

An Overview of the Fisheries Resource Information System and Tools (FiRST) Version 2001: A Database Management System for Storing and Analyzing Trawl Survey Data^{1*}

Len R. Garces and Geronimo T. Silvestre

WorldFish Center

P.O. Box 500 GPO, 10670 Penang, Malaysia

(e-mail: l.garces@cgjar.org)

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Abstract

Demersal trawl surveys have been used for assessments of fisheries potential and monitoring the status of fish stocks in many countries in South and Southeast Asia. This paper presents the development of a database system, the "Fisheries Resource Information System and Tools" (FiRST), from a regional collaborative effort between eight countries and the WorldFish Center. The effort has collated about 21 000 hauls/stations from research trawl surveys across the South and Southeast Asian region.

FiRST (ver. 2001) was designed as a data management system (to organize, store, retrieve and exchange) for extant trawl surveys. In addition, the database system includes an analytical routine to approximate biomasses and generic socioeconomic data, as well as catch and effort statistics for coastal fisheries. Analytical modules from other software needed for data analyses have also been made accessible via the database system.

This paper also presents some examples of the utility of retrospective analysis of trawl survey data in establishing resource baselines and improving understanding of the biology and exploitation status of coastal fishery resources. The database system is now an important regional repository of information for management of coastal fish stocks in developing Asian countries. FiRST is envisioned to provide solid foundations for the formulation of appropriate fisheries management strategies and action plans at the national and regional level.

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Introduction

Resource surveys (e.g. experimental trawl fishing) have been conducted since the early 1900s principally to identify productive fishing grounds and determine the abundance and distribution of fisheries resources. Demersal trawl surveys have been suggested to represent the most straightforward way of finding how much and what kinds of fish occur in a given area (Pauly 1996). In South and Southeast Asia, at least 301 trawl surveys have been carried out in the region between the 1920s to 1990s; they have covered an approximate of 40 000 trawl stations (Silvestre and Pauly 1997). Retrospective analysis of these data would clarify underlying causes and rates of ecological change, and also demonstrate achievable goals for restoration and management of coastal ecosystems that can not be derived from the limited perspective of recent observations.

In July 1996, a Workshop on “Sustainable Exploitation of Coastal Fish Stocks in Asia” was organized by the WorldFish Center (formerly ICLARM - the World Fish Center) with participation of seven countries in Asia. A consensus was achieved on the usefulness of compiling and analyzing past trawl surveys in establishing benchmarks for stock rehabilitation, supplementing existing statistical baselines and improving management directions and strategies (Silvestre and Pauly 1997). A prototype database and analytic tool for this purpose was presented and evaluated during the Workshop using available data from surveys in South and Southeast Asia (Gayanilo et al. 1997).

From 1998 to 2001, the prototype database and analytic tool was further improved and developed by the WorldFish Center with assistance from the Asian Development Bank (ADB). With participation of eight countries namely, Bangladesh, India, Indonesia, Malaysia, Philippines, Sri Lanka, Thailand and Vietnam, the FiRST software was developed to serve as a database system for extant trawl surveys. The database system also provides access to analytic modules from other software for proper data analyses.

The project - “Sustainable Management of Coastal Fish Stocks in Asia (ADB-RETA No. 5766)” - aimed to: (1) strengthen the capabilities of selected institutions in participating Developing Member Countries (DMCs) in the area of coastal fisheries assessment and management; (2) develop a database

(based largely on extant trawl surveys and related environmental and socioeconomic information) relevant to the management needs of the DMCs; and (3) examine management implications (including strategies and action plans as appropriate) of analyses of results based on data contained in the database and related information (Silvestre et al. 2000). This project is commonly referred to throughout the Asian region as the “TrawlBase” project. Full details of the project components and activities are described in <http://www.worldfishcenter.org/trawl>.

The WorldFish Center has given priority to the development of databases for use in management of aquatic resources such as FishBase - a global encyclopedia of fishes (Froese and Pauly 2000), and ReefBase - a global database of status and threats to coral reefs (Vergara et al. 2000). FiRST has been developed and designed to complement these global databases and also to provide fisheries managers with information on the status of fish stocks and options for restoring production of coastal fisheries resources.

