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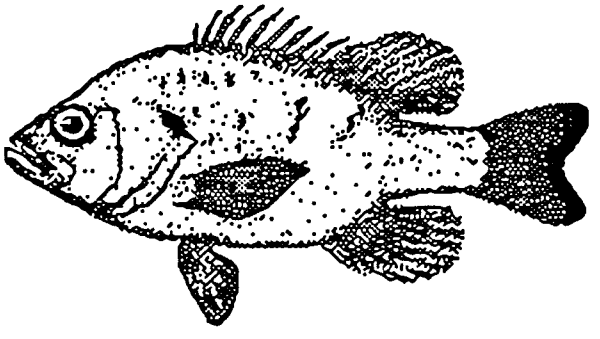
ILLINOIS NATURAL HISTORY SURVEY

Fisheries Analysis System (FAS): An Overview

Aquatic Biology Section

Technical Report

Peter B. Bayley and Douglas J. Austen



Aquatic Biology Technical Report 87/10

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FISHERIES ANALYSIS SYSTEM (FAS): An Overview

Peter B. Bayley and Douglas J. Austen

Peter B. Bayley, Principal Investigator
Aquatic Biology Section

Robert W. Gorden, Head
Aquatic Biology Section

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Fisheries Analysis System (FAS): An Overview

The fisheries analysis system (FAS) is a computerized data management system that was designed for analyses of standard fish population surveys and creel surveys at both the District and statewide level (Figure 1). FAS features: (1) data entry and analysis of individual water bodies at the District level, (2) *uploading* of these data into a statewide data base on a minicomputer, and (3) *downloading* parts of the statewide data base to microcomputers with hard disks.

District managers enter and analyze their data locally on Apple //e systems so that timely management decisions can be made. Data entry programs follow field data sheets, so that direct entry and checking of data are possible. Outputs from the fish population survey part of FAS include stock indices (YAR, PSD, and RSD), condition factor tables and graphs, length-frequency tables and histograms, length-weight plots, graphs of individual and mean length at age, and tables of catch per unit effort. Software designed for creel surveys includes area-season strata and weekday-weekend, boat-shore, and three diurnal substrata for harvested and returned fish by species.

These data are then uploaded and combined into a statewide relational data base, ARC/INFO, on a Prime 9955 minicomputer. The Geographical Information System (GIS) on the Prime allows hydrological, meteorological, and geomorphological data to be accessed conveniently. Large parts of the statewide fisheries data base may be "downloaded" to R:BASE SYSTEM V™ on IBM PC-compatible machines with hard disks drives. Outputs allow tabular and graphical presentation of summary data among water bodies and years and text file generation for statistical packages.

Developed at the Illinois Natural History Survey (INHS) in cooperation with the Illinois Department of Conservation (IDOC), FAS is currently being supported and enhanced under Federal Aid in Fish Restoration Project F-69-R. Comprehensive user's manuals are available for standard fish population surveys (Bayley and Austen 1987a), creel surveys (Bayley and Austen 1987b), and the statewide data base (Bayley and Sobaski 1987).

Data Entry and Analysis at the District Level

DISTRICT FAS was designed to help fisheries managers plan sampling; enter, check, analyze, and store data; and produce tables and graphs. DISTRICT FAS currently consists of a package for fish population surveys from standardized sampling methods and another for creel surveys.

Each District Manager has been trained and has been equipped with the basic hardware and software. Each manager is responsible for data entry, quality control, and analysis of district data. By delegating the responsibility of data entry and analysis to these managers, rather than to a single processing center, we believe that data integrity is maintained and the results are available rapidly to the managers who need them most urgently. In addition, the flexibility of the DISTRICT FAS allows the

