

Toward a Generic Trawl Survey Database Management System¹

F.C. GAYANILO, JR.

*International Center for Living Aquatic Resources Management
MCPO Box 2631, 0718 Makati City, Philippines*

T. STRØMME

*Nansen Programme, Institute of Marine Science
PO 1870, 5024 Bergen, Norway*

and

D. PAULY

*International Center for Living Aquatic Resources Management
MCPO Box 2631, Makati City 0718, Philippines
and
Fisheries Centre, University of British Columbia
Vancouver, B.C., V6T 1Z4, Canada*

GAYANILO, F.C., JR., T. STRØMME and D. PAULY. 1997. Toward a generic trawl survey database management system, p. 116-132. In G. Silvestre and D. Pauly (eds.) *Status and management of tropical coastal fisheries in Asia*. ICLARM Conf. Proc. 53, 208 p.

Abstract

The first assessments of fisheries potential in tropical Asia were based largely on various demersal trawl surveys. In many countries, trawl surveys continue to be used for monitoring the status of stocks. This contribution presents the concept of a trawl survey database management system to organize, store, retrieve and exchange historical and contemporary trawl survey data. Some of the data analyses that can be made based on trawl survey data are also discussed. The prototype of a trawl survey database management system developed along these lines (called TrawlBase) is presented.

Introduction

Trawl surveys constitute an important fisheries-independent method for assessing and monitoring demersal stocks. To a large extent, data collected through this method, as well as analyses performed, are fairly standard in form (Pauly 1996). Whether surveys are random, systematic, stratified-random or encounter-response in design, the data they generate can be easily handled by a database management system (DBMS). A number of DBMSs can accommodate trawl survey data. These are either generic, such as the NAN-SIS software (Strømme 1992), or tailored to the needs of a given country (Vakily 1992).

Recent developments in computer technology—such as higher speed, large increases in memory, the Windows multitasking environment and standard methods for data exchange—open potentials for powerful analyses that in the past were reserved for scientists with specialized skills in computer programming.

For a DBMS to be effective and efficient, special attention should be given to how data are stored (Dates 1981). The design of the DBMS should guarantee that: (1) redundancy of stored data is avoided; (2) inconsistencies within the database are avoided; (3) data are or can be shared and exported to other forms and standards; (4) standards in data entry are enforced; (5)

¹ ICLARM Contribution No. 1380.

conflicting requirements are balanced among users; and (6) integrity of data is maintained through data validation and/or controls in data encoding.

This paper represents an attempt to identify the essential features of a generic DBMS for trawl surveys, given DBMS design considerations and computer technology developments. A special effort was made to include all the functionalities of NAN-SIS, plus other routines thought to be important, given the development of related systems, notably FishBase 97 (Froese and Pauly 1997), ReefBase (McManus and Ablan 1996) and FiSAT (Gayanilo et al. 1996).

Trawl-Survey Data

A description of equipment used in a survey is the first step in designing a trawl survey DBMS. This includes a general description of the vessel or boat used. The items usually included here are:

Vessel Particulars

- name of the vessel;
- total length;
- gross tonnage;
- name and horsepower of the main engine; and
- cruising speed.

Gear Particulars

The trawl gear is identified by:

- length of the headrope;
- circumference;
- length of footrope;
- headline width and height;
- codend mesh size;
- bottom gear;
- otter boards (type, size);
- bridles (length); and
- estimated mean door distance.

Survey Particulars

A cruise logbook is also accomplished before and after a trip, usually with the following items:

- cruise number (related to a project);
- positioning system (geographic positioning system, or GPS, radar, etc.);
- position accuracy;
- log system (surface referenced, bottom referenced);
- names and watch duties;
- head of fishing operation;
- trawl-monitoring system with list of sensors;
- sampling scheme (random, stratified random, adaptive);

- universal time convention, or UTC, for onset and offset of daylight;
- dates of sailing and return to port; and
- time and position of important events along cruise tracks (course change, conductivity-temperature-depth, or CTD, stations, etc.).

Station Particulars

At each trawling station, the following items are recorded:

- station number (or ID);
- date;
- purpose code (biomass estimation, experimental station, etc.);
- starting and ending time (UTC);
- starting and ending positions (latitude and longitude);
- starting and ending fishing depths;
- starting and ending bottom depths;
- starting and ending time of trawling;
- gear damage code;
- haul validity code; and
- quality control code.

In some applications, the ending positions are not recorded, i.e., they are replaced by the towing direction and speed. The final position can be computed using a simple geometric relationship (Box 1) and may be plotted (Box 2).

Box 1. Estimating final position, given initial position, speed and bearing.

Assuming a constant towing speed and that the effects of the surface current and wind speed are negligible, the following relationship may be used to estimate the final position of a trawler.

If we let

- X_{orig} = starting latitude position
- X_{final} = final latitude position
- Y_{orig} = starting longitude position
- Y_{final} = final longitude position
- S_{towing} = towing speed
- T_{start} = time trawling started
- T_{end} = time trawling ended
- T_{total} = total trawling time ($=T_{end} - T_{start}$)
- D = distance traveled ($=S_{towing} \cdot T_{total}$)
- d_{towing} = towing direction (in degrees)

then

$$\begin{aligned} X_{final} &= X_{orig} + D \sin d_{towing} \\ Y_{final} &= Y_{orig} + D \cos d_{towing} \end{aligned}$$

Wind speed and direction have a negligible effect on the direction of the vessel during normal trawling operations. On the other hand, water currents do affect vessels and the geometry of the trawl gear. In

Box 2. Mapping trawl surveys^a

Ideally, a trawl-data management system should be linked with a Geographic Information System (GIS). However, GIS often requires users to have undergone a long training and the resulting applications usually cannot be distributed for copyright reasons.

