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A Relational Database on the Abundance, Distribution, and Environmental Conditions of Pacific Salmon at Sea

by

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Abstracts

Since 1955 Kamchatka Research Institute of Fisheries & Oceanography (KamchatNIRO) has investigated the marine period of life of Pacific salmon in various areas of the North Pacific. One of the objectives of this research is to get information about the abundance of salmon (and other species) collected with various fishing gear (gillnets, trawls, and seines). Moreover, during different years the scientists of the Laboratory of Marine Salmon Investigations (MIL) KamchatNIRO, collected biological information concerning Pacific salmon including biostatistical data (biological analysis and measurements), biochemical composition of salmon and their prey items, food habits data (stomach content analysis), forage base data (zooplankton catches using different plankton nets), tagging data, meteorological and hydrological observations in the study areas, etc.

Primary research materials from the North Pacific (stored in the MIL laboratory) are mainly paper records - trawl, seine and gillnet cards and various paper documents. Also, part of these materials, are stored in the electronic worksheets. Thus, scientists determine the format of the own data (contained in MS Excel files).

A relational database (RDBaseMIL) MS Access was developed, and contains about 35 related tables for storage all information that was received onboard research vessels and in the laboratory. The RDBaseMIL is intended for fast access and efficient processing of various data on the biology and ecology of Pacific salmon during they marine period of life. The RDBaseMIL database can be used for prognosis and monitoring of Pacific salmon stock abundance in the North Pacific.

Introduction

Researchers, studying different aspects of marine biology and ecology, often encounter the situation when the aggregate data is augmenting year by year and it is impossible to analyze it in time, as it takes weeks or months to collect and sort primary data. As a result, the important collected data remains unused.

For example, for full analysis of feeding and food relationships of marine fish trophologists need data not only of food composition of the studied species, but also data of consumer abundance in the studied areas, data of food zooplankton composition and distribution and data of hydrobiological conditions in the areas of collecting etc. Thus, a specialist researching fish feeding in natural conditions has no possibility to use all the aggregate data.

Thereby, one of the main tasks for studying and monitoring marine ecosystems is building of integrated data files, including all the data, collected both in expeditionary conditions and in laboratory conditions, where accurate structural calculations are available.

Since 1955 Kamchatka Research Institute of Fisheries & Oceanography (KamchatNIRO) has investigated the marine period of life of Pacific salmon in various areas of the North Pacific. One of the objectives of this research is to get information about the abundance of salmon (and other species) collected with various fishing gear (gillnets, trawls, and seines) (Birman 1985; Karpenko 1992; 2003; Karpenko et al. 1997). Moreover, during different years the scientists of the Laboratory of Marine Salmon Investigations (MIL) KamchatNIRO, collected biological information concerning Pacific salmon including biostatistical data (biological analysis and measurements), biochemical composition of salmon and their prey items, food habits data (stomach content analysis), forage base data (zooplankton catches using different plankton nets), tagging data, meteorological and hydrological observations in the study areas, etc. (Koval 2003; Koval and Zaochny 2003).

From the beginning of the 90s KamchatNIRO has begun annual researches on board of gillnet vessels during the period of anadromous salmon migrations near the coastal waters of Kamchatka.

The aim of the work was to determine consistent pattern of distribution and relationships of local stocks of the Pacific salmon in the areas before spawning and migrations in connection with dynamic of fish abundance and habitat conditions. The laboratory of MIL is conducting investigations, studying distribution, feeding and annual changes of feeding conditions of salmon before spawning. The studying is based on the materials collected by Russian vessels in the 90s. For this purpose, scientists of different laboratories designed the integrated format for collecting and processing of expeditionary data on board of gillnet vessels. It has been used since 1993 (The program… 2001; Erokhin 2003).

The results of the researches of salmon marine period of life were presented in annual scientific reports, giving generalized data, collected in expeditionary and laboratory conditions for a year or some years of observation.

The annual reports of the 50-90s were based on the first collected materials. Since then the data have been kept in the laboratory in a form of gillnet and trawl cards, journals of biological analyses, cards of plankton processing and feeding, etc. It is very problematic to work with all the materials at the same time. Emergence of personal computers at scientists' disposal allowed to keeping primary data in electronic form, and conduct collection, and sorting of the necessary data much more operatively.

Most of the KamchatNIRO laboratories, including the laboratory of MIL, used MS Excel for that purpose for almost 10 years, where primary data were kept in a form of electronic tables, and as a rule, on separate sheets and files. According to their own tasks of the research, scientists chose a format and contents of the data kept in files. With accumulation of primary data kept in

MS Excel files, the problem of searching and selection of the necessary information occurred again, because MS Excel is not a special program for keeping and processing mass data and, as a rule, it has limited connection between separate files.

MS Access is one of the most popular programs among computer applications for mass data processing. It was designed as full-range Relational Database Management System (RDBMS) containing all the necessary means for data access and processing (Viescas 2000). MS Access has an advantage of the similar products as it was created in Microsoft Office environment, thus data can be converted into MS Excel tables or MS Word files. In addition, MS Access allows to work out a run-time version of RDBMS, which can be realized with richer RDBMS. In fact, all information capacity kept in the laboratory now in written and electronic forms is a database, and it needs to be converted into a relational database, a base where all the data are relative. To solve this problem, the structure of relative database was designed. On its basis a project of electronic application for Microsoft Access 2000/2002 was created. In this application the author tried to structure all the primary data kept in the laboratory of MIL.

Structure of the database

For the convenience to describe the scheme of the Database we saved the main tables used for keeping unique records and key fields connecting them (Fig. 1).

Most of the so-called “reference” tables (tables from where substitution of the total value is realized with SQL queries to the other tables, for example, a vessels list, catching devices, standard fishing areas, etc.) describing the total database scheme we made a mistake. The complete version of the database is given in Fig.2 (all the tables and key fields are given in a list below).

At the first stage, the main tasks for the author were to develop a scheme of the data, which will be included into the shareable database and to adopt the scheme for the multi-user environment. Developing a relative database, it is quite difficult to foresee all the main tasks, realized with the help of the application, and especially those tasks, which are not actual now, but may appear in the future. That is why, at the first stage it is very important to create a database scheme allowing to add new components without changing the basic structure at the next stages.

The primary data kept in the laboratory were analyzed. Then some versions of the scheme were tested. As a result, the author has chosen the scheme given below. In our opinion, the scheme allows to solve the main tasks of the database and to insert all the necessary additions and updates (to create new fields and tables) (Fig. 1).

To adopt the database in the multi-users environment the following procedures were made:

1) A new MDB file was created (named RDBaseMILtbl). Then, 15 main tables of the database were imported into it. They contain the primary data, collected during scientific researches of the laboratory of MIL (Fig. 3).

2) Links with the RDBaseMILtbl tables of KamchatNIRO net file were connected with the main file RDBaseMIL.mdb, containing all the "reference" tables (Fig. 2).

RDBaseMIL.mdb files are installed in the computers of the scientists having access to the database. It allows to provide work of several users simultaneously. The users can view, add and renew data of the database. It depends on the user's group the scientists work in and user's accessibility to the database.

General description

As the laboratory of MIL studies marine fish period of life, all the investigations are conducted both on board of scientific and fishery vessels, collecting primary data for the analyses in the laboratory. Scientific cruises realizing the program for studying marine period of life of the Pacific salmon are conducted on board of different vessels, having the possibility to operate catching devices of different constructions. As a rule, the main tasks of the work are to determine and define the areas of salmon distribution in the sea, to estimate population density of the species, to collect accurate biological and habitat conditions (temperature regime and food composition). (Karpenko et al. 1997). Taking the above mentioned into account, «tblCruise» table was taken as the primary table of the base scheme RDBaseMIL (the field list is shown in table 1). The table contains the data about each vessel, terms and type of scientific work, volume of the collected material. All the participants of the expedition are listed in table 2 «tblParticipant». The next tables of RDBaseMIL are connected with the table «tblCruise» (Fig.1). Complex of different scientific tasks is realized on board of each scientific vessel at separate stations. The data are presented in the table «tblStation» (Fig. 1, tbl 3.).

