

Database documentation: age

K. A. Mackay & K. George

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1 Database documentation series

The National Institute of Water and Atmospheric Research (NIWA) currently carries out the role of Data Manager and Custodian for the fisheries research data owned by the Ministry of Fisheries (MFish).

The Ministry of Fisheries data set incorporates historic research data, data collected more recently by MAF Fisheries prior to the split in 1995 of Policy to the Ministry of Fisheries and research to NIWA, and currently data collected by NIWA and other agencies for the Ministry of Fisheries.

This document provides an introduction to the fish ageing database **age**, and is a part of the database documentation series produced by NIWA. It supersedes the previous documentation by Mackay¹ (1993) on this database.

All documents in this series include an introduction to the database design, a description of the main data structures accompanied by an Entity Relationship Diagram (ERD), and a listing of all the main tables. The ERD graphically shows how all the tables fit in together, and their relationships to other databases.

This document is intended as a guide for users and administrators of the **age** database.

2 Ageing programmes

Currently, otoliths represent the primary source of ageing material in Marine Research. Other ageing materials; e.g., scales, vertebrae, teeth, spines and statolith are rarely taken. Ageing data are derived from four main sources:

1. The Scientific Observer Programme (SOP) provides otoliths from catch sampling, principally for hoki, southern blue whiting, hake, and up until early in the 1992-93 fishing season orange roughy. Additional high priority species include gemfish, ling, stargazers, red cod, jack mackerels, and silver warehou. Many other middle depth species are also sampled to a lesser extent.
2. The Stock Monitoring Programme (SMP) provides ageing material by market sampling. Primarily hoki, red cod, and orange roughy otoliths were collected, with some black cardinalfish also sampled. Additionally kahawai and jack mackerels are also sampled. Orange roughy and black cardinalfish market samples ceased in the 1991-92 sample year, and red cod in the 1992-93 sample year. Recently snapper otoliths have been obtained through market sampling.
3. Research voyages provide an ongoing source of otoliths. These voyages cover a wide range of species including hoki, orange roughy, black and smooth oreos, hake, ling, red cod, and southern blue whiting. A large number of inshore species are also sampled.

¹ Mackay, K. A. 1993. Marine Research database documentation. 6. age. *MAF Fisheries Greta Point Internal Report No 216*. 13p.

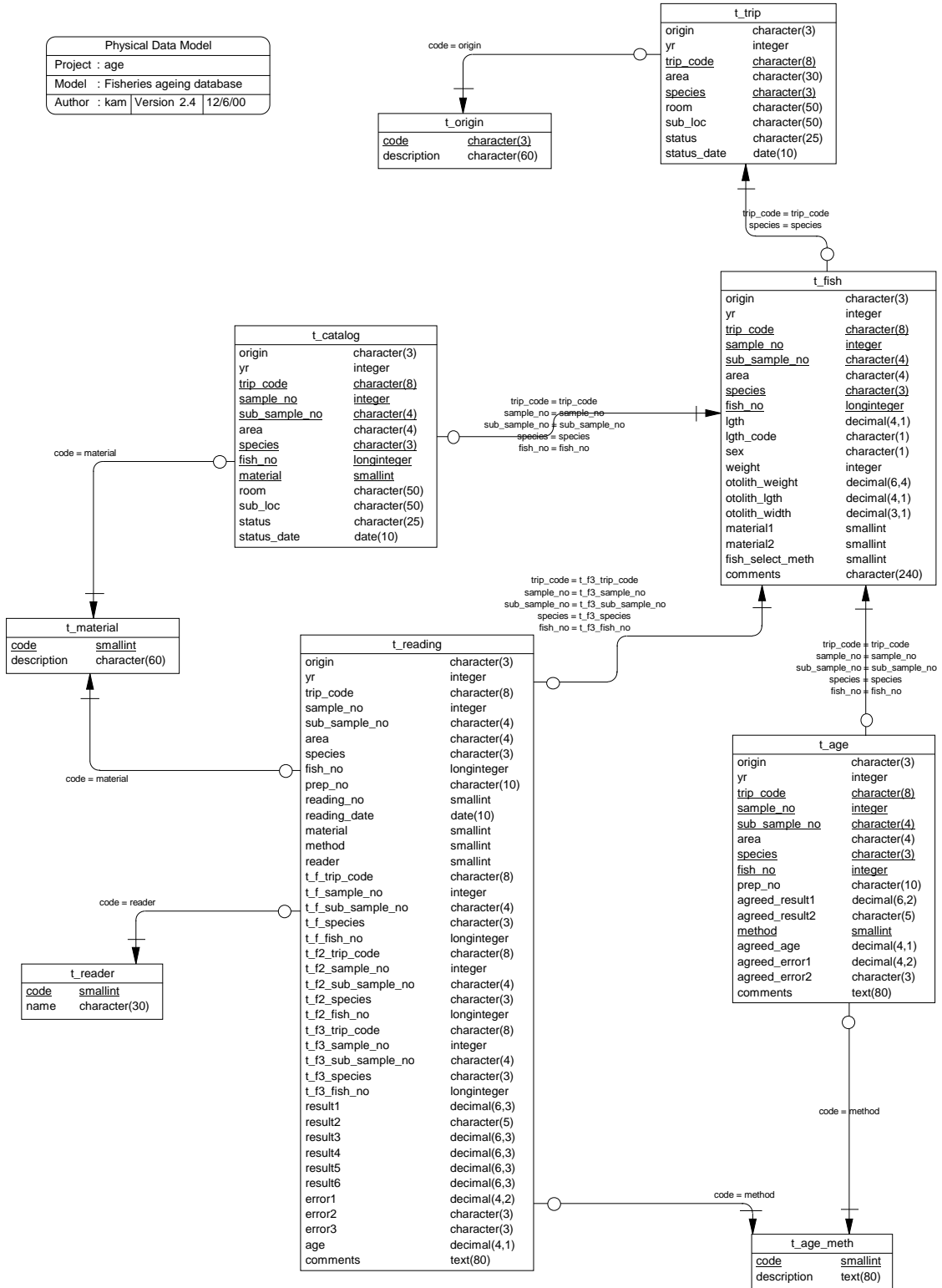


Figure 1: Entity Relationship Diagram (ERD) of the age database.

- 4 Historic catch and market sampling data and ageing programmes are now becoming established on the age database. Age data for bluenose and alfonsino caught through the 1980's and data for snapper caught in the 1970's are on the age database.

To date several species have been read, including, hoki, hake, southern blue whiting, ling, red cod, kahawai, gemfish, silver warehou, elephantfish, freshwater eels and snapper. Some species; e.g., orange roughy and smooth oreo are currently catalogued and stored pending the development of a validated reading method. All otoliths gathered, irrespective of their priority, are inventoried and then catalogued, with a brief description of their location and status.