This paper presents the main features of the FiRST (ver. 2001) software and highlights key results from retrospective analysis of trawl survey data. The analyses provide evidence of the resource situation (i.e. biological extent of excessive fishing).

The Fisheries Resource Information System and Tools (FiRST)

FiRST (ver. 2001) is a Microsoft Access-based database system principally designed as data container (to organize, store, retrieve and exchange) from trawl surveys. Basic analytical routines such as models to approximate biomasses have also been developed and made an integral part of FiRST. The detailed technical description and documentation of the database system is given by (Gayanilo et al. 2001).

The following minimum configuration is required for the system to work:

- Microsoft Windows 95 or 98
- At least 64 MB RAM
- A 1024 x 768 high resolution monitor; and
- At least 5MB free-space in the Windows directory and another 12 MB for the destination address.

The database system contains nine interrelated main tables as illustrated in Fig. 1; their contents and functions are described in Table 1. The general features of the forms (or user interface) used in FiRST are similar to the standard features of commercially available Windows-based programs. The main form in the database system is the catch form (Fig. 2), which contains catch data in a given fishing station. The information includes the taxon (or scientific name), total catch (in kg), sample weight (in g), and sample count or number of sample specimens recorded. Scientific names and species codes (e.g. ISSCAAP² or NANSIS³) can be encoded directly, or selected from a list constructed from previous entries. The database system is also configured to check the valid scientific names using FishBase.

The catch data is linked to the station form, which contains information on geographic location of each trawl haul/station (see Fig. 3). Hence, using a mapping routine and geographic information system (GIS), the spatial distribution of a given species /taxa can be generated from the database.

Other important forms in the database system are gear details and trawler forms. The gear details form records technical details of the gear used in the trawl survey while the trawler form records the technical specifications of the vessel used for the survey. These forms also allow the storage of the scanned image of the gear or trawler. Fig. 4 for example, shows the scanned images with technical specifications of the gear used in the trawl survey. The headline width, although not a required input, is necessary to estimate biomass using the swept-area method. In the absence of the headline width as input, FiRST (ver. 2001) assumes the value to be 50% of the length of the headrope (Pauly 1980). Similarly, the scanned image with technical specification of the research vessel (or fishing boat) can be stored in the trawler form.

Data access protocols in FiRST (ver. 2001) have been established based on recommendations and consultations with various partners (mostly government agencies mandated for fisheries management) under the TrawlBase Project. The FiRST software has been distributed to the eight participating countries of the project and copies of the software can be obtained upon request from the

WorldFish Center. The data access classification in FiRST (ver. 2001) is as follows (Gayanilo et al. 2001): (1) Restricted - only users with proper authorization; (2) Conditional accessible - data which are older than five years, unless otherwise indicated by the national database coordinator; and (3) Fully Accessible - data with no restrictions as to their distribution and use. The trawl data contained in FiRST can be obtained from the country and permission must be secured with the particular country for data access of country-specific data (see <http://www.worldfishcenter.org/trawl> for contact details of the partners).

