National Parks South Australia

Underwater visual census (UVC): Application and data management for the South Australian Marine Parks Program.

DEWNR Technical note 2017/16

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June, 2017

DEWNR Technical note 2017/16

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ISBN 978-1-925668-12-4

Preferred way to cite this publication

Brook J, Miller D, Holland, S, Colella D and Brock D, 2017. *Underwater visual census (UVC): Application and data management for the South Australian Marine Parks Program*. DEWNR Technical note 2017/16, Government of South Australia, Department of Environment, Water and Natural Resources, Adelaide.

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Foreword

The Department of Environment, Water and Natural Resources (DEWNR) is responsible for the management of the State's natural resources, ranging from policy leadership to on-ground delivery in consultation with government, industry and communities.

High-quality science and effective monitoring provides the foundation for the successful management of our environment and natural resources. This is achieved through undertaking appropriate research, investigations, assessments, monitoring and evaluation.

DEWNR's strong partnerships with educational and research institutions, industries, government agencies, Natural Resources Management Boards and the community ensures that there is continual capacity building across the sector, and that the best skills and expertise are used to inform decision making.

Sandy Pitcher
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Acknowledgements

Many people have participated in the collection of diver UVC data in South Australia (SA) over the years, far too many to list individually (in particular those who have worked and helped out with the field program). However, special mention needs to be made to those that have made consistent or large contributions to the SA reef monitoring program. Our collaborative partners from University of Tasmania (UTas) have been instrumental to the program from the beginning. These include Neville Barrett, Graham Edgar, Liz Oh, Rick Stuart-Smith and Toni Cooper to name a few. In SA many people have also made significant contributions to this program. Bryan McDonald initiated the program with UTas, while Ali Bloomfield, Yvette Eglinton, Ben Brayford, Alison Wright and Simon Bryars have been regular divers and logistical coordinators.

We also thank Helen Owens, Mathew Royal and Mathew Miles (DEWNR) for their contributions to the development of a system to input, store and output data within DEWNR's corporate data storage system, and for contributing to the documentation, classification and licencing processes for diver UVC data. Several of the DEWNR staff mentioned above plus Colin Cichon are also thanked for their input at the various stages of editing this report.

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Summary

This report describes how the underwater visual census (UVC) by SCUBA divers is applied in the South Australia's Marine Parks Program to monitor subtidal reefs. It documents the process of UVC data capture, processing and storage in a Department of Environment, Water and Natural Resources (DEWNR) corporate database.

Subtidal reefs were identified as a key ecological value of the South Australian Marine Parks Network. UVC is currently one of the most common methods used to assess these ecosystems, and was recommended for use to assess the effectiveness of the Marine Parks Network at protecting and conserving marine biodiversity.

Prior to Marine Park implementation a number of subtidal reefs across South Australia (SA) were surveyed using the UVC Marine Protected Area (MPA) method developed by the University of Tasmania (UTas) to establish a baseline. Since full implementation of marine parks in October 2014, a modified version of the Reef Life Survey (RLS) UVC method (which was also developed by UTas) has been adopted to assess ecological change. The data for both methods are largely compatible, with the RLS method having several advantages for ongoing monitoring, one of which is the ability to recruit and train volunteer divers to collect data.

The ecological component of DEWNR's Monitoring, Evaluation and Reporting (MER) Program focuses on priority marine parks sanctuary zones (where most change due to marine park implementation is likely) in comparison to suitable control sites outside the sanctuary zones. The monitoring design has taken a Before-After-Control-Impact (BACI) or After Control-Impact (where no 'Before' data is available) approach. Diver UVC is used to compliment other monitoring approaches (such as Baited Remote Underwater Video Systems (BRUVS) surveys), with some sanctuary zones being sampled annually and others less frequently.

Sampling is conducted primarily during the warmer months between December to April when water temperatures are higher and daylight hours are longer. As much as possible, individual sites are resurveyed at the same time of year to reduce seasonal biases. Where possible, zones and sites are selected in such a way that broader spatial patterns (e.g. spatial and physical gradients) can be considered in comparisons of multiple in-and-out sample sets.

A variety of data types are generated during the collection, processing and storage of UVC data. These include field data, diver survey data (raw datasheets and electronic), reference and photoquadrat images, the final 'point of truth' dataset, and the products derived from it (e.g. spatial layers, reporting outputs and documents). Standard procedures and protocols are used in the collection and curation of this data at all stages of the process, to ensure that data collection and processing is consistent across the Marine Parks Program now and into the future.

Data collected in SA is entered, processed and then sent to the UTas who hold the authoritative UVC national dataset for the RLS and MPA Programs. DEWNR receives and stores extracted data for SA which is held in a corporate database. Ultimately, data from this corporate storage point will be made available through DEWNR's 'Fauna Supertable', Atlas of Living Australia, spatial layers, and internally through a purpose-built database in a format suitable for analysis and other purposes (these products are under development).

Classification and licencing of UVC data and products is 'Open' by default in line with the Government of South Australia's Declaration of Open Data. Relevant datasets therefore are classified and licenced according to the DEWNR classification guidelines to establish their confidentiality, integrity and availability. The bulk of the data generated through the collection and processing stages leading to storage and production of outputs for the UVC sampling program is considered 'transitionary' in nature, i.e. stages leading to the production of final, distributable products, and as such, are considered as 'not ready for public distribution'. This data is therefore classified 'For Official Use Only' and archived.

To ensure transparency and provide guidance for individuals seeking knowledge about information collected under the UVC Program, appropriate documentation and metadata records are produced for all relevant data. This report and its appendices fulfill that role at the broadest level, forming a summary guide to the methodology, data management and data storage. Metadata relating more directly to data collected in the field and subsequently stored in the UTas and DEWNR corporate databases are available in the government's Location SA system (LMS: Dataset no. 2022).

1 Scope

Subtidal reefs were identified in Marine Park Baseline Reports (Bryars et al. 2016) as a key ecological value likely to change with the implementation of marine parks. Underwater visual census (UVC) by divers is one of the main ecological sampling methods currently being employed to monitor these systems and assess the long term effectiveness of South Australia's marine park network. The data collected by the UVC method will be used to help answer key evaluation questions (KEQs): KEQ 1, KEQ 2 and KEQ 3 as identified in the South Australian Marine Parks Monitoring, Evaluation and Reporting Plan (MER Plan, Bryars et al. 2017).

The aim of this report is to comprehensively describe the application of UVC to monitor subtidal reefs and document UVC data capture, processing and storage in a DEWNR corporate database. This document will cover the following areas:

- underwater visual census methods
- sampling approach and design
- data entry and validation
- data curation and storage
- standard reporting outputs.

The purpose of the information provided is to:

- demonstrate how ecological monitoring of subtidal reefs outlined in the SA Marine Parks MER Plan is being implemented using UVC
- ensure that standard procedures are followed during UVC surveys so that data collection and processing is consistent across the Marine Parks Program now and into the future
- facilitate access to the UVC data under the government's 'Open Data Policy'
- provide a data platform upon which UVC ecological reporting outputs for the Marine Parks Performance Program will be based.

It is anticipated that this will be a 'live' document such that any future changes to sampling methods, data capture and technological advances can be incorporated as they arise.

2 UVC overview

2.1 Background

UVC by divers is the most widely used method for assessing subtidal reefs worldwide (Girolamo & Mazzoldi 2001, Baron et al. 2004, Stuart-Smith et al. 2017), and in particular for assessing the effectiveness of marine reserves (Barrett et al. 2007, Edgar et al. 2009, Soler et al. 2015). In a review of potential monitoring methods for the South Australian Marine Parks Program, Bryars (2013) recommended the use of UVC in conjunction with BRUVS as techniques for long term monitoring. Consequently, UVC has been adopted as one of the primary monitoring methods to collect biological data that can be used to assess the long term effectiveness of the SA Marine Parks Network.

Diver-based UVC surveys are ideal for marine protected areas as they are non-destructive and collect data across a broad range of fish, invertebrate and macroalgal taxa, thus assessing the impact of protection at ecosystem, habitat and individual species levels. Data is collected simultaneously from different trophic levels (e.g. primary producers, grazers and predators) thus enabling the detection of change across different components of the ecosystem. UVC is particularly effective for assessing species that are shy, reclusive or live in crevices in the reef structure such as lobsters, abalone and cryptic fish (Holmes et. al. 2013).

