Database documentation: rocklob

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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.

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 is a brief introduction to the rock lobster phyllosoma and puerulus database **rocklob**, and is a part of the database documentation series produced by NIWA.

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 the relationships between the tables in **rocklob**.

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

2 Abundance of early life history stages of the rock lobster

Red rock lobsters (*Jasus edwardsii*) support one of New Zealand's most valuable fisheries. Understanding larval recruitment processes greatly assist management of this fishery.

Rock lobsters spend several months as phyllosoma larvae tens to hundreds of kilometres offshore. Phyllosomas can disperse large distances: advanced phyllosomas were taken to the seaward extent of east coast trawl transects during trawl surveys and are widespread in the south Tasman Sea. At least recently, advanced (mid- and late-stage) phyllosomas have been much more abundant off the east coast of the North Island south of East Cape than off the east coast of the South Island (Booth & Forman 1995). This pattern appears to be determined by factors that include levels of local rock lobster larval production and the oceanography. Surveys have been carried out since the 1970s using mainly fine-meshed mid-water trawls, but also bottom trawls and bongo nets. Survey designs have include both transects and strata area.

Rock lobsters return to the shore as pueruli. The puerulus stage is the settling stage: it resembles the juvenile in shape and is 9-13mm in carapace length, but is transparent. Puerulus settlement happens when pelagic pueruli cease extensive forward swimming and take up residence on the substrate or in a crevice collector. Some older pueruli and young juveniles, however, move into collectors after first settling elsewhere.

Key sites to follow levels of settlement on crevice collectors (see Booth *et al*. 1991 for collector design) have been set up in the main rock lobster fishing coasts of New Zealand. Collectors are set in groups of 3-6, with a minimum spacing of 2-3m between individual collectors. At each key site there is a core group; additional groups of collectors are set in both directions along the coast, as conditions allow, 0.1-25km from the core collectors. At most sites, collectors are checked monthly and all lobsters removed. These collectors provide a combined index of:

a) the number of pelagic pueruli in the water column which are settling;
b) the result of post-settlement migration, the net number of older animals (older pueruli, and less often, young juveniles) moving onto the collector after having lived on the surrounding sea floor, and animals of similar age moving from the collector to the surrounding sea floor.

The index of annual settlement is the average catch per collector of pueruli, plus post-pueruli up to and including 14.5mm carapace length combined, of the core collectors over the main settlement season. The main settlement season varies between 6 and 10 months according to site, so values of annual index are not always directly comparable between sites.

Knowing the abundance of early life history stages (phyllosomas, pueruli, and young juveniles) may lead researchers to the factors that drive fishery recruitment. It may be possible to relate changes in levels of settlement to changes in breeding stock abundance, abundance of advanced larvae, and to changes in the ocean climate. Information on year-to-year settlement levels may be used to predict trends in recruitment, provide early warning of over fishing, and indicate to what extent recruitment varies from year to year. A discussion of the abundance of early life history stages of lobsters and the implications to fishery management are detailed in Booth *et al*. 1998.

3 Data structures

3.1 Table relationships

This database contains several tables. The ERD for **rocklob** (Figure 1) shows the physical data model structure[1] 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.

[1] Also known as a database *schema*.

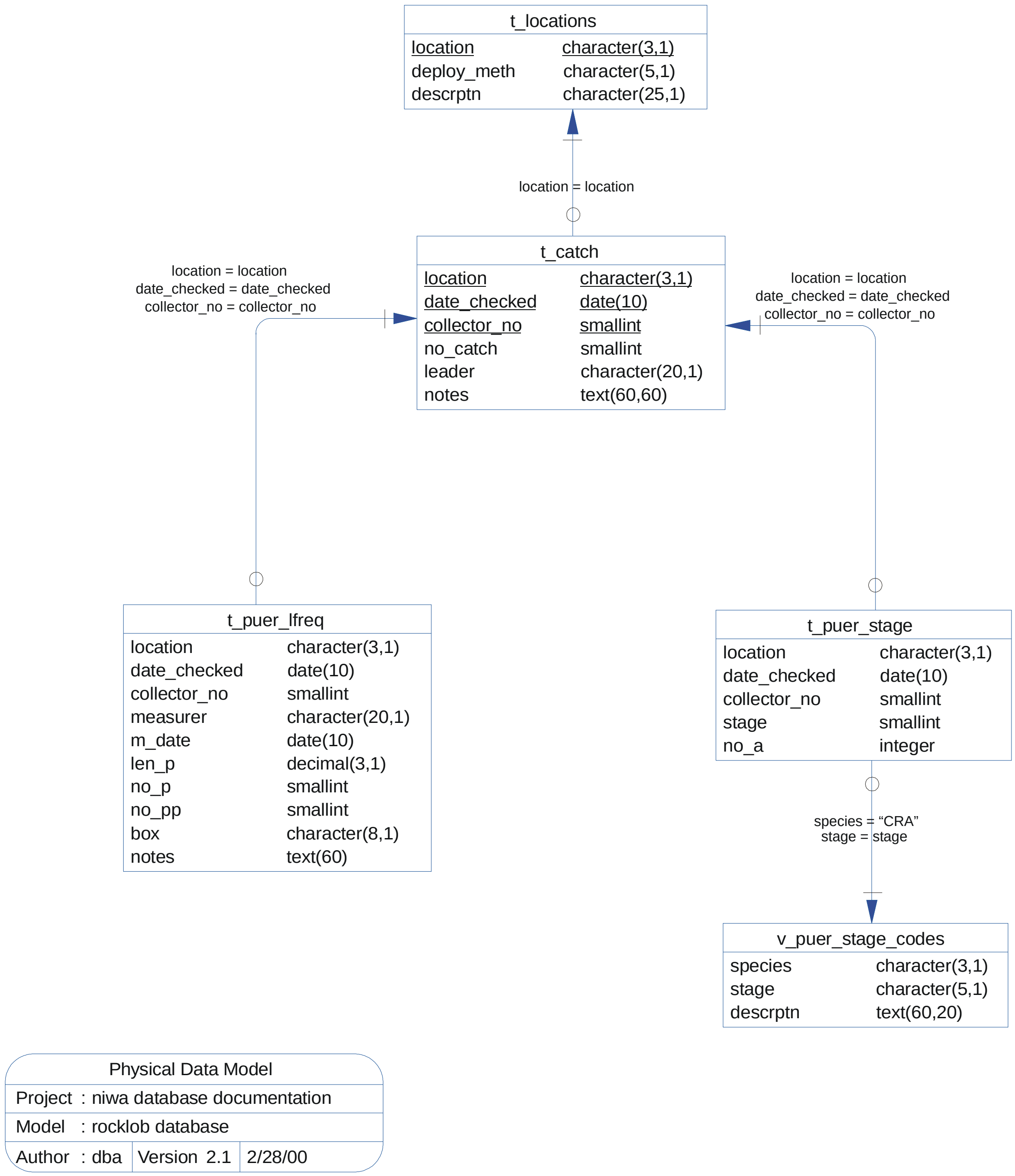

Figure 1: Entity Relationship Diagram (ERD) showing the relationships between the tables that hold data from puerulus settlement collectors.