A geographic component is therefore proposed for TrawlBase, consisting of a preprogrammed set of maps, not requiring user inputs, which can be distributed without restriction. This is based on WINMAP, the successor of MAPPER (Coronado and Froese 1994), developed as a distributable component of FishBase (see text).

As presently designed, the mapping module of TrawlBase is designed to overlay station points off the coast of a selected country.

Generating the plot is done in three steps:

1. Read the position defining the stations (latitude, longitude; use means for stations defined by two positions) for a selected set of stations.
2. Convert the position to X-Y coordinates and save these as a formatted text file (*.TXT).
3. Use WINMAP to plot the country and stations (as solid circles).

The figure in this box presents a facsimile of a map of Sri Lanka and 20 hypothetical stations.

Further developments of this module may include making the points sensitive to clicking by a mouse, thus enabling users to access station-specific information, and performing geostatistical analyses of the station data (e.g., Kriging).

Acknowledgments

Many thanks to Mr. E. Garnace and Mr. N. Quirit for their valuable technical support in the development of the module.

References

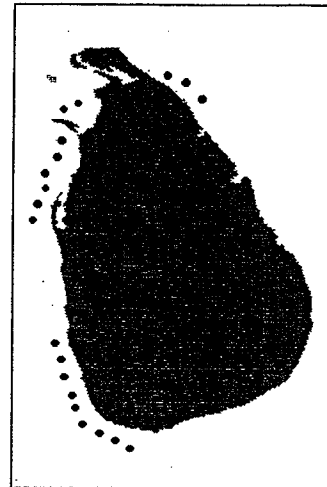
Coronado, G.U. and R. Froese. 1994. MAPPER: a low-level geographic information system. ICLARM Software 9, 23p.

- A.B.A.K. Gunaratne^b and F.C. Gayanilo, Jr.^c

^a Developed during the training course of Mr. Gunaratne at ICLARM, Manila, 2-29 August 1996. The trip was funded by the World Bank through the Agriculture Research Project, SMI Building, Colombo 3, Sri Lanka.

^b National Aquatic Resources Agency, Crow Island, Colombo 15, Sri Lanka.

^c ICLARM, e-mail: f.gayanilo@cignet.com.

**Box 3. Accounting for the effects of surface current when estimating the distance covered by a trawl.**

Let W_d be the direction of the water current, W_s the speed of the surface current and other parameters as defined in Box 1, then the distance (D) from the original position is,

$$D = [(W_s)^2 + (S_{\text{towing}})^2 + 2 \cdot W_s \cdot S_{\text{towing}} \cdot \cos(d_{\text{towing}} - W_d)]^{0.5}$$

The distance covered (D) by the vessel can also be computed when X_{final} , X_{orig} , Y_{final} and Y_{orig} are given as follows:

$$D = 60 \cdot [((X_{\text{final}} - X_{\text{orig}})^2 + (Y_{\text{final}} - Y_{\text{orig}})^2 \cdot \cos^2((X_{\text{final}} + X_{\text{orig}})/2))]^{0.5}$$

cases where both the surface current and its direction are given, the resulting distance is best computed using a simple vector analysis with the assumption that the frictional forces are negligible (Box 3).

Other information usually collected at the trawl station includes:

- reference number to CTD, plankton or grab stations, if taken;
- wind speed (Box 4);
- wind direction;
- current speed and direction;
- bottom type (Box 5);
- sea-surface temperature (SST);
- secchi disc reading;
- salinity;
- dissolved oxygen at bottom;
- trawling speed referred to sea bottom;
- distance towed referred to sea bottom;
- towing warp length (or wire out);
- towing course; and
- area of influence (i.e., area of the polygon surrounding a station, wherein all points of the polygon are closer to the station than to any other neighboring stations).

Catch Particulars

Following the entry of station-related information, the catch is recorded. This includes the following key information:

- name of taxon (preferably species name; genus or higher when specific identification is not possible);
- weight of catch (by species or higher groupings);
- numbers caught (by species or higher groupings);
- reference number or tag indicating whether a length sample was taken; and
- reference number or tag indicating whether biological samples or specimens were taken.

For target species, length-frequency samples are usually taken (and weighted), with the length frequencies (total length, fork length or standard length) usually grouped by constant class intervals. Ungrouped length records are sometimes collected, along with individual weights, for some target fish. In some surveys the sex, maturity stage and stomach contents of some of the fish caught are also recorded.

Box 4. Recording wind observations.

Wind speed and direction can be observed through the use of a wind vane or an electronic instrument. Rough estimates of wind speeds can be recorded using the Beaufort scale.

Beaufort scale, as used to record wind speed (Branson 1987):

Beaufort scale	Wind speed (knots)	Descriptive term	Ave. height of waves (m)	Max. height of waves (m)
0	<1	Calm	-	-
1	1 - 3	Light air	0.1	0.1
2	4 - 6	Light breeze	0.2	0.3
3	7 - 10	Gentle breeze	0.6	1.0
4	11 - 16	Moderate breeze	1.0	1.5
5	17 - 21	Fresh breeze	2.0	2.5
6	22 - 27	Strong breeze	3.0	4.0
7	28 - 33	Near gale	4.0	5.5
8	34 - 40	Gale	5.5	7.5
9	41 - 47	Strong gale	7.0	10.0
10	48 - 55	Storm	9.0	12.5
11	56 - 63	Violent storm	11.5	16.0
12	>64	Hurricane	>14.0	-

Box 5. Recording bottom types.