3 Data structures

3.1 Table relationships

This database contains several tables. The ERD for **age** (Figure 1) shows the physical data model structure² of the database and its entities (each entity is implemented as a database *table*) and relationships between these tables. Each table represents an object, event, or concept in the real world that has been represented in the database. Each *attribute* of a table is a defining property or quality of the table.

All of the table's attributes are shown in the ERD. The underlined attributes represent the table's primary key³. This schema is valid regardless of the database system chosen, and it can remain correct even if the Database Management System (DBMS) is changed.

Note that Figure 1 shows the main tables only. Most of the tables in the **age** database have some attributes, called foreign keys⁴, which contain standard NIWA fisheries codes, such as *species* and *age_meth*. These attributes provide links to tables in **age** and the **rdb** (research database) database, which contains the definitive list of standard codes. Therefore, an expanded ERD for these tables will follow (Figures 2 - 3).

Section 5 shows a listing of all the **age** tables as implemented by the Empress DBMS. As can be seen in the listing of the tables, a table's primary key has an unique index on it. Primary keys are generally listed using the format:

```
Indices:    UNIQUE index_name ON (attribute [, attributes ])
```

where the attribute(s) make up the primary key and the index name is the primary key name. Note that the typographical convention for the above (and subsequent) format is the square brackets [] may contain an item that is repeated zero or more times.

² Also known as a database *schema*.

³ A primary key is an attribute or a combination of attributes that contains an unique value to identify that record.

⁴ A foreign key is any attribute, or a combination of attributes, in a table that is a primary key of another table. Tables are linked together through foreign keys.

This unique index prevents records with duplicate key values from being inserted into the table, e.g., a new trip with an existing trip code, and hence ensures that every record can be uniquely identified.

The **age** database is implemented as a relational database. That is, each table is a special case of a mathematical construct known as a *relation* and hence elementary relation theory is used to deal with the data within tables and their relationships between them. All relationships in **age** are of the type *one-to-many*⁵. This is shown in the ERD by connecting a single line (indicating ‘many’) from the child table (e.g., *t_reading*) to the parent table (e.g., *t_fish*) with an arrow-head (indicating ‘one’) pointing to the parent.

Every relationship has a mandatory or optional aspect to it. That is, if a relationship is mandatory, then it has to occur and least once, while an optional relationship might not occur at all. For example, in Figure 1, consider that relationship between the table *t_fish* and its child table *t_reading*. The symbol “O” by the child *t_reading* means that a fish can have zero or many age readings, while the bar by the parent *t_fish* means that for every age reading there must be a matching fish.

Most of these tables contain foreign keys, which link these tables to each other and to tables in the **rdb** database (Figure 3). The majority of these links are enforced by referential constraints⁶. Constraints do not allow *orphans* to exist in any table, i.e., where a child record exists without a related parent record. This may happen when: a parent record is deleted; the parent record is altered so that the relationship is lost; or a child record is entered without a parent record. Constraints are shown in the table listings by the following format:

```
Referential:      error message (attribute[, attribute]) INSERT|DELETE
                    parent table (attribute[, attribute])
```

For example, consider the following constraint found in the table *t_catalog*:

```
Referential:      invalid ageing material code (material) INSERT
                    t_material (code)
```

This means that the value of the attribute *material* of a record upon insert into *t_catalog* must already exist in the parent table *t_material* or the record will be rejected and an error message will be displayed.

⁵ A one-to-many relationship is where one record in a table (the *parent*) relates to one or many records in another table (the *child*).

⁶ Also known as integrity checks.

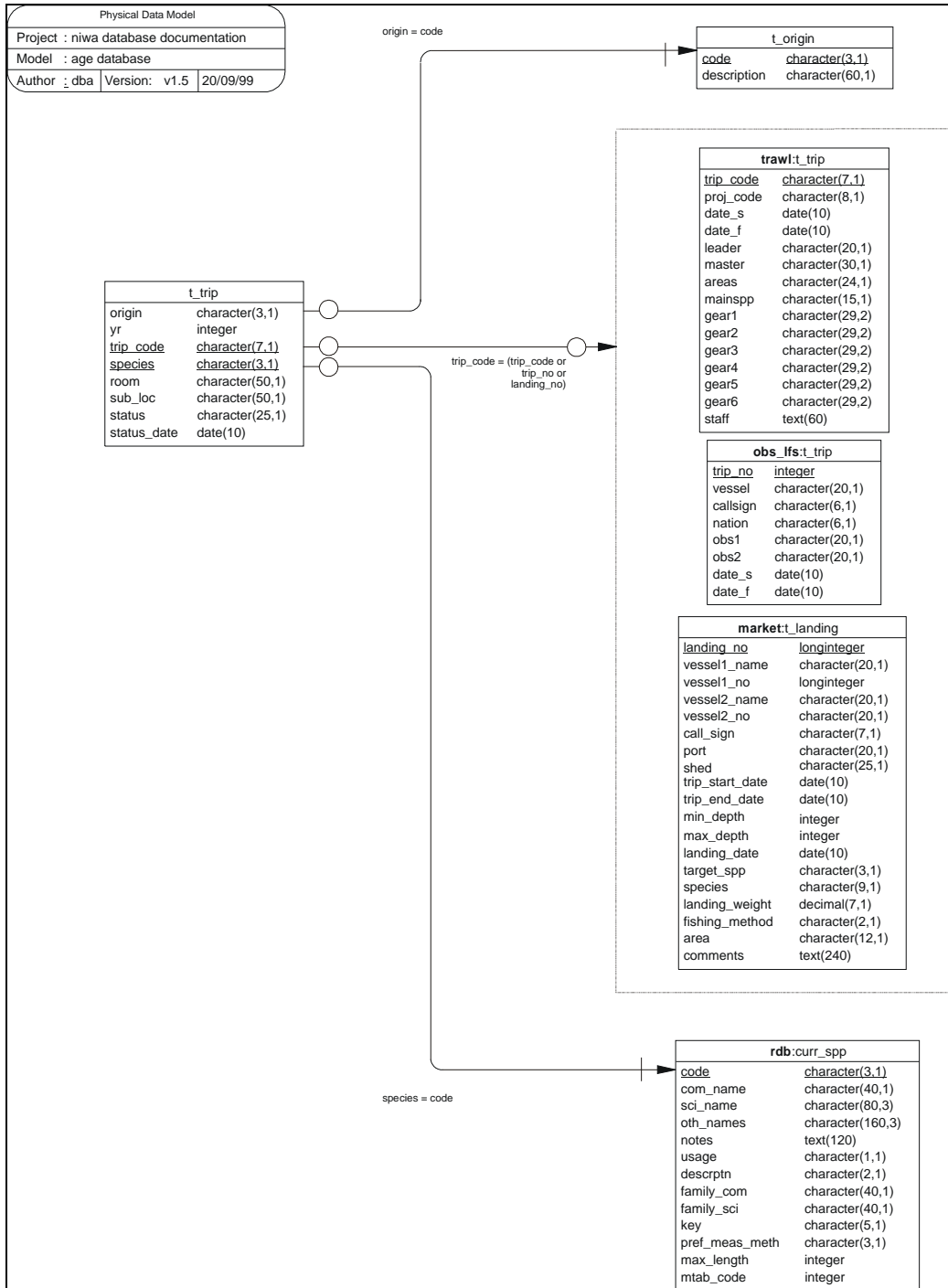


Figure 2: Expanded ERD for *t_trip* showing foreign key relationships to code tables and top-level tables for other databases.