All of the table's attributes are shown in the ERD. The underlined attributes represent the table's primary key[2]. This schema is valid regardless of the database system chosen, and it can remain correct even if the Database Management System (DBMS) is changed. Most of the tables in the **rocklob** database also contain special attributes, called foreign keys[3].

Section 5 shows a listing of all the **rocklob** tables as implemented by the EMPRESS RDBMS. 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 (the key attributes) and the index name is the primary key name. Note that the typographical convention for the above format is that square brackets [] may contain more than one item or none at all.

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

The **rocklob** database is implemented as a relational database. That is, each table is a special case of the mathematical construct known as a *relation* and hence elementary relation theory is used to deal with the data within tables and the relationships between them. All relationships in **rocklob** are of the type *one-to-many*[4]. This is shown in the ERD by connecting a single line (indicating 'many') from the child table (e.g., *t_station*) to the parent table (e.g., *t_trip*) with an arrowhead (indicating 'one') pointing to the parent. For example, consider the relationship between the tables *t_trip* (the parent table) and *t_station* (the child table). Any one trip in *t_trip* can have one or more stations in *t_station*, but any one station can only be a part of one trip.

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_station* and it's child table *t_phy*. The symbol "O" across the relationship line by the child *t_phy* means that a station record can have zero or many phyllosoma catch records, while the bar across the relationship line by the parent *t_station* means that for every phyllosoma catch record there must be a matching station record.

[2] A primary key is an attribute or a combination of attributes that contains an unique value to identify that record.
[3] 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.
[4] A one-to-many relationship is where one record (the *parent*) in a table relates to one or many records (the *child*) in another table; e.g., one survey in *t_trip* can have many stations in *t_station* but any one station can only come from one survey.

These relationships are enforced in the database by the use of referential constraints[5]. 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 the relationship is lost; or a child record is entered without a parent record. All constraints in **rocklob** prevent the latter from occurring. Constraints are shown in the table listings by the following format:

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

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

```
Referential:       No such survey (survey) INSERT t_survey (survey)
```

This means that the value of the attribute *survey* in the current record must already exist in the parent table *t_survey* or the record will be rejected and the error message "No such survey" will be displayed. All tables are indexed. That is, attributes that are most likely to be used for searching, such as *survey*, have like values linked together to optimise search times.

Such indices are shown in the table listings (Section 5) by the following syntax:

```
Indices:    NORMAL (2, 15) index_name ON (attribute{, attributes})
```

Note that indices may be *simple*, pointing to just one attribute, or *composite*, pointing to more than one attribute. The numbers "…(2, 15)…" are EMPRESS default values relating to the amount of space allocated to index storage.

3.2 Database design

The **rocklob** database has been designed around two distinct sources of data: puerulus collector monitoring and phyllosoma trawl surveys.

3.2.1 Puerulus collector monitoring

Pueruli, post-pueruli, and young juveniles of *J. edwardsii* occur most abundantly in shallow waters. Around New Zealand, pueruli occur intertidally in crevices, holes, and indentations under boulders. Artificial crevice collectors, deployed by various methods (shore, sea floor, and surface/midwater), are used in locations around the country as a means of measuring abundance of settlement. Location and the method of collector deployment are stored in the table *t_locations* (Table 1).

Periodically (usually monthly) these collectors and 'natural' settlement (such as intertidal beaches, natural crevices and indentations in boulders) are checked for pueruli settlement. The details of such checks, including numbers of pueruli caught, are stored the table

[5] Also known as integrity checks.

t_catch (Table 2). Each check is uniquely identified by the attributes: *location*, a 3-character code of the geographic location; *date_checked*; and *collector_no*, a unique sequential number given to each collector at a location. The total number of all lobsters caught for each collector during the check in stored in *no_catch.* At the time of the check, lobsters are not staged so there is no distinction made been pueruli, post-pueruli, and young juveniles until each lobster is measured and staged at a later date.

Historically, all lobsters caught by the collectors at certain locations were measured by carapace length. These length frequency data are stored in the table *t_puer_lfreq* (Table 3). Each record in this table stores the number of lobsters per millimetre length class. Lobsters were also recorded as being either pueruli or post-pueruli. So, for each millimetre length class, *t_puer_lfreq* records the numbers of pueruli (*no_p*) and the numbers of poet-pueruli (*no_pp*). The smaller length classes having only pueruli, the larger lengths having only post-pueruli, and in some uncommon cases, a length class may have counts for both.

Currently, all pueruli and post-pueruli lobsters are staged based on their life history. These staging data are stored in the table *t_puer_stage* (Table 4). Staging only takes place on lobsters up to 14.5mm carapace length as it is generally accepted that this is the maximum size that lobsters can grow in one month (the time between collector checks). Lobsters below this size are staged to a four-point scale. The number of all lobsters over this size is also recorded as a measure of post-settlement migration.

3.2.2 Phyllosoma trawl surveys

The phyllosoma trawl survey data model is an adaptation of the trawl survey data model (Mackay 1998).

Several trawl surveys have been carried out since the 1970s to define the extent of occurrence and to index abundance of advanced stage phyllosomas. Details of such trips are stored in the table *t_trip* (Table 5), including start/finish dates, areas surveyed, and parameters of trawl gear used.

Surveys may or may not have included strata as part of the methodology, but where they were involved no details of strata are recorded in **rocklob**. Unlike other stratified trawl surveys, phyllosoma surveys do not involve random stations nor are catches scaled up to any area.

These surveys all involve transects, with a number of stations (where trawl gear was deployed) occurring along the transect path. Station details are stored in the table *t_station* (Table 6). Catch details from each station are included within t_station; e.g., total volume caught, and volume sampled. Only 4 items within each catch are recorded so each has it's own attribute within t_station for catch numbers. These attributes are: *phy* for *Jasus* sp. phyllosomas; *puer* for pueruli; *ibacus* for *Ibacus* sp. phyllosoma; and *scyllarus* for *Scyllarus* sp. phyllosoma.

