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Third Meeting of the Regional Working Group for the Investment Component
Dalian, China, 9-12 September 2006

Final Report on Developments of the Regional GIS and Meta Databases

Based on the approval given by the Project Steering Committee (PSC), the regional GIS and meta databases were established in the China-Korea Joint Ocean Research Center (CKJORC) which is located in Qingdao, China. The databases will help in storing, retrieving, analysing, and presenting the data effectively, which are collected by the RWGs and other contractors. The mirror sites of the databases will be located in R. Korea and PMO.

It should be noted that the co-ordination and co-operation with existing databases are crucial for the Project databases to be more useful and sustainable. Therefore, such co-operative structure has to be established and strengthened.

CKJORC was contracted to develop the databases from April to August 2006, due to unexpected delay. The draft final report was prepared and included in this meeting document. During the 3rd RWG-I Meeting, CKJORC will explain the established databases, highlighting the specifications and functions as well as the operation and maintenance of the databases.

After reviewing the reports and presentations, participants will discuss the information presented and suggest recommendations to improve the operation of and access to the databases, and to facilitate possible co-operation and co-ordination with other data centres and networks. Participants will also review the data requirements for socioeconomic data, which were identified by the other RWGs, as the RWG-I agreed during its 2nd meeting.

For easy understanding of the process to establish the GIS and meta databases, some background information is provided here for easy reference to the participants.

Background of Regional GIS and Meta Databases Development

- The project document decided to establish a regional GIS database and meta database within framework of the project.

- PMO prepared a draft proposal on this matter and submitted to the first meeting of the RWG-I (Yantai, China 17-20 May 2005), with emphases in regional co-ordination of the efforts of the existing data centres, data exchange systems and databases.

- RWG-I considered the proposal and felt it is necessary to establish GIS and meta databases for the project. During the meeting the FIO proposed to host the database in First Institute of Oceanography (FIO), but the meeting did not reach an agreement on this matter.

- This issue was submitted to the 1st meeting of the RSTP (Dalian, China, 4-6 July 2005) for further consideration. It was proposed that the databases could be established in the China-Korea Joint Ocean Research Center (CKJORC), with technical and logistic supports from FIO. The meeting agreed in principle, and requested the CKJORC to prepare a proposal.

- The Project Manager visited CKJORC on 19 October 2005, and prepared, together with Director of the centre, and technical staff of FIO, the proposal to develop the GIS & meta databases. In the proposal, the necessary software (ArcGIS) will be provided by the project budget.

- At the second meeting of RWG-I (Jeju, Korea, 14-17 November 2005), it was announced by a member of the RWG-I (officially nominated) that FIO will provide software (ArcGIS) to show its support to the project activities.

- The second meeting of the RSTP (Kunming, China, 15-17 December 2005) discussed this matter again, and agreed to locate the GIS & meta databases in CKJORC, with the condition the software will be provided by FIO. In the same meeting, it was agreed that a mirror site should be set up in Korea.

- With clarification of a misunderstanding on the software, CKJORC was contracted to develop the GIS and meta databases and to prepare the final report with information, including specifications of the databases, operation and maintenance of the databases, and recommendations for sustainable use of the databases.

YSLME GIS Database System
Final Report

submitted to

Yellow Sea Large Marine Ecosystem Project Management Office

(YSLME PMO)

by

China-Korea Joint Ocean Research Centre

(CKJORC)

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1 Introduction

YSLME GIS database system is sponsored by the UNDP/GEF project *Reducing Environmental Stress in the Yellow Sea Larger Marine Ecosystem* Project Management Office (YSLME PMO). The system is charged by the China-Korea Joint Research Centre (CKJRC) to establishing and maintaining the databases for the YSLME project and technically supported by the First Institute of Oceanography.

This system takes advantage of spatial information technology to input, manage and display the multi-source and heterogeneous information from the YSLME project. By the rapid and effective data sharing services, users could conveniently search, browse and download the target information. The system will promote international scientific research on the regional ecosystem environment in the Yellow Sea and further make the supervision, regulation and development of the Yellow Sea more reasonable and effective.

Since the contract of "YSLME GIS Database System" was signed, the project has been implemented according to the schedule. Based on the help from the YSLME PMO and frequent communication with scientists, the project group made clear and detail user requirements. And the system was designed and developed by the guidance of requirement analysis. Now, the system has been finished and can provide data share services such as metadata query, data query and map-based query about the information of YSLME project for public by Internet.

The following sections provide detail statement of the project.

2 Project objectives and deliverables

2.1 Project objectives

Due to the project requirements, the YSLME GIS database system is designed and developed based on the Microsoft SQL Server 2000 and Arc IMS 4.0 to provide powerful services of data management, query and display about both scientific data and spatial data.

- Make base GIS map for the system with 1:250,000 World Vector Shoreline (WVS), administrative boundary units and rivers;
- Collect, input and manage the attribute data generated by the project components including fisheries, biodiversity, ecosystem, pollution and other environmental data to serve the project components;
- Provide effective management, query and display capabilities of the YSLME project data based on a centralized Microsoft SQL Server database and ArcIMS web server.

2.2 Project deliverables

- A digital base GIS map for the system with 1:250,000 World Vector Shoreline (WVS), administrative boundary units and rivers;
- A centralized database to manage the YSLME project data including fisheries, biodiversity, ecosystem, pollution and other environmental data;
- A metadata database for not only YSLME data but also world ocean scientific data to promote scientific information sharing and accessing;
- An ArcIMS-based Web server to provide powerful functions for dynamic and effective input, query and display of YSLME data in the database;
- A final report on the project and accompanying documentation for the database and GIS system.

3 System environments

According to the requirement analysis, the system environments are listed as follows.

3.1 Software environment

Server:

- Microsoft Windows 2000 Server (or above)
- Microsoft Internet Information Server 4.0 (or above)
- ESRI ArcIMS 9.0
- Microsoft SQL Server 2000

Browser:

- Microsoft Windows 98 (or above)
- Microsoft Internet Explorer 6.0(or above)

Develop environment:

- Microsoft Windows 2000 Professional
- ESRI ArcIMS 9.0
- Microsoft SQL Server 2000
- Microsoft visual studio .NET 2003

3.2 Hardware environmet

Server:

- Two or multi- CPU
- 2GB or multi- memory
- RAID-5 disk ray
- UPS
- Two or multi- fans in computer
- Tape recorder or CD/DVD writer
- 100m/1000m network interface

4 Base GIS map preparation

According to the requirement, the system should provide data browsing services based on the digital map with shoreline and surrounding administrative districts of the Yellow Sea. To prepare the digital map, we downloaded and calibrated the WVS (World Vector Shoreline) data (WGS 84) of the Yellow Sea with scale of 1: 250,000 from Internet and collected the administrative units and rivers datasets from FIO and YSLME PMO respectively. The base GIS map for the system has been finalized now and the data sets of the base map are in ESRI shapefile format (Fig.1).

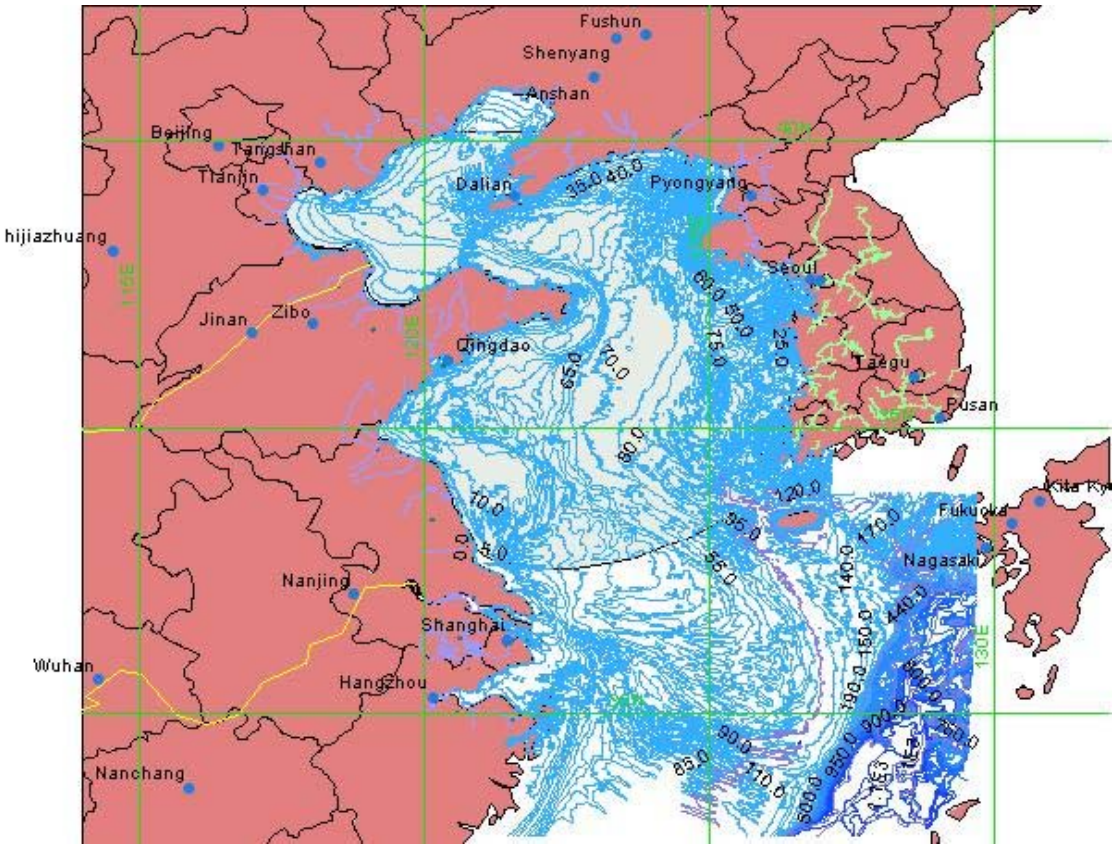

Fig.1 Digital map of YSLME GIS Database System

The data sets of and are in ESRI shapefile format. The features include cities, coastline, isobath, Korean rivers, Chinese rivers, landform borderline, landform contour, latitude & longitude grid, national boundary, traffic, water system, WVS and Yellow Sea area.

5 Database design

5.1 Total design

The project database was designed and constructed based on the Microsoft SQL Server 2000 database management system and it consists of metadata database and YSLME database (Fig.2).

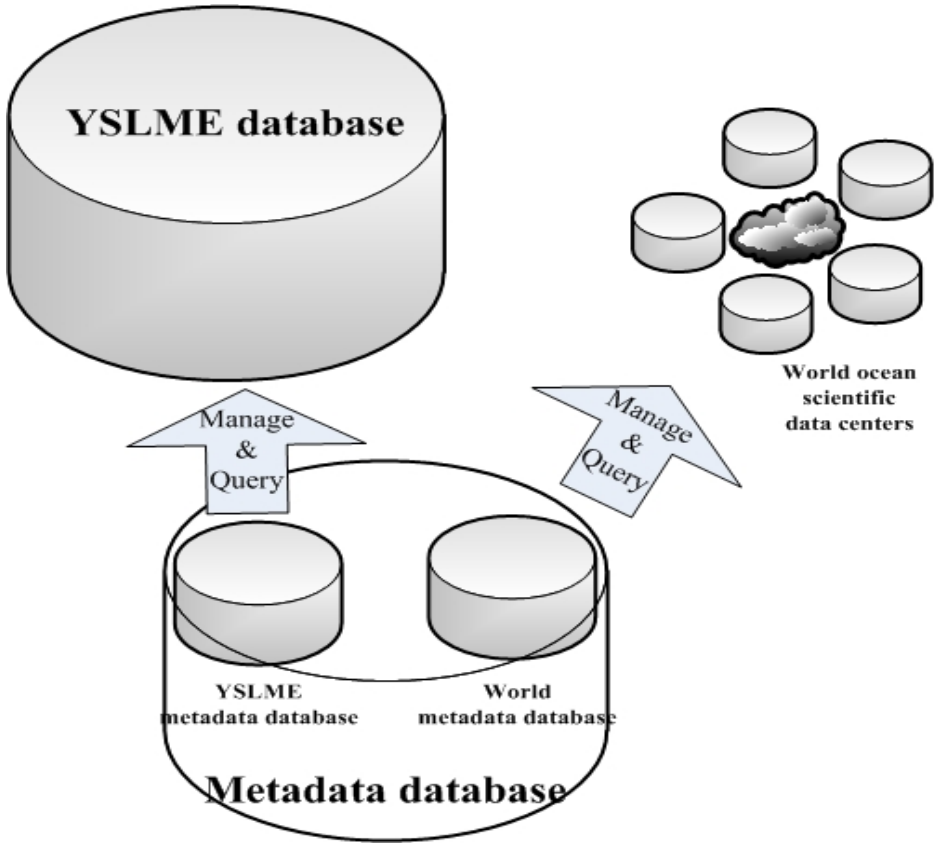

Fig.2 YSLME database architecture

The metadata database was designed based on the international standards such as FGDC, NASA GCMD DIF, ISO 19115 Metadata Standard, ANZLIC Metadata and so on. According to the requirement, it includes YSLME metadata database and World metadata database. YSLME metadata database describes the datasets in the YSLME database to make YSLME scientists share the project data more effectively. World metadata database integrates the information of world ocean scientific data centers, which can make easy access of world ocean scientific data and promote the international scientific data share and exchange.

The YSLME database is designed for the data generated from the YSLME

project components such as fisheries, biodiversity, ecosystem, pollution and so on. The YSLME data are stored in the database by different kinds according to the project components to make the project data management and share more effectively.

5.2 Logical design

The logical design of database is to analyze and design the relationships and structures of the YSLME data. The following part will introduce the relationships and structures of the YSLME data by E-R diagrams and structure tables by different data types.

5.2.1 Metadata database

(1) YSLME metadata database

As described above, the YSLME metadata database is mainly used to manage the datasets of the YSLME database and make data access more conveniently and rapidly. It records the basic information, spatial information, quality information and storage location of the YSLME datasets. The logical structures of the YSLME metadata database are listed as follows.

YSLME metadata table

No	Column Name	Type	width	PKey	NULL	Remarks
1	MetadataID	int	4	Y	N	
2	DatasetID	varchar	80		N	
3	DatasetCNName	varchar	200			
4	CNNameAb	varchar	200			
5	DatasetENName	varchar	200			
6	ENNameAb	varchar	200			
7	Abstracts	varchar	200			
8	Country	varchar	60		N	
9	PubDate	varchar	8			
10	Language	varchar	200			
11	Specialty	varchar	200			
12	Contents	varchar	2000			
13	Keywords	varchar	200			
14	Objectives	varchar	2000			
15	StartTime	varchar	8			
16	EndTime	varchar	8			
17	Marine	varchar	200			
18	LongWest	decimal	9.6			
19	LongEast	decimal	9.6			
20	LatSouth	decimal	9.6			
21	LatNorth	decimal	9.6			

22	URLs	varchar	400			
23	ProjectCode	varchar	200			
24	ProjectCNName	varchar	200			
25	ProjectENName	varchar	200			
26	ProjectType	varchar	200			
27	DataItem	varchar	2000			
28	MangementDepartment	varchar	200			
29	ChargeDepartment	varchar	200			
30	InvestigateDepartment	varchar	200			
31	Navigation	varchar	200			
32	CollectDepartment	varchar	200			
33	CollectTime	varchar	8			
34	SubmitDepartment	varchar	200			
35	SubmitTime	varchar	8			
36	FieldNum	varchar	200			
37	RecordNum	varchar	200			
38	StorageMedia	varchar	200			
39	System	varchar	200			
40	Format	varchar	200			
41	Quantity	varchar	200			
42	Quality	varchar	200			
43	StorageDepartment	varchar	200			
44	ContactPerson1	varchar	200			
45	Address1	varchar	400			
46	ZipCode1	varchar	50			
47	Phone1	varchar	50			
48	Fax1	varchar	50			
49	Email1	varchar	200			
50	SpatialData	varchar	200			
51	Scale	varchar	80			
52	Resolution	varchar	80			
53	LayerNum	int	4			
54	LayerDescript	varchar	2000			
55	OperateTool	varchar	200			
56	Coordinate	varchar	200			
57	IsProj	tinyint	1			
58	ProjName	varchar	200			
59	CentralLong	decimal	9.6			
60	CentralLat	decimal	9.6			
61	EasterOffset	decimal	9			
62	NorthernOffset	decimal	9			
63	ChargeDepartment2	varchar	200			
64	ContactPerson2	varchar	200			

65	Address2	varchar	400			
66	ZipCode2	varchar	50			
67	Phone2	varchar	50			
68	Fax2	varchar	50			
69	Email2	varchar	200			
70	MetadataDefDepartment	varchar	200			
71	MetadataDefPerson	varchar	200			
72	DefineTime	varchar	8			
73	ReferenceStandard	varchar	200			
74	MetadataVersion	varchar	50			
75	XMLName	varchar	200			
76	XMLVersion	varchar	50			
77	ChargeDepartment3	varchar	200			
78	ContactPerson3	varchar	200			
79	Address3	varchar	400			
80	ZipCode3	varchar	50			
81	Phone3	varchar	50			
82	Fax3	varchar	50			
83	Email3	varchar	200			

(2) World metadata database

As described above, world metadata database is mainly used to make an integration of world ocean scientific data centers for convenient and rapid data share. It also records the basic information, spatial information, quality information and storage location.