A delete constraint implies that for a record to be deleted from a table, the values of the constrained attributes must not be equal to the values of the corresponding attributes in any record of the constraining table. This is used to prevent a parent record from being deleted while child records still exist.

All tables in this database are indexed. That is, attributes that are most likely to be used as a searching key have like values linked together to speed up searches. These indices are listed using the following format:

Indices: NORMAL (2, 15) index_name ON (attribute[, attribute])

Note that indices may be simple, pointing to one attribute or composite pointing to more than one attribute. The numbers "... (2, 15) ..." in the syntax are Empress DBMS default values relating to the amount of space allocated for the index.

3.2 Database design

This ageing database can be split into several main areas, each with properties that are important to record:

1. Details about the fish. These details include biological measurements of the fish, e.g., sex, length, etc.
2. Details about the ageing material extracted from the fish.
3. The readings made on the ageing material to determine the age of the fish. One fish may have many items of ageing material.
4. The current location of the ageing material and its status.
5. The agreed age of the fish, based on different materials and reading methods.

These properties represent the main tables in this database.

At the top level we have the trip from which ageing material was collected. Ideally, ageing material should be catalogued down to an individual fish (ref. Table 4 - *t_catalog*). However, more often than not, ageing material from trip is stored in a location until such time that it may be required for research (this can sometimes never happen). Therefore, the location details and status of a collection of ageing material for each species collected from trips are held in the table *t_trip* (Table 1).

For those collections that are used, the details and biological measurements of the fish are held in the table *t_fish* (Table 2). This table has a composite primary key of *trip_code*, *sample_no*, *sub_sample_no*, and *fish_no* to identify uniquely each fish. Apart from the key, the sex and length of the fish are the most common data held in this table, although other information such as the weight of the fish and measurements of the otolith can be held also. Up to two types of ageing material can be taken from any one fish, these being recorded by the attributes *material1* and *material2*. The expanded ERD (Figure 3) shows that this table contains three attributes that are link through referential constraints to master code tables. To aid in locating trips the attribute *origin* is included. This stores a 3-character code, which describes the origin of the fish. The attributes *material1* and *material2* contain codes which identify which

material was taken from the fish for ageing purposes, e.g., otoliths, scales, spines, etc. It is assumed that no more than type of ageing material is taken from any one fish.

A problem arises in the **age** database because the concept of the sub-sample (listed as *sub_sample_no* in **age**), is not used at all for the SOP, and only sometimes for the SMP. Because the possibility exists that it may be used, it must remain a part of the primary key for the four main tables (see Section 3.3 “**Handling different sampling programmes**” on page 10). This can result in the presence of null values as part of some primary keys, and by definition a primary key cannot contain null values. Without primary keys, this database implementation can suffer due to the possibility of allowing duplicate records to enter. To overcome this, all null values are replaced with the value of -1 for the attribute *sub_sample_no*. This allows primary keys to be constructed on all the tables.

The next table *t_reading* (Table 3) records the information for one reading of the material that was used to determine the age, such as the reading method used, who the reader was, and the results generated. Figure 3 shows the expanded ERD for *t_reading*. This table inherits the same primary key as *t_fish* to identify the fish, as well as the additional attribute *reading_no* to further identify individual age readings on the fish. There are four attributes of this table that are linked to master code tables (Figure 3). We have discussed the attributes *origin* and *material* in *t_fish* above. Two other codes are the attribute *method*, which identifies the preparation and reading methods employed, and the attribute *reader*, which identifies just who made the reading. The most common reading method is counting rings although one reading may also be a measurement such as length or otolith weight. Note that measurements such as otolith weight are also an attribute of *t_fish*. Although this data may be duplicated, the distinction is that if it has been used to determine an age, then it is a reading. If not, then it is just an attribute of the fish.

Usually, one reading generates one result with an error flag to denote the results accuracy. However, in some extreme cases, one reading may generate multiple results and error flags; e.g., a reading of an otoliths’ radius can give the measurement to the year 1 annulus, year 2 annulus, and to the otolith edge. Ideally, in a 3NF data model this brings in another entity “*result*” which can be represented by a table *t_result*. The entity “*result*” will have an one-to-many relationship to the *t_reading* table. This table will store the *t_reading* primary key, a code to say what the result represents, and the value of the result. There will also be a table *t_result_code* to store the descriptions of the result codes. The table structures for these two new tables would look something like:

T_RESULT	T_RESULT_CODES
T_READING PKEY	RESULT_CODE
RESULT_CODE	RESULT_DESCRIPTION
RESULT_VALUE	

A decision was made not to implement this new entity, but rather to take the simpler approach to have multiple result and error attributes in *t_reading*. This is because each result and error is relevant only when compared to others to the same reading. Therefore, queries for these data sets need return all the results and error flags for a

reading in the same tuple. In addition, the performance hit of performing multi-table joins in a 3NF scenario would not be supported by the users.

This implementation of *t_reading* does mean that there is a problem of users knowing which result value got into which result field. This is addressed two ways:

1. The results returned are functionally dependent on the aging method as denoted by the method attribute in *t_reading*. Hence, a full description of the results return and which attributes they are stored in is given in the *t_age_meth* table and are listed in Appendix 1.
2. Result types are consistently stored in the same attribute for each given aging method.

Current location and status of the ageing material is held in the table *t_catalog* (Table 4). Again, this table inherits most of its primary key from *t_fish*, as well as the additional attribute *material* to further identify which piece of ageing material from the fish is being cataloged. Only two attributes of *t_catalog* are linked to master code tables (Figure 3), being *origin* and *material*. Details such as room number, and if necessary, filing cabinet number can be recorded, as well as the current status, e.g., “being read” or “missing”, and the date the status was last updated. This table also has an one-to-many relationship with *t_fish*. Any one fish can produce several (although usually one) type of ageing material and each type can be stored in different locations or have a different status.

The agreed age of the fish is held in *t_age* (Table 5). An agreed age is the age in years that has been agreed upon as the age of the fish, based on the various readings made on the ageing material(s). The expanded ERD (Figure 3) shows that only two attributes of *t_age* are linked to master code tables. These attributes, *origin* and *method*, occur through most of the main tables and have explained earlier. It is important to note that this table carries not only the age, but also the agreed result from which the age was based. A fish age is usually calculated from an algorithm applied to the agreed result. This algorithm can be recorded in the attribute *comments*.