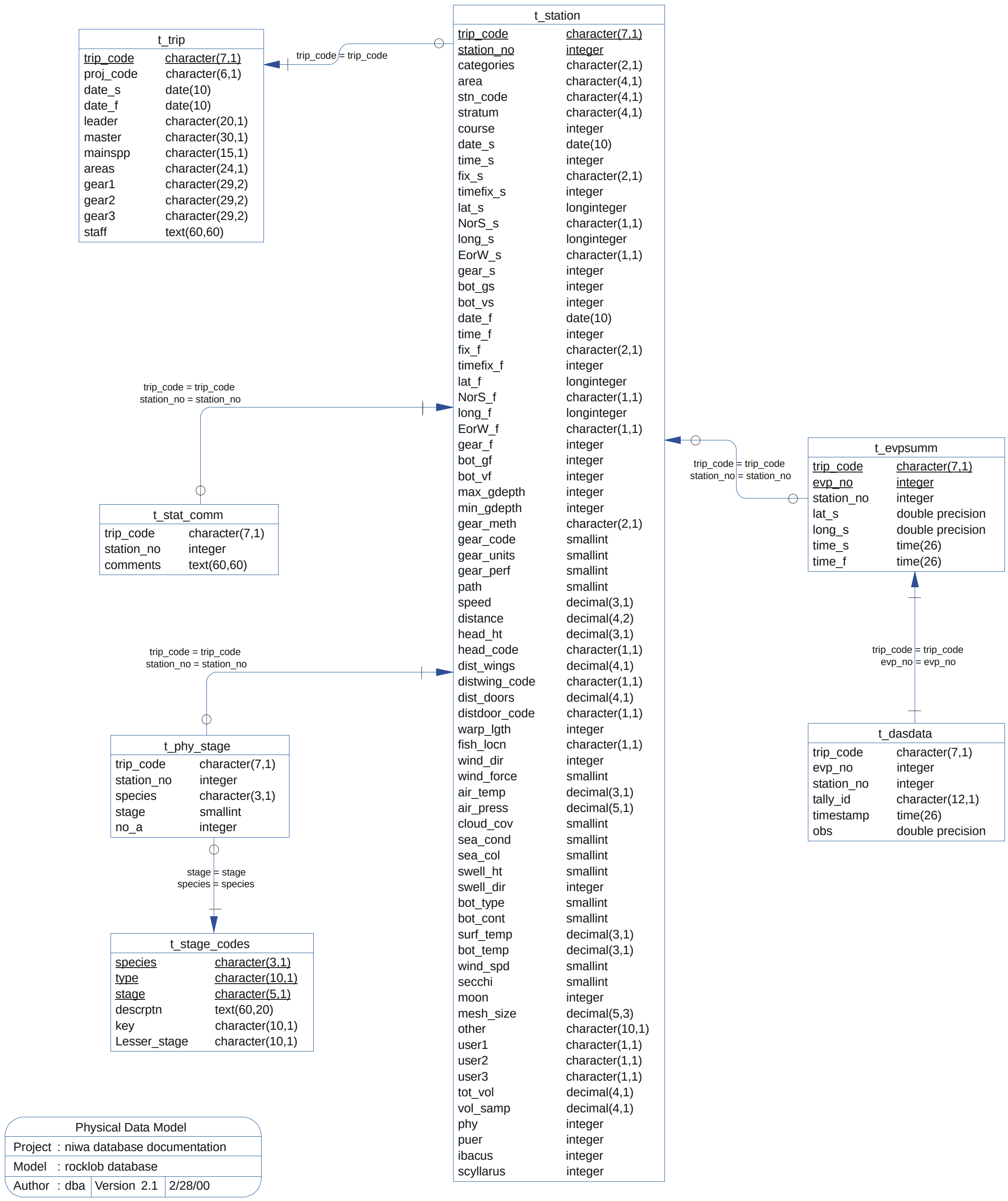

Figure 2: ERD showing the relationships between the tables for the phyllosoma trawl surveys.

Comments on stations are stored in a separate table *t_stat_comm* (Table 7). Having the comments in their own tables means that each station can have none or as many comments as a user wishes.

Measurements taken from individual phyllosoma are stored in *t_phy_stage* (Table 8). Currently, only life history stages are recorded for individual specimens, although, this table can be expanded to include other measurements if required.

Two views of this table (*v_scyllarus* and *v_jasus*) exist to provide phyllosoma stage data for *Scyllarus* sp. and *Jasus* sp. respectively. A view is a table that does not have any existence in its own right but is instead a snapshot of data derived from one or more base tables.

One of the aims of phyllosoma trawl surveys is to compare abundance data with changes in ocean climate. To this end, on RV Tangaroa surveys, physical oceanographic data such as surface temperature, salinity, and sea currents are logged real-time from the vessel's sensors by the Data Acquisition System (DAS). DAS controls data logging automatically by monitoring the trawl gear warp length starting logging when the trawl gear is let out, stopping when the trawl gear is hauled. Data are recorded into discrete envelopes of time and each envelope is roughly comparable with a station. Each envelope is given a sequential envelope number, with summary information such as matching station number and start/finish time stored in *t_evpsumm* (Table 9).

Actual data recorded by the DAS for an envelope are stored in *t_dasdata* (Table 10) with each record having a timestamp (*timestamp*) to say when it was recorded, an identifier (*tally_id*) to say which sensor is being measured, and an observed value (*obs*) from the sensor.

Explanations for all phyllosoma and puerulus developments stages are stored in the table *t_stage_codes* (Table 11). From this table, there are two views, which show explanations of development stage codes for puerulus (*v_puer_stage_codes*) and phyllosoma (*v_phy_stage_codes*) exclusively.

4 Table summaries

This database is arranged as a set of eleven main tables, two views of species-specific data, and a further two views for codes.

The following is a listing and brief outline of the tables contained within **rocklob** pertaining to pueruli settlement:

1. **t_locations :** contains the full name of each location code and the method of puerulus collector deployment.
2. **t_catch** : contains details for each puerulus collector check, including location code, date, and numbers of pueruli caught.
3. **t_puer_lfreq** : contains carapace length data for puerulus caught by collectors during a check.
4. **t_puer_stage** : contains life history stage data for individual pueruli caught by collectors during a check.

