. Data from more than 1 sample are pooled to generate catch statistics and structural indices.

ELECTROFISHING SAMPLE SUMMARY

Bull Shoals 1988

Largemouth Bass

Len. Group	Length (mm)	Freq.	% Freq.	Mean Wt. (gm)	Weight Range	Mean Wr	CI (95%)	Catch Per Hour
6	126 - 150	13	3.7	29.2	20 - 39	87	79 - 96	2.56
7	151 - 175	28	8.0	47.5	34 - 76	86	82 - 90	5.50
8	176 - 200	20	5.7	74.9	58 - 93	87	85 - 89	3.93
9	201 - 225	10	2.9	120.2	86 - 194	91	82 - 101	1.97
10	226 - 250	5	1.4	175.6	158 - 184	92	85 - 99	0.98
11	251 - 275	16	4.6	227.6	178 - 290	88	84 - 92	3.15
12	276 - 300	27	7.8	311.6	252 - 390	89	86 - 91	5.31
13	301 - 325	26	7.5	395.2	331 - 473	88	86 - 91	5.11
14	326 - 350	22	6.3	521.1	418 - 603	91	89 - 93	4.33
15	351 - 375	72	20.7	632.8	228 - 764	88	86 - 90	14.15
16	376 - 400	61	17.5	780.0	444 - 965	89	87 - 91	11.99
17	401 - 425	22	6.3	998.2	841 - 1276	91	88 - 95	4.33
18	426 - 450	9	2.6	1164.0	1024 - 1318	92	86 - 98	1.77
19	451 - 475	3	0.9	1200.3	950 - 1354	81	46 - 116	0.59
20	476 - 500	3	0.9	1953.7	1715 - 2147	103	79 - 127	0.59
21	501 - 525	8	2.3	2114.9	1871 - 2339	99	94 - 105	1.57
22	526 - 550	3	0.9	2811.3	2566 - 3175	106	76 - 137	0.59

Spotted Bass

Len. Group	Length (mm)	Freq.	% Freq.	Mean Wt. (gm)	Weight Range	Mean Wr	CI (95%)	Catch Per Hour
5	101 - 125	5	2.0	18.2	15 - 21	95	75 - 114	0.98
6	126 - 150	22	8.9	34.4	24 - 47	102	97 - 107	4.33
7	151 - 175	27	10.9	56.2	43 - 87	101	96 - 106	5.31
8	176 - 200	24	9.7	85.8	63 - 109	100	96 - 103	4.72
9	201 - 225	23	9.3	126.0	102 - 152	96	93 - 98	4.52
10	226 - 250	27	10.9	189.2	147 - 284	101	94 - 108	5.31
11	251 - 275	25	10.1	244.8	204 - 386	96	92 - 101	4.91
12	276 - 300	25	10.1	309.0	240 - 380	89	85 - 92	4.91
13	301 - 325	25	10.1	411.6	332 - 476	89	87 - 92	4.91
14	326 - 350	27	10.9	535.2	367 - 815	93	88 - 97	5.31
15	351 - 375	10	4.0	630.5	345 - 776	88	77 - 99	1.97
16	376 - 400	3	1.2	765.7	752 - 792	91	83 - 99	0.59
17	401 - 425	4	1.6	1021.5	904 - 1113	94	81 - 107	0.79

Figure 3. Computer generated output displaying catch data provided for each species sampled by electrofishing. Catch data tables can be generated for discreet samples or the data pooled when replicate samples are conducted.

length-frequency histogram with the right vertical axis scaled for relative weight is also printed (Fig. 4). The mean Wr and its respective 95% confidence interval, for each length group, are plotted above the histogram.

The multiple sample output prints a portion of the physical descriptive information and the actual shocking time for each sample selected. The remainder of the multiple sample output is similar to the single sample output except that individual sample data are pooled and catch per hour values are calculated for each sample rather than for each replicate.

Rotenone

Final report output is composed of 3 standard output sections and 2 optional sections. The first section displays physical and descriptive information to summa-

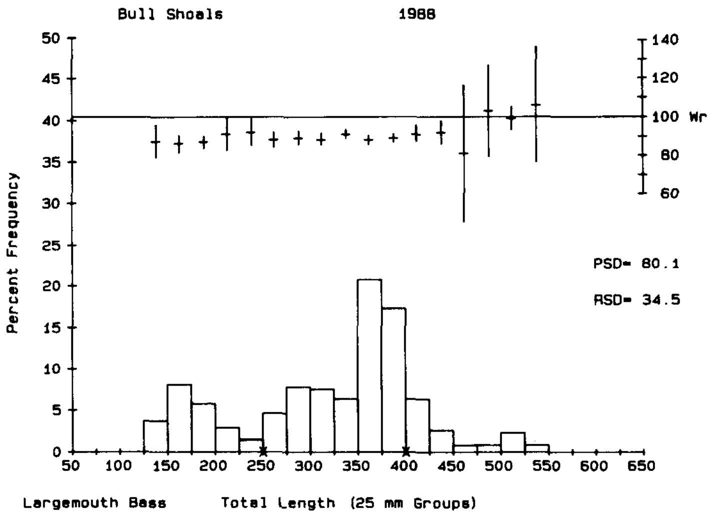

Figure 4. Typical computer generated length-frequency histogram with Wr values bracketed by 95% confidence intervals provided for electrofishing samples. Histograms can be generated for individual samples or using data pooled over more than 1 sample.