2.2 Overview of survey methods used in SA marine parks

Various UVC methods are used around the world and in Australia. The most widespread and ongoing method currently employed for temperate reef ecosystems is the Marine Protected Area (MPA) method and its derivative the Reef Life Survey (RLS) method, both of which were developed by the University of Tasmania (UTas). The MPA and RLS method are currently used for ecological monitoring of subtidal reefs in all Australian states.

2.2.1 Marine Protected Area (MPA) method

The UVC method used by UTas to monitor marine parks across southern Australia was first used at Maria Island in Tasmania in 1992. This method, generally referred to as the 'MPA method' as it was developed for monitoring marine protected areas (of which the SA marine parks are a subset), and is described in detail by UTas (2010; also summarised in Edgar and Barrett 1999). These surveys were primarily undertaken by professional marine scientists. In summary it uses three methods to survey three distinct components of reef communities:

- Method 1: All fish and other large swimming animals, i.e. those that can be viewed while swimming in the water column, above the macroalgal canopy or near the mouth of caves and ledges. The survey method is a belt survey covering 200 m x 5 m on each side of a transect line.
- Method 2: Mobile invertebrates and sedentary or cryptic fish, often hidden under ledges within caves, or underneath the macroalgal canopy. The survey method is a belt survey covering 200 m x 1 m on one side of a transect line.
- Method 3: Macroalgae, including understorey species, sessile invertebrates and substrate information. The survey method is a 0.25 m^2 quadrat replicated 20 times at 10 m intervals along the transect line.

2.2.2 Reef Life Survey (RLS) method

The Reef Life Survey (RLS) Program was established in 2007 in order to make diver-based UVC surveys accessible to well-trained community divers. RLS surveys were initially focused on temperate waters in Australia but have grown into an international program. Most of the RLS data collected in South Australia has been in conjunction with professional scientific divers at RLS training events, on dedicated RLS survey trips, by professional scientific divers from government agencies or private consultancies.

The survey method was adapted from the MPA method and is described in detail by Reef Life Survey (2015). The main differences to the MPA method are:

- The macroalgae, sessile invertebrates and substrate component (Method 3) is surveyed using photoquadrats rather than in-situ quadrat surveys.
- The area covered by the invertebrate and cryptic fish survey (Method 2) is doubled by surveying on both sides of the transect line (total area = 400 m^2).
- There is greater flexibility in the scalability and level of replication within surveys, with surveys based on a number of independent 50 m transects rather than a single composite 200 m transect.

3 Application of diver underwater visual census (UVC) methods

3.1 Approach prior to implementation (2004–14)

The University of Tasmania and their associated fisheries research faculty, (previously the Tasmanian Aquaculture and Fisheries Institute, currently the Institute of Marine and Antarctic Studies; IMAS), commenced marine park monitoring at Maria Island in Tasmania in 1992, before gradually extending to other temperate-water states around Australia.

DEWNR undertook reef surveys in collaboration with UTas during a scientific expedition to the Althorpe Islands in 2004. Following this, DEWNR contracted UTas to undertake baseline UVC surveys of subtidal reefs in the Encounter Region in 2004 as part of the establishment of the Encounter Pilot Marine Park (Edgar et al. 2006). These surveys were conducted using the MPA method. This collaboration has continued between 2004 and 2014 via a series of Australian Research Council (ARC) research partnerships. The principle aim of the ARC research partnerships was to collect as much baseline data as possible prior to full implementation of South Australia's marine parks network when fishing restrictions inside sanctuary zones (SZs) came into effect on 1 October 2014. More than 150 sites were established during this period (Figure 1). Where possible the sites were located in areas considered likely to become SZs in the future and thus form the basis of an ongoing long term monitoring program.

The focus of the baseline surveys was to facilitate future detection of temporal change in protected zones. The surveys were designed to minimise spatial variation that may confound the temporal signal. This was done by assessing fixed sites through time, surveying along a fixed depth contour (generally 5 m or 10 m), and aggregating data over a long distance (200 m) per site (Edgar et al. 2006). Sites were surveyed at the same time of year to minimize seasonal effects (Edgar et al. 2006). Practical considerations for diving resulted in the choice of late summer and autumn (when water temperatures are higher and daylight hours are longer) and a focus on 5 m sites (allowing longer bottom time).

Following the finalisation of zoning in November 2012 it was apparent that some sites would become redundant from the perspective of a marine parks Monitoring, Evaluation and Reporting (MER) Program using comparative sites inside a SZ and sites outside but adjacent to a SZ (see maps in Section 4.1 of Bryars et al 2017). A summary of the sites, locations and years resurveyed is shown in Appendix A.

3.2 Approach post implementation (after 2014)

Location of UVC monitoring

In October 2014 the Marine Park zoning became fully operational with fishing restrictions commencing inside the 83 SZs across the SA marine parks network. As outlined in the MER Plan (Bryars et al. 2017), SZs will be the main focus of the ecological monitoring program in terms of detecting for change due to the management plans. With current resourcing levels it is not feasible to undertake monitoring in all 83 SZs (nor is it necessary). To identify where to allocate ecological monitoring effort a process was undertaken to prioritize the SZs based on their ecological value, socio-economic importance and predicted changes (Bryars et al. 2017). As a consequence of this process, 25 priority sanctuary zones were identified for monitoring (Bryars et al. 2017).