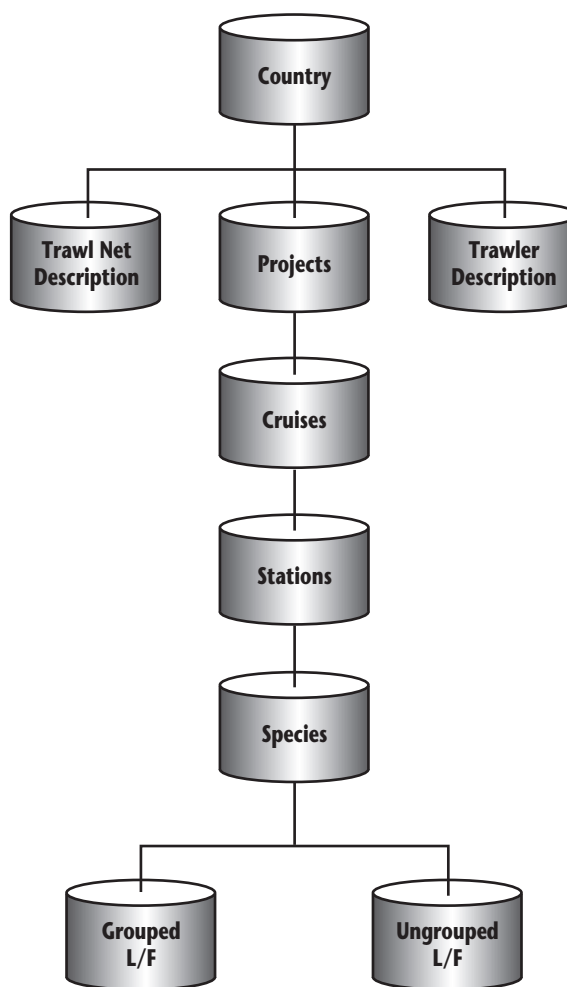


Fig. 1. Schematic representation of the main tables in FiRST (ver. 2001) and their relationships. (Note: L/F means length frequency).

² ISSCAAP - International Standard Statistical Classification of Aquatic Animal and plants.

³ NANSIS is a software for fishery survey data logging and analysis developed by FAO.

Table 1. Main tables of FIRST (ver. 2001), their contents and functions (adapted from Gayanilo et al. (2001)).

Name	Function
Country	Contains information taken from the country table of FishBase 99. The information is static, i.e. it changes only as FishBase changes. A supporting table is attached to this table for remarks about the country.
Trawl Net Description	Contains basic information about the trawl/experimental gear(s) used in the project(s), particularly parameters required to estimate the area swept by the gear.
Trawler Description	Contains basic technical details of the vessel(s) used in the project(s).
Project	Lists all projects undertaken in the country and describes them (e.g. project objectives, collaborating institutions, implementing agencies, etc.).
Cruise	Contains information describing a particular cruise in a project using a specific trawler and trawl net.
Station	Contains other station-related parameters such as geographic location and geophysical condition of the station and trawling period.
Species	Records the catches (in number and weight) by species/taxa. The biomass and catch per unit effort (CPUE) fields in the table are not filled in by the user but by FIRST when the biomass estimation routine is activated.
Grouped L/F	Records frequencies grouped in length classes. The headers, defining the class size, unit used and lower limit of the smallest length group, are stored in the Species table.
Ungrouped L/F	Contains individual length measurements.

The screenshot shows the 'Fisheries Resources Information System and Tools (FIRST)' interface. The main window is titled 'Data: Catch Details...'. The interface includes a menu bar (File, Tools, Window, Help) and a toolbar with various icons. On the left, there is a vertical toolbar with icons for Data Management, Validate Data, Reports, Synchronize, Backup/Restore, Map, Close Form, and Exit Program. The main area is divided into two sections: a form for survey details and a data table.

Survey Details Form:

- Country: MYS (Malaysia)
- Project: PT (HORAD Experimental Survey)
- Gear: BT1 (bottom trawl)
- Trawler: NANSEN (R/V Dr. Fridtjof Nanzen)
- Cruise: 0000 (Unidentified Cruises)
- Station: 1
- Sampling date (day month, year): 21 Mar 1998

Catch Data Table:

Entry No.	Code	Taxonomic Name	Total Catch (kg)	Sample Wt. (g)	Sample Count	Grouped L/F	Ungrouped Data
1	BVAMS1	Amuseum pleuronectes	2.80	2.80	82	Data	Data
2	BOTAR00	Amoglossus sp.	0.01	0.01	1	Data	Data
3	CANAT01	Axule macleayi	2.77	2.77	34	Data	Data
4	CARCS03	Carangoides matabaricus	0.05	0.05	1	Data	Data
5	CRAPO12	Charybdis cruciata	0.10	0.10	1	Data	Data
6	CARDE10	Decapterus marudsi	0.05	0.05	1	Data	Data
7	BOTEN01	Engyprosopon grandisquamis	0.02	0.02	4	Data	Data
8	SEREP00	Epinephelus aeneolatus	0.61	0.61	2	Data	Data
9	ECHHO00	HOLOTHURIOIDEA	0.35	0.35	6	Data	Data
10	SQULO22	Loligo chinensis	10.24	10.24	224	Data	Data
11	SQULO20	Loligo sp.	1.60	1.60	59	Data	Data
12	MISCE00	MISCELLANEOUS	2.27	2.27	0	Data	Data
13	NEMNE09	Nemipterus mesoprion	0.05	0.05	1	Data	Data
14	NEMNE04	Nemipterus nermenus	0.06	0.06	2	Data	Data
15	NEMNE05	Nemipterus peroni	0.40	0.40	5	Data	Data
16	BVPE00	Pecten sp.	0.15	0.15	4	Data	Data
17	GERPE01	Pentaplon longimanus	0.02	0.02	2	Data	Data
18	PLAPL06	Platycephalus sp.	0.05	0.05	4	Data	Data
19	CRAPO33	Portunus pelagicus	0.30	0.30	1	Data	Data