This table is related to «tblCruise» (with the key field «CruiseID») as "one-to-many" and it contains the data about the areas of research, collectors, types of work at each station (trawl catch characteristics, types of catching device (net or seine), plankton collection and hydrological sampling.

As it shown in fig. 1, three key fields were built: «CruiseID», «StationID» and «SampleID». The «CruiseID» field was built to link the main table «tblCruise». The field «StationID» was built as a index for each station. The field «SampleID» was created as a unique index of a separate sampling at a station, because several observations with the use of different

catching devices can be made at a station (for example, trawl catch and plankton collection at different levels with the use of different types of plankton nets).

For salmon estimation in the sea the laboratory of MIL used different types of catching devices. The table «tblStation» was created to unite the data of different types of work. Most of the fields of the table «tblStation» are general for the data collected using all the types of catching devices and other equipment (hydrological samplers), as they have the same format (the date and time of work at station, characteristics of weather conditions). If a vessel made only trawl operations, all the information about the performed operations is put into the table fields «tblStation», which describe a trawl operations. If a vessel carried out a complex of different types of work, all the data are distributed into different fields according to the type of performed work, and each record in the table «tblStation» is one observation. For that purpose, an additional information field «TypeSt» was created. It contains information about the type of work on the station: tr. - trawl station; pl – plankton station; hd – hydrological station etc.

It is necessary to note, that each separate record in the table «tblStation» is taken as a conventional station, and all the next subordinate tables are bound with its coordinates. Though the table «tblStation» of the RDBaseMIL is very bulky, (now it has 68 fields), it allows to avoid doubling of all subsequent tables, because standard types of work are carried out with fish from a sample without reference to a catch device.*

***Notes:** In the first version of the database scheme separate tables were created for different types of catching devices (trawl, net, plankton and hydrobiological station). Thereby, we had to create duplicated tables for each type of station («tblBioAn», «tblMPr», «tblMPrS», etc.), that overloaded the project.*

Then, in the RDBaseMIL there are tables containing plankton composition data «tblPlanktSample» (tbl. 4), fish and invertebrate catch data («tblCatch», tbl.6), bird and mammal catch data («tblBMCatch», tbl. 7), temperature and salinity data («tblT-SS», tbl. 5) for each station and sampling. The enumerated “subordinate” tables are bound with the “main” table «tblStation» on the principle “one-to-many”. That means that plankton composition, catches and hydrobiological data can contain many records for each station. The key field «SampleID» is the main key field for the given tables and the main table «tblStation». If there was plankton collection at a station, all the data about plankton composition were entered into the fields of the table «tblPlanktSample» (Instructions… 1971; Koval 2003). If a fish sampling was made at a station, all the data were input into the table «tblCatch». It is necessary to note, that an additional table was created for the bird and mammal catch data obtained during the work with gillnets («tblBMCatch») (Artukhin et al. 2000; 2001). All the data about species composition and abundance of the birds and marine mammals caught by gillnets are entered into this table from

the general list kept in the table «tblBMItems» (Artukhin and Burkanov 1999) (tbl.16). Then, these data are used in an expedition report to estimate dynamics of bird and mammal catch during vessel operation. Bird and mammal catch also occurs during pelagic trawling. As it is very seldom, usually these data are entered into the list of notes for a separate station. Plankton collection is specific on board of a gillnet vessel. Temperature and water salinity are measured at each station, but as a rule, plankton collection is carried out separately (at night, during debarkments, or during hydrological and hydrobiological surveys). That is why it is often impossible to bind plankton station data with gillnets data, and all the data are input into the table «tblStation» as separate records.

As collection of biological and tagging data of fish and invertebrates is conducted from the general sampling, some "subordinate" tables are connected with the table «tblCatch». Their contents depend on the work done with the catch. Information about tagged fish and invertebrates is entered into «tblTagging» (tbl. 10). The data of fish measurements, containing the data about size group, stage of fish maturity, sex, a number of fish of a certain size group are put into «tblMPr» (tbl. 8). If measurements, including fish opening, sex determination, weighing are conducted, the information about each studied sample goes to «tblMPrS» (tbl. 9) separately.

Results of biological analyses of all caught species are entered into «tblBioAn» (tbl. 11). All the enumerated tables are connected with the table «tblCatch» by three key fields: «SampleID», «FishInvItemID», «GroupCodID». All the fields «FishInvItemID» are bound with the table «tblFishInvItems», where a list of fish species and invertebrates inhabiting the waters of Kamchatka can be found. Thus, this table is a directory for the rest tables containing the field «FishInvItemID» (fig.1, tbl. 16).

The field «GroupCodID» was created to identify size group of the fish registered in a catch at a station. A catch can contain both juvenile and adult fish. To evaluate total fish abundance in a studied area, it is necessary to divide these fish groups, because different catch coefficients are used for the size groups. Thus, an additional field «GroupCodID» was created. It allows sorting records for fish of an appropriate group. Also the usage of the field «GroupCodID» helps to avoid additional records in the table «tblFishInvItems» for the same fish species of different size groups. As a rule, Russian, Canadian and American ichthyologists subdivide the Pacific salmon into three size groups: juv. – juvenile, immt. – immature, adlt. – adults) (Farley et al. 2001).

All the above mentioned information also refers to the table «tblPrPlKU». From this table substitution of the list of zooplankton representatives is performed to the tables of "plankton composition at a station "(«tblPlanktSample»); "fish food composition data, obtained by express

analysis" («tblStContExpr»); "fish food composition data obtained by laboratory analysis" («tblStContLab»).

An additional key field «GroupCodID» was created in the table «tblPrPlKU», because plankton species and food, as well as adult fish are subdivided into different size groups for quantitative estimations of zooplankton biomass and fish food composition studying. Estimations are carried out separately for each group (Koval 2002; 2003). The table «tblPrPlKU» is also used for keeping reference information about catch coefficients, used for calculations of biomass abundance of separate zooplankton species and groups, their caloric value for different sizes (tbl. 16). The full list of food components and zooplankton names is shown in the table «tblPrPlItems».

Beside biological analysis of fish, the express food analysis is conducted on board of a vessel (Maksimenkov et al. 2002). Biochemical samples and stomachs are also collected for the laboratory analysis of biochemical indexes and food composition of studied fish (Methodical manual… 1974).

Periodically, the analysis of morphometrical fish indexes was also made (Pravdin 1966). The data obtained by the express method and laboratory analysis of fish food composition are entered into the tables «tblStContExpr» (tbl. 13) and «tblStContLab» (tbl. 12), which are connected with the table «tblBioAn» by the key field «BioAnID».

Additional key fields «PrPlKUID» of the tables «tblStContExpr», «tblStContLab» are connected with the general table «tblPrPlKU» (tbl. 16), containing the list of the main contents of food and zooplankton determined in expeditionary and laboratory conditions. The table «tblPrPlKU» is also connected with the analogous key field «PrPlKUID» in the table «tblPlanktSample», because species composition of zooplankton and salmon food composition have the same contents (Koval 2001).

The data including biochemical composition and morphometrics of studied fish are entered into the tables «tblBiochem» (tbl. 14) and «tblMorfMetr» (tbl. 15) accordingly (fig. 1). These tables are connected by "one-to-one" link, because each studied sample can have only one record about biochemical and morphological indexes. Logically, the table «tblMorfMetr» must be connected with the table «tblCatch», but as a morphometrical analysis is conducted together with the sampling for biochemical composition determination, there was a necessity to connect the tables «tblBiochem» and «tblMorfMetr» through the table «tblBioAn».

Description of the tables and field formats of the RDBaseMIL

Nowadays the database RDBaseMIL includes 35 tables, containing 335 fields (their general description is shown in tables 1-16).