The following is a listing and brief outline of the tables contained within **rocklob** pertaining to phyllosoma trawl surveys:

5. **t_trip** : contains profile information on all trips.
6. **t_station** : contains data on location, gear used and environment at each station within a trip.
7. **t_stat_comm** : contains comments for a station in a trip.
8. **t_phy_stage** : contains codes for levels of life history development for individual phyllosoma.
   - (a) **v_scyllarus** : a view of the *t_phy_stage* table containing all scyllarus (SHL) phyllosoma life history stage data.
   - (b) **v_jasus** : a view of the *t_phy_stage* table containing all Jasus sp. phyllosoma (PHY) life history stage data.
9. **t_evpsumm :** contains start and finish times and positions, and station numbers contained in, envelopes of DAS data.
10. **t_dasdata :** contains filtered data from the vessel's sensors collected in DAS envelopes
11. **t_stage_codes :** contains crayfish development stage codes and their descriptions, from phyllosoma larvae to juveniles.
   - (a) **v_puer_stage_codes :** contains puerulus development stage codes and their descriptions.
   - (b) **v_phy_stage_codes :** contains phyllosoma development stage codes and their descriptions.

5 rocklob tables

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

See Appendix 1 for attributes that have comments referring to the Trawl Instructions (unpub. NIWA report).

5.1 Table 1: t_locations

Comment: Lists the location used for the deployment of pueruli collectors, the location code, and the method of collector deployment.

Attributes	Data Type	Null?	Comment
location	character(3,1)	No	3-char code for the location of the collector
descrptn	character(25,1)		Location name or description.
deploy_meth	character(5,1) smatch 'BOAT|SHORE'		Method of collector deployment used at the location.

Creator: dba
Indices: UNIQUE BTREE location_codes_pk ON (location)

5.2 Table 2: t_catch

Comment: Shows number of pueruli caught on each collector at each check, with comments.

Attributes	Data Type	Null?	Comment
location	character(3,1)	No	3-char code for the location of the collector
date_checked	date(5)	No	Date the collector was checked
collector_no	smallint	No	Each collector has been given a unique number
no_catch	smallint		Number of pueruli caught
leader	character(20,1)		Name of trip leader
notes	text(50,100,50,1)		Comment for each collector

Creator: dba

Indices:
NORMAL (2, 15) BTREE catch_location_ndx ON (location)
NORMAL (2, 15) BTREE catch_date_checked_ndx ON (date_checked)
NORMAL (2, 15) BTREE catch_collector_no_ndx ON (collector_no)

5.3 Table 3: t_puer_lfreq

Comment: Table of pueruli length frequency data.

Attributes	Data Type	Null?	Comment
location	character(3,1)	No	3-char code for the location of the collector
date_checked	date(5)	No	Date the collector was checked
collector_no	smallint	No	Each collector has been given a unique number
measurer	character(20,1)		Person who recorded the length of the animals
m_date	date(5)		Measurement date
len_p	decimal(3,1)		Carapace length of the puerulus
no_p	smallint		Number of puerulus
no_pp	smallint		Number of post puerulus
box	character(8,1)		Box and container number where the animals are kept
notes	text(50,0,50,1)		

Creator: dba

Indices:
NORMAL (2, 15) BTREE lfreq_location_ndx ON (location)
NORMAL (2, 15) BTREE lfreq_date_checked_ndx ON (date_checked)
NORMAL (2, 15) BTREE lfreq_collector_no_ndx ON (collector_no)

5.4 Table 4: t_puer_stage

Comment: Table of pueruli life history stage data.

Attributes	Data Type	Null?	Comment
location	character(3,1)	No	3-char code for the location of the collector
date_checked	date(5)	No	Date the collector was checked
collector_no	smallint	No	Each collector has been given a unique number
stage	smallint		Numeric code for life history stage
no_a	integer		Number of animals at this stage.

Creator: dba

Indices:
NORMAL (2, 15) BTREE puer_stage_location_ndx ON (location)
NORMAL (2, 15) BTREE puer_stage_date_checked_ndx ON (date_checked)
NORMAL (2, 15) BTREE puer_stage_collector_no_ndx ON (collector_no)

5.5 Table 5: t_trip

Comment: Profile information on all trips held in this database.

Attributes	Data Type	Null?	Comment
trip_code	character(7,1)	No	Trip code - 3 char vessel name, 2 digit year and 2 digit trip number.
	smatch "[a-z0-9][a-z0-9][a-z0-9][6-9][0-9][0-3][0-9]"		
proj_code	character(6,1)	No	Project or programme code.
	smatch "[A-Z][A-Z][A-Z][A-Z][0-9][0-9]"		
date_s	date(5)		Start date for the trip
date_f	date(5)		Finish date for the trip
leader	character(20,1)		Name of trip leader
master	character(30,1)		Name of vessel master(s)
areas	character(24,1)		Codes of area(s) surveyed separated by commas (,)
mainspp	character(15,1)		Target species code(s) separated by commas
	smatch "{[A-Z,]}"		
gear1	character(29,2)		Codend, liner & cover mesh sizes (mm), ground rope, sweep & bridle lengths (m) separated by commas for 1st gear code used
	match "{[0-9,.]}"		
gear2	character(29,2)		Codend, liner & cover mesh sizes (mm), ground rope, sweep & bridle lengths (m) separated by commas for 2nd gear code used
	match "{[0-9,.]}"		
gear3	character(29,2)		Codend, liner & cover mesh sizes (mm), ground rope, sweep & bridle lengths (m) separated by commas for 3rd gear code used
	match "{[0-9,.]}"		
staff	text(20,60,20,1)		Name(s) of all staff on the trip

Creator: dba
Indices: UNIQUE BTREE trip_key ON (trip_code)

5.6 Table 6: t_station

Comment: Data on location, gear used and environment at each station on a trip.

Attributes	Data Type	Null?	Comment
trip_code	character(7,1)	No	Trip code as defined in the trip table
station_no	integer	No	Station number - unique within a trip
categories	character(2,1)		2 separate user-defined categories; definitions should be in trip comments
area	character(4,1)		Code describing area, refer to rdb:area_codes.
stn_code	character(4,1)		Code for a permanent station occupied repeatedly.
stratum	character(4,1)		Stratum number if trip is a stratified survey, else a transect code.
course	integer range 0-359		Course of vessel during the shot (course-made-good).
date_s	date(5)		Starting date of the shot (dd Mmm yy format).
time_s	integer range 0-2359		Starting time (24hr,NZST) of the shot (hhmm format).
fix_s	character(2,1)		Method of fixing position at start of tow, refer rdb:t_fix_meth_codes.
timefix_s	integer		Time (in minutes) elapsed since last position fix at the start of tow.
lat_s	longinteger match “[3-6][0-9][0-5][0-9][0-9][0-9]”		Latitude of vessel at start of tow (ddmmmm format, d=deg, m=min to 2 implied dec. pl.)
NorS_s	character(1,1) smatch “[NS]”		Tow start position hemisphere.