Bottom types can be assessed using a core sampler or a Petersen's grab sampler or by examining the underside of the doors of a trawl net. There are qualitative and quantitative methods of classifying bottom type. One useful classification of bottom types is the Wentworth grade scale.

Wentworth grade scale (English et al. 1994):

Name	Grade Limits (mm)
Boulder	>256
Cobble	256 - 64
Pebble	64 - 4
Granule	4 - 2
Very coarse sand	2 - 1
Coarse sand	1 - 0.5
Medium sand	0.5 - 0.25
Fine sand	0.25 - 0.125
Very fine sand	0.125 - 0.062
Silt	0.062 - 0.0039
Clay	<0.0039

A frequently used maturation scale consists of these stages: immature, developing, active, developed, gravid, ripe-running or spent (Munro and Thompson 1983).

Data Storage

When laying down the specifications for a trawl-survey database, the amount of data that will have to be recorded must be estimated.

To avoid the need for the user to enter vast numbers of characters (hence minimize encoding errors and conserve storage space), codes were utilized in the early 1970s for most elements of a trawl survey (vessel and gear type, cruise, station, and taxa caught). The use of codes is obsolete, with recent advances in computer technology and new interfaces involving the use of choice fields. However, a generic trawl-survey DBMS should support the use of codes in important routines to allow incorporation and transfer of older data sets. Codes are still used in modern computer programs to classify and sort data sets. However, this occurs 'behind the scene' and is of no direct concern to users of the software.

It is also important that the database is organized so it can work on subsets of data. A subset could be one survey or a group of surveys, forming what in NAN-SIS is called a 'project' and organized in separate files or group files. The grouping could make use of directories or filename suffixes, as in NAN-SIS. This will facilitate data maintenance and exchange. The analytical programs in the package must be able to pool 'projects', to enable comparative and time series analyses.

Fig. 1 summarizes the concepts presented above, which can be straightforwardly realized using commercially available relational database systems such as Foxbase, Visual FoxPro, Oracle, Visual dBase, PowerBuilder or Microsoft Access. The choice of the system is not very important and any of the commercially available database development systems can be used since the data are either alphanumeric or numeric. The relationship among tables is so simple that even first-generation database systems such as dBase II (once distributed by Ashton-Tate Co., USA)

can easily be configured to fit the main requirements. Moreover, most of the commercially available database systems include utilities to export and import data from other database systems, making problems of intersoftware communication a thing of the past (Box 6).

The choice of a database system to use is more a question of maintenance. The DBMS should be developed using a system that guarantees both the long-term availability of knowledgeable programmers and a commitment of the company that initially developed the database system to continue to support and upgrade it.

Data Analysis

Storing the data from a trawl survey is only the first step. To be useful, the data must be interpreted, analyzed or presented in some other form. The most useful analysis, and the one most commonly required, is the estimation of biomass or 'standing stock'.

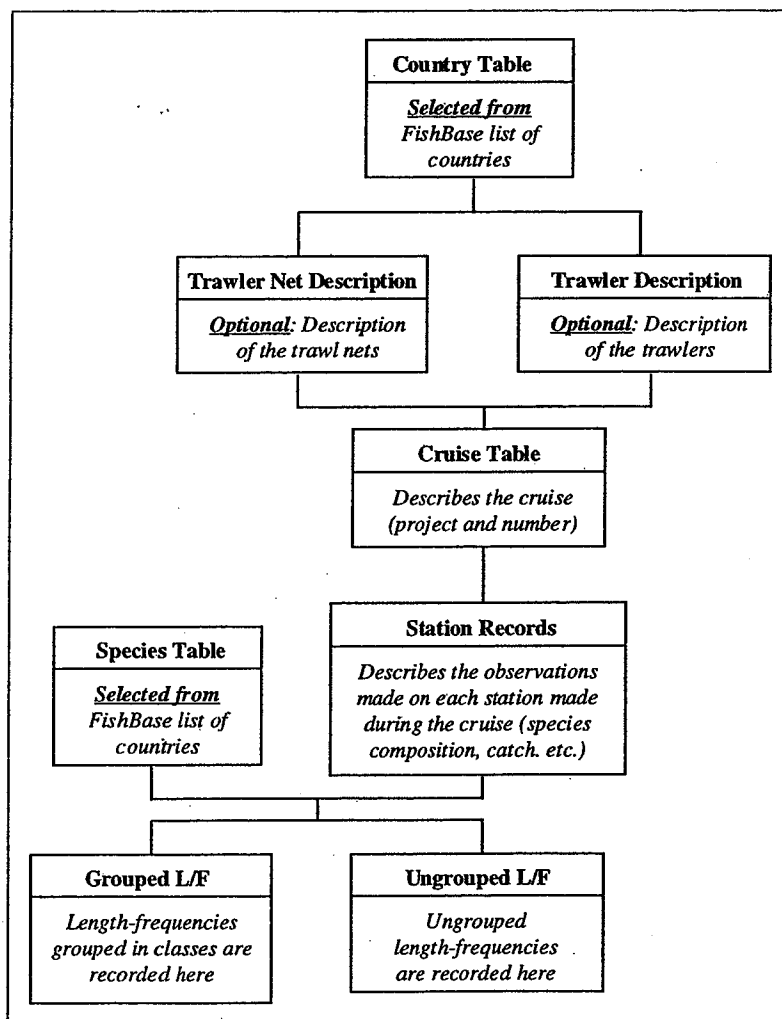


Fig. 1. Schematic representation of the data gathered in a trawl survey. The relationship is one-is-to-many for all the data.