A 15 out of 35 tables are the main tables (their description is given in tables 1-15), the rest tables (20) are “reference” tables (tbl.16). The main tables contain the primary data obtained during cruises, such as characteristics of a catch (catch composition, biological fish characteristics, results of background operations), and the data, analyzed in laboratory conditions (biochemical fish composition, food composition, results of analyses of plankton samples).

The “reference” tables are used when it is necessary to enter the same repeated data into the main table. For example, catch composition can contain the same fish species at separate stations. To avoid multiple entering of the same species manually, an additional table was created. It contains a list of all fish species and other organisms, caught during the catches. In our database this table is presented as «tblFishInvItems». Each fish species of the table has its own unique index (two symbols “ID”, used in the field name stand for index fields of the database RDBaseMIL).

From the substitution tables (with the help of SQL queries) automatic substitution of the same index is carried to the rest database objects, containing information about this species. At the same time, a text name of the species rather than an index of the species appears in other tables. This method makes it easy to input mass data manually, where often the same indexes are used. In addition, it allows to avoid possible mistakes during multiple usage of the data, such as text indexes input, rekeying of the same index for the main record.

It is necessary to note, that a great attention was paid to codification of table records in creation of the marine organism “reference” tables. It was done to conduct selection of the records of both separate organisms and larger systematic groups, while studying distribution of marine organisms. For example, it is necessary to analyze only the organisms belonging to the Crustaceans (Crustacea), analyzing zooplankton biomass and distribution in the observed areas. The similar selection is quite simple if a group of Crustaceans is clearly defined in zooplankton codificator. To create codes for the marine organism “reference” tables, we used the scheme, developed by VNIRO (Codificator… 1980; 1980a). In this scheme each taxonomic category has eight-symbol code of the following structure: the first symbol – a code of hydrobiont; symbols 2, 3 – a code of type, class or family; symbols 4, 5, 6 – a code of genus; symbols 7, 8 – a code of species.

In the database RDBaseMIL the first symbol (1) stands for nekton species (fish and invertebrates) («tblFishInvItems»); the third symbol (3) – zooplankton («tblPrPlItems»); the ninth symbol (9) – birds and mammals («tblBMItems»).

The similar scheme was used in creation of other “reference” tables where possible.

On designing the tables of the database RDBaseMIL, five main types of field formats were used (tbl. 1-16, column «data type»). Their short characteristics are given below:

1) **Text format** – is designed for keeping text data. Input of any text and symbols is possible here. In the RDBaseMIL a number of symbols is limited by the maximum index of the registered value.

2) **Numeric format** – is designed for keeping numeric data (only natural numbers and fractional number are input into numeric fields). Indexed fields (where indexes from other tables are substituted) have a numeric format, as a numeric index is substituted into the field instead of it is value. The numeric format is also used for the fields, containing coordinates of stations, as for the graphical description of stations' positions, provided by *ArcView* or *Golden Software Surfer* programs, values are used in the decimal format instead of degrees and minutes.

3) **Date/time –** is used for keeping time and date data. A short format of date is used in all fields of the database. Thus, any date will be of the type «12.03.2003» (in Russian edition). For keeping time data we used the numeric format, where digits on the left from the comma stand for hours, on the right – minutes.

4) **MEMO** – it is possible to input a long text or a combination of a text and numbers into this field. In the database RDBaseMIL this field is used only for notes, as the size of the symbols input into the field can't be calculated accurately.

5) **Logical** – is a field where only two symbols **Yes/No** or **True/False** can be input. In the database RDBaseMIL these fields are commonly used for registration of collections of any material, and field's name is marked by «(log)» symbol. For example, the field «MPr(log)» of the table «tblCatch» informs that fish were sampled for fish measurements from a general catch at a station. If the symbol YES appears, it means that fish were sampled, if not, the symbol No appears.

Tables 1-15, containing description of all the fields and tables of the RDBaseMIL has the same structure. The first column contains fields' names, the second – a type of the data for each field; the third column has general descriptions of the data entered into the field; the forth column contains units of data measurements, kept in a field; the fifth column contains tables. Substitution of values of the field is conducted to or from these tables.

As the relational data base project, based on Microsoft Access (and RDBaseMIL in particular) is only a program product, it is necessary to import all primary data into the corresponding fields and tables of this program project.

This process can be realized in different ways: by the method of data translation from electronic tables, containing the necessary information as electronic data; keyboard input; data translation with the help of special modules for mass data transmission into the format Microsoft Access etc.*

Notes: *The large number of logical fields in the RDBaseMIL can be explained as follows:*

Primarily, the project was developed for the scientists from laboratory of MIL for their work during cruises. The main way for forming the database was keyboard data input. For this purpose MS Access has special objects, called "forms". That is why, designing the database, a special attention was paid to these objects, as the information, obtained during cruises is of great capacity. Maintainability of the "forms" greatly influences on the results of scientist work, because the data are input manually. The examples of the RDBaseMIL forms are shown in figure 4. They are used for input of the data obtained expeditionary on board of a scientific vessel, the data about gillnets catch and catch composition in nets.

In conclusion we'd like to add that this version of the relational data base RDBaseMIL is not final, because we can encounter new inevitable tasks, not provided by the database. In our opinion, today's scheme of the project is optimal and «normalized», because it allows to input the primary data of the laboratory and create new tables, without changing the base structure of the database RDBaseMIL. Now the database is being augmented for its more effective usage, but its base structure remains.

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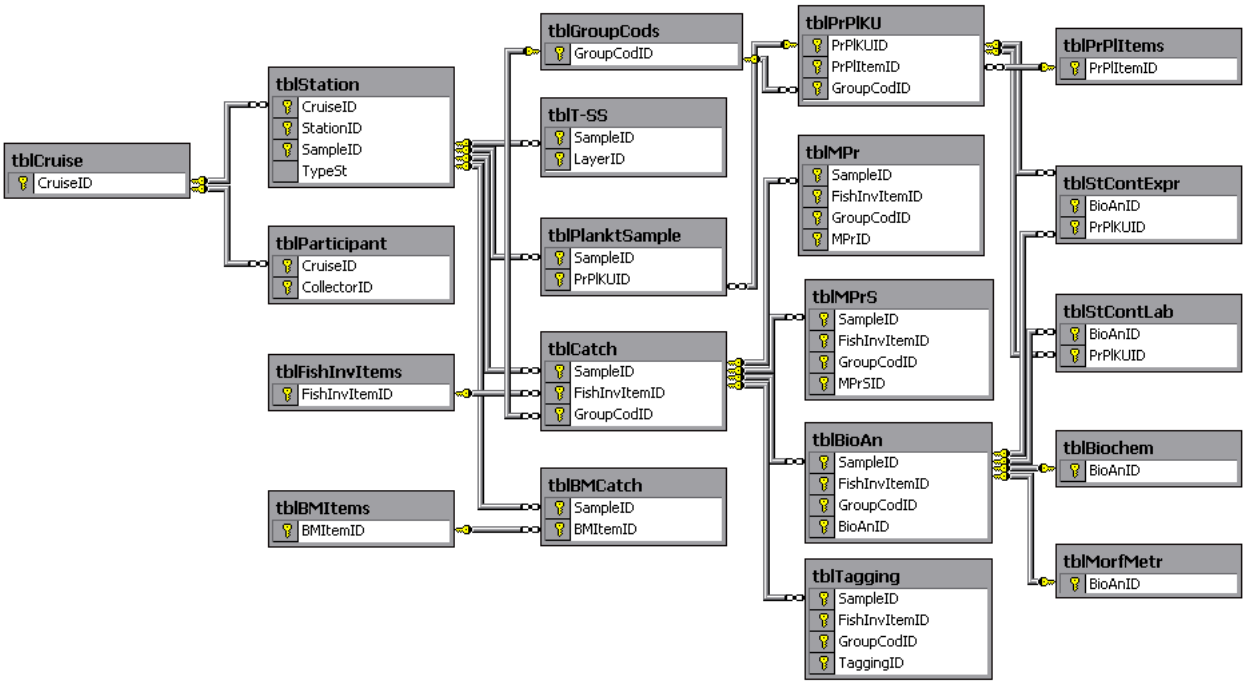

Fig.1. General scheme of relational database RDBaseMIL (the basic tables).

tblStation - tables' names

SampleID - key fields

GrBegSt
GrEndSt - the fields to which substitution of values are made from the other tables

Description of links:

- link "one-to-many" (each record of the table A (from side 1) can have several records of the table B (from side ∞), but a record of the table B can't have more than one record in the table A).