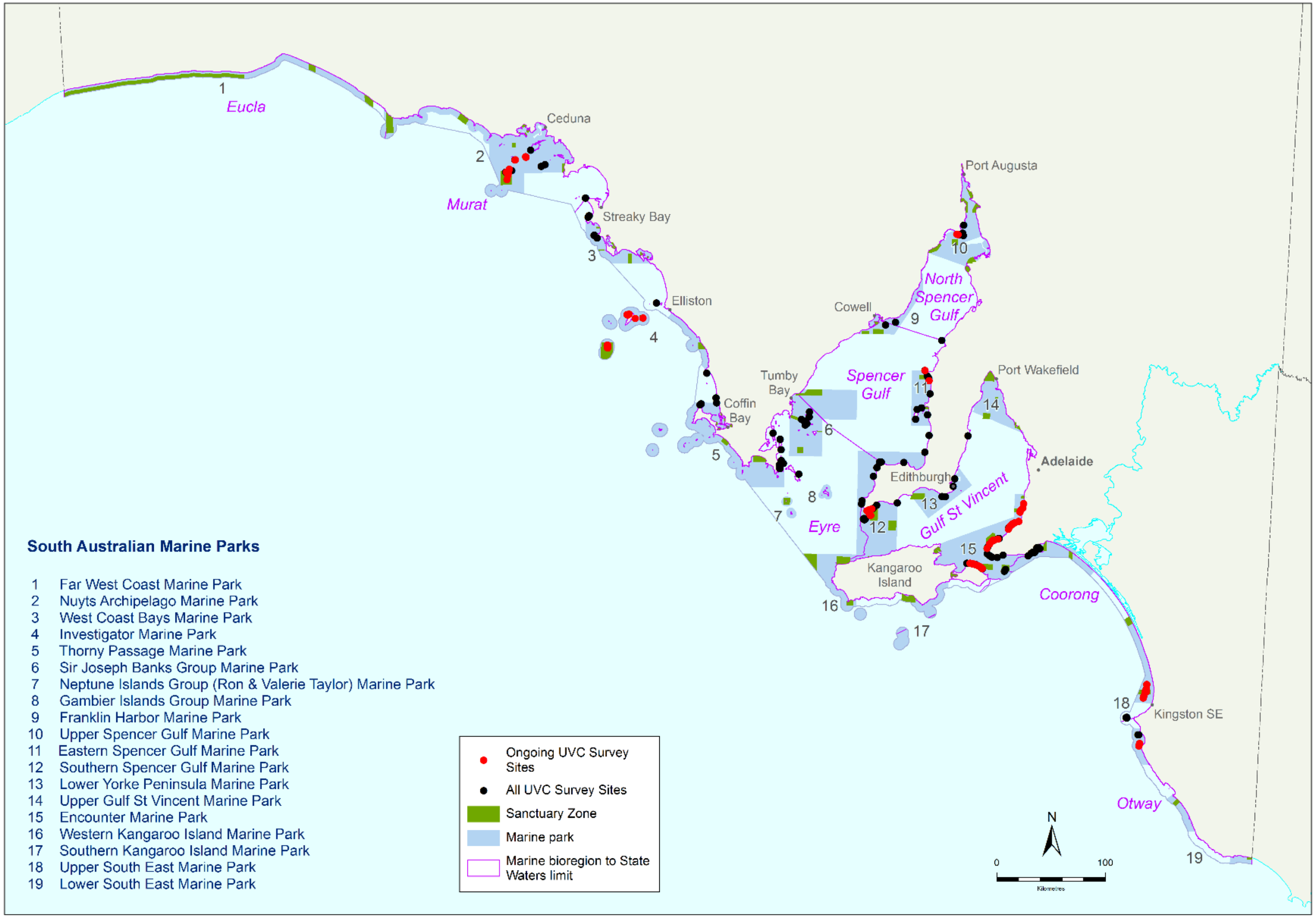

Figure 1: Underwater visual census (UVC) survey sites for baseline monitoring (black dots) using the MPA method (carried out prior to implementation of SA's marine park sanctuary zones in 2014), and ongoing UVC monitoring sites (to date, red dots) for SA's Marine Park Monitoring Program.
Note, many of the 'ongoing survey sites overlay baseline sites.

Monitoring rationale

The design of the ecological monitoring program to answer the relevant key evaluation questions has taken a Before-After-Control-Impact (BACI) or After-Control-Impact (ACI; in cases where no 'Before' data are available) approach, where 'impact' is inside a SZ and 'control' is outside a SZ, and 'before' is pre-1 October 2014 and 'after' is post-1 October 2014. Where feasible, four UVC survey sites are established inside a SZ (Impact) and four sites Outside (Control). The use of four sites was a recommendation from expert workshops held to inform the ecological monitoring program and further supported by Delean (unpublished report). Where possible, previously established MPA sites are used to provide the 'before' component. New sites are established as needed to make up the required number of sites (4 in and 4 out). Therefore depending on the distribution of sites there is a mix of BACI and ACI in the network and the data will be analysed accordingly. A summary of the monitoring sites to date is shown in Figure 1 and Appendix B.

UVC survey method

Since marine parks became fully operational in October 2014, the MPA method has been replaced with a modified RLS method. The justification behind this decision was that the MPA method requires macro algal field experts, of which there is a limited pool and the MPA method is logistically more complicated and time consuming. Other advantages of the RLS method include:

- its broad usage in 50 countries with over 2500 sites established, which provides comparative data at a range of spatial and temporal scales which will assist in interpretation of SA Marine Parks data
- volunteer divers can be trained in the method and therefore collect complementary data to supplement the core monitoring program
- sampling both sides of the transect line for macroinvertebrates and cryptic fish will provide greater potential to detect change over time, particularly for recreationally and commercially important species such as lobster and abalone.

The main differences between the two methods are:

1. Photoquadrats are used in place of in-situ algal assessment.
2. Both sides of the transect are surveyed for macro-invertebrates.

The data collected by the RLS method is directly comparable to the MPA method for fish and macro-invertebrates and a process exists to compare RLS macro-algal photoquadrat data retrospectively with in-situ data collected using the MPA method (Brook and Bryars 2014).

RLS surveys for the marine parks MER Program are configured as four contiguous 50 m transects, in order to maintain consistency with the baseline data collected using the MPA method. In addition, the size of abalone and lobsters are, where possible, measured using calipers and recorded, as opposed to the RLS method which provides only for estimated size classes. A review of the methods will be conducted within the first five years of the MER program and it is envisaged that more detailed algal surveys (matching those collected during the baseline phase) will be periodically included where necessary to provide a higher level of understanding of long term change in the macroalgal community.

This hybrid method will hereafter be referred to as the '*South Australian Marine Parks – Reef Life Survey*' (SAMP-RLS) method.

Frequency of monitoring

Annual monitoring is desirable until natural variation and the likely magnitude of predicted changes are better understood, however logistics and limited resourcing make this approach unfeasible. Instead, a hybrid system has been adopted by the Marine Parks MER Program combining annual monitoring at some sites and less frequent monitoring at others.

There are eight Marine Bioregions in SA. The highest number of priority SZs occur in the Gulf St Vincent Bioregion (MER Plan; Bryars et al. 2017). Annual surveys will be conducted at priority SZs in the GSV Bioregion due to:

1. The number of priority SZs and their distribution in GSV Bioregion provide an opportunity to assess marine park effectiveness at different spatial scales (SZ, Marine Park and Bioregion) as recommended in the MER Plan.
2. Compliance effort is highest in the GSV Bioregion.
3. The GSV is the most tractable Bioregion for field work.

It is planned to survey the remaining Bioregions and priority SZs every three years as part of a rolling program of monitoring (Table 1), but the location and frequency of sampling will be guided by annual operational plans that factor in changes to available resourcing, logistics and priorities.

Table 1. Proposed bioregional monitoring program.
Small 'p' indicates that not all priority SZs will be surveyed in that Bioregion.

Year	Gulf St Vincent	Nth + Spencer Gulf	Coorong + Otway	Eucla + Murat + Eyre
14/15				**X**
15/16	**X**			
16/17	**p**	**X**	**X**	
17/18	**p**			**X**
18/19	**X**			
19/20	**p**	**X**	**X**	
20/21	**p**			**X**
21/22	**X**			
22/23	**p**	**X**	**X**	

4 Data processing and management

4.1 Overview

This section documents how the program manages data and information as a strategic asset of the Department according to corporate standards and protocols, and in accordance with the Managing Environmental Knowledge (MEK) Procedure and the DEWNR Information Management Framework (IMF).

The proper management of information is essential to ensuring that DEWNR effectively and efficiently meets a number of legislative requirements such as those under the *State Records Act 1997* and *Freedom of Information Act 1991*, as well as the Information Privacy Principles. The IMF defines the overarching rationale, principles and lifecycle for the way DEWNR will manage the information it needs to achieve corporate goals and meet policy and legislative requirements which include SAs' declarations of 'Open Data' in 2013 and 'digital by default'. A suite of tools and guidelines in the MEK support achieving these goals.

The Marine Parks Program is committed to evidence based science and as such information collected by the program needs to be managed consistently in line with DEWNRs data management policies. It also needs to ensure that data and information collected as part of this program are available, accessible and well documented. The program uses the MEK resources to meet these requirements.

There are a variety of data components that require management, these include:

- Pre-dive data
- Original datasheets
- Photographs, including photoquadrat images (RLS method only) and photos to assist identification
- Entered data (in databases and/or spreadsheets)
- Processed photoquadrat data (in databases and/or spreadsheets)
- Associated metadata
- Data products

Data are collected, processed and turned into publically available products in a process that is summarised in Figure 2. The data flow through a series of steps with data falling into three categories:

1. Working data (shown in blue in Figure 2) – i.e. data captured in the field (raw datasheets and electronic data entry worksheets), and data from validation and processing steps (which are all eventually archived).
2. Evaluated outputs (shown in maroon in Figure 2) – these are data that have been checked and validated and then approved for upload to corperate storage compiled electronic datasheets and subsequent stored data (in UTas and DEWNR corporate databases).
3. Authorised products (shown in orange in Figure 2) – i.e. data and information for release to the public including standard data outputs available online (e.g. spatial layers in NatureMaps and standard Marine Park reporting tools), technical reports summarising analysis and example footage and educational material.

An important aspect of the data management is an ongoing collaboration with the University of Tasmania and efficient integration with their data management system.