Attributes	Data Type	Null?	Comment
long_s	longinteger match “1[7-8][0-9][0-5][0-9][0-9][0-9]”		Longitude of vessel at start of tow (dddmmmm format, d=deg, m=min to 2 implied dec. pl.)
EorW_s	character(1,1) smatch “[EW]”		Tow start position meridian.
gear_s	integer		Depth (m) of lowest part of gear (groundrope) at the start of tow.
bot_gs	integer		Depth (m) of sea bottom at gear position at start of the tow.
bot_vs	integer		Depth (m) of sea bottom at vessel position at start of the tow.
date_f	date(5)		Finishing date of the shot (dd Mmm yy format).
time_f	integer range 0-2359		Finishing time (24hr,NZST) of the shot (hhmm format).
fix_f	character(2,1)		Method of fixing position at end of tow, refer rdb:t_fix_meth_codes.
timefix_f	integer		Time (in minutes) elapsed since last position fix at end of the tow.
lat_f	longinteger match “[3-6][0-9][0-5][0-9][0-9][0-9]”		Latitude of vessel at end of tow (ddmmmm format, d=deg, m=min to 2 implied dec. pl.)
NorS_f	character(1,1) smatch “[NS]”		Tow finish position hemisphere.
long_f	longinteger match “1[7-8][0-9][0-5][0-9][0-9][0-9]”		Longitude of vessel at end of tow (dddmmmm format, d=deg, m=min to 2 implied dec. pl.)
EorW_f	character(1,1) smatch “[EW]”		Tow finish position meridian.

Attributes	Data Type	Null?	Comment
gear_f	integer		Depth (m) of lowest part of gear (groundrope) at end of the tow.
bot_gf	integer		Depth (m) of sea bottom at gear position at end of tow.
bot_vf	integer		Depth (m) of sea bottom at vessel position at end of tow.
min_gdepth	integer		Minimum depth (m) of lowest part of gear (groundrope) during the tow.
max_gdepth	integer		Maximum depth (m) of lowest part of gear (groundrope) during the tow.
gear_meth	character(2,1)		Gear method code, descriptions in rdb:meth_codes.
gear_code	smallint		Code for set of gear used, details in trip record.
gear_units	smallint		Number of units of gear used in the tow.
gear_perf	smallint range 1-4		Code for performance of gear during the tow, refer to the trawl instructions.
path	smallint range 1-8		Code describing configuration of path of shot, refer to the trawl instructions.
speed	decimal(3,1)		Average speed through water during shot (knots).
distance	decimal(4,2)		Distance of gear over bottom (nautical miles).
head_ht	decimal(3,1)		Average headline height (m).
head_code	character(1,1)		Code showing how headline height was determined, refer to rdb:t_headline_codes.
dist_wings	decimal(4,1)		Average distance between wings (m).

Attributes	Data Type	Null?	Comment
distwing_code	character(1,1)		Code to indicate how distance between the wings was determined for this tow, refer rdb:t_wing_dist_codes.
dist_doors	decimal(4,1)		Average distance between doors of gear (m).
distdoor_code	character(1,1)		Code to indicate how the distance between the doors was determined for this tow, refer rdb:t_door_dist_codes.
warp_lgth	integer		Length of warp during the tow (m).
wind_dir	integer range 0-359, 999		Wind direction (degrees true), 999=No wind.
wind_force	smallint range 0-12		Wind force on Beaufort scale.
air_temp	decimal(3,1)		Air temperature (degrees C).
air_press	decimal(5,1)		Air pressure (millibars).
cloud_cov	smallint range 0-8		Code describing cloud cover during tow, refer to trawl instructions.
sea_cond	smallint range 0-9		Code describing condition of sea, refer to trawl instructions.
sea_col	smallint range 1-8		Code describing colour of sea, refer to trawl instructions.
swell_ht	smallint range 1-3		Code describing height of swell, refer to trawl instructions.
swell_dir	integer range 0-359, 999		Direction of the swell (degrees true).

Attributes	Data Type	Null?	Comment
bot_type	smallint range 0-9		Code describing sea bottom type, refer to trawl instructions.
bot_cont	smallint range 0-5		Code describing sea bottom contour, refer to trawl instructions.
surf_temp	decimal(3,1)		Surface temperature (degrees C).
bot_temp	decimal(3,1)		Temperature at bottom (degrees C).
wind_spd	smallint		Wind speed from anemometer (m/s) (1knot=0.51m/s).
secchi	smallint		Depth at which Secchi disc becomes invisible (m).
moon	integer range 1-4		Quarters of the moon phase.
mesh_size	decimal(5,3)		Mesh size (cm) of the gear.
other	character(6,1)		Any other details, should be fully commented.
user1	character(1,1)		User-defined field 1. Field should be defined in t_stat_comm.
user2	character(1,1)		User-defined field 2. Field should be defined in t_stat_comm.
user3	character(1,1)		User-defined field 3. Field should be defined in t_stat_comm.
tot_vol	decimal(4,1)		Total volume (cubic metres) of material caught during tow.
vol_samp	decimal(4,1)		Volume (cubic metres) of material sampled.
phy	integer		Number of phyllosomas caught.

Attributes	**Data Type**	**Null?**	**Comment**
puer	integer		Number of pueruli caught
ibacus	integer		Number of ibacus sp. caught.
scyllarus	integer		Number of scyllarus sp. caught.

Creator: dba

Referential:
invalid trip_code (trip_code) INSERT t_trip (trip_code)
invalid area code (area) INSERT rdb : area_codes (code)
invalid fix_s code (fix_s) INSERT rdb : t_fix_meth_codes (fix_meth_code)
invalid fix_f code (fix_f) INSERT rdb : t_fix_meth_codes (fix_meth_code)
invalid gear code (gear_meth) INSERT rdb : meth_codes (code)
invalid headline code (head_code) INSERT rdb : t_headline_codes (headline_code)
invalid distwing code (distwing_code) INSERT rdb : t_wing_dist_codes (wing_dist_code)
invalid distdoor code (distdoor_code) INSERT rdb : t_door_dist_codes (door_code)
invalid fish_locn (fish_locn) INSERT rdb : t_fish_obs_codes (fish_obs_code)

Indices:
UNIQUE BTREE stat_key ON (trip_code, station_no)
NORMAL (2, 15) BTREE stat_station_no_ndx ON (station_no)
NORMAL (2, 15) BTREE stat_gear_meth_ndx ON (gear_meth)

5.7 Table 7: t_stat_comm

Comment: Comments for a station in a trip.