The attribute *method* denotes the reading method used from which the age was agreed on. The agreed age can be based on: all methods, i.e., one age for the fish; or a single method, i.e., one fish has many ages based different ageing methods.

An important relationship to note is that between *t_trip* to other sampling databases (Figure 2) so that ageing data can be matched against spatial, temporal, environmental, and biological data. Currently, from *t_trip*, we can link to the tables *t_trip* from the **trawl** database, *t_trip* from the **obs_ifs** database, or *t_landing* from the **market** database.

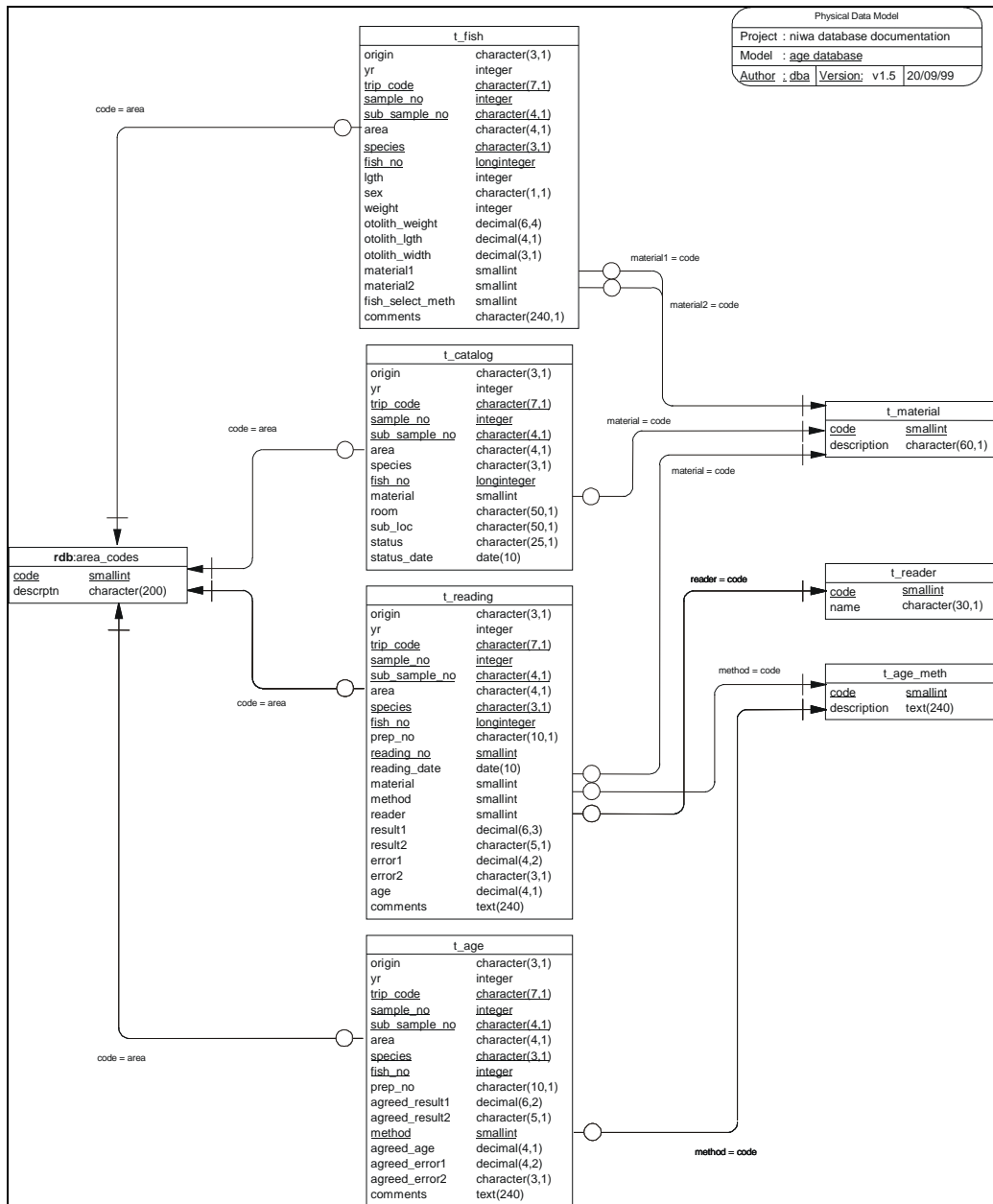


Figure 3: Expanded ERD for the tables *t_fish*, *t_catalog*, *t_reading*, and *t_age* showing foreign key relationships to code tables.

This relationship means that any one fish in the database can be linked through the attribute *trip_code* to the catch and landing records held in these other databases.

There are four other tables in this database that describe the various codes used: the codes used in describing the origin of the ageing material are listed in the table *t_origin* (Table 6); the various material used for ageing are listed in the table *t_material* (Table 7); the names of the readers are listed in the table *t_reader* (Table 8); and the different method used to prepare and read the ageing material are listed in the table *t_age_meth* (Table 9). They all have only two attributes - one for the code and another for a brief description of the codes.

3.3 Handling different sampling programmes

Given the variety of sources for the ageing material, the primary key for each fish involves many attributes. Each of the three sources (SOP, SMP, and Research Voyages) involves a fishing trip as their basic unit, but have their own format of identifying codes. To create a common code fishing trip, the following attributes are used: *origin* (the origin of the ageing material, a three character uppercase code for either the sampling programme, e.g., SOP, SMP or the vessel name, e.g., TAN, KAH), *yr* (the year of the fishing trip), *trip_code* (fishing trip identifier), *sample_no* (tow number for SOP, stratum number for SMP or station number for Research Voyages), *sub_sample_no* (not used for the SOP, cluster number for SMP or sample number for Research Voyages). From this trip code the fish can be identified using the attributes *species* and *fish_no*.

For example, consider the following identifiers:

<i>Fishing trip identifier</i>	
921301	for the SMP
kah9203	for Research voyages
551	for the SOP

This would be stored as:

<i>Origin</i>	<i>yr</i>	<i>trip_code</i>
SMP	1992	921301
KAH	1992	kah9203
SOP	1992	551

Important: the attribute *trip_code* is a character field, unlike the *trip_no* and *landing_no* fields in the **obs** and **market** databases respectively. Therefore, all trip codes must have quotes around them when using an SQL SELECT statement. For example, to select ageing data from *t_reading* for red cod market sample number 920801, we would use:

```
select from t_reading where trip_code = "920801"...
```

A further problem arises because both the SMP and Research programmes use a two-tier strategy to get to an individual fish, but the SOP only uses one. To make matters worse, each programme has their own nomenclature to describe each tier. To handle this, the **age** database has used generic attribute names. The following table shows that relationship between the generic attributes names of **age** to the attributes specific to each programme:

<u><i>Ageing Database</i></u> age	<u><i>SMP Database</i></u> market	<u><i>SOP Database</i></u> obs_lfs	<u><i>Research Trawl</i></u> trawl
trip_code	sample_no	tripnumber	trip_code
sample_no	stratum_no	townumber	station_no
sub_sample_no	cluster_no		subcatch_no

Note that theoretically the *sub_catch_no* is null for certain types of records.