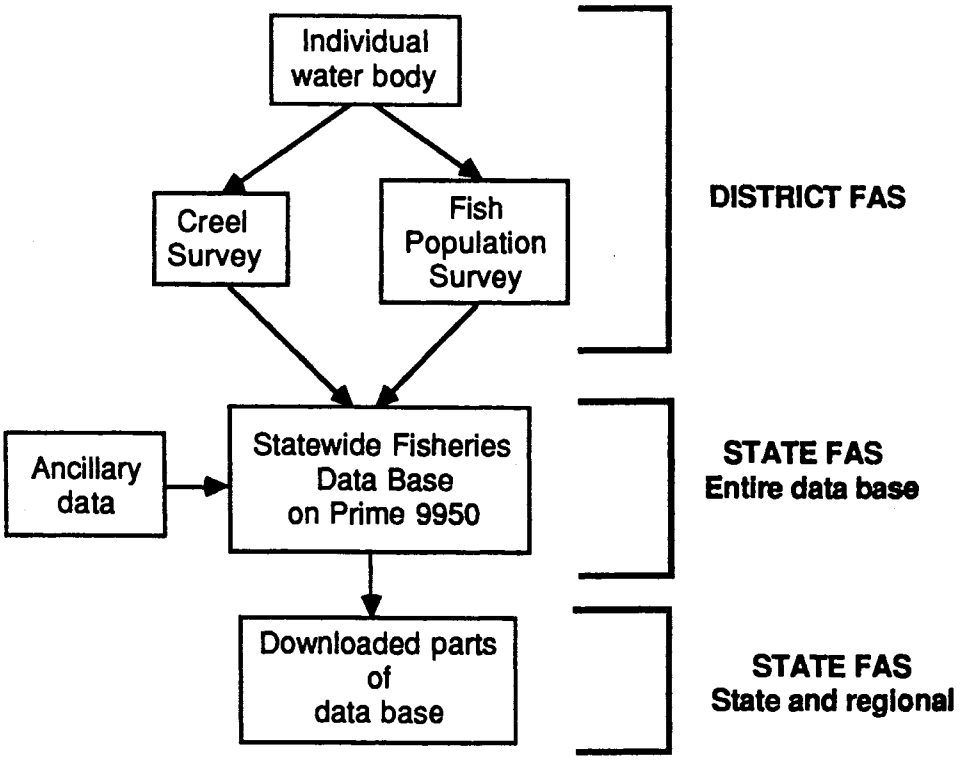

Figure 1. The Fisheries Analysis System (FAS).

manager to analyze data in ways considered most appropriate for specific management problems. At the same time, a common data management package and data collecting system permit standardized reporting and comparable information to be assembled statewide.

Data Base Organization. DISTRICT FAS uses the commercial hierarchical data base package General Manager™ as the template on which a variety of custom input/output programs have been interfaced. The data base structure, called "blank forms," is organized into linked *screens* that contain records of defined fields (Figure 2). The hierarchy does not limit the flexibility of record access by interface programs, speeds up common processing routines, and maintains a compact data base. The DOC9 data base handles all information normally collected by fisheries managers in standard fish population surveys and CREEL (Figure 3) handles all information on recreational fisheries surveys.

Data Entry. Data entry programs were specifically designed for easy entry, checking, and editing. Several video screen formats were programmed to mimic

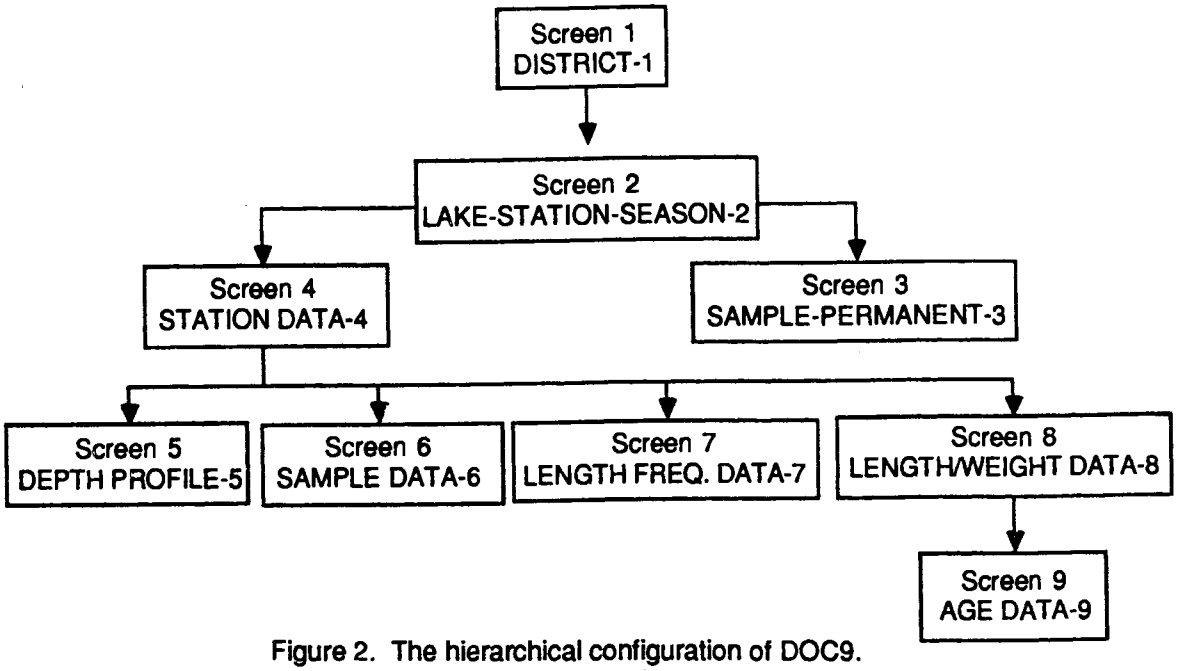

Figure 2. The hierarchical configuration of DOC9.