Box 6. Towards a common fisheries resources survey information system.

In monitoring and assessing fisheries resources, surveys play an essential role. Various generic options for storing and processing survey data are available, but often institutions develop in-house applications tailored to specific needs. In the worst but not uncommon case, data storage is left to the responsibility of the individual scientists, leading to formats that make data exchange even within the institution complicated. Another problem is that well-developed systems may wither away when contracts with computer companies expire, maintenance funds go dry or scientists and/or computer experts quit the institution.

In the light of recent developments in computer systems and database applications, the creation of a Common Fisheries Data Format (CFDF) is proposed to accompany a toolbox of analytical applications that can be composed of a menu-driven shell system tailored for the specific needs of institutions.

By agreeing on a common format for data storage, exchange of data is facilitated and scientists and programmers are invited to contribute to the development of a common box of analytical tools which will be open and transparent to all. Rules for crediting a subprogram to an author/developer should be established and it should be adopted to a common toolbox that will be available on the Internet following a peer review procedure. It is envisaged that after the initial phase, such an arrangement will be self-perpetuating and reinforcing, and the ownership will belong to the scientific community at large, free of commercial interests.

If the CFDF meets acceptance, the Dr. Fridtjof Nansen Project will port the main functions of the NAN-SIS software package to the new environment.

By transferring historic data to CFDF, global analyses in fisheries ecology will be facilitated as well. It is also suggested that this procedure be followed when building a common database and analytical programs for the Southern African BENEFIT Project.

Scientists, programmers or others who would support the idea of a common format for survey data are requested to contact the author in order to create an Internet forum for development of the idea.

T. Strømme^a

^a E-mail: tore@imr.no or in writing to T. Strømme, The Nansen Programme, Institute of Marine Science, PO 1870, 5024 Bergen, Norway.

Biomass Estimation

The biomass (B) of demersal fishes can be estimated using the "swept-area" method (Pauly 1984a, 1984b). It is defined by the equation:

$$B = \frac{\bar{C}/f \cdot A}{a \cdot X_1} \quad \dots 1)$$

where \bar{C}/f is the mean catch per unit effort; A is the total area covered by the survey; X_1 is the escapement factor, i.e., the fraction of the fish in the path of the trawl that was actually retained; and 'a' is the area swept by the trawl in one unit of effort (usually measured in one hour). The swept area is defined by:

$$a = t \cdot v \cdot h \cdot X_2 \quad \dots 2)$$

where 'v' is the trawling speed; 'h' is the length of the trawl's headrope; 't' is the duration of trawling; and X_2 is the effective width of the trawl relative to the length of its headrope. Commonly used values of X_2 range from as low as 0.4 (SCSP 1978) to as high as 0.66 (Shindo 1973), with a value of 0.5 probably being the best compromise (Pauly 1980). Similarly, the value of X_1 in Equation 1, usually ranges from 0.5 (Pauly 1980) to 1.0 (Gulland 1979). Few studies have been made to actually estimate values of X_1 and X_2 , even though they drastically affect the standing stock estimates. Pauly (1980) showed that $X_1 = 0.5$ and $X_2 = 0.5$ generated fishing mortalities compatible with those estimated for various species in the Gulf of Thailand.

To increase the precision of the biomass estimate, a survey area can be divided into several *strata*. For stratified random sampling, Equation 1 is re-expressed as:

$$B = \frac{\sum_{i=1}^n A_i}{X_1 \cdot n} \cdot \sum_{i=1}^n \left[(\bar{C}/f)_i / a \right] \quad \dots 3)$$

where 'n' is the number of strata considered in the analysis and 'i' is the stratum. The variance of B can be computed based on Equation 3 as follows:

$$\text{Var}(B) = \left(\frac{\sum_{i=1}^n A_i}{X_1} \right)^2 \cdot \frac{1}{n(n-1)} \cdot \sum_{i=1}^n \left[(\bar{C}/f)_i - \left(\frac{1}{n} \cdot \sum_{i=1}^n (\bar{C}/f)_i \right) \right]^2 \quad \dots 4)$$

Alternatives to Equation 4 exist (Box 7). One of these assumes the catch/effort data to be log-normally distributed. In this case, an arbitrary value of 1 is added to each catch/effort value (before taking logs) to allow for analysis of data sets with zero entries (as frequently occurs when analyzing catch/effort data pertaining to a single taxon rather than to the total catch). Also, the "D-distribution" (Aitchinson 1955) can be used, which explicitly accounts for the occurrence of zeroes and of rare but extremely high catches (Smith 1981; Pennington 1983).

As an alternative to Equation 4 and its variants, Monte-Carlo analysis can be used to estimate the variance of the biomass estimate from trawl-survey data.

The advantage of this method is that it allows consideration of the uncertainty in the value of all parameters used in estimating biomass, rather than considering only the variance of \bar{C}/f (Box 8).

Box 7. Non-normal distributions and the estimation of biomass.

Estimating biomass when there are lots of small catches and a few very large ones can be done using a log-transformation of the catches, as follows (Som 1973; Cochran 1977; Pauly 1984b):

Step 1. Compute the catch per-hour $(c/f)_j$ per stratum (j). Add 1 to all catches if hauls with zero catch occurs.

Step 2. Take the natural logarithm (ln) of each value $(X_{i,j} = \ln((c/f)_j))$ in Step 1.

Step 3. Compute the uncorrected geometric mean $(\hat{c}/f)_j$
 $(\hat{c}/f)_j = \exp\left(\sum_{i=1}^n X_{i,j}\right)$; where n is the number of hauls in a stratum.