- link «one-to-one» (each record of the table A can have only one record of the table B and vice versa).

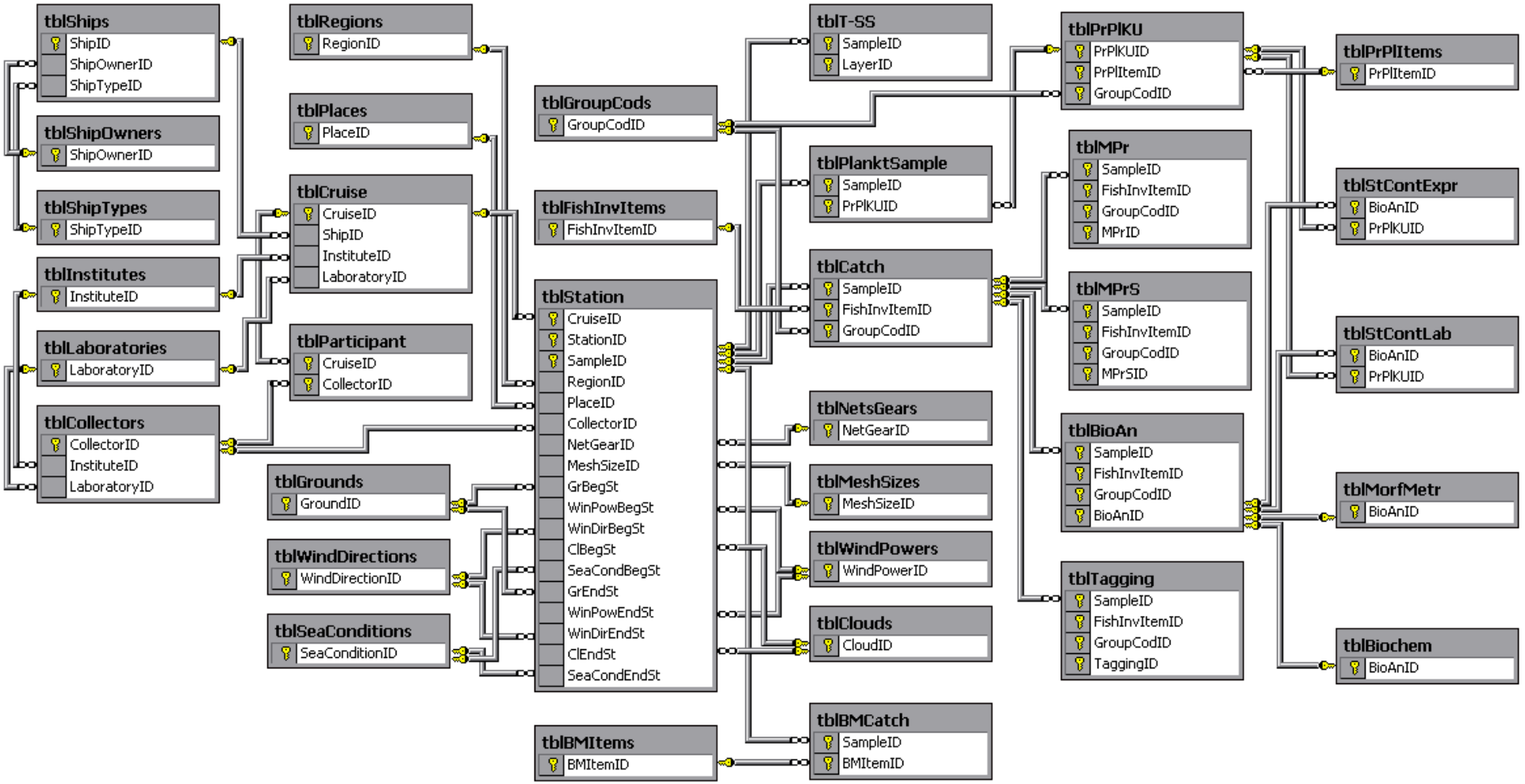

Fig. 2. Complete version of the database RDBaseMIL (file RDBaseMIL)