field data sheets, such as length-frequency distribution and depth profiles. Because the video screen image is similar to the data sheet, the district manager can conveniently check and edit data before transferring them to the data base. Such data entry is fast and efficient with a minimum of copying errors. Errors connected with original field measurements will become apparent as *outliers* using certain output programs described below.

System Flexibility. DOC9 allows individual samples and samples within different areas of the water body (stations in Figure 2) to be identified. Large lakes may have several distinct stations, each characterized by limnological data. However, data analysis can be performed on any combination of samples irrespective of station boundaries.

District FAS also permits subsampling from length distributions for individual length-weight or age data. Because measuring fish lengths is much faster than weighing fish, field time is saved through subsampling. For example, a District Manager may wish to accurately measure the length and weight of three fish per centimeter group, recording subsequent fish in that group as frequencies. When total weights of catches are required, such as in CPUE tables, a geometric mean length-weight regression (Ricker 1973) is computed and used to calculate total weight from the length-frequency information.

Age data, entered as the age at capture for each fish subsampled, may be entered two ways. A convenient option is to use prenumbered envelopes. When scales or otoliths are taken, the envelope number is recorded on the data sheet. When this information is entered into DOC9, a record for each fish,with the envelope number, is automatically created in screen 9. After the scale or otolith is read, the envelope code is retrieved from the data base and the age of the fish is entered. Additional data on the envelope is not needed, thereby saving time in the field. The second option allows age data to be entered directly with the other data. FAS does not currently accommodate back-calculation using annuli measurements.

Capacity. A data base on General Manager may use up to 117 140-Kbyte floppy disks and can be written on a hard disk that recognizes DOS 3.3 volumes. However, annual information on most lakes occupies less than one disk. Data from very large water bodies, such as collected in 1984 from the 10,833-ha (26,000-acre) Carlyle Lake, occupied only 144-Kbytes and included 2,232 length-weight records, 1,307 length-frequency records, and 278 age records from 24 samples.

Analysis and Output of District Data. Data output is accomplished through a combination of programs written in Applesoft Basic™ (for tabular output) and ISYS FORTH™ (for graphics and some tables). Graphics use double hi-resolution mode and a public domain driver is available for the printer and interface.

DISTRICT FAS consists of a set of programs linked to each other by criteria and data files (Bayley and Austen 1987a, 1987b). These data files, generated from the General Manager data base are either length-frequency files (RLF), consisting of the number of fish per centimeter group for fish up to 130 cm long, or length-weight-age files (LWA), consisting of individual fish lengths, weights, and ages. These data files may be written as DOS 3.3 files on the disk or saved in auxiliary memory for fast, but temporary, storage and retrieval. These files may be used directly to produce tables or graphics or they may be analyzed using such programs as the Statistical Processing System (SPS, Buyhoff *et al.* 1982). The format of RLF and LWA files allows direct input into SPS-type data files.