World metadata table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	EntryIden	varchar	200	Y		N	Entry Identifier
2	DataSetName	varchar	200				Data Set Name
3	DataSetProducers	varchar	200				Data Set Producer(s)
4	Para_LandSurface	varchar	200				Parameter - LandSurface
5	Para_Agricultrue	varchar	200				Parameter - Agricultrue
6	Para_SolidEarth	varchar	200				Para - SolidEarth
7	Para_Atmosphere	varchar	200				Para - Atmosphere
8	Para_Ocean	varchar	200				Para - Ocean
9	Para_HumanDimensions	varchar	200				Para - HumanDimensions
10	Para_FreshWater	varchar	200				Para - FreshWater
11	Para_Biosphere	varchar	200				Para - Biosphere
12	LocationName	varchar	200				Location Name
13	LocationCountry	varchar	200				Location Country
14	LatSouth	number	10.6				Southernmost Latitude

15	LatNorth	number	10.6				Northernmost Latitude
16	LongWest	number	10.6				Westernmost Longitude
17	LongEast	number	10.6				Easternmost Longitude
18	HRMin	varchar	200				Horizontal Resolution Minimum
19	HRMax	varchar	200				Horizontal Resolution Maximum
20	MinAltitude	number	10.2				Minimum Altitude
21	MaxAltitude	number	10.2				Maximum Altitude
22	MinDepth	number	10.2				Minimum Depth
23	MaxDepth	number	10.2				Maximum Depth
24	VRMin	varchar	200				Vertical Resolution Minimum
25	VRMax	varchar	200				Vertical Resolution Maximum
26	TCStartDate	varchar	8				Temporal Coverage Start Date
27	TCStopDate	varchar	8				Temporal Coverage Stop Date
28	TRMin	varchar	200				Temporal Resolution Minimum
29	TRMax	varchar	200				Temporal Resolution Maximum
30	AdditionalKeywords	varchar	200				Additional Keywords
31	DQProcedures	varchar	200				Data Quality - Procedures
32	DQPositionAccuracy	varchar	200				Data Quality - Position Accuracy
33	DQDataAccuracy	varchar	200				Data Quality - Data Accuracy
34	DQCompleteness	varchar	200				Data Quality - Completeness
35	DQRecognition	varchar	200				Data Quality - Recognition
36	DQKnowsErrors	varchar	200				Data Quality - KnowsErrors
37	DataSetProgress	varchar	200				Data Set Progress
38	Summary	text					Summary
39	DCLongName	varchar	200				Data Center - Long Name
40	DCShortName	varchar	200				Data Center - Short Name
41	DCGivenName	varchar	200				Data Center - Given Name
42	DCMiddleName	varchar	200				Data Center - Middle Name
43	DCFamilyName	varchar	200				Data Center - Family Name
44	DCEmail	varchar	200				Data Center - E-mail
45	DCPhone	varchar	200				Data Center - Phone
46	DCFax	varchar	200				Data Center - Fax
47	DCMailingAddress	varchar	200				Data Center - Mailing Address
48	DCUrl	varchar	200				Data Center - URL
49	AccessConstraints	varchar	200				Access Constraints
50	UseConstraints	varchar	200				Use Constraints
51	DistributionMedia	varchar	200				Distribution Media
52	DistributionSize	varchar	200				Distribution Size
53	DistributionFormat	varchar	200				Distribution Format
54	DistributionFee	varchar	200				Distribution Fee
55	MetadataCreationDate	varchar	8				Metadata Creation Date

56	LastRevisionDate	varchar	8				Last Revision Date
57	MRBGivenName	varchar	200				Metadata Revised by - Given Name
58	MRBMiddleName	varchar	200				Metadata Revised by - Middle Name
59	MRBFamilyName	varchar	200				Metadata Revised by - Family Name
60	MRBEmail	varchar	200				Metadata Revised by - Email
61	MRBPhone	varchar	200				Metadata Revised by - Phone
62	MRBFax	varchar	200				Metadata Revised by - Fax
63	MRBMailingAddress	varchar	200				Metadata Revised by - Mailing Address

5.2.2 YSLME database

YSLME project includes fisheries, biodiversity, ecosystem, pollution and other environmental components, so we design and organize the YSLME data according to different components. Next, the logical structures of each component data are described separately in different parts.

5.2.2.1 Biodiversity

By managing and analyzing the biodiversity information, most of the subject data are related with the species or species group. So we design two basic tables, **Speciesgroups** and **Species**, with which other subject tables are related. The E-R diagram (Fig.3) shows the relationships between basic tables and subject tables and detail logical structures of the biodiversity data are listed following. At last, we design several views for convenient query and display of the datasets.

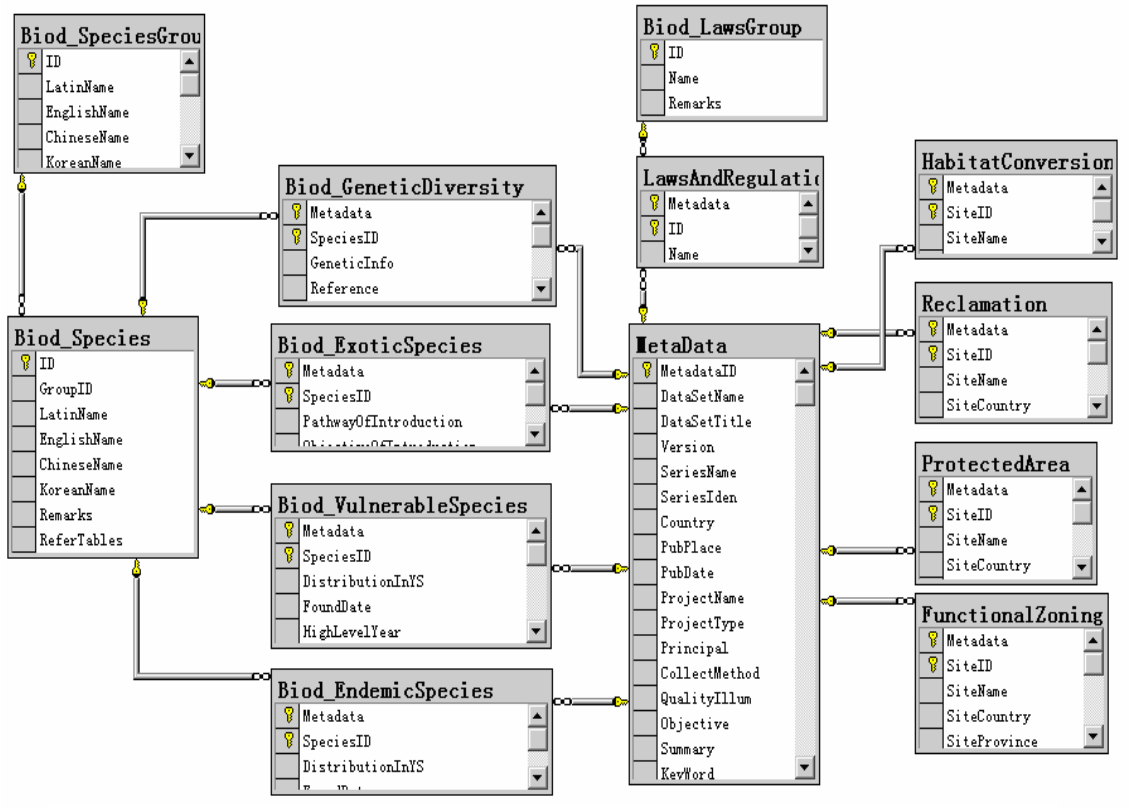

Fig.3 The E-R diagram of the biodiversity logical structure

SpeciesGroups table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	ID	Identity int		Y		N	ID
2	LatinName	varchar	200				Latin Name
3	EnglishName	varchar	200				English Name
4	ChineseName	varchar	200				Chinese Name
5	KoreanName	varchar	200				Korean Name
6	Remarks	varchar	2000				Remarks

Species table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	ID	Identity int		Y		N	ID
2	GroupID	Int			Y	N	Species Group ID
3	LatinName	varchar	200				Latin Name
4	EnglishName	varchar	200				English Name
5	ChineseName	varchar	200				Chinese Name
6	KoreanName	varchar	200				Korean Name
7	Remarks	varchar	2000				Remarks
8	ReferTables	varchar	200				Refer Tables

(2) Subject tables

Bio_EndemicSpecies table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	Int		Y	Y	N	Metadata
2	SpeciesID	int		Y	Y	N	Species ID
3	DistributionInYS	varchar	200				Distribution In Yellow Sea
4	FoundDate	varchar	8				Found Date
5	HighLevelYear	varchar	8				High Level Year
6	LowLevelYear	varchar	8				Low Level Year
7	ThreatenedCategories	varchar	200				Threatened Categories
8	Trend	int					Trend
9	MajorCauses	varchar	2000				Major Causes
10	IUCNRedList	int					IUCNRedList
11	ChinaRedList	int					ChinaRedList
12	KoreaRedList	int					KoreaRedList
13	Reference	varchar	2000				Reference
14	Remarks	varchar	2000				Remarks

Bio_ExoticSpecies table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	Int		Y	Y	N	Metadata
2	SpeciesID	int		Y	Y	N	Species ID
3	PathwayOfIntroduction	varchar	200				Pathway Of Introduction
4	ObjectiveOfIntroduction	varchar	200				Objective Of Introduction
5	DateOfIntroduction	varchar	8				Date Of Introduction
6	OriginOfImport	varchar	200				Origin Of Import
7	RearingSite	varchar	200				Rearing Site
8	DateOfFirstRecordInWild	varchar	8				Date Of First Record In Wild
9	SiteOfFirstRecordInWild	varchar	200				Site Of First Record In Wild
10	WildPopulation	int					Wild Population
11	WildPopulationDistribution	varchar	200				Wild Population Distribution
12	Reference	varchar	2000				Reference
13	Remarks	varchar	2000				Remarks

Bio_GeneticSpecies table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	Int		Y	Y	N	Metadata
2	SpeciesID	int		Y	Y	N	Species ID
3	GeneticInfo	varchar	2000				Genetic Information
4	Reference	varchar	2000				Reference
5	Remarks	varchar	2000				Remarks

Bio_VulnerableSpecies table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	Int		Y	Y	N	Metadata
2	SpeciesID	int		Y	Y	N	Species ID
3	DistributionInYS	varchar	200				Distribution In Yellow Sea
4	FoundDate	varchar	8				Found Date
5	HighLevelYear	varchar	8				High Level Year
6	LowLevelYear	varchar	8				Low Level Year
7	ThreatenedCategories	varchar	200				Threatened Categories
8	Trend	int					Trend
9	MajorCauses	varchar	200				Major Causes
10	IUCNRedList	int					IUCNRedList
11	ChinaRedList	int					ChinaRedList
12	KoreaRedList	int					KoreaRedList
13	Reference	varchar	2000				Reference
14	Remarks	varchar	2000				Remarks

FunctionalZoning table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	Int		Y	Y	N	Metadata
2	SiteID	Identity int		Y		N	Site ID
3	SiteName	varchar	200				Site Name
4	SiteCountry	varchar	60				Site Country
5	SiteProvince	varchar	60				Site Province
6	SiteCity	varchar	60				Site City
7	SiteDescription	varchar	200				Site Description
8	LongWest	number	10.6				West Longitude
9	LongEast	number	10.6				East Longitude
10	LatSouth	number	10.6				South Latitude

11	LatNorth	number	10.6				North Latitude
12	Area_ha	number	18.0				Area(ha)
13	MajorFunction	varchar	200				Major Function
14	CurrentUtilization	varchar	200				Current Utilization
15	ApprovalYear	varchar	8				Approval Year
16	ApprovalGovernment	varchar	200				Approval Government
17	Reference	varchar	2000				References
18	Remarks	varchar	2000				Remarks

HabitatConversion table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	Int		Y	Y	N	Metadata
2	SiteID	Identity int		Y		N	Site ID
3	SiteName	varchar	200				Site Name
4	SiteCountry	varchar	60				Site Country
5	SiteProvince	varchar	60				Site Province
6	SiteCity	varchar	60				Site City
7	SiteDescription	varchar	200				Site Description
8	LongWest	number	10.6				West Longitude
9	LongEast	number	10.6				East Longitude
10	LatSouth	number	10.6				South Latitude
11	LatNorth	number	10.6				North Latitude
12	Date	varchar	8				Date
13	HabitatType	varchar	200				Habitat Type
14	HabitatArea_km2	number	18.3				Habitat Area(km^2)
15	MajorUtilization	varchar	200				Major Utilization
16	HumanActivitiesRank1	varchar	200				Human Activities Rank1
17	HumanActivitiesRank2	varchar	200				Human Activities Rank2
18	HumanActivitiesRank3	varchar	200				Human Activities Rank3
19	Reference	varchar	2000				References
20	Remarks	varchar	2000				Remarks

ProtectedArea table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	Int		Y	Y	N	Metadata
2	SiteID	Identity int		Y		N	Site ID
3	SiteName	varchar	200				Site Name

4	SiteCountry	varchar	60				Site Country
5	SiteProvince	varchar	60				Site Province
6	SiteCity	varchar	60				Site City
7	SiteDescription	varchar	200				Site Description
8	LongWest	number	10.6				West Longitude
9	LongEast	number	10.6				East Longitude
10	LatSouth	number	10.6				South Latitude
11	LatNorth	number	10.6				North Latitude
12	Objectives	varchar	2000				Objectives
13	TotalArea_ha	number	18.3				Total Area(ha)
14	CoreArea_ha	number	18.3				Core Area(ha)
15	BufferArea_ha	number	18.3				Buffer Area(ha)
16	ExperimentArea_ha	number	18.3				Experiment Area(ha)
17	MapOfDistribution	varchar	200				Map Of Distribution
18	HabitatType	varchar	200				Habitat Type
19	HabitatArea_ha	number	18.3				Habitat Area(ha)
20	Trend	int					Trend
21	ImportantSpecies	varchar	2000				Important Species
22	MajorCommunities	varchar	2000				Major Communities
23	HumanActivities	varchar	2000				Human Activities
24	Level	varchar	40				Level
25	ResponsibleDepartment	varchar	200				Responsible Department
26	DateOfEstablishment	varchar	8				Date Of Establishment
27	ActiveManagement	int					Active Management
28	StaffNo	varchar	40				Staff No
29	MonitoringActivities	int					Monitoring Activities
30	Reference	varchar	2000				References
31	Remarks	varchar	2000				Remarks

Reclamation table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	Int		Y	Y	N	Metadata
2	SiteID	Identity int		Y		N	Site ID
3	SiteName	varchar	200				Site Name
4	SiteCountry	varchar	60				Site Country
5	SiteProvince	varchar	60				Site Province
6	SiteCity	varchar	60				Site City
7	SiteDescription	varchar	200				Site Description