The status bar at the bottom indicates 'Ungrouped Data, Record 3 of 2', '6/17/00', and '4:13PM'.

Fig. 2. The catch form of FIRST (ver. 2001). Note that the last two columns indicate presence of related data.

Data: Station Details...

Country:	MYS	Malaysia
Project:	ECF09	East Coast, Fish, #09
Gear:	FBN01	Fish Trawl, Bottom Trawl, Nylon, #01
Trawler:	C001	M.V Changi
Cruise ID:	01	01

Station: Sampling date: Tick box if daylight sampling?

Select the type of access that will be given to the data of this sampling station:

General / Oceanography / Accessories and Remarks

	Start	End
Latitude	N 2° 32' 48"	N 2° 35' 00"
Longitude	E 104° 49' 30"	E 104° 48' 33"
Fishing depth (m):	<input type="text"/>	<input type="text"/>
Bottom depth (m):	59	<input type="text"/>
Local time (hh:mm):	0847	0935

Towing

Speed (knots)	Direction (deg:min:sec)	Towing warp length (m)
<input type="text"/>	<input type="text"/>	200

Fig. 3. The station form of FIRST (ver. 2001) to record station-related information.

Fisheries Resources Information System and Tools (FIRST) - [Trawl Net Description]

File Tools Window Help

Trawl Survey

Country:	MYS	Malaysia
Gear:	FBN 01	Fish Trawl, Bottom Trawl, Nylon, #01
Length of headrope (m):	27.63	
Length of footrope (m):	29.5	
Headline width (m):	<input type="text"/>	
Headline height (m):	1.83	
Codend mesh (cm):	4	
Construction Material:	Nylon	

Remarks:

Picture Filename: D:\First\images\Gear1.bmp

Trawl Net Details, Record 1 of 1







3/21/99 12:56PM

Fig. 4. The gear details form in FIRST (ver. 2001). Note that a scanned picture of the gear used for the trawl survey can be stored.

Basic analytical routines, such as models to approximate biomasses, have been developed and made an integral part of FiRST (ver. 2001). Analytical modules from other software needed for data analyses have been made accessible via the database system (Table 2). These include, among oth-

ers, FiSAT (Gayanilo et al. 1996) for fish population dynamics and fish stock assessment and Ecopath with Ecosim (Christensen et al., 2000) for ecosystem modeling. To facilitate the use of these external softwares, modules have been developed to allow the saving of data in the required format.

Table 2. Available analytical modules in FiRST (version 2001).

Icon	Title	Description
	Map...	Activates the mapping routine.
	Biomass...	Activates the mapping routine.
	Population Dynamics	Links to modules on fish population dynamics and stock assessment which are yet to be developed.
	Community Analysis	Links to modules on fish assemblage analysis which are yet to be developed.
	Ecosystem Modeling	Links to modules on ecosystem modeling which are yet to be developed.
	Bioeconomics	This function is for modules on bioeconomics.