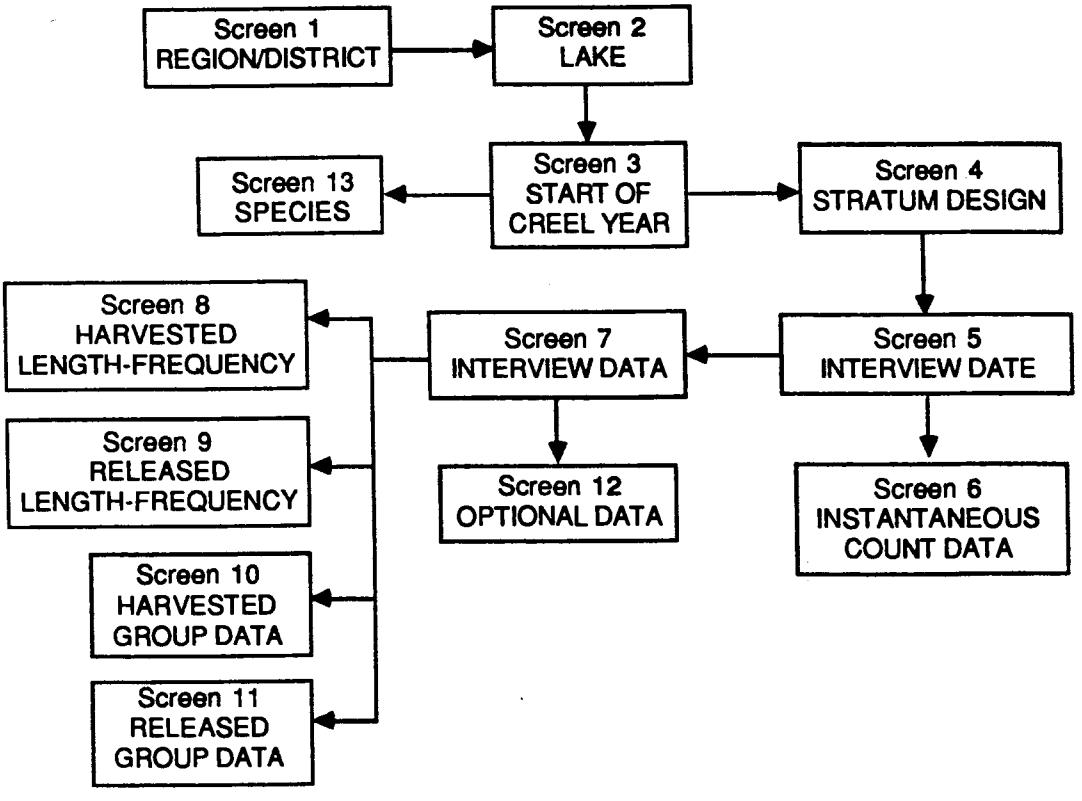

Figure 3. The hierarchical configuration of CREEL.

The user first selects the desired portion of the data base by creating a file of selection criteria, choosing region, district, lake, season, station, year, sample codes, and species. Any combination of stations, samples, and species may be selected. All tabular and graphical output may be previewed on the video screen and optionally labelled and sent to the printer. Outputs contain the criteria selected and are in metric and english units.

Uploading to the Statewide Data Base

District DOC9 and CREEL data bases are uploaded to a relational statewide data base (ARC/INFO) on INHS's Prime 9955 Mk.2 (24-Mbytes core memory). Floppy disks containing the raw data are mailed to INHS where they are uploaded to the Prime. These data, combined with hydrological and meteorological data from other sources, may then by analyzed using GIS. Parallel time series from sets of water bodies can be analyzed to distinguish between internal effects in individual systems and broad climatic, weather, or geomorphological effects. This centralized data base also permits the calculation of standards of condition indices (Bayley and Austen 1987c) and growth rates for key species corrected, if necessary, for climatic and other effects that are important in district and statewide management decisions.

Downloading to Enhanced Microcomputers

State and regional managers and researchers frequently need to compare and contrast data from sets of lakes and to extract data sets in a form suitable for multivariate analyses. Many of these tasks do not need the computing power and GIS software of the Prime minicomputer. A system has been devised that downloads data to the relational data base R:BASE SYSTEM V, on IBM PC-compatibles with 20-Mbyte hard disk drives. Summary statistics for fish population survey data can be displayed using the reporting program in R:BASE SYSTEM V (Bayley and Sobaski 1987). Summary tables that combine biological and creel survey data to compare impoundments or to study trends within impoundments are being developed under F-69-R.

Research and Long-term Management Applications

Research into why fish populations change is usually based on single-lake observations over time. Typically, such time series are difficult to analyze because of multicolinearity of variables with time or changes in sampling methods. However, concurrent time series of comparable sets of lakes will markedly increase the power to detect cause-and-effect relationships. Such problems as the type and degree of interaction between fish populations and the factors causing recruitment variation or production of desired fish species need to be addressed over many systems to determine the probable causes. These causes can then be couched in terms of testable hypotheses and investigated with the knowledge that the outcome will be of general application to a known range of conditions. Balancing the parochial or organismic level of most fishery-related research with such an approach will improve our understanding and also provide more useful information to fisheries managers.

Future Hardware/Firmware Additions

As more water bodies are added to the district data bases, a moderate increase in capacity and a significant increase in processing speed is being implemented under F-69-R. Disk capacity is being increased by using 3.5-in. 800-Kbyte drives that can accept up to 5 chained 140-Kbyte volumes of General Manager data. Programs and data files will be loaded into 1- Mbyte Ramfactor cards for fast processing.

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