8	LongWest	number	10.6				West Longitude
9	LongEast	number	10.6				East Longitude
10	LatSouth	number	10.6				South Latitude
11	LatNorth	number	10.6				North Latitude
12	Name	varchar	200				Name
13	Date	varchar	8				Date
14	Status	varchar	200				Status
15	NHabitatType	varchar	200				Nhabitat Type
16	NHabitatArea_km2	number	18.3				NHabitatArea_km2
17	NHabitatLength_km	number	18.3				NHabitatLength_km
18	AHabitatType	varchar	200				AHabitatType
19	AHabitatArea_km2	number	18.3				AHabitatArea_km2
20	AHabitatLength_km	number	18.3				AHabitatLength_km
21	HumanActivitiesRank1	varchar	200				Human Activities Rank1
22	HumanActivitiesRank2	varchar	200				Human Activities Rank2
23	Reference	varchar	2000				References
24	Remarks	varchar	2000				Remarks

LawsAndRegulations table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	Int		Y	Y	N	Metadata
2	ID	Identity int		Y		N	ID
3	Name	varchar	200				Name
4	GroupID	Int					Group ID
5	IssuedDate	varchar	8				Issued Date
6	IssuedBy	varchar	200				Issued By
7	Reference	varchar	2000				References
8	Remarks	varchar	2000				Remarks

(3) Views

EndemicSpecies:

```
CREATE VIEW dbo.EndemicSpecies
AS
SELECT sg.EnglishName AS GroupName,
        s.ID as SpeciesID,
        s.LatinName,
        s.EnglishName,
        s.ChineseName,
        s.KoreanName,
```

```
        es.DistributionInYS,
        es.FoundDate,
        es.HighLevelYear,
        es.LowLevelYear,
        es.ThreatenedCategories,
        es.Trend,
        es.MajorCauses,
        es.IUCNRedList,
        es.ChinaRedList,
        es.KoreaRedList,
        es.Reference,
        es.Remarks,
        es.Metadata as Metadata
FROM dbo.Biod_EndemicSpecies es INNER JOIN
        dbo.Biod_Species s INNER JOIN
        dbo.Biod_SpeciesGroups sg
        ON s.GroupID = sg.ID ON es.SpeciesID = s.ID
```

ExoticSpecies:

```
CREATE VIEW dbo.ExoticSpecies
AS
SELECT sg.EnglishName AS GroupName,
    s.ID as SpeciesID,
    s.LatinName,
    s.EnglishName,
    s.ChineseName,
    s.KoreanName,
    es.PathwayOfIntroduction,
    es.ObjectiveOfIntroduction,
    es.DateOfIntroduction,
    es.OriginOfImport,
    es.RearingSite,
    es.DateOfFirstRecordInWild,
    es.SiteOfFirstRecordInWild,
    es.WildPopulation,
    es.WildPopulationDistribution,
    es.Reference, es.Remarks,
    es.Metadata as Metadata
  FROM dbo.Biod_ExoticSpecies es INNER JOIN
        dbo.Biod_Species s INNER JOIN
        dbo.Biod_SpeciesGroups sg
          ON s.GroupID = sg.ID ON es.SpeciesID = s.ID
```

GeneticDiversity:

```
CREATE VIEW dbo.GeneticDiversity
AS
```

```
SELECT sg.EnglishName AS GroupName,
        s.ID as SpeciesID,
        s.LatinName,
        s.EnglishName,
        s.ChineseName,
        s.KoreanName,
        gd.GeneticInfo,
        gd.Reference,
        gd.Remarks,
        gd.Metadata as Metadata
FROM dbo.Biod_GeneticDiversity gd INNER JOIN
      dbo.Biod_Species s INNER JOIN
      dbo.Biod_SpeciesGroups sg
      ON s.GroupID = sg.ID ON gd.SpeciesID = s.ID
```

VulnerableSpecies:

```
CREATE VIEW dbo.VulnerableSpecies
AS
SELECT sg.EnglishName AS GroupName,
        s.ID as SpeciesID,
        s.LatinName,
        s.EnglishName,
        s.ChineseName,
        s.KoreanName,
        es.DistributionInYS,
        es.HighLevelYear AS DateOfPeakCatch,
        es.LowLevelYear AS DateOfLowestCatch,
        es.ThreatenedCategories,
        es.Trend,
        es.MajorCauses,
        es.IUCNRedList,
        es.ChinaRedList,
        es.KoreaRedList,
        es.Reference,
        es.Remarks,
        es.Metadata as Metadata
FROM dbo.Biod_VulnerableSpecies es INNER JOIN
      dbo.Biod_Species s INNER JOIN
      dbo.Biod_SpeciesGroups sg
ON s.GroupID = sg.ID ON es.SpeciesID = s.ID
```

5.2.2.2 Fisheries

Like biodiversity tables, fisheries data are also divided into basic tables and subject tables. The subject tables refer to the relative basic tables. Following are the E-R diagram (Fig.4) and detail logical structures of the fisheries data.

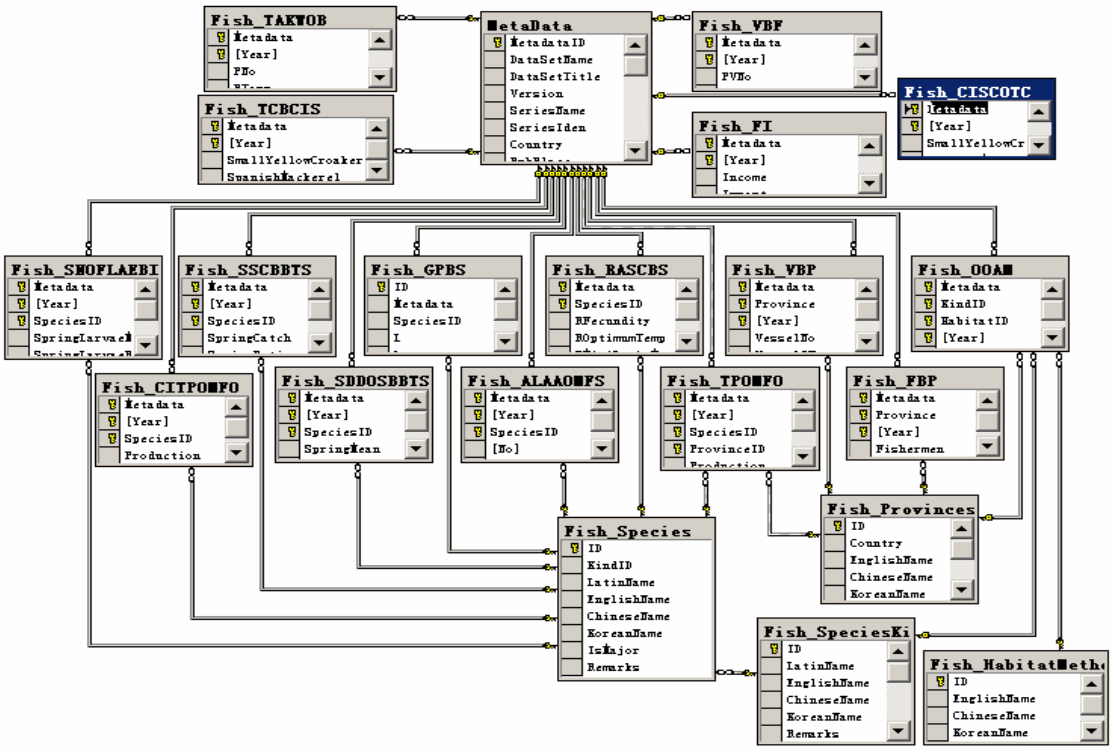

Fig.4 The E-R diagram of the fisheries logical structure

(1) Basic tables

Fish_SpeciesKind table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	ID	Identity int		Y		N	ID
2	LatinName	varchar	200				Latin Name
3	EnglishName	varchar	200				English Name
4	ChineseName	varchar	200				Chinese Name
5	KoreanName	varchar	200				Korean Name
6	Remarks	Text					Remarks

Fish_Species table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	ID	Identity int		Y		N	ID
2	KindID	Int			Y	N	Species Kind ID
3	EnglishName	varchar	50				English Name

4	ChineseName	varchar	50				Chinese Name
5	KoreanName	varchar	200				Korean Name
6	IsMajor	Int					IsMajor
7	Remarks	Text					Remarks

Fish_Provinces table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	ID	Identity int		Y		N	ID
2	Country		50				Country
3	EnglishName	varchar	50				English Name
4	ChineseName	varchar	50				Chinese Name
5	KoreanName	varchar	200				Korean Name

Fish_HabitatMethods table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	ID	Identity int		Y		N	ID
2	EnglishName	varchar	200				English Name
3	ChineseName	varchar	200				Chinese Name
4	KoreanName	varchar	200				Korean Name
5	Remarks	Text					Remarks

(2) Subject tables

Fish_TCBCIS table

（Total Catch by Commercially Important Species）

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	Year	varchar	8	Y		N	Year
3	SmallYellowCroaker	real					Small Yellow Croaker
4	SpanishMackerel	real					Spanish Mackerel
5	Anchovy	real					Anchovy
6	ChubMackerel	real					Chub Mackerel
7	LargeheadHairtail	real					Largehead Hairtail
8	PacificHerring	real					Pacific Herring
9	Sandlance	real					Sandlance
10	Acetes	real					Acetes
11	FleshyPrawn	real					Fleshy Prawn
12	Squids	real					Squids

Fish_TAKWOB table

（Tonnage and KW of Boats）

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	Year	varchar	8	Y		N	Year
3	PNo	Int					Powered Vessel No
4	PTons	Int					Powered Vessel Tons
5	PKW	Float					Powered Vessel KW
6	NNo	Int					Non-Powered Vessel No
7	NTons	int					Non-Powered Vessel Tons

Fish_CISCOTC table

（Commercially Important Species Composition of Total Catch）

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	Year	varchar	8	Y		N	Year
3	SmallYellowCroaker	decimal	18.3				Small Yellow Croaker
4	SpanishMackerel	decimal	18.3				Spanish Mackerel
5	Anchovy	decimal	18.3				Anchovy
6	ChubMackerel	decimal	18.3				Chub Mackerel
7	LargeheadHairtail	decimal	18.3				Largehead Hairtail
8	PacificHerring	decimal	18.3				Pacific Herring
9	Sandlance	decimal	18.3				Sandlance
10	Acetes	decimal	18.3				Acetes
11	FleshyPrawn	decimal	18.3				Fleshy Prawn
12	Squids	decimal	18.3				Squids

Fish_GPBS table

（Growth Parameters by Species）

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	ID	int		Y		N	ID
2	Metadata	int			Y	N	Metadata
3	SpeciesID	int			Y	N	Species ID
4	L	real					L(cm)
5	k	real					k
6	t0	real					t0

7	a	real					a
8	b	real					b
9	Longevity	varchar	50				Longevity(yr)
10	Remarks	text					Remarks

Fish_RASCBS table

（Reproduction and Spawning Characteristics by Species）

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	SpeciesID	int		Y	Y	N	Species ID
3	RFecundity	varchar	200				Fecundity (× 10,000)
4	ROptimumTemp	varchar	200				Optimum temp. (℃)
5	RMiniLenAtMaturity	varchar	200				Mini length at maturity (cm)
6	Season	varchar	200				Season
7	Remarks	text					Remarks

Fish_SSCBBTS table

（Seasonal Species Composition by Bottom Trawl Survey）

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	Year	Varchar	8	Y		N	Year
3	SpeciesID	Int		Y	Y	N	Species ID
4	SpringCatch	real					Spring Catch
5	SpringRatio	real					Spring Ratio
6	WinterCatch	real					Winter Catch
7	WinterRatio	real					Winter Ratio

Fish_SDDOSBBTS table

（Seasonal Density Distribution of Species by Bottom Trawl Survey）

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	Year	Varchar	8	Y		N	Year
3	SpeciesID	Int		Y	Y	N	Species ID
4	SpringMean	real					Spring Mean
5	SpringRangeMin	real					Spring Range Min
6	SpringRangeMax	real					Spring Range Max
7	WinterMean	real					Winter Mean

8	WinterRangeMin	real					Winter Range Min
9	WinterRangeMax	real					Winter Range Max

Fish_SNOFLAEBIS table

（Seasonal Number of Fish Larvae and eggs by Ichthyoplankton Survey）

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	Year	Varchar	8	Y		N	Year
3	SpeciesID	Int		Y	Y	N	Species ID
4	SpringLarvaeMean	real					Spring Larvae Mean
5	SpringLarvaeRangeMin	real					Spring Larvae Range Min
6	SpringLarvaeRangeMax	real					Spring Larvae Range Max
7	SpringEggsMean	real					Spring Eggs Mean
8	SpringEggsRangeMin	real					Spring Eggs Range Min
9	SpringEggsRangeMax	real					Spring Eggs Range Max
10	WinterLarvaeMean	real					Winter Larvae Mean
11	WinterLarvaeRangeMin	real					Winter Larvae Range Min
12	WinterLarvaeRangeMax	real					Winter Larvae Range Max
13	WinterEggsMean	real					Winter Eggs Mean
14	WinterEggsRangeMin	real					Winter Eggs Range Min
15	WinterEggsRangeMax	real					Winter Eggs Range Max

Fish_TPOMFO table

（Total production of marine farmed organisms (unit: M/T)）

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	Year	Varchar	8	Y		N	Year
3	SpeciesID	Int		Y	Y	N	Species ID
4	ProvinceID	Int		Y	Y	N	Province
5	Production	real					Production

Fish_CITPOMFO table

（Change in total production of marine farmed organisms(unit: M/T) ））

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	Year	Varchar	8	Y		N	Year

3	SpeciesID	Int		Y	Y	N	Species ID
4	Production	real					Production

Fish_ALAAOMFS table

（Aquaculture Licenses and Area of Marine Farmed Species）

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	Year	Varchar	8	Y		N	Year
3	SpeciesID	Int		Y	Y	N	Species ID
4	No	real					No
5 Year	ha	real					ha

Fish_OOAM table

（Overview of Aquaculture Methods）

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	KindID	Int		Y	Y	N	Kind ID
3	HabitatID	Int		Y	Y	N	Habitat ID
4	Year	Varchar	8	Y		N	Year
5	ProvinceID	Int		Y	Y	N	Province
6	No	real					No
7	ha	real					ha

Fish_VBF 表结构

（Vessels by Fishery）

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	Year	Varchar	8	Y		N	Year
3	PVNo	Int					Power Vessels No
4	NPVNo	numeric	18.0				Non-Power Vessels No
5	PVGT	numeric	18.0				Power Vessels GT
6	NPVGT	numeric	18.0				Non-Power Vessels GT
7	DVNo	numeric	18.0				Distant Waters Fisheries No
8	DVGT	numeric	18.0				Distant Waters Fisheries GT
9	CVNo	numeric	18.0				Coastal Fisheries No
10	CVGT	numeric	18.0				Coastal Fisheries GT

Fish_VBP table

（Vessels by Province）

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	Province	Int		Y	Y	N	Province
3	Year	Varchar	8	Y		N	Year
4	VesselNo	numeric	18.0				Vessel No
5	VesselGT	numeric	18.0				Vessel GT

Fish_FBP table

（Fishermen by province）

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	Province	Int		Y	Y	N	Province
3	Year	Varchar	8	Y		N	Year
4	Fishermen	Int					Fishermen

Fish_FI table

（Fisheries income）

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	Year	Varchar	8	Y		N	Year
3	Income	Varchar	60				Income
4	Import	Varchar	60				Import
5	Export	Varchar	60				Export
6	GDP	Varchar	60				GDP
7	FisheriesGDP	Varchar	60				FisheriesGDP
8	GDPRatio	Varchar	60				GDPRatio
9	Consumption	Varchar	60				Consumption

5.2.2.3 Pollution

Pollution component is about seasonal, regional-monthly, regional-seasonally and regional-yearly statistic data of different pollution problems or data kinds. So the pollution problem and pollution data kind are designed as basic tables and the statistic data are designed as subject tables refer to the relative elements in basic tables. Following are the E-R diagram (Fig.5~Fig.8) and detail logical structures of the

pollution data.