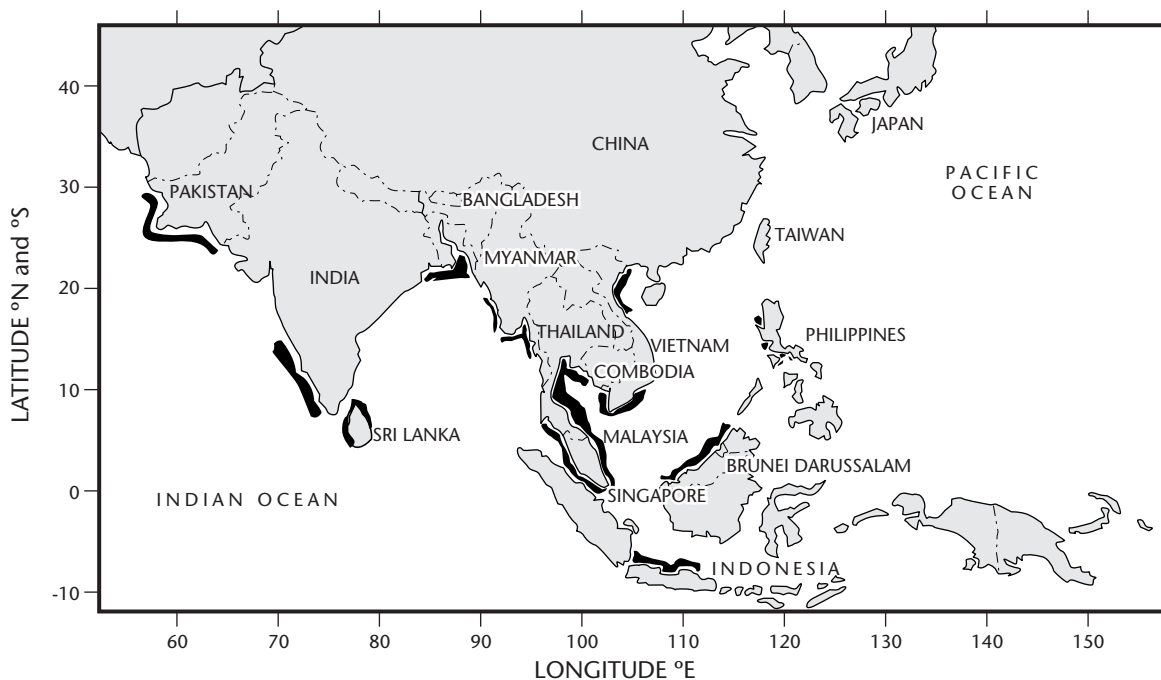


Fig. 5. Geographical coverage of trawl survey data in FiRST (ver. 2001).

Collectively, the database system contains about 20 620 hauls/stations from eight participating countries and published trawl data from Singapore, Myanmar and Pakistan. Fig. 5 shows the geographical distribution of these data and Table 3 gives a

list of the distribution of the trawl data contained in FiRST (ver. 2001). In addition to the trawl survey data, the FiRST 2001 release also includes socio-economic and related information from the eight participating countries (Table 4).

Table 3. List of trawl surveys contained in the database system (FiRST ver. 2001).