Attributes	Data Type	Null?	Comment
trip_code	character(7,1)	No	Trip code as in the trip table
station_no	integer	No	Station number as in station table
comments	text(60,120,60,1)		Comments for this station – should include comments about catch or any special action taken during tow

Creator: dba
Referential: invalid trip_code, station_no (trip_code, station_no) INSERT t_station (trip_code, station_no)
Indices: NORMAL (2, 15) BTREE scom_trip_code_ndx ON (trip_code)
NORMAL (2, 15) BTREE scom_station_no_ndx ON (station_no)

5.8 Table 8: t_phy_stage

Comment: Phyllosoma life history stage table.

Attributes	Data Type	Null?	Comment
trip_code	character(7,1)	No	Trip code as in the trip table.
station_no	integer	No	Station number as in station table.
species	character(3,1)		3-char species code, refer rdb:curr_spp.
stage	smallint		Numeric code for life history stage
no_a	integer		Number of animals at this stage.

Creator: dba
Referential: no trip-code, station (trip_code, station_no) INSERT t_station (trip_code, station_no)
Indices: NORMAL (2, 15) BTREE phy_stage_trip_code_ndx ON (trip_code)
NORMAL (2, 15) BTREE phy_stage_station_no_ndx ON (station_no)
NORMAL (2, 15) BTREE phy_stage_stage_ndx ON (stage)

5.8.1 v_scyllarus

Comment: View of all scyllarus (SHL) phyllosoma life history stage data.

View: select attr 'trip_code', attr 'station_no', attr 'species', attr 'stage', attr ‘no_a’ from 't_phy_stage' where (attr 'species' = 'SHL')

Attributes	Data Type	Null?	Comment
trip_code	character(7,1)	No	
station_no	integer	No	
species	character(3,1)		
stage	smallint		
no_a	integer		

5.8.2 v_jasus

Comment: View of all jasus (PHY) phyllosoma life history stage data.

View: select attr 'trip_code', attr 'station_no', attr 'species', attr 'stage', attr ‘no_a’ from 't_phy_stage' where (attr 'species' = 'PHY')

Attributes	Data Type	Null?	Comment
trip_code	character(7,1)	No	
station_no	integer	No	
species	character(3,1)		
stage	smallint		
no_a	integer		

5.9 Table 9: t_evpsumm

Comment: Table storing start/finish times/positions of stations/envelopes.

Attributes	Data Type	Null?	Comment
trip_code	character(7,1)	No	Standard 7 char code for the trip
evp_no	integer	No	Number to identify an envelope of DAS data
station_no	integer		Number for station assigned to envelope
lat_s	double precision	No	Latitude for start of envelope/station
long_s	double precision	No	Longitude for start of envelope/station
time_s	time(0)	No	Time at start of envelope/station
time_f	time(0)	No	Time at finish of envelope/station

Creator: dba
Referential: Invalid trip (trip_code) INSERT t_trip (trip_code)
Indices: UNIQUE evpsumm_pk ON (trip_code, evp_no)
NORMAL (2, 15) BTREE evpsumm_evp_no_ndx ON (evp_no)
NORMAL (2, 15) BTREE evpsumm_station_no_ndx ON (station_no)

5.10 Table 10: t_dasdata

Comment: Table storing filtered records from DAS envelopes.

Attributes	Data Type	Null?	Comment
trip_code	character(7,1)	No	Standard 7 char code for the trip
evp_no	integer	No	Number to identify an envelope of DAS data
station_no	integer	No	Number for station assigned to envelope
tally_id	character(12,1)	No	Label assigned by REACT to identify records
timestamp	time(0)	No	Rounded timestamp when observation was made
obs	double precision	No	Value of observation for tally_id at timestamp

Creator: dba
Referential: Invalid trip (trip_code) INSERT t_trip (trip_code)

5.11 Table 11: t_stage_codes

Comment: Descriptions of crayfish development stages from phyllosoma larvae to juveniles.

Attributes	Data Type	Null?	Comment
species	character(3,1)	No	3-char species code, refer rdb:curr_spp.
type	character(10,1) smatch “PHYLLOSOMA|PUERULUS”	No	Flag to denote whether the stage is for a phyllosoma or a puerulus.
stage	character(5,1)	No	Code for phyllosoma larvae development stage.
descrptn	text(80,20,20,1)		Description of the puerulus development stage code.
key	character(10,1)		Group number in which a stage Belongs. Used by some researchers to group similar stages together into one ‘super stage’.
Lesser_stage	character(10,1)		Stage, as defined by Lesser, J.H.R 1978. Phyllosoma larvae of Jasus edwardsii and their distribution off the east coast of North Island. N.Z. Journal of Marine and Freshwater Research 12 (4): 357-70.

Creator: dba
Indices: UNIQUE BTREE stage_codes_pk ON (species, type, stage)

5.11.1 v_puer_stage_codes

Comment: View of descriptions of development stages of rock lobsters from puerulus to juveniles.

View: select attr ‘species’, attr ‘stage’, attr ‘descrptn’ from ‘t_stage_codes’ where (attr ‘type’ = ‘PUERULUS’)

Attributes	Data Type	Null?	Comment
species	character(3,1)	No	3-char species code, refer rdb:curr_spp
stage	character(5,1)	No	Development stage code.
descrptn	text(80,20,20,1)		Description of the puerulus development stage code

5.11.2 v_phy_stage_codes

Comment: View of descriptions of development stages of phyllosoma larvae.

View: select attr ‘species’, attr ‘stage’, attr ‘descrptn’, attr ‘key’, attr ‘Lesser_stage’ from ‘t_stage_codes’ where (attr ‘type’ = ‘PHYLLOSOMA’)

Attributes	Data Type	Null?	Comment
species	character(3,1)	No	3-char species code, refer rdb:curr_spp.
stage	character(5,1)	No	Code for phyllosoma larvae development stage.
descrptn	text(80,20,20,1)		Description of the puerulus development stage code.
key	character(10,1)		Group number in which a stage Belongs. Used by some researchers to group similar stages together into one ‘super stage’.
Lesser_stage	character(10,1)		Stage, as defined by Lesser, J.H.R 1978. Phyllosoma larvae of Jasus edwardsii and their distribution off the east coast of North Island. N.Z. Journal of Marine and Freshwater Research 12 (4): 357-70.