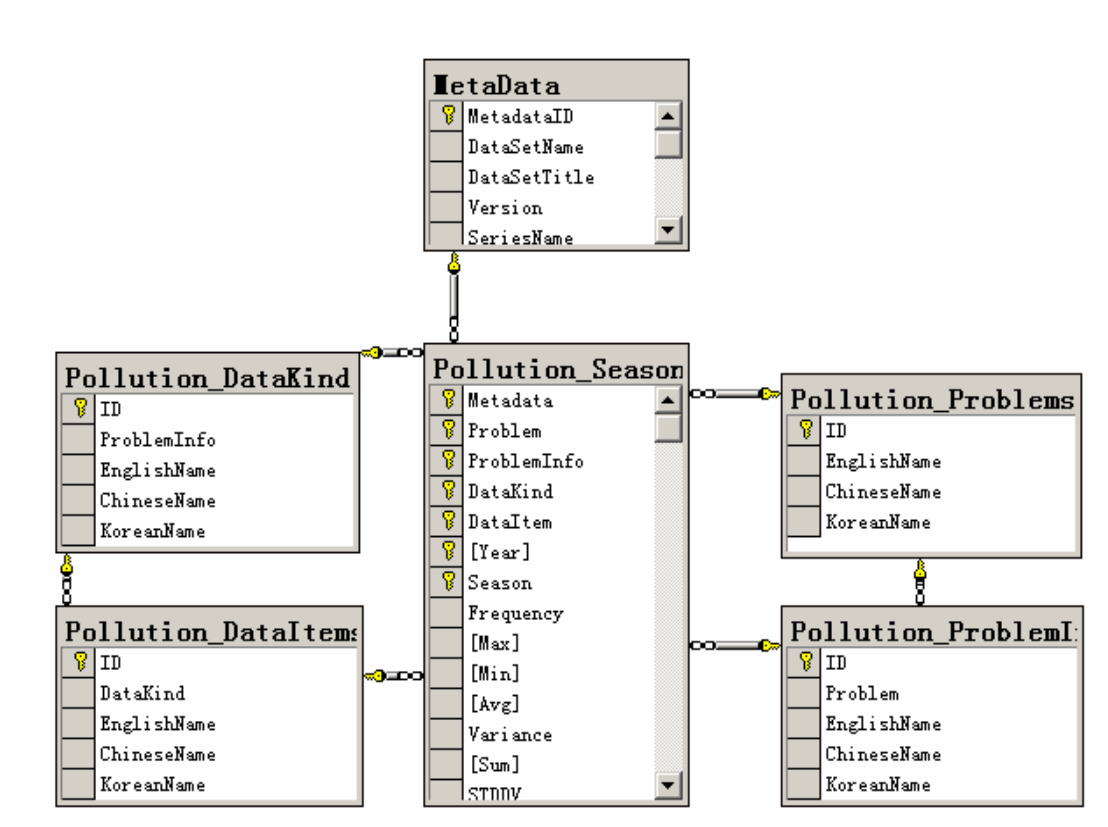

Fig.5 The E-R diagram of the seasonal pollution statistic data

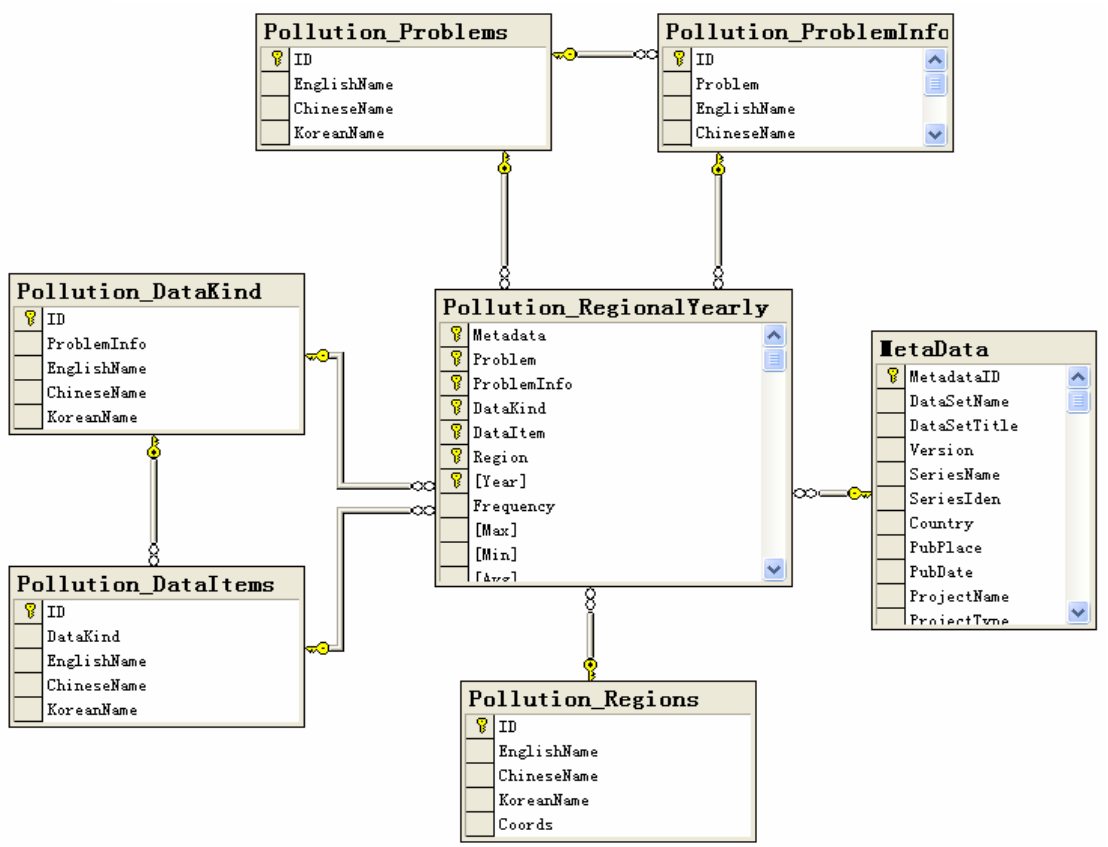

Fig.6 The E-R diagram of the regional-yearly pollution statistic data

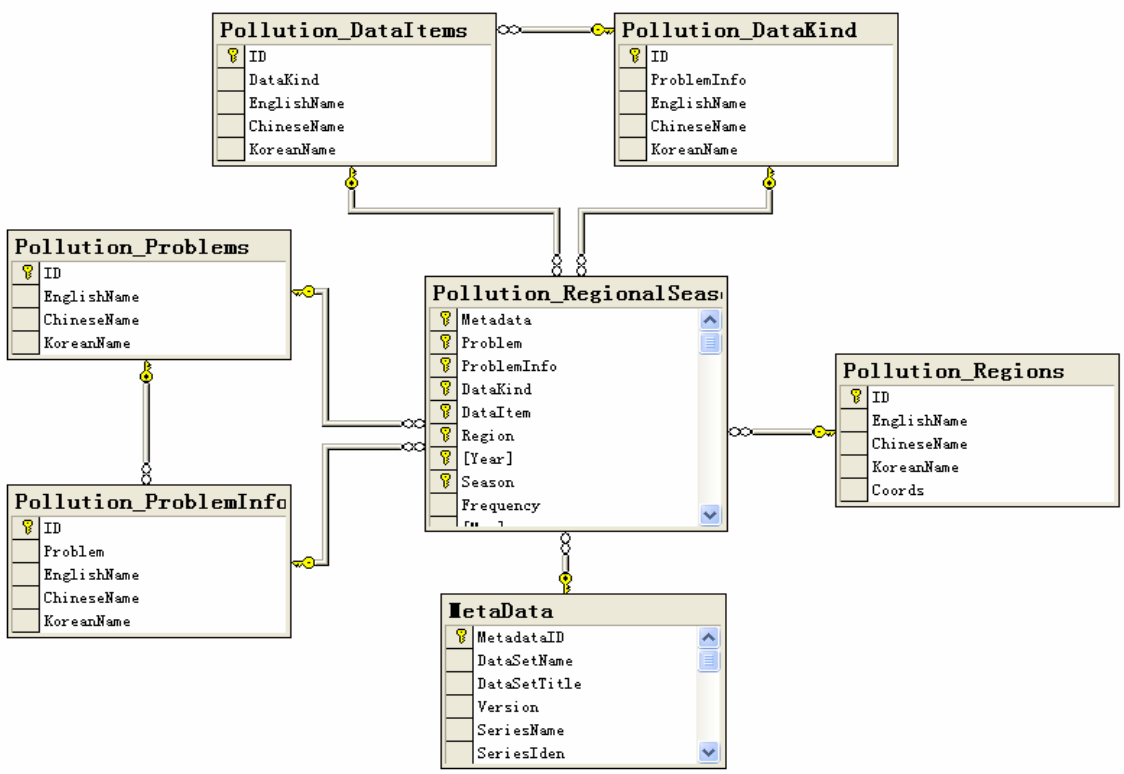

Fig.7 The E-R diagram of the regional-seasonally pollution statistic data

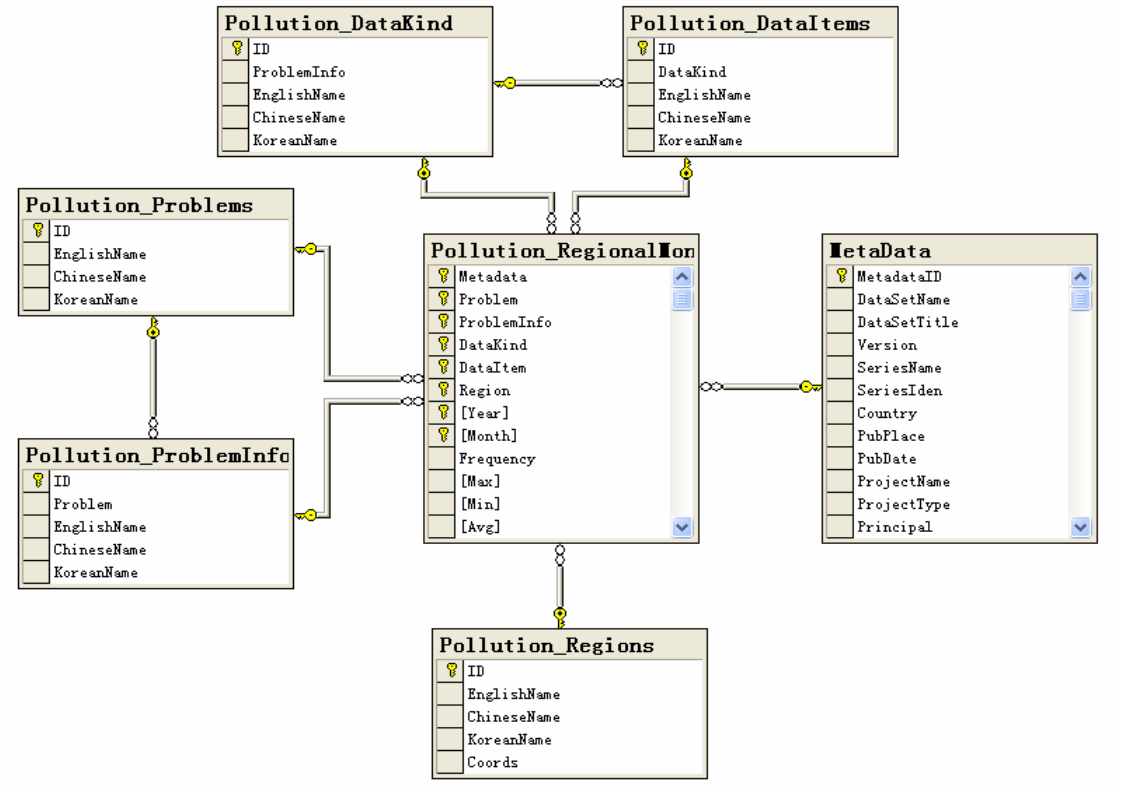

Fig.8 The E-R diagram of the regional-monthly pollution statistic data

(1) Basic tables

Pollution_Problems table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	ID	Identify int		Y		N	ID
2	EnglishName	Varchar	200				English Name
3	ChineseName	Varchar	200				Chinese Name
4	KoreanName	Varchar	200				Korean Name

Pollution_ProblemInfo table

（Information needed to detect problem）

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	ID	int		Y		N	ID
2	Problem	Int			Y	N	Problem
3	EnglishName	Varchar	200				English Name
4	ChineseName	Varchar	200				Chinese Name
5	KoreanName	Varchar	200				Korean Name

Pollution_DataKind table

（Kinds of data needed）

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	ID	int		Y		N	ID
2	ProblemInfo	Varchar	200			N	Information needed to detect problem
3	EnglishName	Varchar	200				English Name
4	ChineseName	Varchar	200				Chinese Name
5	KoreanName	Varchar	200				Korean Name

Pollution_DataItems table

（Data Items）

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	ID	int		Y		N	ID
2	DataKind	int			Y	N	Data Kind
3	EnglishName	Varchar	200				English Name
4	ChineseName	Varchar	200				Chinese Name
5	KoreanName	Varchar	200				Korean Name

Pollution_Regions table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	ID	Identify int		Y		N	ID
2	EnglishName	Varchar	200				English Name
3	ChineseName	Varchar	200				Chinese Name
4	KoreanName	Varchar	200				Korean Name
5	Coords	Varchar	2000				Coords

(2) Subject tables

Pollution_Seasonal table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	Problem	int		Y	Y	N	Problem
3	ProblemInfo	int		Y	Y	N	Problem Information
4	DataKind	int		Y	Y	N	Data Kind
5	DataItem	int		Y	Y	N	Data Item
6	Year	Varchar	8	Y		N	Year
7	Season	int		Y	Y	N	Season
8	Frequency	int					Frequency
9	Max	decimal	10.2				Max
10	Min	decimal	10.2				Min
11	Avg	decimal	10.3				Avg
12	Variance	decimal	10.3				Variance
13	Sum	decimal	10.2				Sum
14	STDDV	decimal	10.3				STD DV

Pollution_RegionalYearly table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	Problem	int		Y	Y	N	Problem
3	ProblemInfo	int		Y	Y	N	Problem Information
4	DataKind	int		Y	Y	N	Data Kind
5	DataItem	int		Y	Y	N	Data Item
6	Region	int		Y	Y	N	Region
7	Year	Varchar	8	Y		N	Year
8	Frequency	int					Frequency

9	Max	decimal	10.2				Max
10	Min	decimal	10.2				Min
11	Avg	decimal	10.3				Avg
12	Variance	decimal	10.3				Variance
13	Sum	decimal	10.2				Sum
14	STDDV	decimal	10.3				STD DV

Pollution_RegionalSeasonal table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	Problem	int		Y	Y	N	Problem
3	ProblemInfo	int		Y	Y	N	Problem Information
4	DataKind	int		Y	Y	N	Data Kind
5	DataItem	int		Y	Y	N	Data Item
6	Region	int		Y	Y	N	Region
7	Year	Varchar	8	Y		N	Year
8	Season	int		Y	Y	N	Season
9	Frequency	int					Frequency
10	Max	decimal	10.2				Max
11	Min	decimal	10.2				Min
12	Avg	decimal	10.3				Avg
13	Variance	decimal	10.3				Variance
14	Sum	decimal	10.2				Sum
15	STDDV	decimal	10.3				STD DV

Pollution_RegionalMonthly table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	Problem	int		Y	Y	N	Problem
3	ProblemInfo	int		Y	Y	N	Problem Information
4	DataKind	int		Y	Y	N	Data Kind
5	DataItem	int		Y	Y	N	Data Item
6	Region	int		Y	Y	N	Region
7	Year	Varchar	8	Y		N	Year
8	Month	int		Y		N	Month
9	Frequency	int					Frequency
10	Max	decimal	10.2				Max
11	Min	decimal	10.2				Min

12	Avg	decimal	10.3				Avg
13	Variance	decimal	10.3				Variance
14	Sum	decimal	10.2				Sum
15	STDDV	decimal	10.3				STD DV
15	Source	Varchar	200				Source

5.2.2.4 Ecosystem

Ecosystem component has some basic entities such as ecosystem stations, ecosystem species, ecosystem problems, ecosystem indicators and ecosystem numerical units. The subject ecosystem data are related with the basic elements. So the ecosystem datasets also includes basic tables and subject tables. Following are the E-R diagram (Fig.9) and detail logical structures of the ecosystem data.