Country	Survey Areas	Name of Project/Survey	No. of Cruises	No. of Stations	Year
Malaysia	East Coast of Peninsular Malaysia	East Coast, #01	13	341	1926
	East Coast of Peninsular Malaysia	East Coast, #02	9	262	1927
	East Coast of Peninsular Malaysia	East Coast, #04	4	153	1967
	East Coast of Peninsular Malaysia	East Coast, #07	6	148	1972
	East Coast of Peninsular Malaysia	East Coast, #09	37	822	1969 - 73
	East Coast of Peninsular Malaysia	East Coast, #11	4	85	1981 - 85
	East Coast of Peninsular Malaysia	East Coast, #13	6	130	1984
	East Coast of Peninsular Malaysia	East Coast, #16	5	114	1986
	East Coast of Peninsular Malaysia	East Coast, #19	5	186	1991
	West Coast of Peninsular Malaysia	West Coast, #01	3	64	1926
	West Coast of Peninsular Malaysia	West Coast, #02	13	303	1927
	West Coast of Peninsular Malaysia	West Coast, #05	4	121	1971
	West Coast of Peninsular Malaysia	West Coast, #06	4	79	1972
	West Coast of Peninsular Malaysia	West Coast, #07	4	105	1973
	West Coast of Peninsular Malaysia	West Coast, #08	4	93	1974
	West Coast of Peninsular Malaysia	West Coast, #11	4	103	1980
	West Coast of Peninsular Malaysia	West Coast, #12	4	192	1981
	West Coast of Peninsular Malaysia	West Coast, #13	3	44	1984
	West Coast of Peninsular Malaysia	West Coast, #15	1	50	1987
	West Coast of Peninsular Malaysia	West Coast, #16	4	52	1988
	West Coast of Peninsular Malaysia	West Coast, #18	5	61	1990 - 91
	West Coast of Peninsular Malaysia	West Coast, #19	4	32	1992 - 93
	Sabah - Sarawak Waters	Sabah, Sarawak #01	3	87	1927
	Sabah - Sarawak Waters	Sabah, Sarawak #07	10	300	1972
	Sabah - Sarawak Waters	Sabah, Sarawak #11	6	134	1981
	Sabah - Sarawak Waters	Sabah, Sarawak #12	3	141	1986
	Sabah - Sarawak Waters	Sabah, Sarawak #14	1	17	1986
Sabah - Sarawak Waters	Sabah, Sarawak #15	12	96	1989 - 93	
	ALL Malaysia Surveys		177	4 418	
Philippines	Malampaya, Palawan	Assessment of the Fisheries	14	60	1975,1979
	Philippine Waters	Otter trawl explorations	24	157	1947 - 49
	Samar	Samar Sea Trawl Survey	11	300	1980
	San Miguel Bay	San Miguel Bay	22	64	1992 - 93
	Ragay Gulf	REA of Ragay Gulf	1	62	1994 - 95
	San Pedro Bay	San Pedro Bay	17	158	1994, 1995
	Manila Bay	Manila Bay	36	37	1992, 1993
		ALL Philippine Surveys		125	838
Thailand	Gulf of Thailand	Bottom trawl survey	106	5 890	1968 - 76
Singapore	Mostly offshore	M/V Changi survey	42	925	1969 - 73
Indonesia	Western Indonesia	RV Mutiara survey	2	1 376	1974 - 79
Myanmar	Myanmar waters	Surveys on the Marine Fisheries	4	375	1979 - 80

Table 3. List of trawl surveys contained in the database system (FIRST ver. 2001). (continued)

Country	Survey Areas	Name of Project/Survey	No. of Cruises	No. of Stations	Year
Bangladesh	EEZ of Bangladesh	Bottom trawl survey (fish)	32	1 021	1984 - 87
		Acoustic survey (bottom & pelagic)	12	324	1988
		Marine Fisheries survey	7	90	1980
		Shrimp trawl survey	4	15	
		ALL Bangladesh Surveys	55	1 450	
India	Southwest coast of India	Experimental fishing	12	613	1994 - 95
Sri Lanka	Waters around Sri Lanka	Fish Resource Survey in Sri Lanka	13	393	1920, 1921
		Resource Survey (RV F. Nansen)	3	225	1978 - 80
		ALL Sri Lanka Surveys	16	618	
Vietnam	Vietnamese Sea Waters Southwest Sea Waters	Fishery Survey in Vietnam	78	3 894	1979 - 82
		Fishery Survey in Vietnam	4	127	1993 - 95
		ALL Vietnam Surveys	84	4 021	
Pakistan	Pakistan waters area in Pakistan	Records on survey area in Pakistan	5	96	1976
TOTAL (ALL countries)				20 620	

Table 4. Summary of the standard workbooks and worksheets as provided by FIRST (ver. 2001) to store socioeconomic and related information.