Step 4. Subtract the value of 1 previously added to obtain partially corrected mean
 $(\check{c}/f)_j = (\hat{c}/f)_j - 1$.

Step 5. Compute the corrected mean catch per unit of effort (\bar{c}/f)

$$(\bar{c}/f)_j = (\check{c}/f)_j \cdot \exp(\text{Var}(X_{i,j}))^2 \text{ where } \text{Var}(X_{i,j}) = \sum X_{i,j}^2 / (n-1)$$

Step 6. Estimate the variance of the corrected mean $(\text{Var}((\bar{c}/f)_j))$

$$\text{Var}((\bar{c}/f)_j) = (\bar{c}/f)_j^2 \cdot \exp(\text{Var}(X_{i,j})) \cdot ((\exp(\text{Var}(X_{i,j}))) - 1) / n$$

Note: Step 1 to 6 should be done for each stratum separately.

Step 7. Compute the biomass (B_j) per stratum

$$B_j = q_j \cdot (\bar{c}/f)_j \text{ where } q_j = 2A/a_j \text{ (A and } a_j \text{ are as defined in Eq. 1)}$$

Step 8. Compute the overall biomass per stratum.

$$B_{\text{total}} = \sum B_j$$

Step 9. Compute the standard error of the overall biomass (B_{total}).

$$\text{s.e.}(B_{\text{total}}) = \sqrt{\sum (\text{Var}((\bar{c}/f)_j) \cdot q_j^2)}$$

The degrees of freedom (d.f) is the number of all the hauls for all strata minus the number of strata used in the analysis.

Box 8. A Monte-Carlo approach for estimating the variance of the biomass estimates.

The procedure outlined in Box 7 does not consider the uncertainties associated with the estimates of parameters such as the trawling speed, the escapement factor (X_1) and the effective width of the headrope (X_2). A Monte-Carlo approach can be used to obtain a picture of the confidence region of the biomass estimate.

Using a 'triangular' probability function given the lower limit (i.e., smallest acceptable value), the upper limit (the largest acceptable value), and the 'best' estimate (the value found most credible), and drawing several random values from each of the probability functions, a series of biomass estimates can be computed using the procedure in Box 7. The estimates obtained can be plotted in the form of a histogram from which an estimate of the variance of the biomass can be obtained.

The 'triangular' probability function may not necessarily be symmetrical (i.e., the 'best' estimate does not have to be the midpoint between the lower and upper limits). Theoretically, a log-normal distribution of the biomass estimates is expected when drawing a large number (e.g., 10 000 runs) of random samples.

Other Analyses

Trawl surveys are usually conducted in highly heterogeneous environments, with distinct fish assemblages associated with a variety of identifiable habitats (McManus 1985, this volume., Bianchi 1996). Several classification techniques can be used to define such assemblages and their relationships to their habitat. Two-way indicator analysis (TWIA, Hill 1979) is widely used for this (McManus 1985, 1986; Bianchi 1991, 1996). Several software like PRIMER (Clarke and Warwick 1994), CANOCO (ter Braak 1991), TWINSpan (Hill 1979) and other commercially available statistical packages can also execute the required routines. However, unlike biomass estimation, which can easily be programmed as part of a DBMS, the data required for community analysis are best exported to formats that can be read by specialized software.

Often, these independent software will contain other functions such as ordination methods, e.g., DCA (detrended correspondence analysis) and MDS (multidimensional scaling analysis), to further support the results of the community analyses. On the other hand, approaches designed to measure ecological stresses (Pielou 1977; Warwick 1986; McManus and Pauly 1990) which can use trawl survey data can be made a part of the DBMS as they require relatively little programming.

When length frequencies are available, they can be used to estimate growth and mortality parameters useful for predicting the behavior of the stock with changes in fishing pressure through variants of the models of Beverton and Holt (1957) and Thompson and Bell (1934), as incorporated in the FiSAT software (Gayanilo et al. 1996). Thus, exporting length-frequency data to FiSAT is a straightforward way for a trawl-survey DBMS to accommodate length-frequency data.

The Prototype

The following presents the prototype of a generic DBMS for trawl surveys called TrawlBase. The prototype is structured around the principles discussed above.

System Requirements

TrawlBase was developed for use with microcomputers running on Microsoft Windows 3.x (or Windows 95 and NT). It requires a minimum of 4 megabytes of free disk space. Although the software will run on 4 megabytes of memory (RAM), 16 megabytes is highly recommended.

Installation

A SETUP.EXE is available on the first disk (Disk No. 1) to install TrawlBase on a computer. It may also be installed on a network server, but this should have control functions to prevent two users from updating the database at the same time. SETUP.EXE creates a group in the Program Manager with an icon which can be used to activate the program.

Main Menu

The first screen display is the *Main Menu* containing five command buttons: (1) *Trawl Survey*, (2) *View Species List*, (3) *View Country List*, (4) *Import/Export Data* and (5) *Exit* (Fig. 2). The *Trawl Survey* command button will open the form that allows the user to enter and retrieve survey data and estimate biomasses. The *View Species List* and *View Country List* buttons open forms that display information imported from FishBase 97 (Froese and Pauly 1997). The *Import/Export Data* command button opens forms that allow users to export data to a LOTUS 1-2-3, Microsoft Excel or FiSAT data formats, and to import NAN-SIS data files.