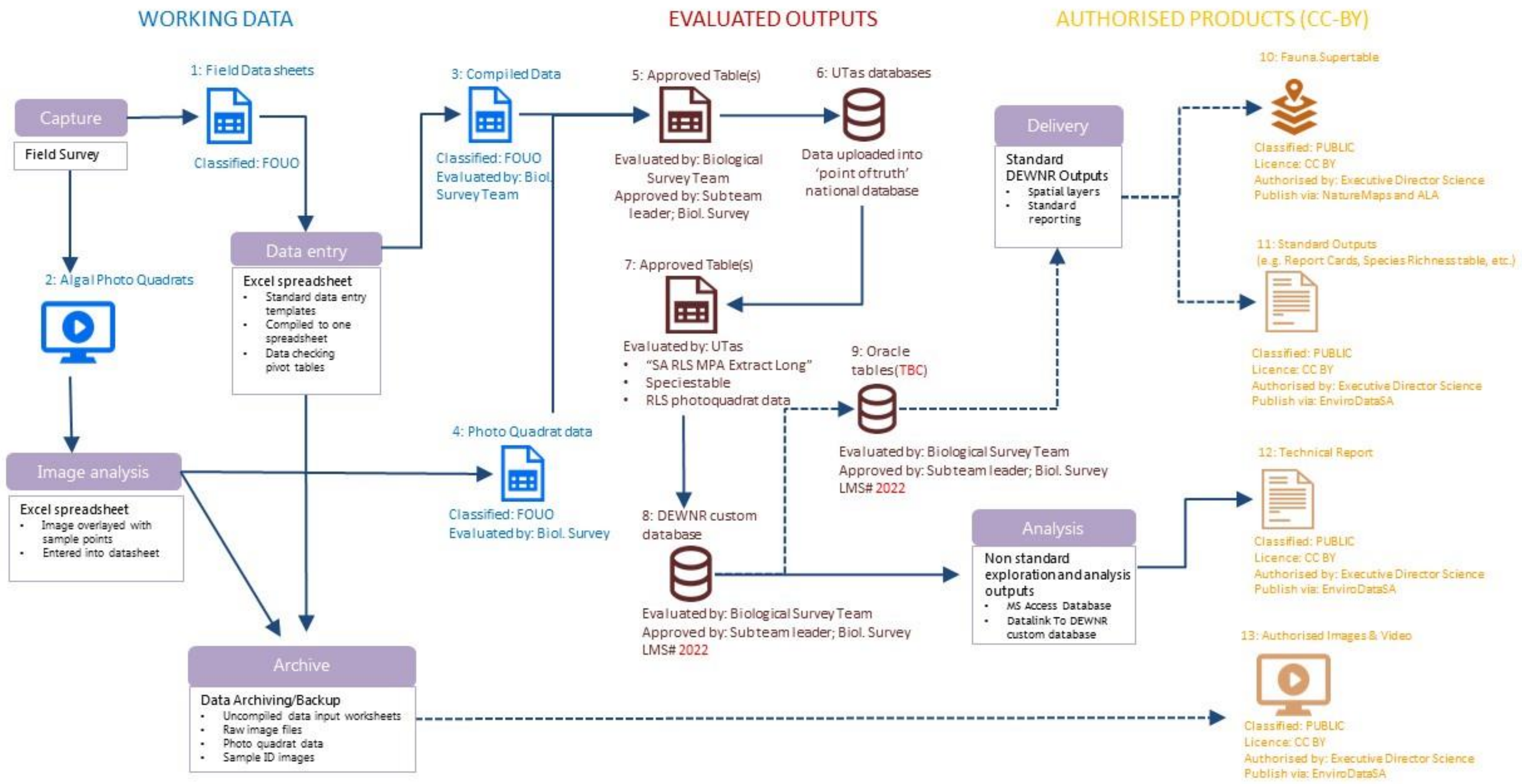

Figure 2. Dataflow, data classification and data licencing within DEWNR's diver UVC monitoring program.
Blue icons indicate working or draft data, maroon icons indicate outputs that have been evaluated and approved, and orange icons represent authorised products ready for publishing. Dashed flow lines represent 'aspirational' items and products that are under development. At each stage where data is produced, a classification is assigned and where appropriate, data is licenced and metadata records produced. (BST = Biological Survey Team, UTas = University of Tasmania, TBC = to be created, FOUO = For Official Use Only, CC BY = Creative commons 'Attribution' licence).

4.2 Field preparation data

Field preparation data are generally limited to GPS marks for established sites, generally loaded to a GPS device and in hardcopy, along with printed maps of the survey locations.

A summary of previously recorded species and abundances at established sites may also be useful.

4.3 Data capture

The appropriate format for recording survey data on the datasheets for the MPA and RLS methods is described in detail by University of Tasmania (2010) and Reef Life Survey (2015), respectively. Additional points are:

- Datasheets (Item 1, Figure 2) should contain data for a single site only to facilitate data processing and storage.
- The GPS marks for any new sites should be recorded on one of the survey datasheets and the dive log.

For the RLS method, the capture of photoquadrats (Item 2, Figure 2) is described in detail by Reef Life Survey (2015). Additional points are:

- The date and time on the camera should be checked prior to the dive as this will facilitate the processing and curation of photoquadrat or identification photos.

4.4 Data processing and validation

4.4.1 Field validation

Data validation begins in the field and should be supervised by a dedicated data collator. At the conclusion of each dive, each diver and the data collator should check that:

- each datasheet includes the site name, date, depth, transect, diver name and buddy name
- at least one datasheet includes the GPS mark (and waypoint number) for any new sites
- at least one datasheet with fish data includes a visibility estimate
- each species recorded has an abundance for at least one size class (method 1), the total abundance (Method 2) or at least one quadrat (MPA Method 3)
- any variations to the standard order for taking photoquadrats should be noted. The standard order would see photos taken in the order of T2 then T1 towards the right hand end (when facing the shoreline), and T3 then T4 towards the left hand end.

Each diver should check that:

- all species names and abundance values are unambiguous and sufficiently legible to enable subsequent coding and/or data entry.
- any sample invertebrates brought to the surface, for which identifications cannot be confirmed by the dive team, are photographed.

Datasheets should be rinsed in fresh water at the completion of each day.

4.4.2 Data entry

Data entry for MPA and RLS data should use the respective South Australian MS Excel templates supplied by UTas for these methods.

Data entry is generally facilitated by using short codes for species (generally three letters but sometimes longer, which are integrated into the data entry template). It is generally desirable for the individual divers to write the codes onto the datasheets, to facilitate data entry by someone other than the diver who recorded the data. Care should be taken, however, when using codes. The codes may vary a little between the RLS and MPA Programs, between methods within the RLS Program, and also between local (state level) or global species lists. Most of the codes are formed from the first letter of the genus concatenated with the first two letters of the specific epithet, with additional letters from the specific epithet added where disambiguation is required. This disambiguation results in some pairs of species for which coding can be error prone and for which particular care should be taken during data entry and checking, e.g. *Parequula melbournensis* vs *Paraplesiops meleagris, Petricia vernicina* vs *Phasianella ventricosa,* and *Pleuroploca australasia* vs *Phasianella australis*.

For RLS data, the depth field (decimal data type) has a critical second role, in that it is used to distinguish between individual transects. For the SAMP-RLS method:

- the integer part of the depth field should be used to record the depth of the survey. For resurveys of established sites, the same value should be entered as for previous surveys, and should be independent of variation associated with tide.
- The decimal part of the depth field reflects the transect number, with '.0' or no decimal used for T1 through to '.3' for T4.

Size data

The MPA template has dedicated columns for the entry of size measurements and estimates.

For RLS, abalone and lobster sizes are entered into standard size classes in the 'DATA' worksheet of the RLS template (Reef Life Survey 2015). In addition, the more precisely measured or estimated sizes can be entered into the 'NOTES' worksheet of the RLS template, as follows:

1. Columns B to R from row 1 of the 'DATA' worksheet are copied to columns A to Q of the first row of the 'NOTES' worksheet
2. Labels 'Size', 'Estimate' and 'Sex' are added in Row 1 of the columns R to T
3. Columns B to R from the relevant line of the 'DATA' worksheet are copied (paste special values and number formats) to columns A to Q of the 'NOTES' worksheet for a number of rows corresponding to the total abundance of abalone or lobster.
4. Columns R to T are populated with the size, estimate flag (1=estimated, blank = measured) and sex (m, f or blank, always blank for abalone), respectively, for each individual abalone or lobster.

Following data entry, each sheet should be marked as 'Entered' and initialed by the person entering the data. Datasheets should initially be collated in the same order as they are entered, as this will facilitate spreadsheet data validation.