3.4 Null Values and *sub_catch_no* in the Primary Key

It is important to note that in instances where *sub_sample_no* should be null, the attribute will be assigned the value of “-1”. This value can be ignored; its only purpose is to allow for a primary key to be implemented.

4 Table Summaries

This database can be broken down into four main tables containing information on the ageing material, four other tables describing the various codes that are used, and one view.

The following is a listing and brief outline of the tables contained within **age**:

1. **t_trip** : contains location information about ageing material from species caught on a trip. This may sometimes just be a summary of records in the table *t_catalog*.
2. **t_fish** : contains biological details from all fish that ageing material has been taken; e.g., sex, length, weight (and otolith data).
3. **t_reading** : contains results generated from an individual reading of an ageing material, e.g., otolith, scale.
4. **t_catalog** : contains the current location and status of the ageing material.
5. **t_age** : contains the agreed age of the fish based on either all the readings or readings by one method.

Also contained in the **age** database are the numerous master tables containing all codes and their descriptions. Most of the codes used in the **age** database are checked against these master tables before being inserted. The following is a summary list of these master code tables:

6. **t_origin** : contains explanations for the codes used to describe the origin of the ageing material.
7. **t_material** : contains explanations for the codes used to describe the ageing material used.
8. **t_reader** : contains names of the readers of the ageing material.
9. **t_age_meth** : lists the meanings of the codes for the different preparation and reading methods used and describes what reading measurements go into what result and error attributes in the *t_reading* table.

5 age Tables

The following are listings of the tables in the **age** database, including attribute names, data types (and any range restrictions), and comments.

5.1 Table 1: t_trip

Comment: Table of location information about ageing material from species caught on a trip.

Attributes	Data Type	Null?	Comment
origin	character(3,1)	No	3 character code for the origin of the ageing material. Refer:t_origin.
yr	integer	No	Year fish was sampled.
trip_code	character(8,1)	No	Up to 8 char trip identification code.
area	character(4,1)		Up to 4 character area code. Codes depend on the species sampled.
species	character(3,1)	No	Species code of fish. Refer rdb:curr_spp.
room	character(50,1)		Room number which the ageing material can be found.
sub_loc	character(50,1)		Location within the room; e.g., file cabinet number, draw number.
status	character(25,1)		Current status of the ageing material.
status_date	date(5)		Date when status was updated.
Creator:	dba		
Referential:	invalid origin code (origin) INSERT t_origin (code) invalid species code (species) INSERT rdb:curr_spp (code)		
Indices:	NORMAL (2, 15) BTREE ON (origin) NORMAL (2, 15) BTREE ON (yr) NORMAL (2, 15) BTREE ON (species) UNIQUE BTREE ON (trip_code, species)		

5.2 Table 2: t_fish

Comment: Table of biological information of fish aged.

Attributes	Data Type	Null?	Comment
origin	character(3,1)	No	3 character code for the origin of the ageing material. Refer:t_origin.
yr	integer	No	Year fish was sampled.
trip_code	character(8,1)	No	Up to 8 char trip identification code.
sample_no	integer	No	Number of sample within the trip. This will be station number for Research, stratum number for SMP, and tow number for SOP.
sub_sample_no	character(4,1)	No	Number of sub sample. This will be subcatch number for Research trawls, cluster (box) number for SMP. SOP do not use this. -1 = Not Used.
area	character(4,1)		Up to 4 character area code. Codes depend on the species sampled.
species	character(3,1)	No	Species code of fish. Refer rdb:curr_spp.
fish_no	longinteger	No	Sequential identifying number of fish for any one trip, sample, sub sample, species.
lgth	integer	No	Length (rounded down cm) of the fish.
sex	character(1,1)		Sex code. Ref rdb:t_sex_codes.
weight	integer		Weight (grams) of the fish.
otolith_weight	decimal(6,4)		Weight (grams) of a otolith.
otolith_lgth	decimal(4,1)		Length (mm) of a otolith.
otolith_width	decimal(3,1)		Width (mm) of a otolith.
material1	smallint		1 digit code for the material that was taken for ageing; e.g., otolith, spine, scale. Refer t_material.
material2	smallint		1 digit code for the second material taken for ageing (if at all). Refer t_material
fish_select_meth	smallint		Code for how the fish was selected for ageing: 1 = random; 2 = every i th fish; 3 = size class

range 1 - 3

Attributes	Data Type	Null?	Comment
comments	character(240,1)		Contains information on fish sampled
Creator:	dba		
Referential:	invalid origin code (origin) INSERT t_origin (code) invalid ageing material1 code (material1) INSERT t_material (code) invalid ageing material2 code (material2) INSERT t_material (code) invalid sex code (sex) INSERT rdb:t_sex_codes (sex_code) invalid species code (species) INSERT rdb:curr_spp (code) invalid trip (trip_code) INSERT t_trip (trip_code)		
Indices:	NORMAL (2, 15) BTREE ON (origin) NORMAL (2, 15) BTREE ON (yr) NORMAL (2, 15) BTREE ON (trip_code) NORMAL (2, 15) BTREE ON (species) NORMAL (2, 15) BTREE ON (area) UNIQUE BTREE uniq_fish ON (origin, yr, trip_code, sample_no, sub_sample_no, species, fish_no)		

5.3 Table 3: t_reading

Comment: Table describing the (sometimes many) results generated from each reading to estimate the age of a fish. The result and error fields are generic to handle the numerous types of reading and measurement techniques. Explanations for what result and error is stored in what attribute is recorded in the matching reading method record in t_age_meth.

Attributes	Data Type	Null?	Comment
origin	character(3,1)	No	3 character code for the origin of the ageing material. Refer:t_origin.
yr	integer	No	Year fish was sampled.
trip_code	character(8,1)	No	Up to 8 char trip identification code.
sample_no	integer	No	Number of sample within the trip. This will be station number for Research, stratum number for SMP, and tow number for SOP.
sub_sample_no	character(4,1)	No	Number of sub sample. This will be subcatch number for Research trawls, cluster (box) number for SMP. SOP do not use this. -1 = Not Used.
area	character(4,1)		Up to 4 character area code. Codes depend on the species sampled.
species	character(3,1)	No	Species code of fish. Refer rdb:curr_spp.
fish_no	longinteger	No	Sequential identifying number of and individual fish for any one trip, sample, sub sample, and species.
prep_no	character(10,1)		Number to identify ageing material within a prepared sample
reading_no	smallint	No	Sequential number for each reading for each fish.
reading_date	date(5)		Date the reading was made on.
material	smallint	No	1 digit code for the type of material used for reading; e.g., otolith, scales, spines.
method	smallint	No	Up to 2 digit code for the method used to read ageing material
reader	smallint	No	Numeric code to identify the reader. Refer t_reader.
result1	decimal(6,3)		The result of the reading.