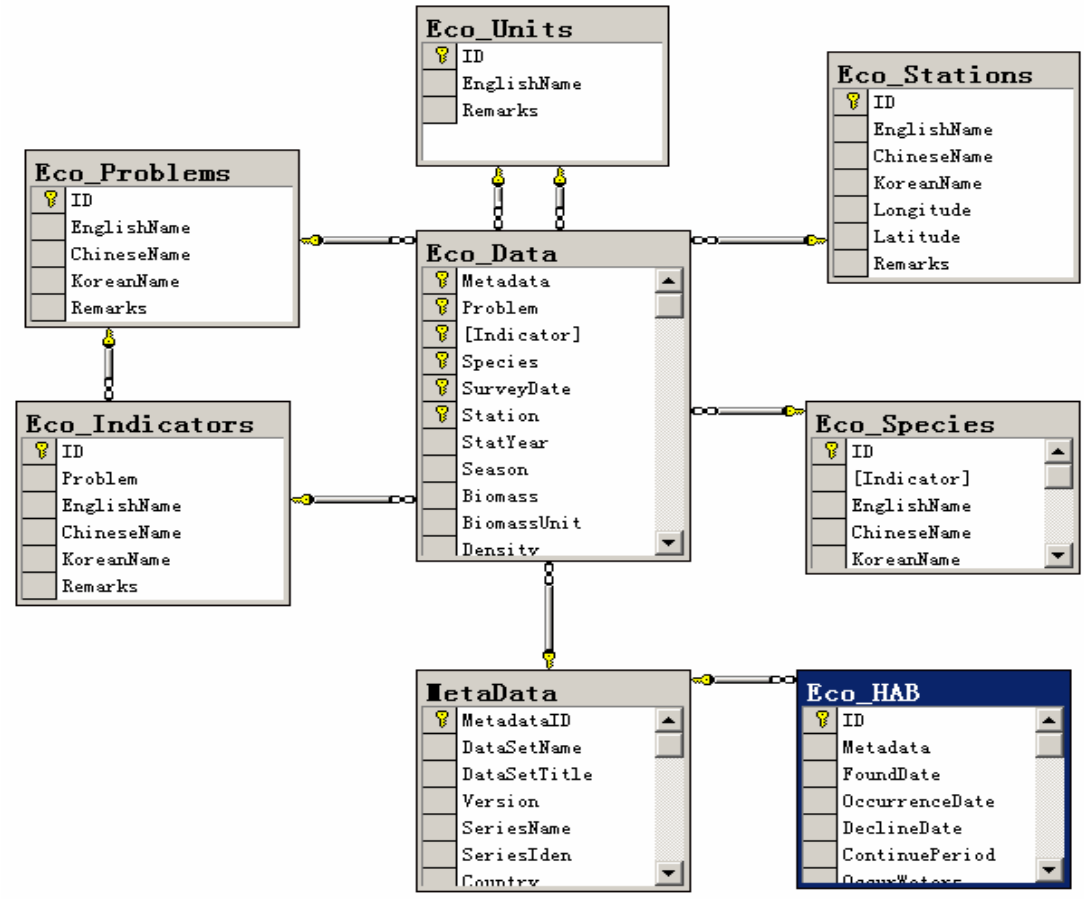

Fig.9 The E-R diagram of ecosystem data

(1) Basic table

Eco_Problems table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	ID	Identify int		Y		N	ID
2	EnglishName	Varchar	200				English Name
3	ChineseName	Varchar	200				Chinese Name
4	KoreanName	Varchar	200				Korean Name
5	Remarks	Varchar	200				Remarks

Eco_Indicators table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	ID	Identify int		Y		N	ID
2	Problem	Int			Y	N	Problem
3	EnglishName	Varchar	200				English Name
4	ChineseName	Varchar	200				Chinese Name
5	KoreanName	Varchar	200				Korean Name
6	Remarks	Varchar	200				Remarks

Eco_Species table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	ID	Identify int		Y		N	ID
2	Indicator	Int			Y	N	Indicator
3	EnglishName	Varchar	200				English Name
4	ChineseName	Varchar	200				Chinese Name
5	KoreanName	Varchar	200				Korean Name
5	Remarks	Varchar	200				Remarks

Eco_Stations table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	ID	Identify int		Y		N	ID
2	EnglishName	Varchar	200				English Name
3	ChineseName	Varchar	200				Chinese Name
4	KoreanName	Varchar	200				Korean Name
5	Longitude	numeric	18.2				Longitude
6	Latitude	numeric	18.2				Latitude
7	Remarks	Varchar	200				Remarks

Eco_Units table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	ID	Identify int		Y		N	ID
2	EnglishName	Varchar	200				English Name
3	Remarks	Varchar	200				Remarks

(2) Subject table

Eco_Data table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	Metadata	int		Y	Y	N	Metadata
2	Problem	int		Y	Y	N	Problem
3	Indicator	int		Y	Y	N	Indicator
4	Species	int		Y	Y	N	Species
5	SurveyDate	Varchar	8	Y		N	SurveyDate
6	Station	int		Y	Y	N	Station
7	StatYear	Varchar	4				Statistics Year
8	Season	int			Y		Season
9	Biomass	Varchar	20				Biomass
10	BiomassUnit	int					BiomassUnit
11	Density	Varchar	20				Density
12	DensityUnit	int					DensityUnit
13	Remarks	Varchar	200				Remarks

Eco_HAB table

ID	Column Name	Type	Width	PKey	FKey	NULL	Remarks
1	ID	Identity int		Y		N	
1	Metadata	int			Y	N	Metadata
3	FoundDate	Varchar	60				Found Date
4	OccurrenceDate	Varchar	60				Occurrence Date
5	DeclineDate	Varchar	60				Decline Date
6	ContinuePeriod	Varchar	60				Continue Period
7	OccurWaters	Varchar	200				Occur Waters
8	Area	Varchar	60				Area
9	Species	Varchar	60				HAB Species
10	CellDensity	Varchar	60				HAB cell density *1000cells/ml
11	WaterColor	Varchar	200				Water Color

6 System design

6.1 Total design

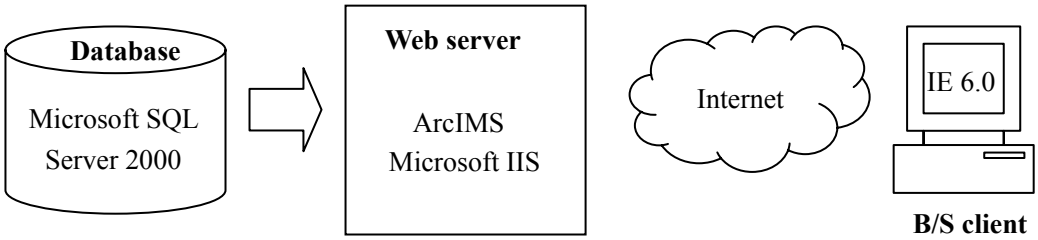

Fig.10 YSLME GIS system architecture

According to the requirement analysis, the YSLME system is designed and developed based on the B/S (Browser/Server) system architecture that showed as Fig.10. The system consists of three parts: database, web server and client. The database is constructed based on the Microsoft SQL Server 2000 and can provide effective data management and rapid data access. The web server is developed based on the Microsoft IIS and ArcIMS and can provide powerful services of data query and display about both scientific data and spatial data. The information can be browsed in the client based on the Microsoft Internet Explorer 6.0 or above and it doesn't need to install any other software.

6.2 Modules design

Fig.11 shows the organization of YSLME GIS system modules. Home the first page of the system and it contains the login interface, introduction of the system, news, modules link and so on. Users can't access the system unless he logs in the system from the homepage (Fig.12). Metadata query, data query, map query and system management are the main modules of the system. Metadata query module can provide the metadata information of YSLME database or world ocean scientific data centers according to the query conditions submitted by users. Data query module includes biodiversity data query, fisheries data query, pollution data query and ecosystem data query. Users can access different components data in YSLME database by input and submit the query elements. Map query module can make users query and browse the YSLME data based on a digital map including WVS of the Yellow Sea, surrounding administrative units and rivers. Management module includes system management module and data management module. System management module is mainly used to manage users, notices and so on. Data management can add, edit and delete the data of metadata database and YSLME database. These modules work together to make users

manage and access YSLME data more conveniently and effectively.

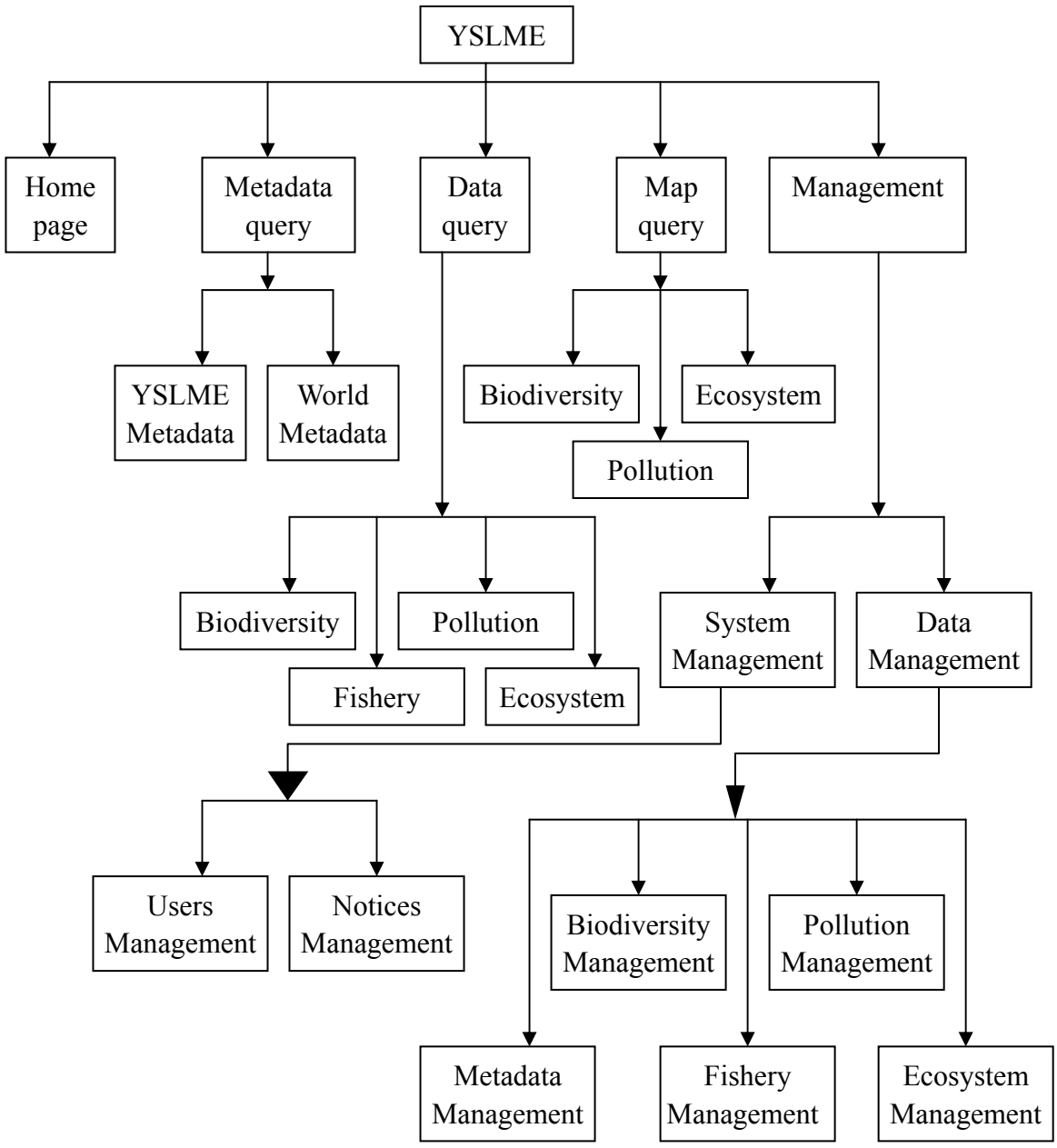

Fig.11 YSLME GIS system modules organization

Fig.12 Homepage of YSLME GIS system

The following sections introduce the functions of the modules in detail.

6.2.1 Metadata query module

The metadata query module includes YSLME metadata query module and world metadata query module. As show in Fig.13, in each metadata query module, users input and submit the key words of metadata and a record list of the query results return. Users can click the hyperlink in the list to view the detail information of metadata or the relative data (Fig.14).

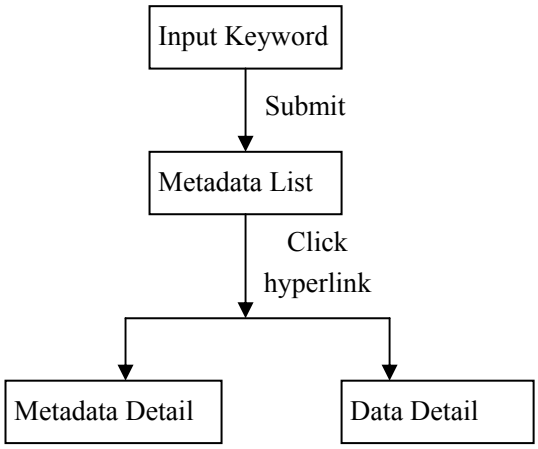

Fig.13 Workflow of Metadata query module

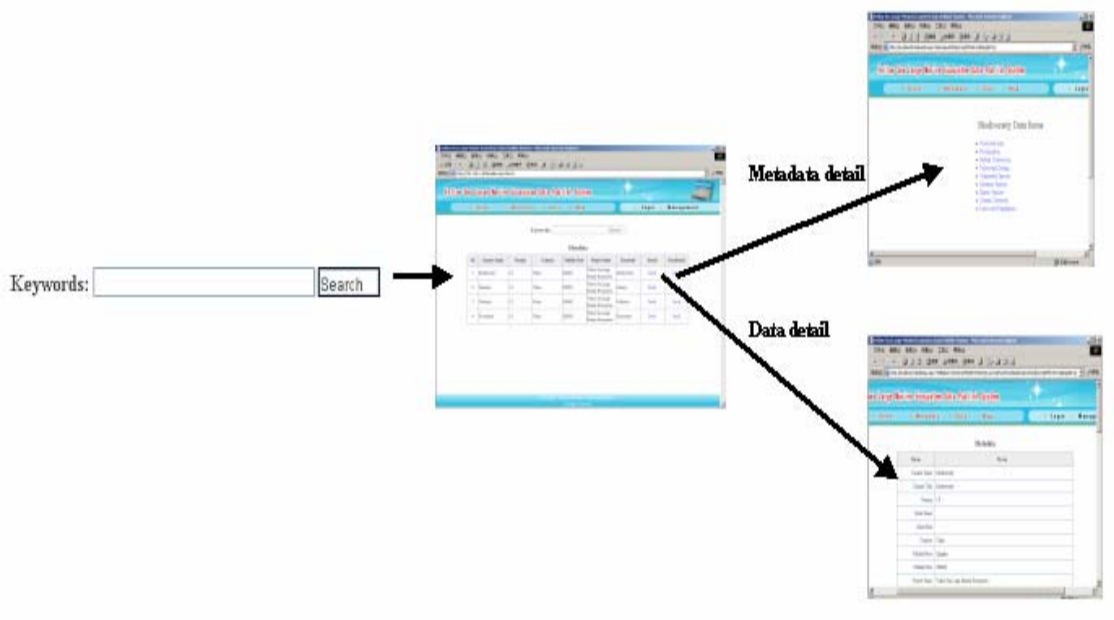

Fig.14 Realization of Metadata query module

6.2.2 Data query module

According to the YSLME project components, data query module consists of biodiversity data query module, fisheries data query module, pollution data query module and ecosystem data query module.