6 rocklob business rules

6.1 Introduction to business rules

The following are a list of business rules pertaining to the rocklob database. A business rule is a written statement specifying what the information system (i.e., any system that is designed to handle rock lobster life cycle 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

Puerulus collector locations (t_locations)

location	Location code, must be unique.
deploy_meth	Puerulus collector deployment method code, must be a valid code as listed in Appendix 1.

Puerulus catch from a collector (t_catch)

location	Must be equal to a location code held in the *t_locations* table.
date_checked	The date a collector is checked must be a legitimate date.
collector_no	Must be a unique number within all collectors checked at a location on a date.

Puerulus length frequencies (t_puer_lfreq)

location	Must be equal to a location code held in the *t_locations* table.
date_checked	The date a collector is checked must be a legitimate date. The date must also equal a date checked in the t_catch table for a matching location code.
collector_no	Must be a unique number within all collectors checked at a location on a date. The collector number must also equal a collector number in the *t_catch* table for a matching location code and date checked.
m_date	Date of measurement of pueruli and/or post-pueruli. Must be a legitimate date on or after *date_checked.*
len_p	Carapace length (mm), should fall within the reasonable range of 5-25.
no_p	Number of pueruli measured at the length specified by the *len_p* attribute. The value of *len_p* should not exceed 14.5.
no_pp	Number of post-pueruli measured at the length specified by the *len_p* attribute. The value of len_p should not be less than 14.5.

Puerulus length frequencies (t_puer_stage)

location Must be equal to a location code held in the *t_locations* table.

date_checked The date a collector is checked must be a legitimate date. The date must also equal a date checked in the *t_catch* table for a matching location code.

collector_no Must be a unique number within all collectors checked at a location on a date. The collector number must also equal a collector number in the *t_catch* table for a matching location code and date checked.

stage Puerulus life cycle stage number, must be a valid code as listed in Appendix 1.

no_a Number of pueruli at the stage number, should fall within the reasonable range of 1-50.

Phyllosoma survey trip details (t_trip)

trip_code Trip code, must be unique. Trip codes are in the following format: 3 character vessel code (see the *vessels* table in the **rdb** database for available codes); 2 digit year (e.g., 99 = 1999, 00 = 2000); 2 digit sequential trip number for each vessel each year.

proj_code Project code must be a valid code within the NIWA project management system.

date_s The start date of the trip must be a legitimate date.

date_f The start date of the trip must be a legitimate date.

Multiple column checks on date:
The start date must not be later than the finish date.

areas Each of the listed area codes must be a valid code as listed in the *area_codes* table in the **rdb** database.

mainspp Each of the listed species codes must be a valid code as listed in the *curr_spp* table in the **rdb** database.

Phyllosoma survey station details (t_station)

trip_code	Must be equal to a trip code as listed in the *t_trip* table.
station_no	Must be a unique number within a single trip.
area	Area code must be a valid code as listed in the ***area_codes*** table in the **rdb** database.
course	Course must be within the range of 0 – 359 degrees.
date_s	The date at the start of a station must be a legitimate date. **Multiple column checks on start date:** The date must fall within the range of the range of the trip start and finish dates.
time_s	Start time of the station must be a valid 24-hour time and fall within the range of 0 – 2359 hours.
fix_s } **fix_f }**	The method of position fix code must be valid code as listed in Appendix 1.
lat_s	Must be a valid latitude
NorS_s	Northern or Southern Hemisphere at station start, must be equal to either “N” or “S”.
long_s	Must be a valid longitude.
EorW_s	Longitude east or west at station start, must be equal to either “E” or “W”.
bot_gs	Depth of sea bottom must not be less than depth of gear
date_f	The date at the finish of a station must be a legitimate date. **Multiple column checks on finish date:** The date must fall within the range of the range of the trip start and finish dates.

time_f Finish time of the station must be a valid 24-hour time and fall within the range of 0 – 2359.

Multiple columns checks on date and time:
The start date must not be later than the finish date and within a reasonable time period.

lat_f Must be a valid latitude

NorS_f Northern or Southern Hemisphere at station finish, must be equal to either “N” or “S”.

long_f Must be a valid longitude.

EorW_f Longitude east or west at station finish, must be equal to either “E” or “W”.

Multiple columns checks on position:
The finish position should be within a reasonable distance from the start position.

bot_gf Depth of sea bottom must not be less than depth of gear

min_gdepth Minimum gear depth must be less than or equal to the depth of gear at the start and finish of the station.

max_gdepth Maximum gear depth must be greater than or equal to the minimum gear depth and the depth of gear at the start and finish of the station

gear_meth Gear method code must be a valid code as listed in the *meth_codes* table in the **rdb** database.

gear_code Must within the range 1 – 3 to relate to *gear1*, *gear2*, and *gear3* respectively in the *t_trip* table.

gear_perf The gear performance code must be valid code as listed in Appendix 1.

path The path code must be valid code as listed in Appendix 1.

speed The vessel’s recorded speed during the station should be within the range 0 – 5 knots and be reasonable for the gear method.

distance	The distance traveled during the station should be reasonable for the type of gear method.
	Multiple columns check on: distance; start and finish positions; and speed and start/finish times: The distance traveled during a station as calculated by (1) the difference between start and finish positions; (2) speed * elapsed time; and (3) recorded distance should be in approximate agreement.
head_code	Headline height code must be a valid code as listed in the *t_headline_codes* table in the **rdb** database.
distwing_code	Distance between trawl wings code must be a valid code as listed in the *t_wing_dist_codes* table in the **rdb** database.
distdoor_code	Distance between trawl doors code must be a valid code as listed in the *t_door_dist_codes* table in the **rdb** database.
wind_dir	Wind direction must fall within the range of 0-359, 999.
wind_force	Wind force must fall within the range of 0 – 12.
air_temp	Air temperature should fall within the reasonable range of 5 – 30.
air_press	Air pressure should fall within the reasonable range of 960 to 1040.
cloud_cov	Cloud cover must fall within the range of 0-8.
sea_cond	The sea condition code must be valid code as listed in Appendix 1.
sea_col	The sea colour code must be valid code as listed in Appendix 1.
swell_ht	The swell height code must be valid code as listed in Appendix 1.
swell_dir	Wind direction must fall within the range of 0-359, or equal 999.
bot_type	The bottom type code must be valid code as listed in Appendix 1.
bot_cont	The bottom contour code must be valid code as listed in Appendix 1.
surf_temp	Sea surface temperature should fall within the reasonable range of 5 – 28.

bot_temp Sea bottom temperature should fall within the reasonable range of 3 – 25.

wind_spd Wind speed should fall within the reasonable range of 0 - 30.

secchi Secchi disc distance should fall within the reasonable range of 0 – 40.

moon Moon phase must fall within the range of 1 - 4.