Attributes	Data Type	Null?	Comment
result2	character(5,1)		Up to 5 character code for the result
result3	decimal(6,3)		Additional result of the reading.
result4	decimal(6,3)		Additional result of the reading.
result5	decimal(6,3)		Additional result of the reading.
result6	decimal(6,3)		Additional result of the reading.
error1	decimal(4,2)		The error for result1; i.e. result1 + or - error1.
error2	character(3,1)		Additional character code for the error.
error3	character(3,1)		Additional character code for the error.
error4	character(3,1)		Additional character code for the error.
error5	character(3,1)		Additional character code for the error.
error6	character(3,1)		Additional character code for the error.
error7	character(3,1)		Additional character code for the error.
age	decimal(4,1)		Agreed age (in years) for the reading.
Comments	text(240,240,240,1)		
Creator:	dba		
Referential:	invalid material code (material) INSERT t_material (code) invalid reader (reader) INSERT t_reader (code) invalid reading method (method) INSERT t_age_meth (code) invalid origin code (origin) INSERT t_origin (code) invalid species code (species) INSERT rdb:curr_spp (code) insert t_fish before t_reading (trip_code, sample_no, sub_sample_no, species, fish_no) INSERT t_fish (trip_code, sample_no, sub_sample_no, species, fish_no)		
Indices:	NORMAL (2, 15) BTREE ON (species) NORMAL (2, 15) BTREE ON (origin) NORMAL (2, 15) BTREE ON (yr) NORMAL (2, 15) BTREE ON (trip_code) NORMAL (2, 15) BTREE ON (area) UNIQUE BTREE uniq_reading ON (trip_code, sample_no, sub_sample_no, species, fish_no, reading_no)		

5.4 Table 4: t_catalog

Comment: Catalog of all ageing material, their storage location, and current ageing status.

Attributes	Data Type	Null?	Comment
origin	character(3,1)	No	3 character code for the origin of the ageing material. Refer:t_origin.
yr	integer	No	Year fish was sampled.
trip_code	character(8,1)	No	Up to 8 char trip identification code.
sample_no	integer	No	Number of sample within the trip. This will be station number for Research, stratum number for SMP, and tow number for SOP.
sub_sample_no	character(4,1)	No	Number of sub sample. This will be subcatch number for Research trawls, cluster (box) number for SMP. SOP do not use this. -1 = Not Used.
area	character(4,1)		Up to 4 character area code. Codes depend on the species sampled.
species	character(3,1)	No	Species code of fish. Refer rdb:curr_spp.
fish_no	longinteger	No	Sequential identifying number of an individual fish for any one trip, sample, sub sample, and species.
material	smallint		1 digit code for the type of material used for ageing; e.g., otolith, scales, and spines.
room	character(50,1)		Room number which the ageing material can be found.
sub_loc	character(50,1)		Location within the room; e.g., file cabinet number, draw number.
status	character(25,1)		Current status of the ageing material.

Attributes	Data Type	Null?	Comment
status_date	date(5)		Date when status was last updated.
Creator:	dba		
Referential:	invalid origin code (origin) INSERT t_origin (code) invalid species code (species) INSERT rdb:curr_spp (code) invalid ageing material code (material) INSERT t_material (code)		
Indices:	NORMAL (2, 15) BTREE ON (origin) NORMAL (2, 15) BTREE ON (yr) NORMAL (2, 15) BTREE ON (trip_code) NORMAL (2, 15) BTREE ON (area) NORMAL (2, 15) BTREE ON (species) UNIQUE BTREE uniq_catalog ON (origin, yr, trip_code, sample_no, sub_sample_no, species, fish_no)		

5.5 Table 5: t_age

Comment: Table listing the agreed age assessment for each fish aged.

Attributes	Data Type	Null?	Comment
origin	character(3,1)	No	3 character code for the origin of the ageing material. Refer:t_origin.
yr	integer	No	Year fish was sampled.
trip_code	character(8,1)	No	Up to 8 char trip identification code.
sample_no	integer	No	Number of sample within the trip. This will be station number for Research, stratum number for SMP, and tow number for SOP.
sub_sample_no	character(4,1)	No	Number of sub sample. This will be subcatch number for Research trawls, cluster (box) number for SMP. SOP do not use this. -1 = Not Used.
area	character(4,1)		Up to 4 character area code. Codes depend on the species sampled.
species	character(3,1)	No	Species code of fish. Refer rdb:curr_spp.
fish_no	longinteger	No	Sequential identifying number of an individual fish for any one trip, sample, sub sample, and species.
prep_no	character(10,1)		Number to identify ageing material within a prepared sample
agreed_result1	decimal(6,2)		The agreed result of the reading.
agreed_result2	character(5,1)		Up to 5 character code for the result.
method	smallint	No	Up to 2 digit code for the method used to read ageing material.
agreed_age	decimal(4,1)		Agreed age (years) of the fish.
agreed_error1	decimal(4,2)		The error for result1; i.e. result1 + or - error1.
agreed_error2	character(3,1)		Additional character code for the agreed error.

Attributes	Data Type	Null?	Comment
comments	text(240,240,240,1)		Contains information on materials and methods used to arrive at the agreed age of the fish.
Creator:	dba		
Referential:	invalid species code (species) INSERT rdb:curr_spp (code)		
	invalid reading method (method) INSERT t_age_meth (code)		
Indices:	NORMAL (2, 15) BTREE ON (trip_code)		
	NORMAL (2, 15) BTREE ON (species)		
	NORMAL (2, 15) BTREE ON (origin)		
	NORMAL (2, 15) BTREE ON (yr)		
	NORMAL (2, 15) BTREE ON (area)		
	UNIQUE BTREE uniq_age ON (trip_code, sample_no, sub_sample_no, species, fish_no, method)		

5.6 Table 6: t_origin

Comment: Table describing the origin codes of the ageing material.

Attributes	Data Type	Null?	Comment
code	character(3,1)	No	3 character code for the origin of the ageing material.
description	character(60,1)	No	Brief description of the origin of the ageing material.

Creator: dba

Indices: UNIQUE BTREE origin_pk ON (code)

5.7 Table 7: t_material

Comment: List of materials used for ageing; e.g., otoliths, vertebrae, scales.

Attributes	Data Type	Null?	Comment
code	smallint	No	1 digit code for material used for reading.
description	character(60,1)	No	Brief description of the ageing material.