6.2.2.1 Biodiversity data query module

By managing and analyzing, biodiversity data can be divided into three subjects: species, laws & regulations and site. And each subject has several groups. So the workflow of biodiversity data query module is designed as Fig. 15. Firstly, users need to select or input biodiversity subjects, relative groups and the keyword. When the query conditions are submitted to the server, a record list return and we can get site information, detail data and detail metadata by click the hyperlink in the list. The realization of the biodiversity data query module is showed as Fig.16.

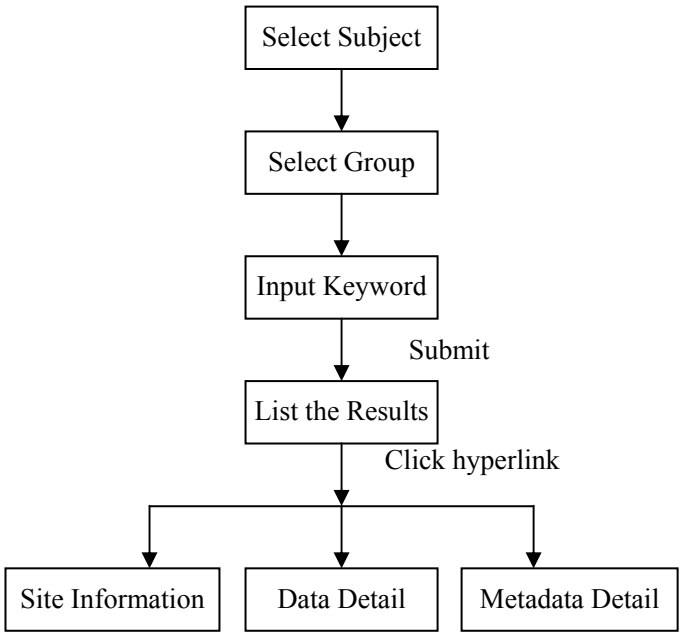

Fig.15 Workflow of Metadata query module

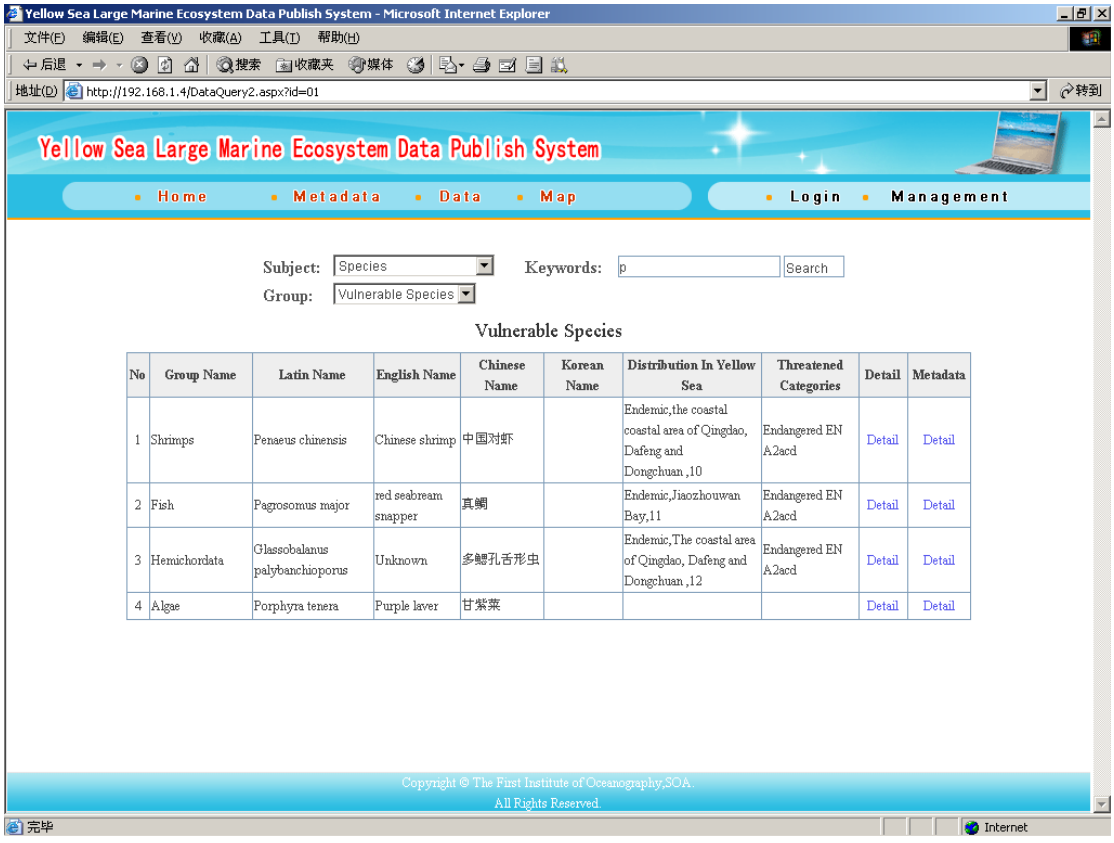

Fig.16 Realization of Metadata query module

6.2.2.2 Fisheries data query module

In fisheries query modules, fisheries data are divided into three subjects: fisheries, mariculture and socio-economic and each subject has many groups such as year, country, species or provinces. Users need to select the subject and group, input keywords and then submit the query conditions. In the result list that returns from the server, users can click the relative hyperlink to view the detail information of data and metadata. The Fig. 17 shows the workflow of fisheries data and Fig. 18 demonstrates the realization of the fisheries data query module.

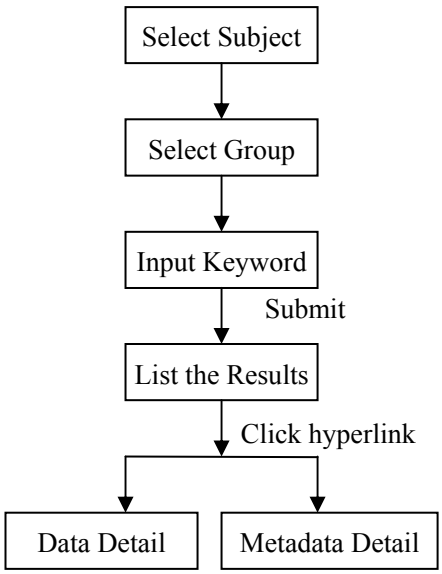

Fig.17 Workflow of fisheries data query module

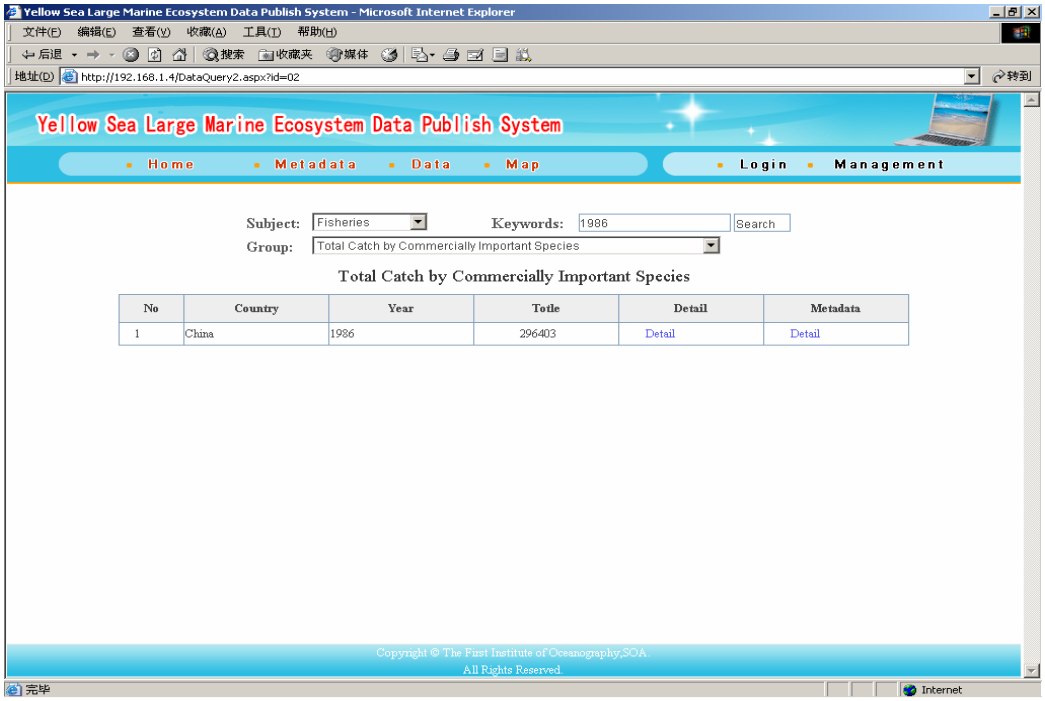

Fig.18 Realization of fisheries data query module

6.2.2.3 Pollution data query module

In pollution data query module, users need to select or input the pollution problem，pollution information，pollution data kinds, pollution data tables and the keywords of the data items. When the query conditions submitted, a result list returns and users can click the relative hyperlink to browse detail information of region, data and metadata. Fig.19 and Fig.20 show the workflow of pollution data query module and realization of pollution data query module respectively.

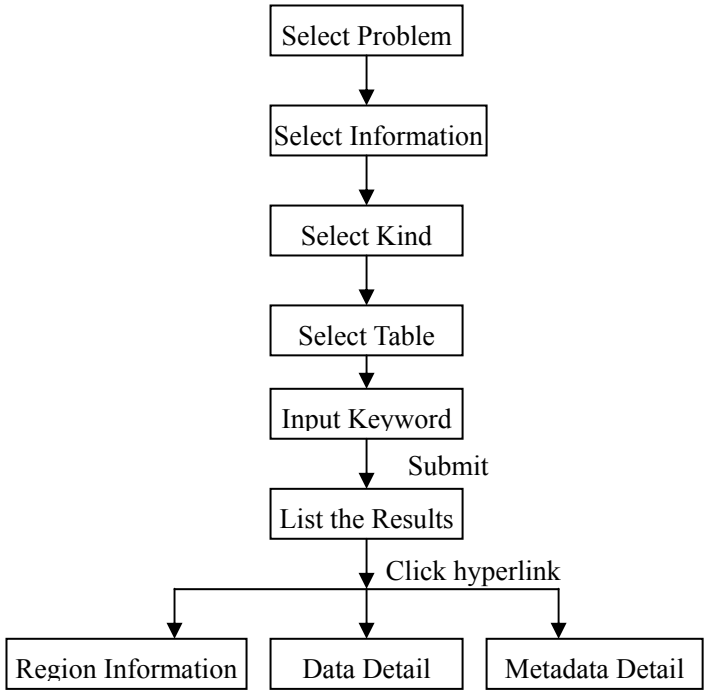

Fig.19 Workflow of pollution data query module

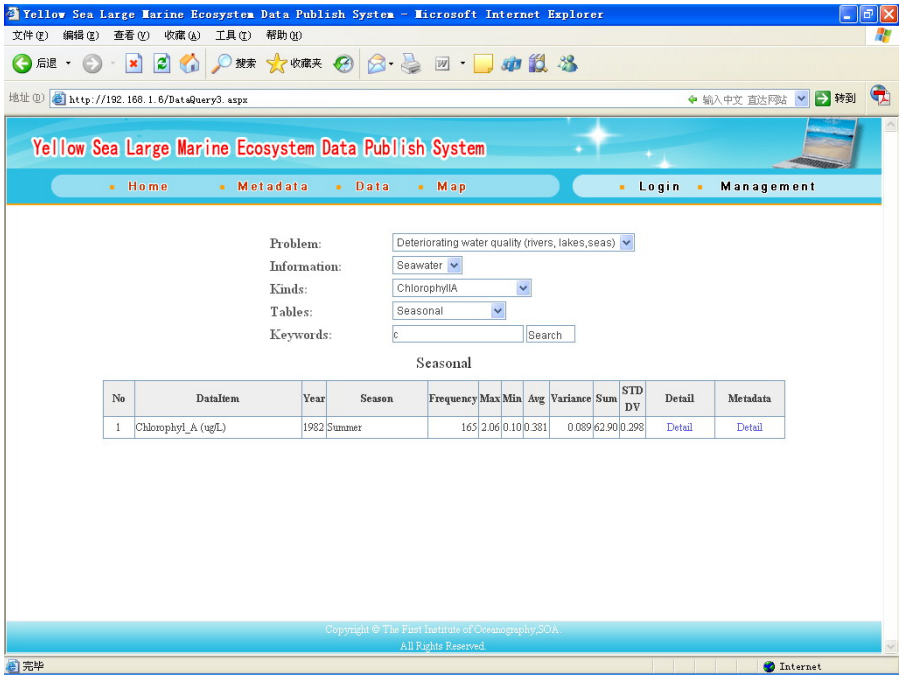

Fig.20 Realization of pollution data query module

6.2.2.4 Ecosystem data query module

In ecosystem data query module, users need to select ecosystem problem and information and input the keywords to submit the query conditions. In the result list returned, users can click the hyperlink to view the detail information of station, data and metadata. The workflow of ecosystem data query module and realization of ecosystem data query module are showed as follows.

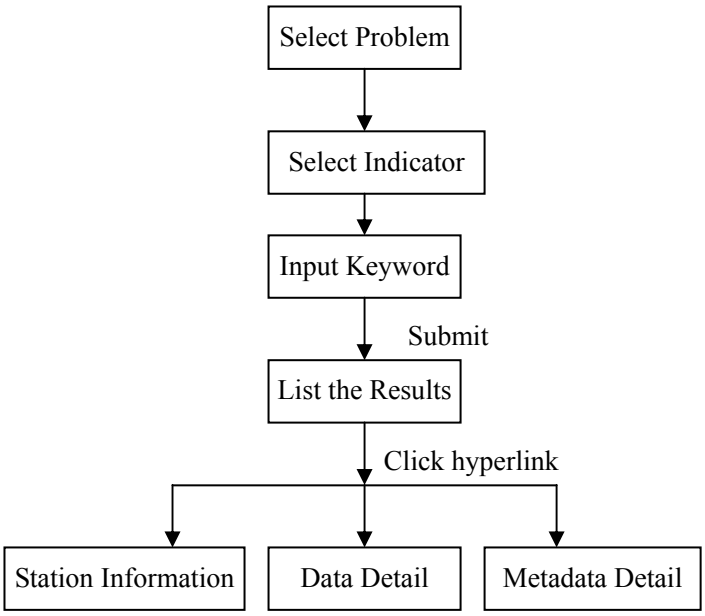

Fig.21 Workflow of ecosystem data query module

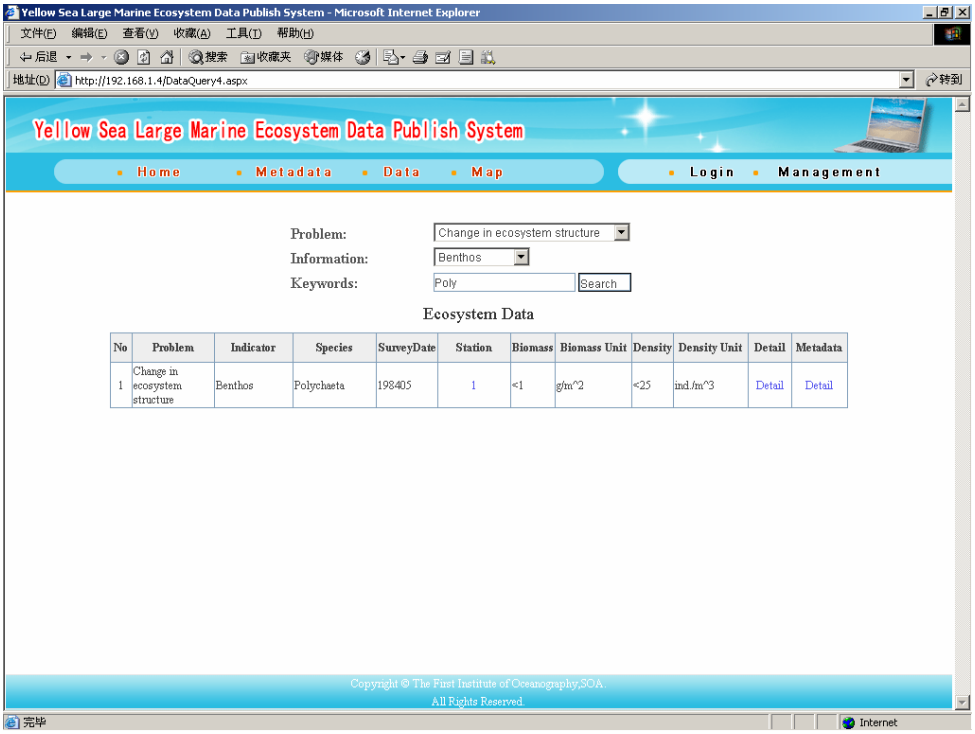

Fig.22 Realization of ecosystem data query module

6.2.3 Map query module

Map query module can provide users a direct and convenient way to query and browse the YSLME project data on a base GIS map. After choosing or inputting the constraint elements, a digital base map with the spatial sites or regions that meet the search constraint can display. Users can directly make operations on the map such as zoom in, zoom out, measure, *etc.* and choose one spatial sites or regions to browse their general information. According to the data generated from different YSLME project components, map query module includes biodiversity map query module, pollution map query module and ecosystem map query module. Each map query module will be introduced in the following sections.