Trawl Survey

This command button opens the main form of TrawlBase (Fig. 3), and the default view is the first record in the database. There are 12 command buttons on the lower portion of the working screen. The first of the two command buttons allow *Biomass* estimation, based on the approaches presented above. Immediately following the *Biomass* command buttons are two reserved buttons: *EcoStress*, for estimating indices of ecological stresses as briefly mentioned above; and *Plot*, for plotting the locations of the stations, by survey, in the form of a simple map. The next four command buttons are (from left to right) *Print Record*, *Add a Record*, *Delete Record* and *Find a Record*. Sample table outputs under the *Print Record* command — typical of outputs frequently required from trawl surveys — are given in Tables 1 to 5. The next four buttons are used to scroll through the database, and the last is to close the form and return to the *Main Menu*.

Data entry starts by clicking the *Add a Record* command button. The entry form is displayed, and the user will be asked to provide values for the fields. The name for the country where the data were collected is the first input. The country list imported from FishBase 97 (Froese and Pauly 1997) is used for this purpose and can be modified or added to. The command button at the right of the country name may be used to view key information on the country selected.

The gear code is the next input. If the code is not on the list, the program will automatically open the entry form for gear description. The command button located on the right of the gear name may also be used to add a gear record. The entry form to describe the gear (Fig. 4) includes data that describe the trawl. The data enable the software to estimate the biomasses based on the swept-area method described above.

The trawler used during the survey is the next input. The command button on the right of trawler's name opens the form to record data about the trawler (Fig. 5). The next input is the cruise number. The command button on the right of the cruise's description opens the form to record details concerning the cruise (Fig. 6). The station number is the next input, and the command button on the right of the sampling date opens the form to enter station-related data (Fig. 7a and 7b).

The next set of inputs are the catches. These include the name of the taxon, the weight of the catch, and the numbers caught. When the species name entered is not in the TrawlBase list (imported from FishBase 97), the program will search the database for synonyms (also from FishBase 97). It will display the valid name if found, or alert the user to a possible error. It will accept the entry, nonetheless, if the user chooses to proceed with the name entered (this allows

the entry of names of invertebrates, not included in FishBase).

When length frequencies are available, two buttons can be used to open the form designed for these data. For grouped length frequencies (as in NAN-SIS), the class interval and the smallest (lower) class limit are the first required inputs, along with the length type (Fig. 8). When available, sample weights may also be entered. Ungrouped length measurements these may be entered along with individual weight (in g), sex (male, female or unknown), as well as sexual maturity code (Fig. 9).

The length frequencies (grouped and ungrouped) can be readily exported to FiSAT (Gayanilo et al. 1996). FiSAT allows for growth, mortality and related parameters to be estimated from these data, and for yield-per-recruit and other analyses to be performed based on the parameters estimated.

View Species List

This command button opens the form containing species information imported from FishBase 97 (Fig. 10). This cannot be modified by users (but will be periodically updated using new releases of FishBase). A click in any of the fields opens a dialog box allowing users to search the database.

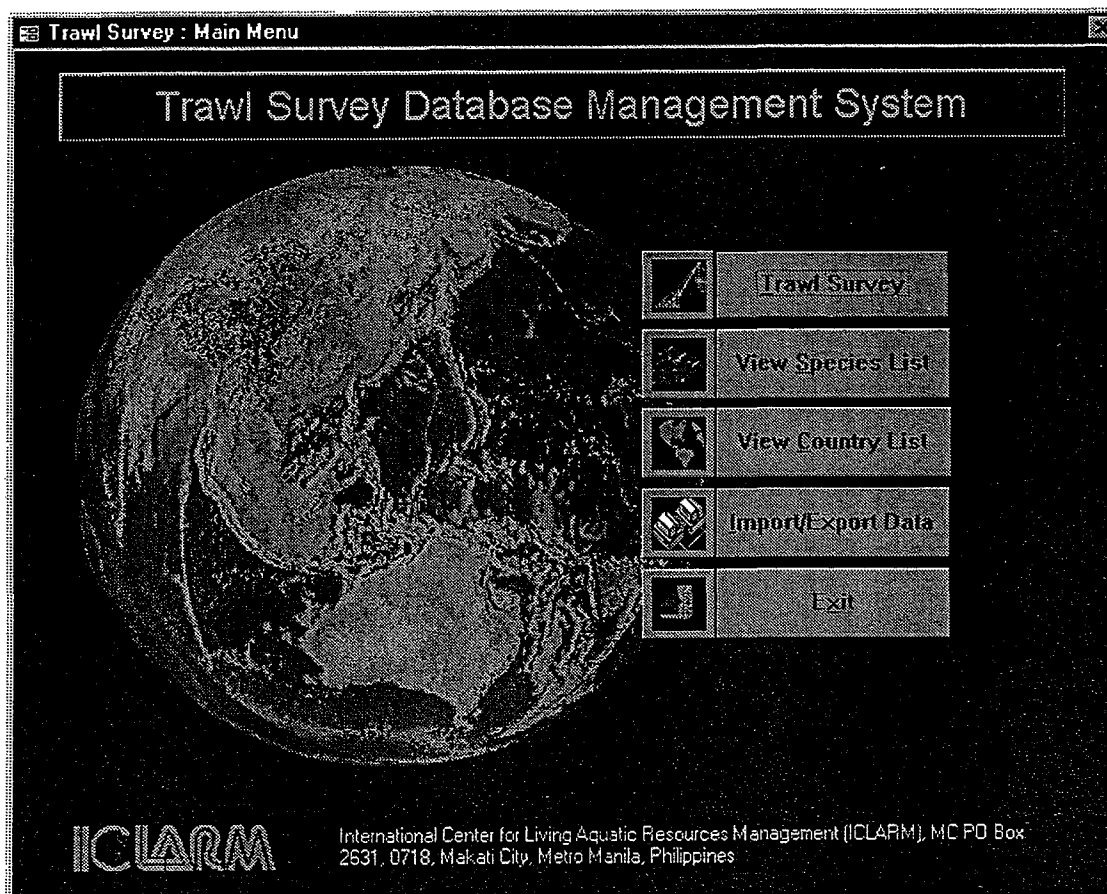


Fig. 2. Trawl survey Main Menu.