Creator: dba

Indices: UNIQUE BTREE ON (code)

5.8 Table 8: t_reader

Comment: List of names of persons who have carried out the ageing analysis.

Attributes	Data Type	Null?	Comment
code	smallint	No	Numeric code identifying the reader.
Name	character(30,1)	No	Name of the reader associated with the code.

Creator: dba

Indices: UNIQUE BTREE ON (code)

5.9 Table 9: t_age_meth

Comment: Table listing the methods used for estimating ages.

Attributes	Data Type	Null?	Comment
code	smallint	No	Numeric code for ageing method used.
description	text(240,24,24,1)	No	Details on method used to prepare and read ageing material.

Creator: dba

Indices: UNIQUE BTREE ON (code)

6 age Business Rules

6.1 Introduction to business rules

The following are a list of business rules pertaining to the age database. A business rule is a written statement specifying what the information system (i.e., any system that is designed to handle fish ageing data) must do or how it must be structured.

There are three recognized types of business rules:

Fact	Certainty or an existence in the information system
Formula	Calculation employed in the information system
Validation	Constraint on a value in the information system

Fact rules are shown on the ERD by the cardinality (e.g., one-to-many) of table relationships. Referential constraints, range checks, and algorithms both in the database and during data validation implement the formula and validation type rules.

6.2 Summary of rules

Trip details (t_trip)

origin	Must be a valid data origin code as listed in the <i>t_origin</i> table.
yr	Must be a valid 4 digit year less than or equal to the current year.
trip_code	Should be (but not necessarily) a valid alphanumeric code to uniquely identify a trip, survey, or landing as listed in the header tables of such databases as trawl , market , or obs_lfs .
area	Must be a valid area code as listed in the <i>area_codes</i> table in the rdb table.
species	Must be a valid species code as listed in the <i>curr_spp</i> table in the rdb database.
status_date	Must be a valid date.

Fish details (*t_fish*)

origin	Must be a valid data origin code as listed in the <i>t_origin</i> table.
yr	Must be a valid 4 digit year less than or equal to the current year.
trip_code	Should be (but not necessarily) a valid alphanumeric code to uniquely identify a trip, survey, or landing as listed in the header tables of such databases as trawl , market , or obs_ifs .
sample_no	Must be an integer greater than zero.
sub_sample_no	Must contain a value. Default = “-1”.
area	Must be a valid area code as listed in the <i>area_codes</i> table in the rdb table.
species	Must be a valid species code as listed in the <i>curr_spp</i> table in the rdb database.
fish_no	Must be an integer greater than zero.
lgth	Must be an integer greater than zero.
sex	Must be a valid sex code as listed in the <i>t_sex_codes</i> table in the rdb database.
weight	Must be a number greater than zero.
otolith_weight	Must be a number greater than zero.
otolith_lgth	Must be a number greater than zero.
otolith_width	Must be a number greater than zero.
material1	Must be a valid ageing material code as listed in the <i>t_material</i> table in the rdb database.
material2	Must be a valid ageing material code as listed in the <i>t_material</i> table in the rdb database.
fish_select_meth	Must be a value of either “1”, “2”, or “3”.

Age reading details (*t_reading*)

origin	Must be a valid data origin code as listed in the <i>t_origin</i> table.
yr	Must be a valid 4 digit year less than or equal to the current year.
trip_code	Should be (but not necessarily) a valid alphanumeric code to uniquely identify a trip, survey, or landing as listed in the header tables of such databases as trawl , market , or obs_ifs .
sample_no	Must be an integer greater than zero.
sub_sample_no	Must contain a value. Default = “-1”.
area	Must be a valid area code as listed in the <i>area_codes</i> table in the rdb table.
species	Must be a valid species code as listed in the <i>curr_spp</i> table in the rdb database.
fish_no	Must be an integer greater than zero.
reading_no	Must be an integer greater than zero.
reading_date	Must be a valid date.
material	Must be a valid ageing material code as listed in the <i>t_material</i> table in the rdb database.
method	Must be a valid ageing method code as listed in the <i>t_age_meth</i> table.
reader	Must be a valid reader code as listed in the <i>t_reader</i> table.
result1} result3} result4} result5} result6}	Must be a number greater than or equal to zero.
error1	Must be a number greater than or equal to zero.
age	Must be a number greater than or equal to zero.

Ageing material catalog details (*t_catalog*)

origin	Must be a valid data origin code as listed in the <i>t_origin</i> table.
yr	Must be a valid 4 digit year less than or equal to the current year.
trip_code	Should be (but not necessarily) a valid alphanumeric code to uniquely identify a trip, survey, or landing as listed in the header tables of such databases as trawl , market , or obs_ifs .
sample_no	Must be an integer greater than zero.
sub_sample_no	Must contain a value. Default = “-1”.
area	Must be a valid area code as listed in the <i>area_codes</i> table in the rdb table.
species	Must be a valid species code as listed in the <i>curr_spp</i> table in the rdb database.
fish_no	Must be an integer greater than zero.
material	Must be a valid ageing material code as listed in the <i>t_material</i> table in the rdb database.
status_date	Must be a valid date.

Age details (t_age)

origin	Must be a valid data origin code as listed in the <i>t_origin</i> table.
yr	Must be a valid 4 digit year less than or equal to the current year.
trip_code	Should be (but not necessarily) a valid alphanumeric code to uniquely identify a trip, survey, or landing as listed in the header tables of such databases as trawl , market , or obs_ifs .
sample_no	Must be an integer greater than zero.
sub_sample_no	Must contain a value. Default = “-1”.
area	Must be a valid area code as listed in the <i>area_codes</i> table in the rdb table.
species	Must be a valid species code as listed in the <i>curr_spp</i> table in the rdb database.
fish_no	Must be an integer greater than zero.
agreed_result1	Must be a number greater or equal to zero.
method	Must be a valid ageing method code as listed in the <i>t_age_meth</i> table.
agreed_age	Must be a number greater or equal to zero.
agreed_error1	Must be a number greater or equal to zero.

Age material origin codes (t_origin)

code Must contain a unique code.
description Must contain a value.

Age material type codes (t_material)

code Must contain a unique code.
description Must contain a value.

Age material reader codes (t_reader)

code Must contain a unique code.
name Must contain a value.

Ageing method codes (t_age_meth)

code Must contain a unique code.
description Must contain a value.