rize the data and to describe the conditions existing when the sample was collected. A species summary is printed to provide a quick synopsis of the entire sample and includes individual species and their respective density (*N*/ha), biomass (kg/ha), and percent composition in the sample by weight. The next section prints the individual species data in number and weight within a specified length group (25 mm by default) per hectare. This section is the core of the report output. Data from replicate samples can be combined and averaged. Output enables a review of community and species structural composition, and numeric and gravimetric percentages of a subclassification within a species. A brief summary at the end of the section gives total numbers, weights, and percent composition relative to the total for predators, forage, and commercial species. The last section of the standard output is an Available Prey/Predator analysis table and plot. Optional output provides a temporal trend comparison of up to five sample-years per reservoir and the Fish Biomass Model (Ploskey and Jenkins 1982) printout.

Discussion

Standardized sampling procedures and computer assisted report generation were initiated in 1987 after a year of evaluating sampling procedures and developing programs and dBASE files. The system was written and designed to enact sufficient quality control on sample techniques to ensure an adequate accounting of results but with enough flexibility to allow individual biologists to meet the restraints of time, personnel, and differing habitat types in order to enact management responses. A large measure of success of these efforts has been the quick turnover of processed data afforded by the streamlined collection, reporting, and processing procedures. Sample information delivered to the computer operator is often entered into the data processing system, reports generated, and posted for return mail to the biologist on the same day. The tedious and time-consuming tabulation of sample data and computation of population indices which formerly took hours to complete are now processed in a matter of minutes without direct involvement of field personnel.

Furthermore, complex computations such as the AP/P model (Jenkins and Morais 1978) and Fish Biomass Model (Ploskey and Jenkins 1982) were not available to the district biologist prior to the data management system. Use of AP/P ratios give fishery managers a tool to better understand reservoir fish populations, including insights into prey shortages and possible competition between and within species. The Fish Biomass Model estimates production and food requirements of five functional groups of fish biomass categorized according to the type of food supporting each group. It can be used to simulate the effects of reservoir operations, species introductions, corrective stocking of native species, and harvest and other management techniques on reservoir ecosystems.

The development of a systematic procedure to collect, process, analyze, and store electrofishing and cove-rotenone data has significantly improved the ability of field biologists to monitor fish populations in Arkansas waters and implement management programs based on current field data. Initial centralization of data processing and storage was a desired feature for quality control of data entry. Continuing modifications and improvements to the computer programs also precluded processing of data in individual field offices. Decentralization of data processing will take place as fine tuning of computer programs is completed, more personal computers are installed in district field offices, and staff is trained. Central storage of processed data as a final archive will be continued for research or other purposes.

Literature Cited

Anderson, R. O. 1976. Management of small warm water impoundments. Fisheries 1:5–7, 26–28.

———. 1980. Proportional Stock Density (PSD) and Relative Weight (Wr): interpretive indices for fish populations and communities. Pages 27–33 *in* S. Gloss and B. Shupp, ed. Practical fisheries management: more with less in the 1980s. Proc. First Annu. Workshop, New York Chap. Am. Fish. Soc.

Anderson, R. O., and A. S. Weithman. 1978. The concept of balance for coolwater fish populations. Am. Fish. Soc. Spec. Pub. 11:371–381.

Armstrong, M. L. 1988. Arkansas standardized sampling procedures. Ark. Game and Fish Comm., Fish. Div. Adm. Rept., Little Rock, Ark. 18pp.

Gabelhouse, D. W., Jr. 1984. A length-categorization system to assess fish stocks. North Am. J. Fish. Manage. 4:273–285.

Hall, G. E. 1974. Sampling reservoir fish populations with rotenone. Pages 249–259 *in* R. Welcome, ed. Symposium on the methodology for the survey, monitoring, and appraisal of fishery resources in lakes and rivers. FAO European Inland Fisheries Advisory Comm. Tech. Pap. No. 23, Rome, Italy.

Jenkins, R. M. and D. I. Morais. 1978. Predator-prey relations in the predator-stocking-evaluation reservoirs. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 30:141–157.

Novotny, D. W. and G. R. Priegel. 1974. Electrofishing boats: Improved designs and operational guidelines to increase the effectiveness of boomshockers. Wis. Dep. Nat. Resour. Tech. Bul. 73. 48pp.

Ploskey, G. R. and R. M. Jenkins. 1982. Biomass model for reservoir fish and fish-food interactions, with implications for management. North Am. J. Fish. Manage. 2:105–121.

Surber, E. W. 1959. Suggested standard methods for reporting fish population data for reservoirs. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 13:313–325.

Wege, G. J. and R. O. Anderson. 1978. Relative Weight (Wr): a new index of condition for largemouth bass. Pages 79–91 *in* G. D. Novinger and J. G. Dillard, eds. New approaches to the management of small impoundments. North Cent. Div. Am. Fish. Soc. Spec. Publ. No. 5.