6.2.3.1 Biodiversity map query module

In biodiversity map query module, users should select the site such as protected are, functional zoning, reclamated region and habitat conversion. If the site is related to the species, users also need to select species group and species. After users confirm the query conditions and click **search** button, the target areas that match the search elements is highlighted and users can click the area to view the detail information of the area.

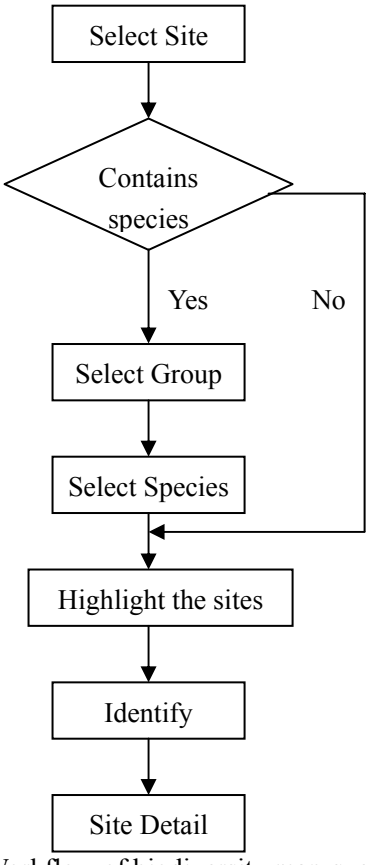

Fig.23 Workflow of biodiversity map query module

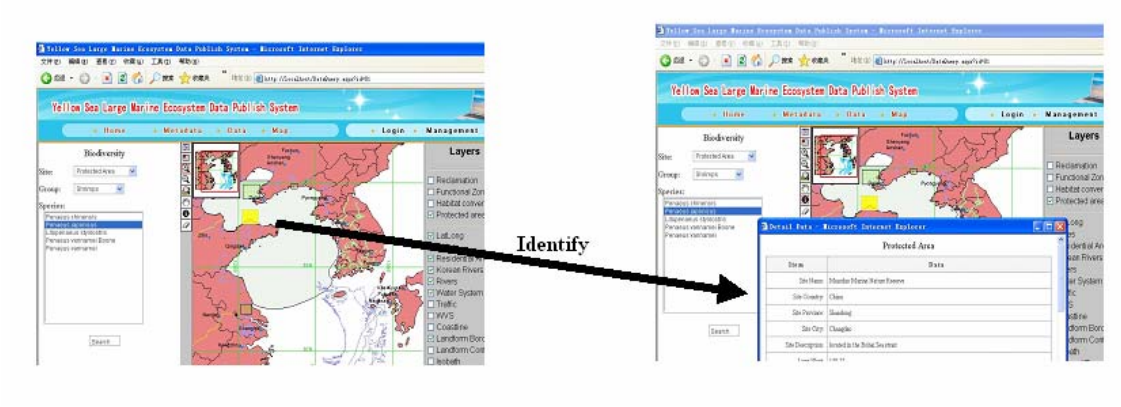

Fig.24 Realization of biodiversity map query module

6.2.3.2 Pollution map query module

In pollution map query module, users should make certain the pollution problem, information, data kinds and data items. After **search** button clicked, the target areas highlighted and users can identify the areas for general information of the area. In the result list of general information, users can click the hyperlink to view the detail information of regions, data and metadata.

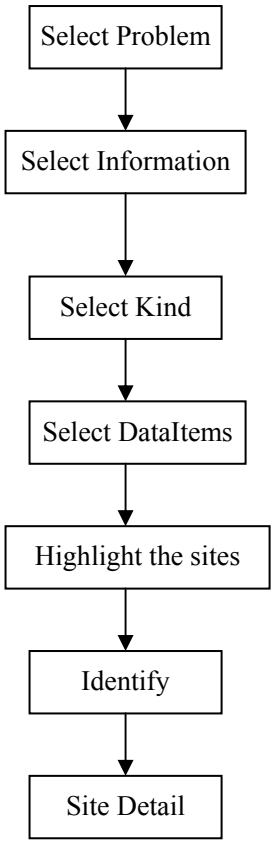

Fig.25 Workflow of pollution map query module

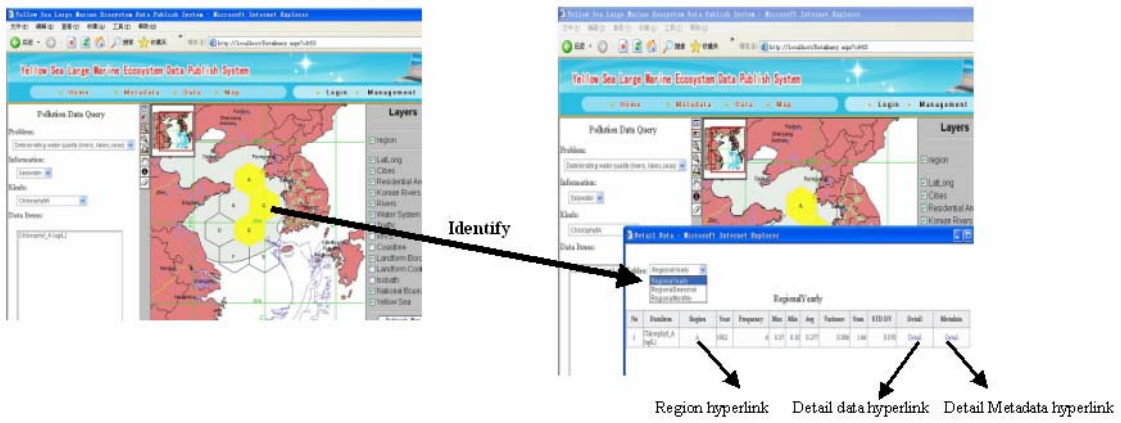

Fig.26 Realization of pollution map query module

6.2.3.3 Ecosystem map query module

In ecosystem map query module, users should choose the target problem, indicator and species. After **search** button clicked, the target areas highlighted and users can identify the areas for general information of the area. In the result list of general information, users can click the hyperlink to view the detail information of stations, data and metadata.

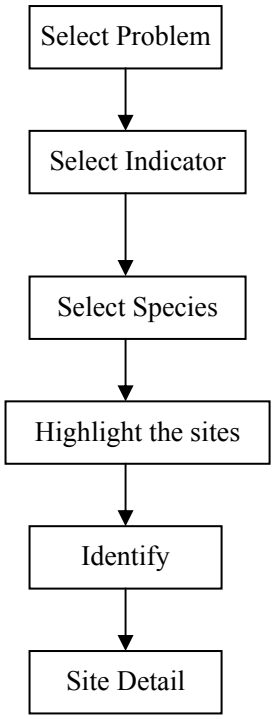

Fig.27 Workflow of ecosystem map query module

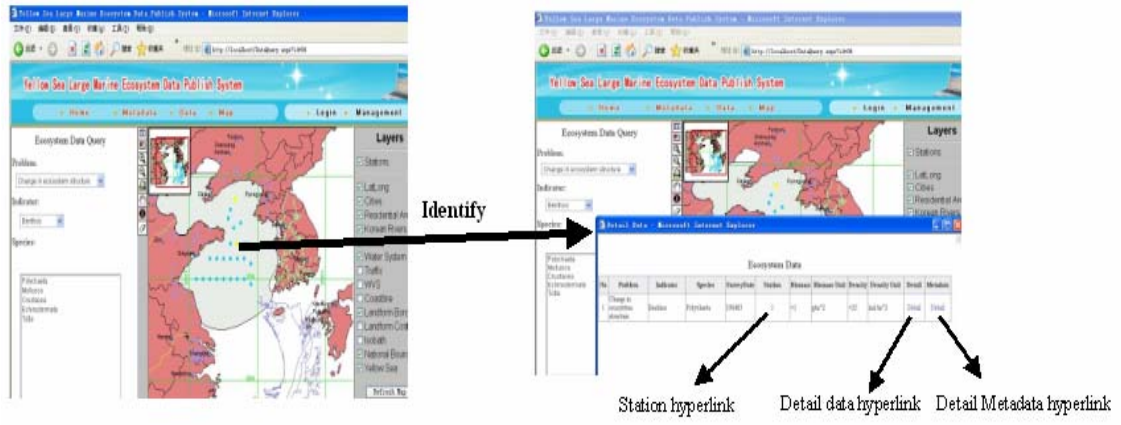

Fig.28 Realization of ecosystem map query module

6.2.4 management module

Management module provides users a powerful tool to manage and maintain the system and database. It includes system management module and data management module. System management module includes user management module and data management includes metadata management module and YSLME project components data management module.

6.2.4.1 System management module

(1) User management module

User management module can make users to manage users and control their rights of system operation.

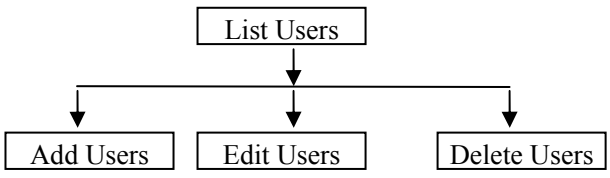

Fig.29 Workflow of user management module

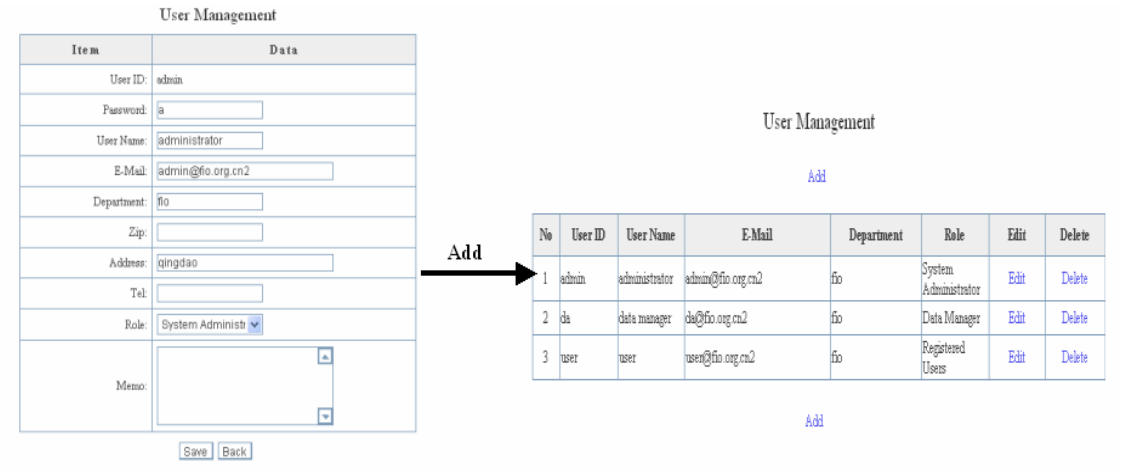

Fig.30 Realization of user management module

(2) Notices management module

Notices management module can provide users a tool to manage and broadcast the notices of the website or YSLME project.

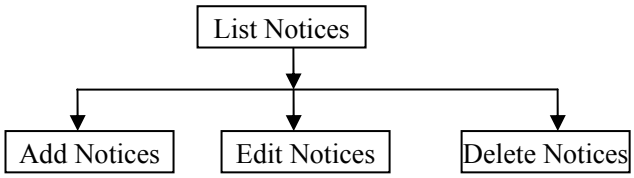

Fig.31 Workflow of notices management module

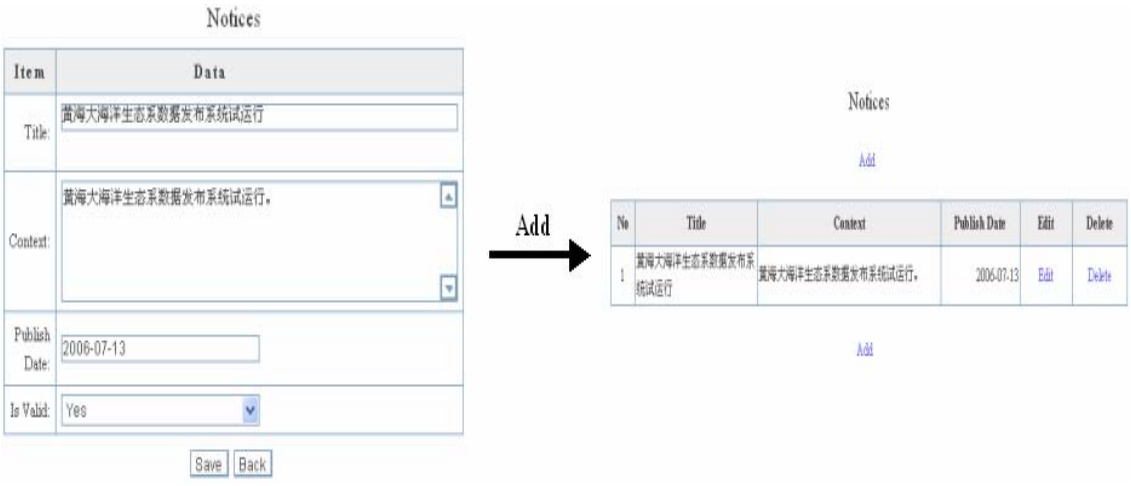

Fig.32 Realization of notices management module

6.2.4.2 Data management module

Data management module is a database maintenance tool to make user add, edit and delete data such as metadata, biodiversity data, fisheries data, pollution data and ecosystem data conveniently and effectively (Fig. 33).

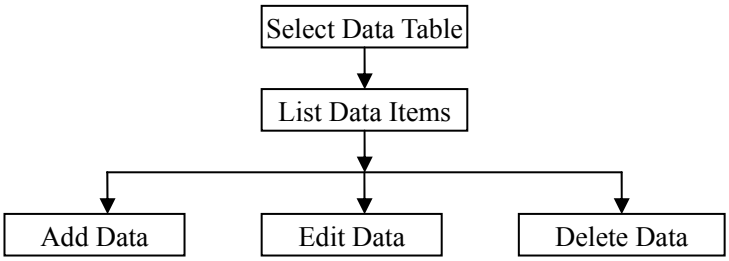

Fig.33 Workflow of data management module

The workflow of each data management module is the same as Fig.33. The following sections will introduce the main operation interface of each data management module.

(1) Metadata management module

The workflow of each data management module is the same as Fig.33. The following sections will introduce the main operation interface of each data management module.