Workbook	Worksheet	Description
Socioeconomic Profile	A.1	Fishery production and value by fishery sector
	A.2.1	Gross national product (GNP), gross domestic product (GDP) and gross value added (GVA)
	A.2.2	Income and employment indicators by sector
	A.2.3	Volume and value of fish exports and imports
	A.2.4a	Food balance sheet of fish and fishery products in live weight and fish contribution to protein supply
	A.2.4b	Household expenditure by food item
	A.2.5	Projected production and demand for fish
Fleet Operation Dynamics	B.1a	Number of vessels and characteristics
	B.1b	Other indicators of fishing operation
	B.2a	Productivity efficiency indicators
	B.2b	Estimated production function by type of fishing gear
	B.3.1	Investment costs by major assets
	B.3.2a	Monthly fixed costs
	B.3.2b	Monthly variable costs
	B.3.3	Costs, earnings and profitability
	B.3.4	Share system, mode and frequency of payment
	B.3.5	Capital intensity and cost effectiveness indicators
	B.4	Amount and proportion of discards/ bycatch by type of gear
	B.5a	Catch composition by type of gear
	B.5b	Price of fish by type of species
Bioeconomic Modeling	C.1	Catch and effort data
	C.2	Catch and effort data by type of gear

Some Illustrative Examples of the Results of the Analysis

Results of the resource analyses conducted under the TrawlBase project illustrate substantive degradation and over-fishing of coastal fish stocks in the areas covered by the studies. The analyses indicate that catch rates, and hence resource biomass, have declined to about 5 to 30% of original (“baseline”) biomass levels in these areas (see <http://www.worldfishcenter.org/rawl>). Table 5 gives some illustrative examples on decline in total biomass in Asian fishing areas. The compiled population parameters from length-based assessments indicate that E (exploitation ratios) values of more abundant species are above the optimum levels (i.e. 0.3 - 0.5), and thus confirm the trends in biomass decline

from the trawl surveys (Silvestre and Garces In press).

There are also indications of undesirable changes in relative abundance of species/taxa in the trawl survey catches. For example, the abundance of more valuable species (such as groupers, snappers, sharks and rays) has decreased sharply while smaller, less valuable species have increased in numbers (i.e. cardinal and trigger fishes).

The results of analyses of trawl survey data using software for community and ecological studies (e.g. TWINSPAN, CANOCO) also showed assemblage boundaries at about 50 m and 100 m depth. This type of information will be useful for policy recommendations in designing or revising zonation schemes for fisheries management.

Table 5. Some estimates of the declines in demersal biomass from trawl surveys in Asian countries (adapted from Garces et al. (2001))

Country Area	Year	Stock Density (t·km ²)	Relative Density (%)	Source	
PHILIPPINES San Miguel Bay	1947	10.60	100.00	Warfel and Manacop (1950) Vakily (1982) Cinco et al. (1995)	
	1980 - 81	2.13	20.10		
	1992 - 93	1.96	18.50		
	Manila Bay	1949 - 52	4.61	100.00	Warfel and Manacop (1950) MADECOR (Mandala Agricultural Development Corporation) and National Museum (1995)
		1992 - 93	0.47	10.20	
	INDONESIA Java Sea	1977	3.72	100.00	Naamin (2001)
1998		2.20	59.10		
MALAYSIA West Coast	1971 - 72	2.44	100.00	Abu Talib et al. (this volume)	
	1997	0.36	15.06		
	East Coast	1972	5.09	100.00	Abu Talib et al. (this volume)
		1998	0.20	3.90	
	Sarawak	1972	3.90	100.00	Abu Talib et al. (this volume)
		1998	1.11	28.50	
	Sabah	1972	12.52	100.00	Abu Talib et al. (this volume)
		1998	0.87	6.90	
THAILAND Gulf of Thailand	1961	6.70	100.00	Kongprom et al. (this volume)	
	1991	0.55	14.20		

Conclusion

FiRST currently contains nearly 21 000 stations from eight countries in South and Southeast Asia. This has allowed retrospective analyses of trawl data, providing insights into the extent of over-fishing and the tremendous decline in demersal biomass (i.e. 4 to 60% of original un-fished levels). FiRST is now an important regional repository of information for sustainable management of coastal fish stocks in eight Asian countries. The development of FiRST provides a solid basis for countries to formulate and implement improved policies for fisheries management.

The FiRST (version 2001) software is distributed by the WorldFish Center. Access to country-specific data contained in FiRST requires permission from relevant government institutions in the participating countries. There are plans for further enhancement of the FiRST database through expanded geographic and temporal coverage. The analysis modules, such as models to approximate fish biomasses and mapping routines, can also be developed further.

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