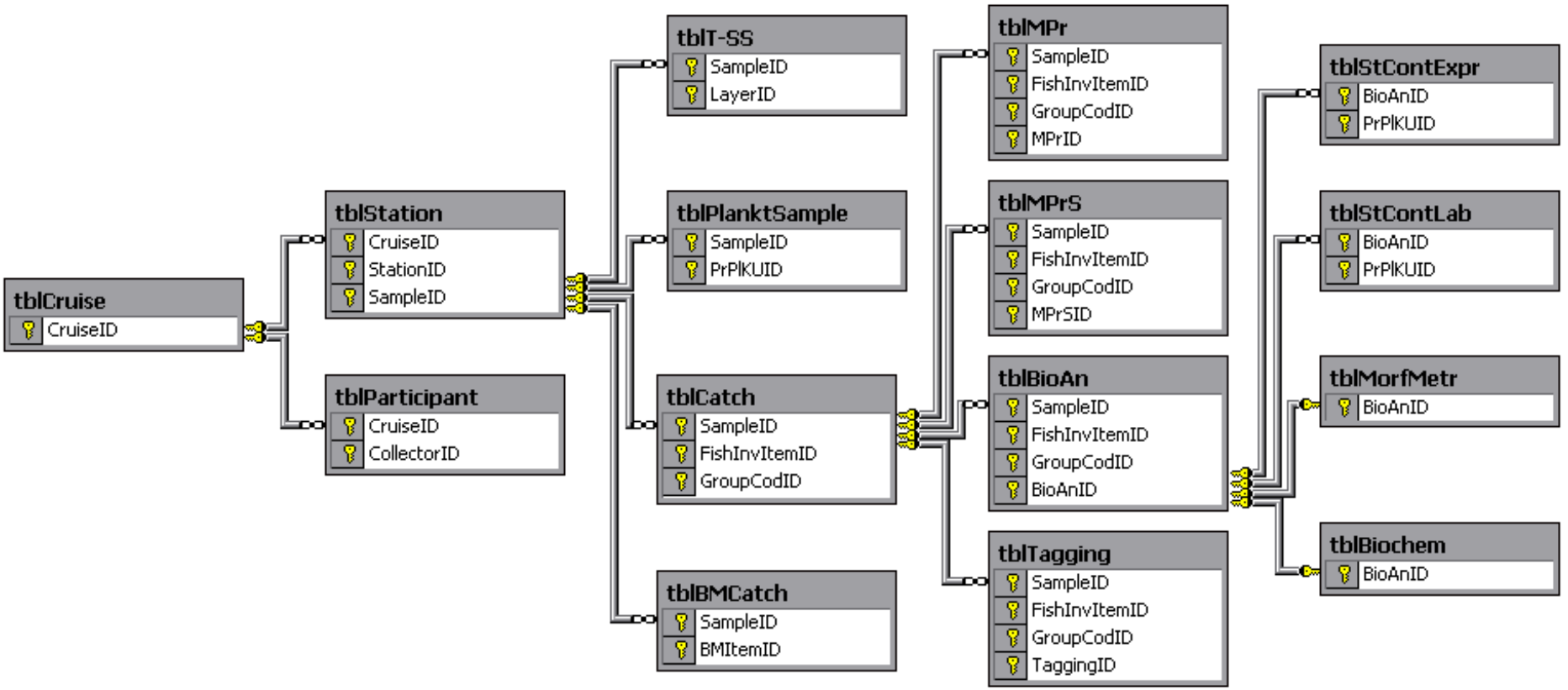

Fig. 3. Links between tables of the database RDBaseMIL in the file RDBaseMILtbl

Table 1

Field list of the table "tblCruise" from the database RDBaseMIL

Field name	Data type	Field description	Measure unit	Table of substitution
CruiseID*	numeric	Index of cruise	-	**→tblStation →tblParticipant**
ShipID	numeric	Index of vessel	-	**←tblShips**
Year	text	Year	-	-
InstituteID	numeric	Institute-performer	-	**←tblInstitutes**
LaboratoryID	text	Laboratory-performer	-	**←tblLaboratories**
DateBeg	Date/time	The date of cruise beginning	-	-
DateEnd	Date/time	The date of cruise finishing	-	-
TrawlSt(log)	logical	Trawl operations	YES/NO	-
TrawlSt	numeric	Number of trawl stations	-	-
GillnetSt(log)	logical	Gillnet operations	YES/NO	-
GillnetSt	numeric	Number of gillnet stations	-	-
SeineSt(log)	logical	Seine operations	YES/NO	-
SeineSt	numeric	Number of seine stations	-	-
PlanktSt(log)	logical	Plankton net operations	YES/NO	-
PlanktSt	numeric	Number of plankton stations	-	-
TssSt(log)	logical	Hydrological device operations	YES/NO	-
TssSt	numeric	Number of hydrological stations	-	-
MPr(log)	logical	Measurements without fish opening	YES/NO	-
MPr	numeric	Number of measurements without fish opening	individual	-
MPrS(log)	logical	Measurement with fish opening	YES/NO	-
MPrS	numeric	Number of measurements with fish opening	individual	-
BioAn(log)	logical	Biological analysis	YES/NO	
BioAn	numeric	Number of Biological analysis	individual	-
Tagging(log)	logical	Tagging	YES/NO	-
Tagging	numeric	Number of tagged fish	individual	-
StContLab(log)	logical	Stomach collection	YES/NO	-
StContLab	numeric	Number of collected stomachs	sample	-
Biochem(log)	logical	Collection of samples for biochemical analysis	YES/NO	-
Biochem	numeric	Number of samples for biochemical analysis	sample	-
MorfMetr(log)	logical	Morphometrical study	YES/NO	-
MorfMetr	numeric	Number of fish analyzed by morphometrical method	sample	-
NotesCr	MEMO	Notes	-	-
ComplCr(log)	logical	All the data obtained expeditionary are input into the database	YES/NO	-

* - key fields, connecting the tables; symbol «→» before an object name implies the table a substitution goes to ; symbol «←» before an object name implies the table a substitution goes from

Table 2

Field list of the table "tblParticipant"

Field name	Data type	Field description	Measure unit	Table of substitution
CruiseID*	numeric	Index of cruise	-	**←tblCruise**
CollectorID*	numeric	Index of collector	-	**←tblCollectors**

Table 3

Field list of the table "tblStation"

Field name	Data type	Field description	Measure unit	Table of substitution
CruiseID*	numeric	Index of cruise	-	**←tblCruise**
StationID*	numeric	Index of station	-	-
SampleID*	numeric	Index of sample	-	**→tblPlanktSample →tblT-SS →tblBMCatch →tblCatch→ →tblBioAn →tblMPr →tblMPrS →tblTagging**
TypeSt	text	Type of station (tr - trawl, gl – gillnets, sn - seine, pl - plankton, hd - hydrological)	-	-
PlSt(log)	logical	Plankton collection at a station	YES/NO	-
T-SS(log)	logical	Hydrological data collection at a station	YES/NO	-
T-SSPlSt(log)	logical	Hydrological data collection at a plankton station	YES/NO	-
RegionID	numeric	Index of fishery area (fishery zone)	-	**←tblRegions**
PlaceID	numeric	Index of station location (place-name)	-	**←tblPlaces**
CollectorID	numeric	Index of a scientist performing station	-	**←tblCollectors**
NStation	text	Number of station (in a catch card)	-	-
NCatch	text	Number of catch (in a catch card)	-	-
NetGearID	numeric	Index of catching or hydrological device	-	**←tblNetsGears**
LOneNet	numeric	Catching device length (net, seine, horizontal trawl opening)	m	-
HOneNet	numeric	Catching device height (of a net or seine side, vertical trawl opening by wings)	m	-
HOneNetDsk	numeric	Vertical trawl opening by trawl boards	m	-
SumNets	numeric	Number of operating nets	sample	-
SumLongLines	numeric	Number of operating longlines	sample	-
LLongLines	numeric	Length of longlines	m	-
MeshSizeID	numeric	Trawl mesh size (net, number or size of plankton net material)	mm	**←tblMeshSizes**
RKMeshSize	numeric	Trawl mesh size (in wings)	mm	-
ContSt	numeric	Duration of catch at a station	Hour, min.	-
SpeedSt	numeric	Catch speed	knot	-

Table 3 (Continued)

HorizonSt	text	Catch or hydrological data collection horizon	m	-
IsobataSt	text	Catch fathom	m	-
WaterVolPlSt	numeric	Volume of filtered water at a plankton station	m^3	-
SampleVolPlSt	numeric	Volume of plankton sample	Liter	-
DateBegSt	Data/time	Station data (at the beginning of a station)	-	-
TimeBegSt	numeric	Station time (at the beginning of a station)	Hour, min.	-
LatBegSt	numeric	Latitude (at the beginning of a station)	Degree.Hour Minute	-
LonBegSt	numeric	Longitude (at the beginning of a station)	Degree.Hour Minute	-
CourseBegSt	numeric	Course of trawl, net adjustment (at the beginning of a station)	Degree	-
TempABegSt	numeric	Air temperature (at the beginning of a station)	°C	-
TempWSBegSt	numeric	Surface water temperature (at the beginning of a station)	°C	-
TempWBBegSt	numeric	Bottom water temperature (at the beginning of a station)	°C	-
DepthBegSt	numeric	Station depth (at the beginning of a station)	m	-
GrBegSt	numeric	Type of ground on the station (at the beginning of a station)	-	**←tblGrounds**
WinPowBegSt	numeric	Wind strength (at the beginning of a station)	m/sec	**←tblWindPowers**
WinDirBegSt	numeric	Wind direction (at the beginning of a station)	-	**←tblWindDirections**
AtmPrBegSt	numeric	Atmosphere pressure (at the beginning of a station)	HectoPascal	-
ClBegSt	numeric	Cloudy (at the beginning of a station)	-	**←tblClouds**
SeaCondBegSt	numeric	Sea conditions (at the beginning of a station)	ball	**←tblSeaConditions**
TimeEndBegSt	numeric	Time of final gillnet or seine adjustment	Hour, min.	-
LatEndBegSt	numeric	Latitude of final gillnet or seine adjustment	Degree.Hour Minute	-
LonEndBegSt	numeric	Longitude of final gillnet or seine adjustment	Degree.Hour Minute	-
DateEndSt	Data/time	Date (at the final of a station)		-
TimeEndSt	numeric	Time (at the final of a station)	Hour, min	-
LatEndSt	numeric	Latitude (at the final of a station)	Degree.Hour Minute	-
LonEndSt	numeric	Longitude (at the final of a station)	Degree.Hour Minute	-
CourseEndSt	numeric	Course (at the final of a station)	Degree	-
TempAEndSt	numeric	Air temperature (at the final of a station)	°C	-
TempWSEndSt	numeric	Surface water temperature (at the final of a station)	°C	-
TempWBEndSt	numeric	Bottom water temperature (at the final of a station)	°C	-
DepthEndSt	numeric	Depth (at the final of a station)	m	-

Table 3 (Continued)