Fig. 3. Main form of TrawlBase.

Fig. 4. Entry form to describe the trawl net.

Table 4. Table output of biomass analysis. The definition of the strata (here by depth in m) and the breakdown for the catch/effort data are user-defined.

Species name	Catch per unit effort (kg/hr)						% incidence	Mean density (t/m ²)	Mean density by stratum (t/m ²)				
	<30	30-90	90-300	300-900	900-3000	>3000			<50m	50-90m	100-199m	200-399m	≥400
Species 1													
Species 2													
Species 3													
.....													
.....													
.....													
Species n													
Sum													

Table 5. Table output summarizing the catches for all stations by species and by cruise for a particular country.

Country : _____																					
Cruise : _____																					
Species/Station	01	02	03	04	05	06	07	08	09	n	Total
Species 1																					
Species 2																					
Species 3																					
.....																					
.....																					
.....																					
Species n																					
Total																					

Trawl Net Description

Trawl Net Description

Gear Code: Name:

Cicumference: Remarks:

Length of headrope:

Length of footrope:

Headline width:

Headline height:

Codend length:

Codend mesh:

Record: 1 of 1 (Filtered)

Fig. 5. Entry form to describe the trawler.

Cruise

Cruise Identification

Cruise number: Survey:

Captain: Remarks:

Date of sailing:

Date of return:

Record: 1 of 1 (Filtered)

Fig.6. Entry form for the cruise's description.

Station






Trawler Description

Name:
 Year:
 Number:
 Cruise number: Survey:

Station Code: Date of Sampling: Validity Code:

	Start	End	Towing
Latitude:	<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/>	Speed: <input type="text"/>
Longitude:	<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/>	Direction (ddd.mm:ss): <input type="text"/> : <input type="text"/> : <input type="text"/>
Fishing depth:	<input type="text"/>	<input type="text"/>	
Bottom depth:	<input type="text"/>	<input type="text"/>	
Time:	<input type="text"/>	<input type="text"/>	

Remarks:

Records: of 1 (filtered)

Fig. 7a. Entry form for station-related data.

Station

Other Station Data

Beaufort scale: Wind direction:

Current speed: Current direction:

Bottom type:

SST:

Secchi disc:

Salinity:

DO:

Towing warp length:




Fig.7b. Subform for station-related data.

Grouped LF

Grouped Length Frequencies

County: Date: Trailer: Trawl:

Station: Species name:

Measurement type: Remarks:

Class interval:

Smallest class limit:

	Lower Class Limit	Upper Class Limit	Frequency
▶			
✱			

Record: 1 of 1

Record: 1 of 1 (Filtered)

Fig. 8. Entry form for grouped length frequencies.

Ungrouped LF

Ungrouped Length Frequencies

County: Date: Trailer: Trawl:

Station: Species name:

Obs. No.	Total length	Fork length	Standard length	Weight	Sex	Maturity
▶						
✱						

Record: 1 of 1

Record: 1 of 1 (Filtered)

Fig. 9. Entry form for ungrouped length frequencies.

Trawl Survey Database Management System (rel. 1996)

Species List (from FishBase 96)

Class:

Family:

Common name:

Order:

This data were taken directly from the FishBase 96 (May 1996 release). The data cannot be edited. This is only for viewing the list. Click the field you wish to search or click the Search Button for database search.

Species name:

Author:

Common name:

ISSCAAP code:

Record: of 15166

Fig.10. The View form containing species information imported from FishBase 97.

View Country List

This command button displays key country information, to be updated with each new release of FishBase. Clicking any of the fields opens a dialog box that allows users to search the database.

Import/Export Data

The *Import/Export Data* routine allows users to import *NAN-SIS* data files, or to export any part of a table (or a combination of tables) in *TrawlBase* to a spreadsheet file. The difference between this routine and the routine available in the *Trawl Survey* forms is that users are not limited to exporting data for community analyses.

The following are the available options when exporting a data file:

1. Microsoft Excel format (ver. 2.0 to 4.0, or 5.0);
2. LOTUS (wk1);
3. LOTUS (wks);
4. LOTUS (wk3); and
5. FISAT (ver. 1.10)

Acknowledgments

The authors thank Mr. E. Garnace for assistance in developing the *NAN-SIS* import routine and Mr. F. Torres, Jr. for initial testing of the prototype.

References

- Aitchinson, J. 1955. On the distribution of a positive random variable having a discrete probability mass origin. *J. Am. Stat. Assoc.* 50: 901-908.
- Beverton, R.J.H. and S.J. Holt. 1957. On the dynamics of exploited fish populations. *Fish. Invest. London Ser. 2* (19): 533 p.
- Bianchi, G. 1991. Demersal assemblages of the continental shelf and slope edge between the gulf of Tehuantepec (Mexico) and the Gulf of Papagayo (Costa Rica). *Mar. Ecol. (Prog. Ser.)* 81: 101-120.
- Bianchi, G. 1996. Demersal fish assemblages of trawlable grounds off northwest Sumatra, p.123-130. *In* D. Pauly and P. Martosubroto (eds.) *Baseline studies of biodiversity: the fish resources of Western Indonesia*. ICLARM Stud. Rev. 23, 312 p.
- Branson, P. 1987. *Fishermen's handbook*. Fishing News Books Ltd., Farnham, Surrey, England.