4.4.3 Spreadsheet data validation

Data entered into spreadsheets needs to be checked against the original datasheets. This is most effectively done by two people working together, ideally one of whom is the diver who recorded the data. One person should read out the data as presented on the sheet, while the other checks it against the spreadsheet.

The following actions should be taken depending on the error found:

- If species codes or abundances (total or a size category) are wrong then they should be amended and highlighted in yellow.
- If one or two consecutive rows require deletion, then the rows from the spreadsheet can be deleted. If there are more than two rows then the row below the block to be deleted should first be copied and pasted back as values.
- If rows need to be added, they should be added after the last line of valid data. If there are no rows remaining in the template then rows can be copied and pasted from an earlier row (copy/paste rather than fill down). The survey details (Columns B to O) can be copied and pasted (values and formats) from an earlier row from the same survey. The new rows should be highlighted in green.

It is important to remember that the datasheets should be completed to the point of being a standalone representation of the data. Therefore the datasheet should be modified for legibility where necessary and should be updated with any post-field identifications from photos. It is also important to remember that in some cases the datasheet may contain additional information that is not entered into the RLS template, e.g. sex information for fish.

Once data entry has been validated against the data sheets, individual spreadsheets relating to the same survey should be combined into a single, master spreadsheet. This should also collate and include any highlighted additions to the species, site or diver worksheets.

A pivot table should then be used to check that there are data for all transects. This pivot table is already available in the RLS data entry template. Pivot tables can also be used to check for data inconsistencies in site/position information, between divers, depths/transects and blocks, as well as species lists for each diver.

4.4.4 Photoquadrat image processing

File sorting

Sorting of photoquadrat image files should occur as soon as possible after the completion of a diving day, particularly if there is any variation from the standard order for taking photos. The standard order would see photos taken in the order of T2 then T1 towards the right hand end (when facing the shoreline), and T3 then T4 towards the left hand end. If the photo image files are displayed in order of 'Date taken' and as icons/thumbnails then it is easy to segregate the photos into transects. Additional aids like a photo of the datasheet or hand/fingers (indicating transect no.) before each transect can also be helpful.

The naming convention for photos is as follows (Reef Life Survey 2015):

<site code>_<diver initials><depth>m<date (ddmmyy)><site name>

e.g. ENC7_JBB5.3m040314CarrickalingaHead

Note that the decimal component of the depth represents the transect number (with '.0' for T1 incrementing by 0.1 for each transect up to 0.3 for T4).

A folder named according to this convention should be created for each RLS transect. Photoquadrat images should be labelled as a batch for each transect, e.g. using the Windows rename function. This involves highlighting all photos for one transect, leaving the cursor on the first of these highlighted quadrats, right-clicking and selecting rename. This highlights the title of the first photoquadrat image and details should then be typed in (or pasted from the previously copied folder name) with the file extension (.jpg) added. The rename function will apply this naming convention to all PQs for that transect, adding suffices, (1), (2) etc., for disambiguation.

It is very important that the details in the photoquadrat image labels (site, diver, date) exactly match the details for that survey in the RLS fish and invertebrate data entry worksheet to allow these two components to be matched up in the RLS database.

The images should be backed up, at least until such time as they are received (via dropbox or external hard drive) by the Reef Life Survey team at UTas.

Image interpretation

Image interpretation is a process whereby particular characteristics of the image (e.g. percentage cover of canopy-forming macroalgae) are determined. There is generally a manual component to this process, but future technologies may provide fully-automated methods.

The standard characteristics required for the MER Program are the percentage covers of benthic habitat classes defined in a hierarchical classification. These are determined through a sample point overlay method where each of the 20 images for a transect is sampled using 5 sample points, totaling 100 points for a full 50m transect (400 for a site). Identification of target groups (macroalgae, sessile invertebrates and substrate) is to the highest level possible prior to aggregation to an appropriate level for analysis). Photoquadrat interpretation and analysis for the MER Program is in its early stages and may further assessed and modified.

Comparison with MPA quadrat data

RLS photoquadrat data can be compared to the MPA method algal quadrats using a process outlined by Brook and Bryars (2014). While RLS produces a '2D' estimate of the percent cover of algae (generally canopy forming species), the MPA method produces a '3D' estimate of the percent cover of all species present by examining individual layers of canopy. This multilayered estimate can be used to produce a percent cover range (ie from a possible maximum and minimum '2D' values that could be derived from the multilayered data), which can be used to compare with RLS algal data.

4.4.5 Identification photo processing

Photos taken for the purpose of species identification should be retained and stored in a folder labeled using the same convention as for the photoquadrats.

4.5 Post processing data management and storage

4.5.1 Datasheets, data submission, checking and storage

Data entry is often shared between DEWNR and UTas staff. Once data inputs have been checked and compiled as per the instructions in the sections above, they are compiled into a single spreadsheet for submission to UTas for storage in their national MPA/RLS databases. Datasheet originals are collated by site and region, scanned and then archived by the respective organizations depending on who entered them. Scanned copies are retained by both organisations. DEWNR archives datasheet scans on their corporate network.

Data submitted to UTas (Item 5, Figure 2) for upload to the national database undergoes further data checking as per the RLS and MPA manuals (RLS and MPA methods manuals; Reef Life Survey 2015 and UTas 2010). Stored data in the national database (Item 6, Figure 2) is made available to DEWNR on request. Ideally, DEWNR will request a data update annually as soon as practical after the field season has concluded and the data entry and validation process is complete.

Future plans for storage of the national database include the possibility of housing it through the Australian Oceans Data Network (AODN) portal. This is currently under investigation and it is hoped data stored in this way could be made available directly to contributing agencies such as DEWNR.

4.5.2 DEWNR storage of dive survey data

Annual (or when required) data exports from UTas will be stored and made available locally. The 'flat' standard output table received from UTas (Item 7, Figure 2) will be processed through a custom MS Access database (Item 8, Figure 2; also see Appendix C) to create a set of tables to be uploaded and stored on the corporate system. These tables will likely take the form of Oracle database tables (e.g. a site table and a fish and invertebrates table) which will provide for broad access to the data through the State Fauna and Flora 'Supertable' and a variety of other spatial and reporting tools (shown under 'authorised products in Figure 2). The custom MS Access database will also act as an interim storage solution for the data until such time an Oracle database can be created and is stored on DEWNR's corporate network.

4.6 Outputs and access

Outputs for the MER Program are mostly derived from the locally stored copy of the final dataset (held by UTas) and include:

1. Data to support the MER Program (analysis and reporting)
2. Spatial layers
3. Metadata
4. Archived data

Some of these data outputs are currently under development and not yet available. It is also possible some details may change during development.

4.6.1 Data to support MER Program analysis and reporting

Data stored in the national reef databases (managed by UTas) is available for analysis and reporting in two ways:

- Via locally (SA) held output from the UTas databases, currently stored in a custom relational database (Item 8, Figure 2, described in Appendix C) on the DEWNR network. Ultimately, the goal of the program is to store this data in custom Oracle data tables (Item 9, Figure 2) which will have 'live' links to various outputs.
- Through a set of standardised reporting tools. It is envisaged that other reporting tools (linking directly to stored data) will be developed. These may include metrics such as species presence, richness and biomass by sanctuary zone and bioregion (inside and outside of protected areas).

4.6.2 Spatial layers

Spatial information will be available in the following forms:

- Publicly via the State Fauna Supertable (which it is hoped will ultimately be linked to the network stored Oracle data tables discussed above) and the 'UVC sampling locations' layer (currently under development).
- Internally available DEWNR data layers

4.6.3 Metadata

Formal metadata records for dive survey data mainly relate to the 'Storage' and 'Outputs' stages of the UVC dataflow (Figure 2). The University of Tasmania maintains metadata for both the MPA and the RLS datasets. Metadata for locally stored database (currently Item 8 in Figure 2) is available through the government's *Location SA System* (LMS; Dataset 2022).

4.6.4 Archived photoquadrats, identification photos and scanned data sheets

For each transect surveyed, a set of 20 algal photoquadrats is collected. These images are later used to derive algal percent cover data. In addition, fish and invertebrate reference/identification images are collected by divers as needed. Currently both image types are stored on duplicate backup drives (catalogued on on the DEWNR network) and by the UTas (as part of their RLS program). These images, reference images in particular, often provide a source of images for media and reporting.