Phyllosoma survey station comments (t_stat_comm)

trip_code Must be equal to a trip code as listed in the *t_trip* table.

station_no Must be a unique number within a single trip.

Multiple columns check trip code and station number:
The combination of trip code and station number must exist in the *t_station* table.

Phyllosoma survey stage data (t_phy_stage)

trip_code Must be equal to a trip code as listed in the *t_trip* table.

station_no Must be a unique number within a single trip.

Multiple columns check trip code and station number:
The combination of trip code and station number must exist in the *t_station* table.

species The species code must be valid code as listed in Appendix 1.

stage The phyllosoma life history stage code must be valid code as listed in Appendix 1.

Phyllosoma survey DAS envelope summary (t_evp_summ)

trip_code Must be equal to a trip code as listed in the *t_trip* table.

station_no Must be a unique number within a single trip.

Multiple columns check trip code and station number:
The combination of trip code and station number must exist in the *t_station* table.

evp_no Must be a unique number within a single trip.

lat_s Must be a valid latitude.

long_s Must be a valid longitude

time_s Must be a valid date and time.

time_f Must be a valid date and time.

Phyllosoma survey DAS data (t_dasdata)

trip_code Must be equal to a trip code as listed in the *t_trip* table.

station_no Must be a unique number within a single trip.

Multiple columns check trip code and station number:
The combination of trip code and station number must exist in the *t_station* table.

evp_no Must be a unique number within a single trip.

tally_id The DAS data tally id code must be valid code as listed in Appendix 1.

timestamp Must be a valid date and time.

Puerulus development stage codes (t_stage_codes)

species Species code must be a valid species code as listed in Appendix 1.

type Must be equal to either "PHYLLOSOMA" or "PUERULUS".

stage Puerulus development stage code must contain a value.

Multiple columns check on species, type, and stage:
The values in the species, type, and stage attributes must be a unique combination.

7 References

1 Booth, J. D., Carruthers, A. D., Bolt, C. D., and Stewart, R. A. 1991: Measuring depth of settlement in the red rock lobster, *Jasus edwardsii. New Zealand journal of marine and freshwater research.*

2 Booth, J. D. & Forman, J. S. 1995: Larval recruitment in the red rock lobster, *Jasus edwardsii. N.Z. Fisheries Assessment Research Document 95/7*. 46p.

3 Booth, J. D., Forman, J. S., and Stotter, D. R. 1998: Abundance of early life history stages of the red rock lobster, *Jasus edwardsii*, with management implications*. N.Z. Fisheries Assessment Research Document 98/10*. 71p.

4. Mackay, K. A. 1998: Database documentation: trawl*. NIWA Internal Report No. 16*. 35p.

Appendix 1 – Reference Code Tables

Position fix method code

01	Radar
02	Dead reckoning
03	Astrofix
04	Transect marks
05	Radio (RDF)
06	Radar and RDF
07	Satnav
08	Global positioning satellite (GPS)
09	Local knowledge
10	GPX

Gear performance code

2.	Excellent
3.	Satisfactory, catch unlikely to be reduced by performance
4.	Unsatisfactory, catch probably reduced by malfunction or damage
5.	Unsatisfactory, catch reduced by malfunction or damage

Path code

1.	Horizontal straight line
2.	Vertical straight line
3.	Closed circle or loop
4.	Closed triangle or square
5.	Zigzag
6.	U-bend
7.	Contour at constant depth
8.	Retrack on straight line

Sea condition code

0	Calm, glassy	0m
1	Calm	0 – 0.1m
2	Smooth	0.1 – 0.5m
3	Slight	0.5 – 1m
4	Moderate	1 – 2.5m
5	Rough	2.5 – 4m
6	Very rough	4 – 6m
7	High	6 - 10m
8	Very high	10 – 15m
9	Huge	over 15m

Sea colour code

01	Deep blue
02	Blue
03	Light blue
04	Greeny blue
05	Bluey green
06	Deep green
07	Green
08	Yellow green

Swell height code

1	Low	0 – 2m
2	Moderate	2 – 4m
3	Heavy	over 4m

Bottom contour code

0	Unknown
1	Smooth/flat
2	Undulating
3	Hillocky
4	Rugged
5	Very rugged

Bottom type code

0	Unknown
1	Mud or ooze
2	Mud with some sand
3	Sand
4	Sand/gravel and shells
5	Shells (broken)
6	Gravel
7	Rock
8	Coral
9	Stone
10	Live shell beds
11	Mud with broken shells
12	Sponge beds

Species code

PHC	Packhorse rock lobster	*Jasus verreauxi*
PHY	Phyllosoma	
PRK	Prawn killer	*Ibacus alticrenatus*
PUE	Puerulus	
CRA	Rock lobster	*Jasus edwardsii*
SHL	Shovelnosed lobster	*Scyllarus* sp
SLO	Spanish lobster	*Arctides* sp

DAS data tally id code

GPLat	Latitude
GPLong	Longitude
GPHDT	GPS Heading
GPVkts	GPS Velocity
KMCdbt	Kaijo Denki Depth
ReqLen	Required warp length
SSSal	Surface salinity
SSMTW	Surface water temperature
BarPressur	Barometric Pressure
AirTemp	Air Temperature
WindDirn	Wind Direction
Nvelocity	Wind Speed
SNSDep	Scanmar gear depth
SNSDi1	Scanmar distance 1
SNSDi2	Scanmar distance 2
SNSDiR1	Scanmar distance 1 change
SNSDiR2	Scanmar distance 2 change
CN22	Depth from Furuno CN22
MagLat	Latitude from Magnavox GPS
MagLong	Longitude from Magnavox GPS
EK5dbt1	EK500 depth 1
EK5dbt2	EK500 depth 2
PlHDT	Plath heading
NKvhw	Naviknot speed
LenStbd	Length of starboard warp
LenPort	Length of port warp
TenStbd	Length of starboard warp
TenPort	Tension in port winch
CI30Depth	Depth of top layer on doppler
CI30Spd	Speed of doppler log current
CI30Dir	Direction of doppler current
CI30L1Dep	Depth of first layer on doppler
CI30L1Cur	Speed of first layer doppler log current
CI30L1Dir	Direction of first layer doppler current
CI30L2Dep	Depth of second layer on doppler
CI30L2Cur	Speed of second layer doppler log current
CI30L2Dir	Direction of second layer doppler current
CI30L3Dep	Depth of third layer on doppler
CI30L3Cur	Speed of third layer doppler log current
CI30L3Dir	Direction of third layer doppler current