GrEndSt	numeric	Type of ground on the station (at the final of a station)	-	**←tblGrounds**
WinPowEndSt	numeric	Wind strength (at the final of a station)	m/sec	**←tblWindPowers**
WinDirEndSt	numeric	Wind direction (at the final of a station)	-	**←tblWindDirections**
AtmPrEndSt	numeric	Atmosphere pressure (at the final of a station)	HectoPascal	-
ClEndSt	numeric	Cloudy (at the final of a station)		**←tblClouds**
SeaCondEndSt	numeric	Sea conditions (at the final of a station)	ball	**←tblSeaConditions**
TimeEndEndSt	numeric	Time of final gillnet or seine operation	Hour, min.	-
LatEndEndSt	numeric	Latitude of final gillnet or seine operation	Degree.Hour Minute	-
LonEndEndSt	numeric	Longitude of final gillnet or seine operation	Degree.Hour Minute	-
PlcDetMethSt	text	Device for determination of catch location	-	-
CrashSt	text	Catch troubles	-	-
BMCatch(log)	logical	Bird and mammal catch at a station	YES/NO	-
NotesSt	MEMO	notes	-	-
ComplSt(log)	logical	All the data obtained at a station are input into the database	YES/NO	-

Table 4

Field list of the table "tblPlanktSample"

Field name	Data type	Field description	Measure unit	Table of substitution
SampleID*	numeric	Index of sample	-	**←tblStation**
PrPlItemID*	numeric	Index of prey and plankton items	-	**← tblPrPlItems**
GroupCodID*	numeric	Index of size group	-	**←tblGroupCods**
LMinPlSmp	numeric	Min length in a sample	mm	-
LMaxPlSmp	numeric	Max length in a sample	mm	-
LAvgPlSmp	numeric	Average length in a sample	mm	-
NumPlSmp	numeric	Number in a sample	individual	-
MasPlSmp	numeric	Weight in a sample	g	-

Table 5

Field list of the table "tblT-SS"

Field name	Data type	Field description	Measure unit	Table of substitution
SampleID*	numeric	Index of sample	-	**←tblStation**
LayerID*	numeric	Layer of temperature measurements	m	-
T	numeric	Temperature in the study horizon	°C	-
SS	numeric	Salinity in the study horizon	°/₀₀	-

Table 6

Field list of the table "tblCatch"

Field name	Data type	Field description	Measure unit	Table of substitution
SampleID*	numeric	Index of sample	-	**←tblStation**
FishInvItemID*	numeric	Index of species in a catch	-	**←tblFishInvItems**
GroupCodID*	numeric	Index of size group	-	**←tblGroupCods**
NumCth	numeric	Number of caught fish	individual	-
MasCth	numeric	Weight of caught fish	kg	-
AvgMFishCth	numeric	Average fish weight	kg	-
MPrCth(log)	logical	Measurements without fish opening	YES/NO	-
MPrSCth(log)	logical	Measurement with fish opening	YES/NO	-
BioAnCth(log)	logical	Biological analysis	YES/NO	-
TaggingCth(log)	logical	Tagging	YES/NO	-
StLabCth(log)	logical	Stomach collection (for laboratory analisis)	YES/NO	-
BiochemCth(log)	logical	Biochemical samplings	YES/NO	-
MorfMetrCth(log)	logical	Morphometrical study	YES/NO	-

Table 7

Field list of the table "tblBMCatch"

Field name	Data type	Field description	Measure unit	Table of substitution
SampleID*	numeric	Index of sample	-	**←tblStation**
BMItemID*	numeric	Index of birds and mammals in a catch	-	**←tblBMItems**
NumBMCth	numeric	Number of caught organisms	individual	-
MasBMCth	numeric	Weight of caught organisms	kg	-

Table 8

Field list of the table "tblMPr"

Field name	Data type	Field description	Measure unit	Table of substitution
SampleID*	numeric	Index of sample	-	**←tblCatch**
FishInvItemID*	numeric	Index of species in a catch	-	**←tblCatch**
GroupCodID*	numeric	Index of size group	-	**← tblCatch**
MPrID*	numeric	Index of measurement	-	-
LacMPr	numeric	Size group (length by Smith)	cm	-
ZrMPr	text	Stage of fish maturity (salmon: empty - adult, j - juvenile)	-	-
NumMPr	numeric	Number of fish of the given size group	individual	-
SexMPr	text	Sex	m - male f - female	-

Table 9

Field list of the table "tblMPrS"

Field name	Data type	Field description	Measure unit	Table of substitution
SampleID*	numeric	Index of sample	-	**←tblCatch**
FishInvItemID*	numeric	Index of species in a catch	-	**←tblCatch**
GroupCodID*	numeric	Index of size group	-	**← tblCatch**
MPrSID*	numeric	Index of measurement with fish opening	-	-
LacMPrS	numeric	Length by Smith (AC)	cm	-
MasMPrS	numeric	Fish weight	kg	-
SexMPrS	text	Sex	m - male f - female	-

Table 10

Field list of the table "tblTagging"

Field name	Data type	Field description	Measure unit	Table of substitution
SampleID*	numeric	Index of sample	-	**←tblCatch**
FishInvItemID*	numeric	Index of species in a catch	-	**←tblCatch**
GroupCodID*	numeric	Index of size group	-	**← tblCatch**
TaggingID	numeric	Index of tagging	-	-
LacTag	numeric	Length by Smith (AC)	cm	-
NTag	text	Tag number	-	-

Table 11

Field list of the table "tblBioAn"

Field name	Data type	Field description	Measure unit	Table of substitution
SampleID*	numeric	Index of sample	-	**←tblCatch**
FishInvItemID*	numeric	Index of species in a catch	-	**←tblCatch**
GroupCodID*	numeric	Index of size group	-	**← tblCatch**
BioAnID*	numeric	Index of biological analysis	-	-
FishNBA	numeric	Fish number in register (journal)	-	-
LacBA	numeric	Length by Smith (AC)	cm	-
LadBA	numeric	Body length (AD)	cm	-
Mas1BA	numeric	Fish full weight	g	-
Mas2BA	numeric	Fish weight (without insides)	g	-
MasgBA	numeric	Gonad weight	g	-
SexBA	text	Sex	m - male f - female	-
ZrBA	text	Stage of fish maturity (salmon: empty - adult, j - juvenile)	-	-
StFulnBA	numeric	Stomach fullness, ball	0,1,2,3,4	-
StContMasBA	numeric	Weight of stomach contents	g	-
LivMasBA	numeric	Liver mass	g	-
AgeScBA	text	Age by scale	-	-

Table 11 (Continued)

AgeOtBA	text	Age by otholits	-	-
ScaleBA(log)	logical	Scale sampling	YES/NO	-
OtholithBA(log)	logical	Otholits sampling	YES/NO	-
GenethicBA(log)	logical	Genetic sampling	YES/NO	-
StLabBA(log)	logical	Stomach sampling (for laboratory analysis)	YES/NO	-
StExprBA(log)	logical	Stomach express analysis	YES/NO	-
BiochemBA(log)	logical	Biochemical sampling	YES/NO	-
MorfMetrBA(log)	logical	Morphometrical study	YES/NO	-
NotesBA	text	Notes	-	-

Table 12

Field list of the table "tblStContLab"

Field name	Data type	Field description	Measure unit	Table of substitution
BioAnID*	numeric	Index of biological analysis	-	**←tblBioAn**
PrPlItemID*	numeric	Index of prey and plankton items	-	**←tblPrPlItems**
GroupCodID*	numeric	Index of size group	-	**←tblGroupCods**
LMinStLab	numeric	Min length in stomach	mm	-
LMaxStLab	numeric	Max length in stomach	mm	-
LAvgStLab	numeric	Average length in stomach	mm	-
NumStLab	numeric	Number in stomach	individual	-
MasStLab	numeric	Weight in stomach	g	-
DStageStLab	numeric	Stage of componet's digestion in stomach, ball	0,1,2,3,4	-