- Clarke, K.R. and R.M. Warwick. 1994. Change in marine communities: an approach to statistical analysis and interpretation. Plymouth Marine Laboratory, UK.
- Cochran, W.G. 1977. Sampling techniques (3rd edition). John Wiley and Sons, Inc., New York.
- Coronado, G.U. and R. Froese. 1994. MAPPER: a low-level geographic information system. ICLARM Software 9. 23 p.
- Dates, C.J. 1981. An introduction to database systems (3rd edition). Addison-Wesley Pub., Reading, Massachusetts, USA.
- English, S., C. Wilkinson and V. Baker (eds.) 1994. Survey manual for tropical marine resources. Australian Institute of Marine Science. Townsville, Qld., Australia.
- Froese, R. and D. Pauly (eds.) 1997. FishBase 97: concepts, design and data sources. ICLARM, Manila.
- Gayanilo, F.C., Jr., P. Sparre and D. Pauly. 1996. The FAO-ICLARM stock assessment tools (FISAT) user's guide. FAO Comput. Info. Ser. (Fish.) No. 8. FAO, Rome. 126 p.
- Gulland, J.A. 1979. Report of the FAO/IOP workshop on the fishery resources of the Western Indian Ocean South of the Equator. IOFC/DEV/79/45. FAO, Rome.
- Hill, M.O. 1979. TWINSpan - a FORTRAN program for arranging multivariate data in an ordered two-way table by classification of individuals and attributes. Cornell University, Ithaca, New York.
- McManus, J.W. 1985. Descriptive community dynamics: background and an application to tropical fishes management. University of Rhode Island. Narragansett, R.I. 217 p. Ph.D. dissertation.
- McManus, J.W. 1986. Depth zonation in a demersal fishery in Samar Sea, Philippines, p. 483-486. In J.L. Maclean, L.B. Dizon and L.V. Hosillos (eds.) The First Asian Fisheries Forum. Asian Fish. Soc., Manila.
- McManus, J.W. and D. Pauly. 1990. Measuring ecological stress: variations on a theme by R.M. Warwick. Mar. Biol. 106: 305-308.
- McManus, J.W. and M.C.A. Ablan (eds.) 1996. ReefBase: a global database on coral reefs and their resources. ICLARM, Manila. 150 p.
- Munro, J.L. and R. Thompson. 1983. Areas investigated, objectives and methodology, p. 15-25. In J.L. Munro (ed.) Caribbean coral reef fishery resources. ICLARM Stud. Rev. 7, 276 p.
- Pauly, D. 1980. A new methodology for rapidly acquiring basic information on tropical fish stocks: growth, mortality and stock-recruitment relationships, p. 154-172. In S. Saila and P. Roedel (eds.) Stock assessment for tropical small-scale fisheries. Proc. of a workshop held 19-21 September 1979 at the University of Rhode Island. Int. Cent. Mar. Res. Dev., University of Rhode Island, Kingston, R.I.
- Pauly, D. 1984a. Methods for assessing the marine stocks of Burma, with emphasis on the demersal species. BUR/77/003. FAO Field Doc. 6. FAO, Rome. 22 p.
- Pauly, D. 1984b. Fish population dynamics in tropical waters: a manual for use with programmable calculators. ICLARM Stud. Rev. 8, 325 p.
- Pauly, D. 1996. Biodiversity and the retrospective analysis of demersal trawl surveys: a programmatic approach, p. 1-6. In D. Pauly and P. Martosubroto (eds.) Baseline studies of biodiversity: the fish resources of Western Indonesia. ICLARM Stud. Rev. 23, 312 p.
- Pennington, M. 1983. Efficient estimator of abundance for fish and plankton surveys. Biometrics 39: 281-286.
- Pielou, E.C. 1977. Mathematical ecology. John Wiley and Sons, New York.
- SCSP. 1978. Report of the workshop on the demersal resources of the Sunda Shelf, 31 October-6 November 1977, Penang, Malaysia. Part II. SCS/GEN/77/13. South China Sea Fisheries Development and Coordinating Programme, Manila.
- Shindo, S. 1973. General review of the trawl fishery and demersal fish stocks of the South China Sea. FAO Fish. Tech. Pap. 120. 49 p.
- Smith, S.J. 1981. A comparison of estimators of location for skewed populations with application to ground fish trawl surveys, p. 154-163. In W.G. Doubleday and D. Rivard (eds.) Bottom trawl surveys. Can. Pub. Fish. Aquat. Sci. 58.
- Som, R.K. 1973. A manual of sampling techniques. Heinemann Educational Books, Ltd., London.
- Strømme, T. 1992. NAN-SIS: Software for fishery survey data logging and analysis. User's manual. FAO Comput. Info. Ser. (Fish.) No. 4.
- ter Braak, C.J.F. 1991. CANOCO - a FORTRAN program for canonical community ordination by (partial) (detrended) (canonical) correspondence analysis, principal components analysis and redundancy analysis (version 3.10) ITI-TNO. Wageningen, the Netherlands. (manual and update notes.)
- Thompson, W.F. and F.H. Bell. 1934. Biological statistics of the Pacific halibut fishery. Rep. Int. Fish. (Pacific Halibut) Comm. 8.
- Vakily, J.M. 1992. Assessing and managing the marine fish resources of Sierra Leone, West Africa. Naga, ICLARM Q. 15(1): 31-35.
- Warwick, R.M. 1986. A method for detecting pollution effects on marine macrobenthic communities. Mar. Biol. 92: 557-562.