Original data sheets are scanned and stored as a permanent reference and are held on DEWNR's corporate drives and by UTas.

4.7 Data classification and licencing

In 2013, the South Australian government committed to making government data 'open' and proactively releasing government data to community, research and business organisations (SA Gov. Declaration of Open Data). The Open Data Policy requires that data be freely available (published online where possible) and openly licensed. Production and distribution of data in this way necessitates the classification and licencing of relevant sets of data. DEWNR's procedure for classifying, licensing and releasing data are based on the SA government's Information Security Management Framework.

Data and information collected by DEWNR is considered a valuable asset and as such, should be classified and labelled according to the DEWNR classification guidelines. Classification establishes the confidentiality, integrity and availability of each set of data or information. Data or information that is to be made available publicly (e.g. on a web site, in a report, or on request) needs to be licenced according to the DEWNR licencing guidelines.

Diver survey 'working data' (Nos 1–4 in Figure 2) are all 'transitional' in nature, i.e. they are collection and data preparation stages leading to the stored and reporting versions of the dataset. Although retained for reference, these data are not intended for distribution and therefore can be considered as 'not ready for public distribution or posting. These data, including reference images and photoquadrats are archived. Future consideration will be required in some cases (e.g. reference images deemed appropriate for promotional use) as the MER Program expands and the team seek to further develop what can be made available.

Dive survey data stored within the national UTas reef database (No. 6 in Figure 2) are subject to licencing under both DEWNR and UTas guidelines. Data in the locally held copy of the SA data are considered open data and therefore classified for 'Public distribution'. This data (eg. species presence, abundance and size) will eventually be publically available via the 'Fauna Supertable'. In exceptional cases where it is deemed necessary to delay release or where partial data restriction is necessary (e.g. species sensitivity) a 'data restriction category' can be applied to the relevant data. The Biological Survey Team authorise forwarding of data to UTas for upload to the database, while restrictions will be implemented through application of the criteria in DEWNR's information classification guidelines.

Data for 'Non-standard outputs' ('Analysis' in Figure 2) is intended for internal use, that is, data analysis and the production of outputs for use in Marine Parks reporting. This data therefore is considered as a transitional stage for analysis and reporting outputs that ultimately form part of reports and other documents. It is therefore considered to be 'For Official Use Only' based on the classification criteria. Reporting products (Nos 10–13) derived from this data will undergo classification on a case by case basis, however, ultimately will generally be classified for 'Public' distribution. In some instances where there is a justification, a caveat may be applied delaying release of the document pending approval for release by the document authority.

Licencing of the data and products classified 'Public' will be applied based on DEWNR's licencing guidelines and a Creative Commons Attribution (CC BY) licence should be applied where possible. However, since much of the data collected as part of the UVC survey program were done in collaboration with UTas (under a national research project being conducted through the National Environmental Science Programmes; NESP, Marine Biodiversity Hub) licencing of data products will in some instances need to comply with their licencing arrangements. While data sharing and licencing arrangements are covered under this project, the UVC Program with UTas is ongoing and has spanned multiple projects over many years. DEWNR is therefore seeking to set up a broader 'data memorandum of understanding' maintained between the two agencies to manage data sharing and licencing issues.

5 Appendices

A. Underwater Visual Census (UVC) survey locations prior to establishment of sanctuary zones in 2014 (using baseline MPA survey method)

REGION	SITE NAME	LATITUDE	LONGITUDE	DEPTH	ESTABLISHED	No. Surveys
Encounter Bay	Blowhole Beach	-35.65974	138.15997	5	2007	1
Encounter Bay	Cable Hut	-35.73268	138.01910	5	2005	4
Encounter Bay	Cable Hut	-35.7332	138.02020	10	2005	3
Encounter Bay	Cape Coutts	-35.75872	138.06698	10	2007	2
Encounter Bay	Carrickalinga Beach North	-35.41036	138.32463	5	2013	1
Encounter Bay	Carrickalinga Head	-35.39799	138.33590	5	2005	3
Encounter Bay	Carrickalinga North1	-35.3777	138.36289	5	2013	1
Encounter Bay	Carrickalinga North2	-35.37312	138.37358	5	2013	1
Encounter Bay	Carrickalinga North3	-35.37119	138.37876	5	2013	1
Encounter Bay	Carrickalinga South Bay	-35.42444	138.31901	5	2005	3
Encounter Bay	Deep Creek/Boat Harbour	-35.64086	138.27265	5	2007	1
Encounter Bay	Dodd's Beach	-35.40415	138.33042	5	2005	4
Encounter Bay	Fisheries Beach	-35.6341	138.11183	5	2007	1
Encounter Bay	Flat Irons	-35.6178	138.55720	6	2005	4
Encounter Bay	Haycock Point	-35.41506	138.32132	5	2005	3
Encounter Bay	Hoggs Point	-35.71974	137.96447	10	2005	3
Encounter Bay	Hoggs Point	-35.71974	137.96447	5	2005	3
Encounter Bay	Kangaroo Point	-35.71667	137.90710	5	2005	3
Encounter Bay	Kangaroo Point	-35.71667	137.90710	10	2005	1
Encounter Bay	Kings Head	-35.60551	138.58308	5	2005	2
Encounter Bay	Kings Head North	-35.60675	138.57594	5	2005	2
Encounter Bay	La Hacienda	-35.57859	138.11379	5	2013	1
Encounter Bay	Loo with a View	-35.65378	138.14596	5	2007	1

Encounter Bay	Morgans	-35.58845	138.10838	5	2005	3
Encounter Bay	Myponga Point	-35.37987	138.36068	5	2005	4
Encounter Bay	Myponga South	-35.38821	138.34922	5	2005	4
Encounter Bay	Newland Head	-35.64094	138.52662	5	2005	2
Encounter Bay	North Pages	-35.75794	138.30288	5	2007	1
Encounter Bay	Outside Granite Island	-35.56753	138.63157	5	2005	4
Encounter Bay	Penneshaw East	-35.72509	138.00006	10	2005	3
Encounter Bay	Porpoise Head	-35.66231	138.21435	5	2007	1
Encounter Bay	Rapid Head Cliffs	-35.52045	138.16442	5	2005	3
Encounter Bay	Rapid Head East	-35.51949	138.17718	5	2013	1
Encounter Bay	Rapid Head North	-35.51921	138.17416	5	2005	3
Encounter Bay	Rapid Head South	-35.53144	138.15190	5	2005	1
Encounter Bay	Rapid Head SZ Site2	-35.52217	138.16338	5	2013	1
Encounter Bay	Rapid Head SZ Site3	-35.5186	138.17102	5	2013	1
Encounter Bay	Rapid Head Windmill	-35.53084	138.15289	5	2005	4
Encounter Bay	Ripple Rock	-35.38385	138.35589	5	2005	3
Encounter Bay	Rock Slide	-35.72056	137.96141	5	2006	2
Encounter Bay	Salt Creek/Nev's Windmill	-35.5526	138.12983	5	2007	2
Encounter Bay	Seal Island, SA	-35.57617	138.64428	5	2005	4
Encounter Bay	Second Valley	-35.50593	138.21446	5	2005	3
Encounter Bay	Shag Rock	-35.39933	138.33456	5	2005	3
Encounter Bay	Snapper North	-35.74982	138.05537	5	2005	3
Encounter Bay	Snapper North	-35.74982	138.05537	10	2005	2
Encounter Bay	South Pages	-35.77521	138.29171	5	2007	1
Encounter Bay	Spaceship East	-35.64675	138.13310	5	2007	1
Encounter Bay	Sunset Cove South	-35.50466	138.22923	5	2005	4
Encounter Bay	The Bluff	-35.58995	138.60644	5	2005	4
Encounter Bay	West Island Outer	-35.61029	138.59289	10	2005	2
Encounter Bay	Whalebone	-35.57139	138.61166	5	2007	2
Eyre Peninsula	Boston Island North	-34.66902	135.92636	5	2007	1