Table 13

Field list of the table "tblStContExpr"

Field name	Data type	Field description	Measure unit	Table of substitution
BioAnID*	numeric	Index of biological analysis	-	**←tblBioAn**
PrPlItemID*	numeric	Index of prey and plankton items	-	**←tblPrPlItems**
GroupCodID*	numeric	Index of size group	-	**←tblGroupCods**
PerStExpr	numeric	Portion in stomach	%	-
NumStExpr	numeric	Number in stomach	individual	-
DStageStExpr	numeric	Stage of componet's digestion in stomach, ball	0,1,2,3,4	-

Table 14

Field list of the table "tblBiochem"

Field name	Data type	Field description	Measure unit	Table of substitution
BioAnID*	numeric	Index of biological analysis	-	**←tblBioAn**
Lipids	numeric	Fat in fish body	%	-
Protein	numeric	Protein in fish body	%	-
Water	numeric	Water in fish body	%	-
Ash	numeric	Ash in fish body	%	-

Table 15

Field list of the table "tblMorfMetr" (Pravdin, 1966; with additions)

Field name	Data type	Field description	Measure unit	Table of substitution
BioAnID*	numeric	Index of biological analysis	-	**←tblBioAn**
LngBoby	numeric	Body length (od)	mm	-
LatLineForm	numeric	Number of the lateral line scales	-	-
NumDRays	numeric	Number of the dorsal fin (D) rays	individual	-
NumARays	numeric	Number of the anal fin (A) rays	individual	-
Num1GillRk	numeric	Number of gill rakers on the first arch	individual	-
LngMaxGillRk	numeric	Length of the bigger gill raker	mm	-
LngGillArch	numeric	Length of the first gill arch	mm	-
NumPilorC	numeric	Number of the pyloric caeca	individual	-
NumVert	numeric	Number of the vertedrates	individual	-
BodyAx	numeric	Body axle	mm	-
LngSn	numeric	Snout length (an)	mm	-
DimEye	numeric	Eye diameter (np)	mm	-
LngBhEye	numeric	Distance behind eye and end of the head (po)	mm	-
LngHead	numeric	Head length (ao)	mm	-
DptHead	numeric	Head depth (lm)	mm	-
WdhInter	numeric	Interorbital width	mm	-
LngUppJaw	numeric	Length of the upper jaw (ad_6)	mm	-
MaxDptBoby	numeric	Maximal body depth (qh)	mm	-
MinDptBody	numeric	Minimal body depth (jk)	mm	-
MaxThickBody	numeric	Maximal body thickness	mm	-
AntDorz	numeric	Antedorzal distance (aq)	mm	-
PostDorz	numeric	Postorzal distance (rd)	mm	
AntVentr	numeric	Anteventral distance (az)	mm	-
AntAnal	numeric	Anteanal distance (ay)	mm	-
LngCaudalPed	numeric	Caudal peduncle length (fd)	mm	-
LngDtoF	numeric	Distance between dorsal and adipose fin	mm	-
LngBasisD	numeric	Length of the dorsal fin basis (qs)	mm	-
DptD	numeric	Dorsal fin depth (fu)	mm	-
LngBasisA	numeric	Length of the anal fin basis (yy_1)	mm	-
DptA	numeric	Anal fin depth (ej)	mm	-
LngP	numeric	Pectoral fin (P) length (ox)	mm	-
LngV	numeric	Pelvic fin (V) length (zz_1)	mm	-
LngPtoV	numeric	Distance between pectoral and pelvic fin (vz)	mm	-
LngVtoA	numeric	Distance between pelvic and anal fin (zy)	mm	-

Table 16

Field list of the «reference» tables RDBaseMIL

Table name	fields	Data type	Field description (measurement unit)	Tables of substitution	General fields
tblShips	**ShipID***	numeric	Index of vessel	**→tblCruise**	ShipID
Vessels	ShName	text	Vessel name		
	ShipOwnerID	numeric	Index of the last owner	**←tblShipOwners**	ShipOwnerID
	ShDateReg	Data/time	Last date of registration		
	ShipTypeID	numeric	Vessel type	**←tblShipTypes**	ShipTypeID
	ShBoardN	text	Vessel's board number		
	ShRadioSign	text	Call signal		
	ShYearBuild	numeric	Year of producing		
	ShCountryBuild	text	Country-producer		
	ShLength	numeric	Vessel length (m)		
	ShWidth	numeric	Vessel width		
	ShEnginePower	numeric	Engine power (кВт)		
	ShCrew	numeric	Crew staff		
tblShipOwners	**ShipOwnerID***	numeric	Index of vessel owner	**→tblShips**	ShipOwnerID
Vessel owners	ShOwName	text	Company name		
	ShOwAddress	text	Address		
	ShOwManager	text	Manager name		
	ShOwPhone	text	Phone number		
	ShOwFax	text	Fax		
	ShOwTelex	text	Telex		
	ShOwEmail	text	e-mail		
tblShipTypes	**ShipTypeID***	numeric	Index of vessel type	**→tblShips**	ShipTypeID
Vessel types	ShTypeAbr	text	Abbreviation of vessel type		
	ShTypeName	text	Full name of vessel type		

Table 16 (Continued)

tblInstitutes	**InstituteID***	numeric	Index of institute	**→tblCruise**	InstituteID
Institutes of Fishery State committee	InstAbr	text	Institute abbreviation	**→tblCollectors**	InstituteID
	InstName	text	Institute full name		
	InstAddress	text	Institute address		
tblLaboratories	**LaboratoryID***	numeric	Index of laboratory	**→tblCruise**	LaboratoryID
Laboratories of structural subdivisions	LabAbr	text	Laboratory abbreviation	**→tblCollectors**	LaboratoryID
	LabName	text	Laboratory full name		
tblRegions	**RegionID***	numeric	Index of fishery area	**→tblStation**	RegionID
Areas of catches (standard fishery areas)	RegIndex	text	Fishery area index (Russia)		
	RegName	text	Fishery area name		
tblPlaces	**PlaceID***	numeric	Index of station location	**→tblStation**	PlaceID
Catch locations	PlcName	text	Place-name		
tblCollectors	**CollectorID***	numeric	Index of collector	**→tblStation**	CollectorID
Collectors	ColName	text	Full name, patronymic of collector	**→tblParticipant**	CollectorID
	ColFirstName	text	First name of collector		
	InstituteID	numeric	Collector's institute	**←tblInstitute**	InstituteID
	LaboratoryID	numeric	Collector's laboratory	**←tblLaboratory**	LaboratoryID
	ColPos	text	Collector's post/occupation		
	ColGr	text	Collector's scientific degree		
	ColEmail	text	Collector's e-mail		
tblNetsGears	**NetGearID***	numeric	Index of catching device	**→tblStation**	NetGearID
Catching devices and hydrological samplers	NGName	text	Name		
	NGDiscr	text	Description		
tblMeshSizes	**MeshSizeID***	numeric	Index of net material (mesh size)	**→tblStation**	MeshSizeID
Mesh size	Msize	text	Mesh size (mm)		