Appendix 1 - Reference code tables

Origin code

SMP	Stock Monitoring Programme - Market Sampling
SOP	Scientific Observer Programme - Catch Sampling
TAN	Tangaroa
KAH	Kaharoa
AEX	Amaltal Explorer
COR	Cordella
GIL	Giljanes
WIL	Will Watch
JCO	James Cook
WES	Wesermunde
ARR	Arrow
REC	Recreational
MIS	Miscellaneous e.g., mixed landing, or no length frequency
AKA	Akagi Maru
BFN	Bluefin - MAF Auckland Vessel
SHI	Shinkai Maru
RIG	Rig catch sampling (gill-netting and trawl surveys)
ELE	Elephantfish catch sampling
WJS	W.J.Scott
BUC	Otago Buccaneer
AKS	Akebono Maru No. 3
AKE	Akebono Maru No. 73

Reader code

0	Agreed Age
1	David A. Banks
2	David O. Fisher
3	Adam D. Langley
4	Kerri E. Lister
5	Kevin A. Mackay
6	Heidi Getrost
7	Elizabeth Halsey
8	Colin Docherty
9	Mike Coakley
10	Peter Horn
11	C. L. Newport
12	Claire L. Gabriel
13	Gerard Worsfold
14	Kevin J. Sullivan
15	Kimon George
16	Ian Rosemergy
17	Jonathan Ingerson
18	Peter Marriott
19	Darren Stevens
20	Larry Paul

Reader code [cont...]

21	Bruce Hartill
22	Cameron Walsh
23	Ken Kawiti
24	Helena Cadenhead
25	Bill Trusewich
26	Guido I. Kucerans
27	Dave J. Gilbert
28	A. J Taylor
29	C.Smith
30	D. J Hollaway
31	Pat. Swanson
32	N. J Millar
33	K. A Fisher
34	Brent A Wood
35	B. L Bycroft
36	Ian F West
37	CLC
38	BJW
39	Colin Sutton
40	Greg Meikle
41	Jim Drury
42	Victor Cauty
43	Derrick Parkinson
44	Simon Carter
45	Mark Morrison
46	Helen Johnson
47	Elwyn Green
48	Andy Hay
49	Andrea Price
50	Dominic McCarthy
51	Tracey Osborne
52	Diederik Meenken
53	Paul Creswell
54	Eunice Warren
55	Nick Davies
56	Malcolm Haddon
57	Sheryl Mutton
58	Tim Lowe
59	Jeremy McKenzie
60	Dave Allen
61	Paul Fraser
62	Eddie Sides
63	Carmen Gray
64	Stuart Hanchet
65	Evan Skipworth
66	Andrew Hamilton
67	John Taunton-Clark

Reader code [cont...]

68	Tessa Fagan
69	Glenn Mackay
70	Mike Beentjes
71	Don Jellyman
72	Ben Chisnall
73	Jill Parkyn
74	Glen Carbines
75	Derek Kater
76	Matthew Smith
77	Caoimhghin O Maolagain
78	Gavin James
79	ERM
80	REM
81	JF
82	T P
83	Robert Bedford
84	SJH
85	Adrian Colman
86	Malcolm Francis
87	Arthur Hore
88	Nathan Singleton
89	Shaun Henderson
91	Niki Alcock
92	Bruce Dudley
93	Crispin Middleton
99	Not Known
100	Di Tracey
101	Peter Horn and Di Tracey

Ageing method code

1	Break, polish, bake and count rings from the centre, looking at 2 halves of the one otolith.(used by stock monitoring for the 1989 seasons otoliths)
2	Break, polish, burn and count rings from the centre, looking at one half of the otolith. A 2 mm diameter scale was used to help locate the first ring. (used by G. Worsfold, C. Gabriel and K. Sullivan for the pilot phase; i.e., 1988 otolith readings.)
3	Break, polish, burn or bake and count rings using a graticle as a guide to the 1st 3 years (1 year at 2mm, 2yrs at 4mm & 3 years at 5mm) looking at one half of the otolith. (Used for sub-samples of 1988 and 1990 seasons otoliths.)
4	Otolith read whole, immersed in water, paraffin oil or like

Ageing method code [cont...]

- 5 Whole, bleached vertebral centra were obliquely illuminated with a fibre optic light source. By moving the light source above and below the rim of the articulating face, it was possible to quickly view the hypermineralised vertebral bands with both transmitted and reflected light. The theoretical birthday was defined as 1 September. The time of band deposition approximately coincides with the theoretical birthday. Therefore, the age assigned to each rig was the band count minus one for the birth band, plus the fraction of the year elapsed between 1 September and the sampling date. The mean of two age estimates (made by two readers) was taken as the final age estimate.
- 6 Break and Burn
- 7 Whole otolith baked, embedded in epoxy resin, cut transversely through nucleus with diamond tip blade. Read using binocular microscope to count rings from one or both sides of a prepared otolith.
- 8 Ageing material bleached, embedded in epoxy resin, sectioned, attached to a slide and polished.
- 10 Otolith weight in grams to 3 decimal places
- 11 Thin section, as in Tracey & Horn 1999; Background & review of ageing ORH.
- 12 Modified Ageing Methodology for Juvenile Hoki Age 1 - 2. As of December 2000.
Result and error attributes in the *t_reading* table:

Attribute	Value Stored
<i>result1</i>	Age
<i>result2</i>	Radius to Zone 1
<i>result3</i>	Radius to Zone 2
<i>result6</i>	Radius to otolith edge
<i>error3</i>	Overall clarity (1-3), where 1 = best
<i>error5</i>	split/multiple 2nd zone (1 = true, 0 = false)

Ageing method code [cont...]

- 13 Modified Ageing Methodology for Juvenile Hoki Age 3. As of December 2000.

Result and error attributes in the *t_reading* table:

Attribute	Value Stored
<i>result1</i>	Age
<i>result2</i>	Radius to Zone 1
<i>result3</i>	Radius to Zone 2
<i>result4</i>	Radius to Zone 3
<i>result5</i>	Radius to edge of the juvenile zone
<i>result6</i>	Radius to otolith edge
<i>error1</i>	Clarity of Zone 1 (1-4), where 1 = best, 4 = unreadable
<i>error2</i>	Clarity of juvenile zone 1 (1-4), where 1 = best, 4 = unreadable
<i>error4</i>	Split/multiple 1 st zone (1=true, 0=false)
<i>error5</i>	split/multiple 2nd zone (1 = true, 0 = false)
<i>error6</i>	split/multiple 3rd zone (1 = true, 0 = false)

- 14 Modified Ageing Methodology for Hoki. As of December 2000.

Result and error attributes in the *t_reading* table:

Attribute	Value Stored
<i>result1</i>	Age
<i>result2</i>	Radius to Zone 1
<i>result3</i>	Radius to Zone 2
<i>result4</i>	Radius to Zone 3
<i>result5</i>	Radius to edge of the juvenile zone
<i>error1</i>	Clarity of Zone 1 (1-3), where 1 = best
<i>error2</i>	Clarity of juvenile zone 1 (1-4), where 1 = best, 4 = unreadable
<i>error7</i>	Clarity for Zones 1 to 3 combined (1-3), where 1=best

Ageing material code

- 1 Otolith
- 2 Scales
- 3 Spines
- 4 Vertebrae
- 5 Teeth
- 6 Statolith (cephalopod)

7 Acknowledgements

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