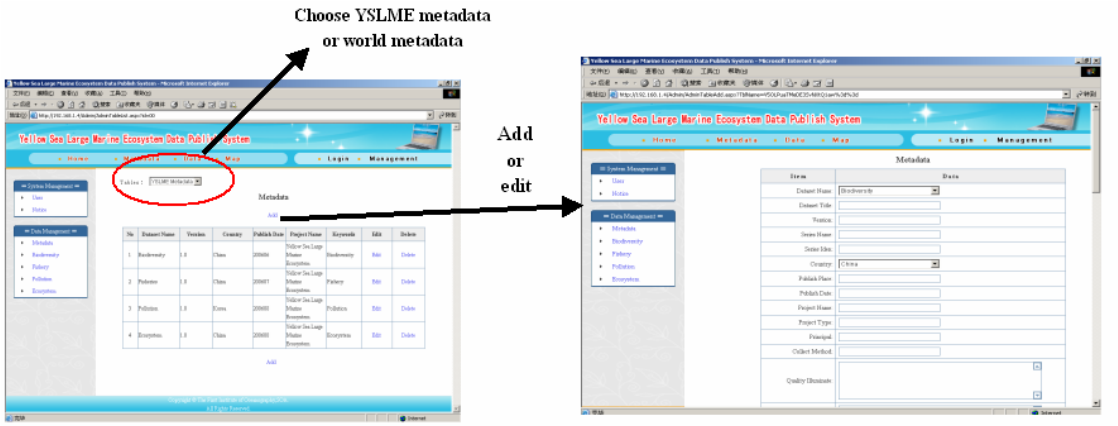

Fig.34 Realization of metadata management module

(2) Biodiversity data management module

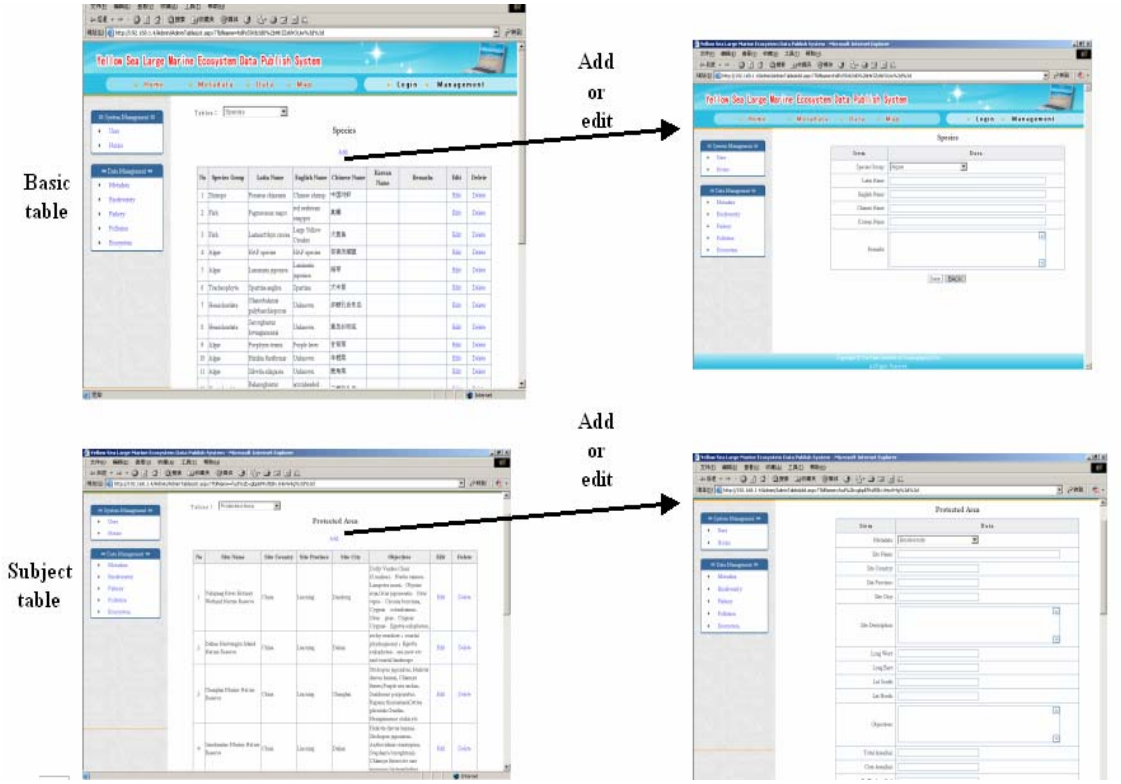

Fig.35 Realization of biodiversity management module

(3) Fisheries data management module

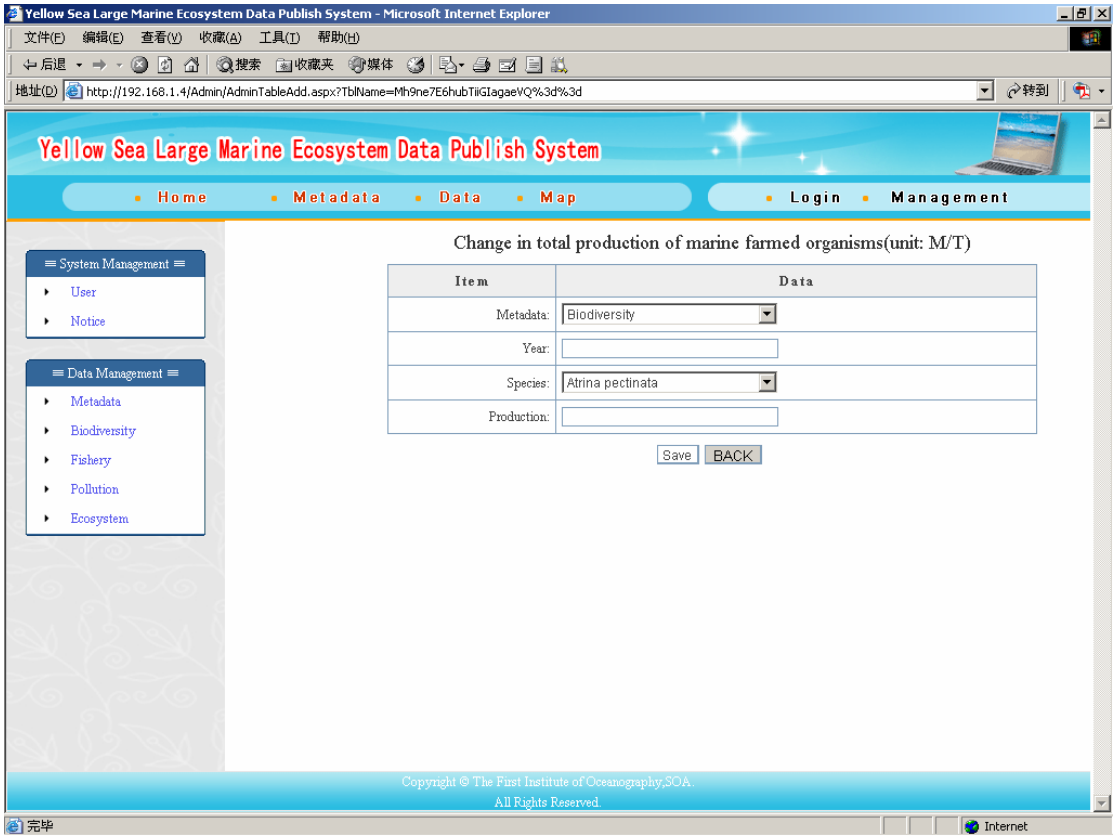

Fig.36 Realization of fisheries management module

(4) Pollution data management module

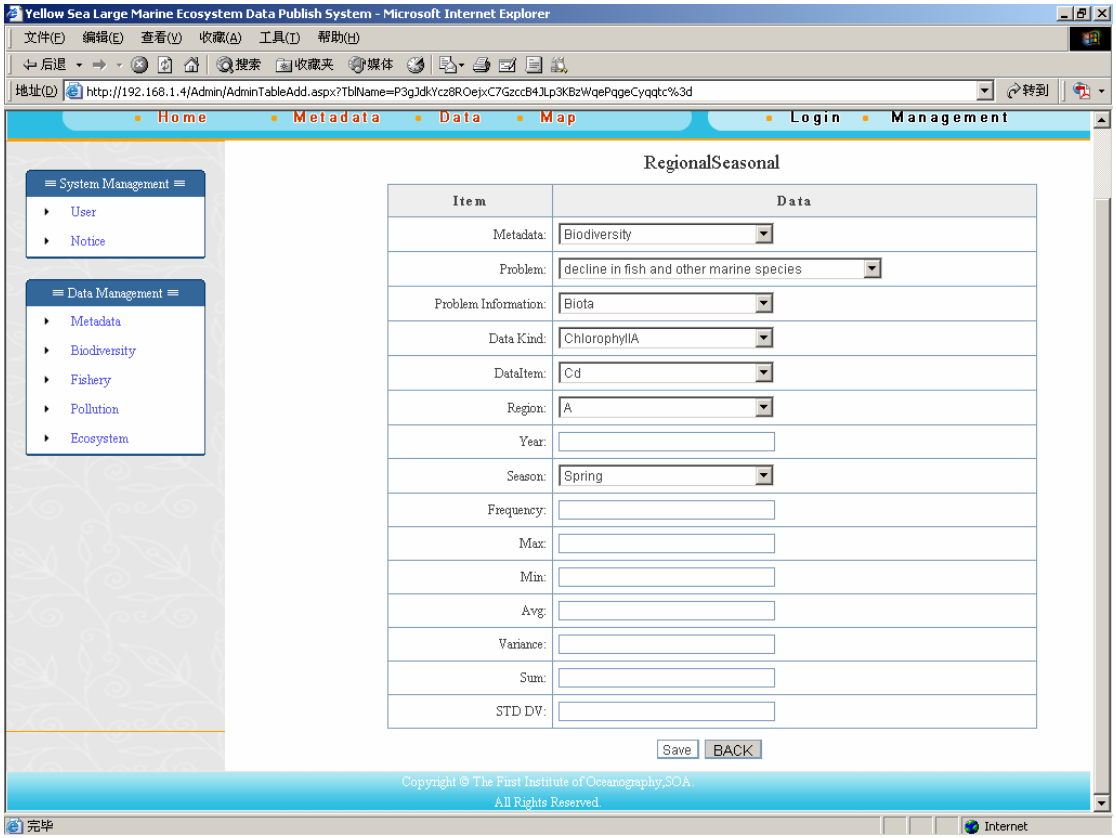

Fig.37 Realization of pollution management module

(5) Ecosystem data management module

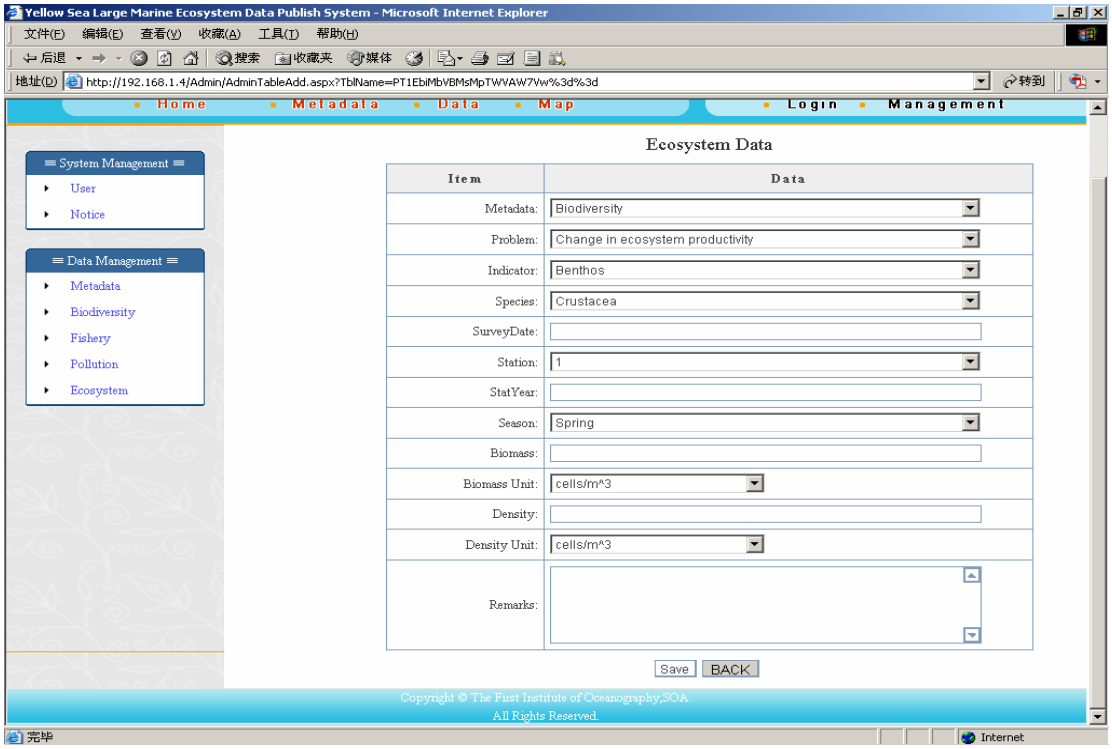

Fig.38 Realization of ecosystem management module

7 Users design

For system security, we assign relative rights to different users according to their rank. There are three ranks of users in YSLME GIS system: system manager, database manager and registered user (Fig. 43). The rights of each rank of users are listed in Table 1.

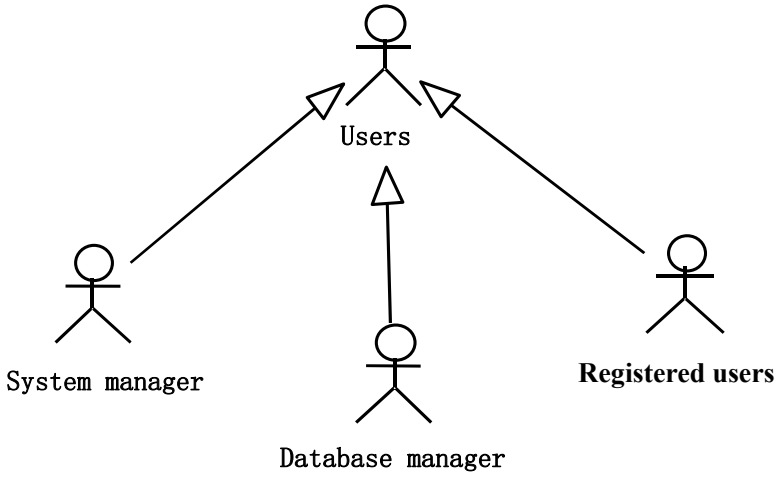

Fig.43 Users classification of YSLME GIS system

Table1 Rights of different users

Users / Modules	System manager	Database manager	Registered manager
Metadata query	√	√	√
Data query	√	√	√
Map query	√	√	√
User management	√		
Notices management	√		
Data management	√	√	

8 Conclusions and recommendations

8.1 Conclusions

To meet YSLME project's requirement for an convenient and effective data management and share, a prototype application of YSLME GIS system has been designed and built using Microsoft Visual Studio .NET 2003, ESRI ArcIMS 9.0 and Microsoft SQL Server 2000. The programming life cycle involved extensive research, design and coding from a starting point of zero and is focused specifically on the needs of the end user. Now the system has been installed and running steadily and safely. It can provide effective and rapid services for users to manage, query, and display the YSLME project data.

Because of the time limitation, the project team developed basic functionality for the system. With further testing and refinement, the system can be as a reliable and efficient tool to promote the scientific research on the Yellow Sea area and other sea area.

8.2 Recommendations

Now, the YSLME GIS system has been finished and is in testing and refinement. But we are faced with an important problem for further system maintenance such as data collection and input, database management, system upgrade, *etc*.

Additionally, in order to provide better services, 3D visualization, time-series simulation and other advanced application have been in consideration and the key technology is to be solved soon.

So, we recommend the YSLME PMO to take system maintenance and upgrade in consideration and provide more support for the system.