Table 16 (Continued)

tblGrounds	**GroundID***	numeric	Index of ground	**→tblStation**	GrBegSt
Types of ground	GrIndex	text	Cartographic index		GrEndSt
	GrDescr	text	Ground description		
tblWindPowers	**WindPowerID***	numeric	Index of wind power	**→tblStation**	WinPowBegSt
Wind power scale	WinPowMSek	text	Wind power (m/sec)		WinPowEndSt
	WinPowKmHour	text	Wind power (km/h)		
	WinPowKnots	text	Wind power (knots)		
	WinPowInflLand	text	Wind influence on ground objects		
	WinPowInflSea	text	Wind influence on sea surface		
	WinPowDescr	text	General description of wind power		
tblWindDirections	**WindDirectionID***	numeric	Index of wind direction	**→tblStation**	WinDirBegSt
Scale of wind directions	WinDir	text	Wind direction (north, south, west, east)		WinDirEndSt
tblClouds	**CloudID***	numeric	Index of cloudy	**→tblStation**	ClBegSt
Cloudy	ClIndex	text	Literal cloudy index		ClEndSt
	ClDescr	text	General description of cloudy types		
tblSeaConditions	**SeaConditionID***	numeric	Index of sea conditions	**→tblStation**	SeaCondBegSt
Scale of sea conditions	SeaCondBall	text	Sea conditions (ball)		SeaCondEndSt
	SeaCondM	text	Wave height (m)		
	SeaCondDescr	text	General description of sea conditions		
tblFishInvItems	**FishInvItemID***	numeric	Index of species in a catch	**→tblCatch→**	**FishInvItemID***
Species of fish and invertebrate	FILatGenus	text	Genus (Latin)	**→tblBioAn**	**FishInvItemID***
	FILatSpecies	text	Species (Latin)	**→tblMPr**	**FishInvItemID***
	FIRusName	text	Russian name	**→tblMPrS**	**FishInvItemID***
	FIEngName	text	English name	**→tblTagging**	**FishInvItemID***
	FIAutor	text	Author of species description		

Table 16 (Continued)

tblBMItems	**BMItemID***	numeric	Index of birds and mammals in a catch	**→tblBMCatch**	**BMItemID***
Birds and mammals	BMLatGenus	text	Genus (Latin)		
	BMLatSpecies	text	Species (Latin)		
	BMRusName	text	Russian name		
	BMEngName	text	English name		
tblPrPlItems	**PrPlItemID***	numeric	Index of prey and plankton items	**→tblPrPlKU**	**PrPlItemID***
List of prey and plankton items	PrPlLatGenus	text	Genus (Latin)		
	PrPlLatSpecies	text	Species (Latin)		
	PrPlRusName	text	Russian name		
	PrPlEngName	text	English name		
tblGroupCods	**GroupCodID***	numeric	Index of size group	**→tblPrPlKU**	**GroupCodID***
Size groups of fish, their prey items and plankton organisms	Group	text	Size group	**→tblCatch→**	**GroupCodID***
				→tblBioAn	**GroupCodID***
				→tblMPr	**GroupCodID***
				→tblMPrS	**GroupCodID***
				→tblTagging	**GroupCodID***
				→tblPrPlKU	**GroupCodID***
tblPrPlKU	**PrPlKUID***	numeric	PrPlKU index	**→tblPlanktSample**	**PrPlKUID***
Catch coefficients, body size and calorific capacity of plankton organisms	**PrPlItemID***	numeric	Index of prey and plankton items	**→tblStContExpr**	**PrPlKUID***
	GroupCodID*	numeric	Index of size group	**→tblStContLab**	**PrPlKUID***
	BodySize	text	Individual sizes of plankton organisms (mm)	**←tblPrPlItems**	**PrPlItemID***
	IKS-80	numeric	Coefficients for plankton biomass and abundance calculations, used for net IKS-80	**←tblGroupCods**	**GroupCodID***
	BJN	numeric	Coefficients for plankton biomass and abundance calculations, used for Big Juday net (BJN)		
	CalWW	numeric	Caloric value of plankton organisms for wet weight (cal/g)		

Table 16 (Continued)

	CalDW	numeric	Caloric value of plankton organisms for dry weight (cal/g)		
	PerWat	numeric	Water in plankton organism body (%)		
	PerAsh	numeric	Dry ash in plankton organism body (%)		
	PerLip	numeric	Dry fat in plankton organism body (%)		
	PerProt	numeric	Dry protein in plankton organism body (%)		
	PerCarbo	numeric	Dry carbohydrate in plankton organism body (%)		
	CalSeas	text	Season, caloric value was calculated for		
	CalReg	text	Area , caloric value was calculated for		
	CalAutor	text	Author, who published the caloric value data		

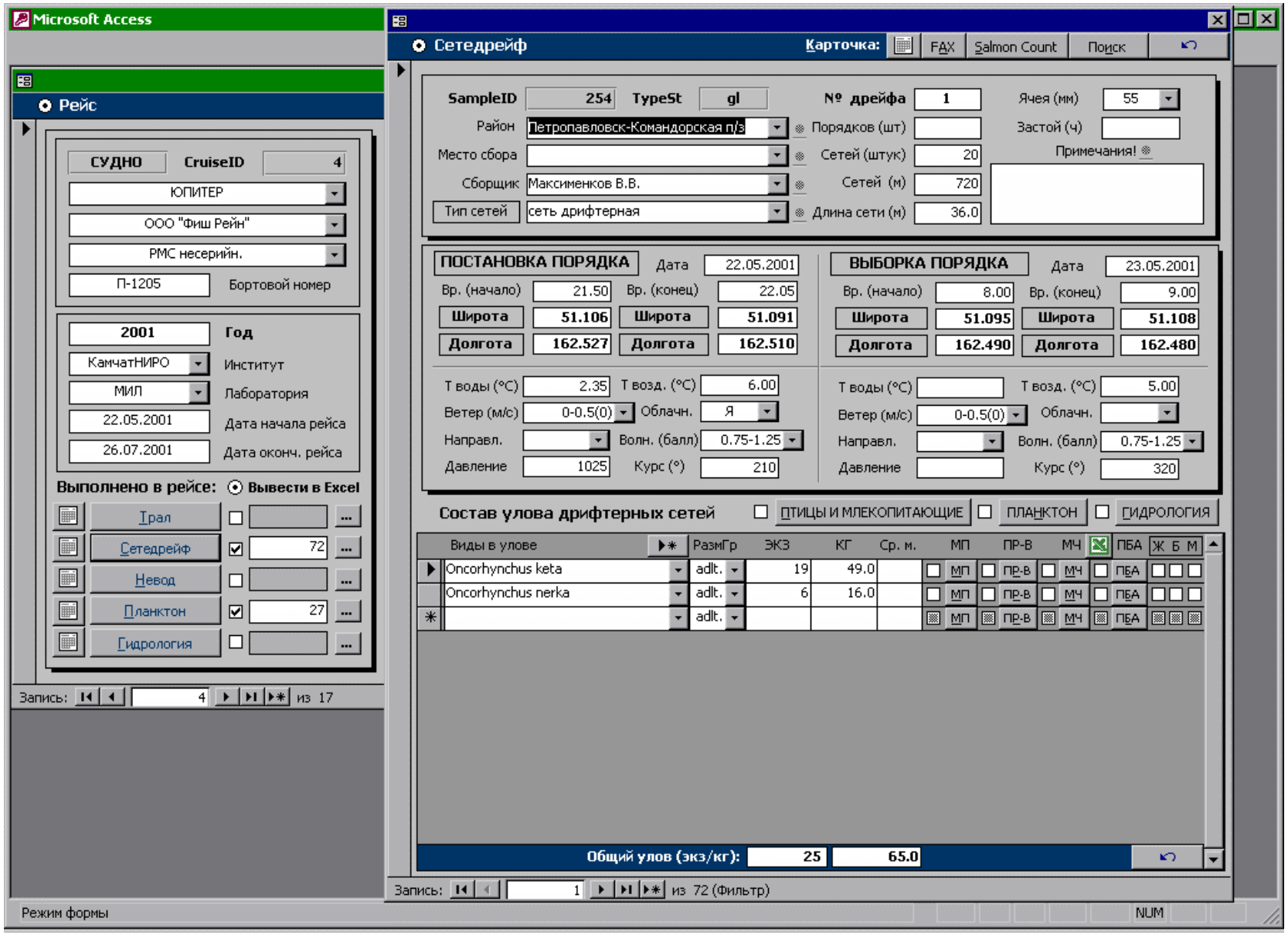

Fig. 4. Forms «Cruise», «Gillnet station» and «Catch composition» RDBaseMIL (Russian edition)