Eyre Peninsula	Coles Point	-34.37894	135.35258	10	2007	1
Eyre Peninsula	Coles Point	-34.37883	135.35214	5	2007	1
Eyre Peninsula	Dalby Island	-34.56293	136.23466	5	2007	1
Eyre Peninsula	Donnington Rocks	-34.71974	135.99806	5	2007	1
Eyre Peninsula	Donnington Rocks	-34.71786	135.99899	10	2007	1
Eyre Peninsula	Flinders Island	-33.71843	134.54824	5	2007	1
Eyre Peninsula	Frenchmans	-34.41943	135.35858	5	2007	1
Eyre Peninsula	Grindal Island	-34.91761	136.03392	10	2007	1
Eyre Peninsula	Horny Point	-35.00533	136.19067	10	2007	1
Eyre Peninsula	Horny Point	-35.00533	136.19067	5	2007	1
Eyre Peninsula	Kirkby Island	-34.55311	136.21157	5	2007	1
Eyre Peninsula	Langton Island	-34.59804	136.24836	5	2007	1
Eyre Peninsula	McLaren South	-34.80433	136.00877	5	2007	1
Eyre Peninsula	Memory Bommie	-34.92844	135.99281	5	2007	1
Eyre Peninsula	Memory Cove	-34.95991	135.99861	10	2007	1
Eyre Peninsula	Memory Cove	-34.95927	135.99572	5	2007	1
Eyre Peninsula	Point Drummond	-34.1747	135.26000	10	2007	1
Eyre Peninsula	Point Sir Isaac	-34.42819	135.20443	5	2007	1
Eyre Peninsula	Point Sir Isaac	-34.42763	135.20449	10	2007	1
Eyre Peninsula	Point Sir Isaac South	-34.43658	135.19186	5	2007	1
Eyre Peninsula	Reevesby Island	-34.53094	136.28894	5	2007	1
Eyre Peninsula	Smith Rocks	-34.58713	136.26600	5	2007	1
Eyre Peninsula	Taylors South	-34.89336	136.01235	5	2007	1
Eyre Peninsula	Topgallant Island	-33.71548	134.62463	10	2007	1
Eyre Peninsula	Waldegrave Island	-33.59196	134.75929	5	2007	1
Eyre Peninsula	Winceby Island	-34.48919	136.28933	5	2007	1
Robe	Baudin Rocks 1	-37.085	139.72065	5	2012	1
Robe	Baudin Rocks inside	-37.0845	139.73106	5	2012	1
Robe	Doorway Rock	-37.15893	139.74278	5	2012	1
Robe	Goat Island 1	-37.1767	139.73460	5	2012	1

Robe	Kingston North Control 1	-36.66592	139.78806	11	2014	1
Robe	Kingston North Control 2	-36.70194	139.78662	12	2014	1
Robe	Kingston South Control 1	-36.77928	139.75878	10	2014	1
Robe	Kingston South control 2	-36.76642	139.76296	10	2014	1
Robe	Kingston SZ 1	-36.72985	139.77534	12	2014	1
Robe	Kingston SZ 2	-36.7288	139.78598	12	2014	1
Robe	Kingston SZ 3	-36.73718	139.77555	12	2014	1
Robe	Kingston SZ 4	-36.71961	139.77873	12	2014	1
Robe	Margaret Brock Reef North 10	-36.94507	139.59677	10	2014	1
Robe	Margaret Brock Reef North 5m	-36.9481	139.59012	5	2014	1
Robe	Margaret Brock Reef SE	-36.95076	139.59953	5	2014	1
Robe	Robe Control 10	-37.16649	139.73927	10	2014	1
Robe	Robe SZ 10	-37.15644	139.74210	10	2014	1
Upper Spencer Gulf	Backy Point	-32.91555	137.78793	3	2009	1
Upper Spencer Gulf	Black Point	-32.9923	137.72176	5	2009	1
Upper Spencer Gulf	Bokos Reef	-33.75761	137.03616	8	2009	1
Upper Spencer Gulf	Fitzgerald Bay Log Cabins	-32.98183	137.78093	3	2009	1
Upper Spencer Gulf	Lucky Bay Offshore	-33.73386	137.13480	8	2009	1
Upper Spencer Gulf	Point Lowly Lighthouse	-33.00088	137.78640	5	2009	1
Upper Spencer Gulf	Santos Fenceline	-32.9963	137.74538	5	2009	1
Upper Spencer Gulf	Third Dip	-32.99436	137.73256	5	2009	1
West Coast SA	Breakwater Reef	-32.31492	133.52983	10	2009	1
West Coast SA	Cape Bauer	-32.71799	134.06143	6	2009	1
West Coast SA	Cape Bauer East	-32.7163	134.06381	5	2009	1
West Coast SA	Dreadnaughts	-32.86466	134.09806	5	2009	1
West Coast SA	Dreadnaughts	-32.86304	134.09712	10	2009	1
West Coast SA	Eagle Bay	-33.02611	134.14756	5	2009	1
West Coast SA	Eagle Rock	-33.02705	134.14384	10	2009	1
West Coast SA	East Franklin Island North East	-32.43518	133.67033	5	2009	1
West Coast SA	Evans Island	-32.36866	133.48233	10	2009	1

West Coast SA	Evans Island	-32.36866	133.48233	5	2009	1
West Coast SA	Freeling Island North West	-32.48099	133.34266	5	2009	1
West Coast SA	Lacey Island North East	-32.39383	133.37550	5	2009	1
West Coast SA	Lacey Island North East	-32.39383	133.37550	10	2009	1
West Coast SA	South East Slade Point	-33.05036	134.17370	5	2009	1
West Coast SA	St Francis Island North Point Inner	-32.49305	133.28840	5	2009	1
West Coast SA	St Francis Island North Point Outer	-32.49399	133.28199	10	2009	1
West Coast SA	St Francis Island Petrel Cove East	-32.50099	133.30349	10	2009	1
West Coast SA	St Francis Island Petrel Cove East	-32.39286	133.37675	5	2009	1
West Coast SA	St Francis Island South East Point (Hat)	-32.52116	133.30316	5	2009	1
West Coast SA	The Granites	-32.87641	134.08746	5	2009	1
West Coast SA	West Franklin Island North West	-32.45033	133.63183	5	2009	1
West Coast SA	West Franklin Island North West	-32.45033	133.63183	10	2009	1
Yorke Peninsula	Balgowan	-34.32126	137.49455	3	2006	1
Yorke Peninsula	Boulders (East of Bay)	-35.36965	136.86759	10	2004	1
Yorke Peninsula	Boulders (East of Bay)	-35.36965	136.86759	5	2004	1
Yorke Peninsula	Cable Bay	-35.29366	136.89819	6	2005	3
Yorke Peninsula	Cape DeBerg	-34.94163	136.97491	10	2004	1
Yorke Peninsula	Cape DeBerg	-34.94025	136.97793	5	2004	1
Yorke Peninsula	Cape Elizabeth North	-34.1295	137.43708	6	2005	3
Yorke Peninsula	Cape Elizabeth Site2	-34.21243	137.48164	5	2013	1
Yorke Peninsula	Cape Elizabeth SZ North	-34.17325	137.46156	5	2005	3
Yorke Peninsula	Cape Elizabeth SZ Site1	-34.18672	137.47160	5	2013	1
Yorke Peninsula	Cape Elizabeth SZ Site2	-34.19367	137.47779	5	2013	1
Yorke Peninsula	Cape Spencer	-35.30033	136.88429	5	2013	1
Yorke Peninsula	Chinamans Hat Island SZ	-35.2887	136.91939	5	2013	1
Yorke Peninsula	Corny Point Inside	-34.89451	137.01889	5	2005	1
Yorke Peninsula	Corny Point Outside	-34.89509	137.00183	10	2004	1
Yorke Peninsula	Corny Point Outside	-34.89471	137.00697	5	2004	1
Yorke Peninsula	Edithburgh	-35.08314	137.74876	2	2006	1

Yorke Peninsula	Gleesons	-35.01375	136.94128	5	2006	1
Yorke Peninsula	Goose Island	-34.45304	137.36770	5	2005	2
Yorke Peninsula	Haystack Island NE	-35.32085	136.90715	5	2004	2
Yorke Peninsula	Haystack Island SE	-35.32342	136.90832	5	2004	1
Yorke Peninsula	Haystack Island SW	-35.32357	136.90686	5	2013	1
Yorke Peninsula	Marion Bay	-35.25268	136.97956	6	2006	1
Yorke Peninsula	Middle Island	-35.21767	136.83219	5	2006	1
Yorke Peninsula	Minlacowie	-34.80519	137.45567	3	2006	1
Yorke Peninsula	North East Boobs	-35.36785	136.84919	10	2004	1
Yorke Peninsula	North West Bay	-35.3645	136.85676	10	2004	1
Yorke Peninsula	Point Pearce	-34.44027	137.41288	5	2006	1
Yorke Peninsula	Point Riley	-33.87631	137.59858	5	2005	2
Yorke Peninsula	Point Souttar	-34.89345	137.24671	4	2005	1
Yorke Peninsula	Point Yorke	-35.23088	137.18814	5	2005	2
Yorke Peninsula	Port Giles	-35.02034	137.76240	2	2006	1
Yorke Peninsula	Port Julia	-34.66289	137.88554	2	2006	1
Yorke Peninsula	Port Rickaby	-34.66718	137.49324	4	2006	1
Yorke Peninsula	Port Victoria	-34.49603	137.47366	6	2006	1
Yorke Peninsula	Seal Island SZ_East	-35.33763	136.92104	5	2013	1
Yorke Peninsula	Seal Island SZ_West	-35.33815	136.91770	5	2013	1
Yorke Peninsula	South East Cove	-35.37413	136.86195	5	2004	1
Yorke Peninsula	South East Cove	-35.37413	136.86195	10	2004	1
Yorke Peninsula	Stenhouse	-35.28049	136.94395	5	2006	1
Yorke Peninsula	Stenhouse Cliffs SZ	-35.28418	136.93308	5	2013	1
Yorke Peninsula	Swallowtail Bay	-35.37456	136.85800	10	2004	1
Yorke Peninsula	Swallowtail Bay	-35.37466	136.85842	5	2004	1
Yorke Peninsula	Troubridge Lighthouse	-35.16911	137.63816	6	2006	1
Yorke Peninsula	Troubridge Point	-35.16955	137.67405	6	2005	2
Yorke Peninsula	Wardang	-34.53525	137.35482	5	2005	2
Yorke Peninsula	West Cape	-35.24345	136.82542	5	2006	1

B. Ongoing UVC monitoring sites (as of 2017)

BIOREGION	SiteName	LATITUDE	LONGITUDE	AssociatedSZs	Inside	First Surveyed	No. Surveys
Coorong	Kingston North Control 1	-36.6659	139.7881	Lacepede Bay	No	2014	1
Coorong	Kingston North Control 2	-36.7019	139.7866	Lacepede Bay	No	2014	1
Coorong	Kingston South Control 1	-36.7793	139.7588	Lacepede Bay	No	2014	1
Coorong	Kingston South control 2	-36.7664	139.763	Lacepede Bay	No	2014	1
Coorong	Kingston SZ 1	-36.7299	139.7753	Lacepede Bay	Yes	2014	1
Coorong	Kingston SZ 2	-36.7288	139.786	Lacepede Bay	Yes	2014	1
Coorong	Kingston SZ 3	-36.7372	139.7756	Lacepede Bay	Yes	2014	1
Coorong	Kingston SZ 4	-36.7196	139.7787	Lacepede Bay	Yes	2014	1
Eyre	Pearson Island Bay NW	-33.9405	134.2667	Pearson Isles	Yes	2014	1
Eyre	Pearson Island East	-33.9512	134.2743	Pearson Isles	Yes	2014	1
Eyre	Pearson Island Inner Bay North	-33.9536	134.2695	Pearson Isles	Yes	2014	1
Eyre	Pearson Island Inner Bay South	-33.9604	134.2679	Pearson Isles	Yes	2014	1
Eyre	Pearson Island North	-33.9409	134.2729	Pearson Isles	Yes	2014	1
Eyre	Pearson Island SE Bay	-33.9624	134.2715	Pearson Isles	Yes	2014	1
Eyre	Flinders Island	-33.7184	134.5482	Pearson Isles, Top-Gallant Isles	No	2007	2
Eyre	Flinders Island Anchorage	-33.6844	134.4868	Pearson Isles, Top-Gallant Isles	No	2014	2
Eyre	Flinders Island NW point	-33.6894	134.4738	Pearson Isles, Top-Gallant Isles	No	2014	2
Eyre	Flinders Island NW Reef	-33.6862	134.4653	Pearson Isles, Top-Gallant Isles	No	2014	2
Eyre	Ward Island	-33.7387	134.2852	Pearson Isles, Top-Gallant Isles	No	2006	1
Eyre	Topgallant Island	-33.7155	134.6246	Top-Gallant Isles	Yes	2007	1
Gulf St Vincent	Aldinga SZ1	-35.2663	138.4365	Aldinga Reef	Yes	2016	1

Gulf St Vincent	Aldinga SZ2	-35.272	138.4327	Aldinga Reef	Yes	2016	1
Gulf St Vincent	Aldinga SZ3	-35.2804	138.4315	Aldinga Reef	Yes	2016	1
Gulf St Vincent	Gull Rock	-35.2462	138.4596	Aldinga Reef	No	2016	1
Gulf St Vincent	Moana Inside	-35.2091	138.4644	Aldinga Reef	No	2016	1
Gulf St Vincent	Sellick South	-35.3578	138.4215	Aldinga Reef	No	2016	1
Gulf St Vincent	Carrickalinga Head	-35.3980	138.3359	Carrickalinga Cliffs	Yes	2005	3
Gulf St Vincent	Carrickalinga North1	-35.3777	138.3629	Carrickalinga Cliffs	No	2013	2
Gulf St Vincent	Carrickalinga North2	-35.3731	138.3736	Carrickalinga Cliffs	No	2013	2
Gulf St Vincent	Carrickalinga North3	-35.3712	138.3788	Carrickalinga Cliffs	No	2013	2
Gulf St Vincent	Carrickalinga South Bay	-35.4245	138.319	Carrickalinga Cliffs	No	2005	8
Gulf St Vincent	Dodd's Beach	-35.4042	138.3304	Carrickalinga Cliffs	Yes	2005	5
Gulf St Vincent	Myponga South	-35.3882	138.3492	Carrickalinga Cliffs	Yes	2005	5
Gulf St Vincent	Ripple Rock	-35.3839	138.3559	Carrickalinga Cliffs	Yes	2005	4
Gulf St Vincent	Cable Bay	-35.2937	136.8982	Chinamans Hat	No	2005	3
Gulf St Vincent	Cape Spencer	-35.3003	136.8843	Chinamans Hat	No	2013	1
Gulf St Vincent	Chinamans Hat Island SZ	-35.2887	136.9194	Chinamans Hat	Yes	2013	1
Gulf St Vincent	Haystack Island NE	-35.3209	136.9072	Chinamans Hat	No	2004	2
Gulf St Vincent	Haystack Island SW	-35.3236	136.9069	Chinamans Hat	No	2013	1
Gulf St Vincent	Seal Island SZ_East	-35.3376	136.921	Chinamans Hat	Yes	2013	1
Gulf St Vincent	Seal Island SZ_West	-35.3382	136.9177	Chinamans Hat	Yes	2013	1
Gulf St Vincent	Stenhouse Cliffs SZ	-35.2842	136.9331	Chinamans Hat	Yes	2013	1
Gulf St Vincent	Morgans	-35.5885	138.1084	Rapid Head	No	2005	4
Gulf St Vincent	Rapid Head	-35.5205	138.1638	Rapid Head	Yes	2005	8
Gulf St Vincent	Rapid Head East	-35.5195	138.1772	Rapid Head	No	2011	5
Gulf St Vincent	Rapid Head South	-35.5314	138.1519	Rapid Head	Yes	2005	3
Gulf St Vincent	Rapid Head SZ Site2	-35.5222	138.1634	Rapid Head	Yes	2013	2
Gulf St Vincent	Rapid Head SZ Site3	-35.5186	138.171	Rapid Head	Yes	2012	2
Gulf St Vincent	Salt Creek	-35.5526	138.1298	Rapid Head	No	2007	3
Gulf St Vincent	Second Valley Boat Shed	-35.5095	138.2145	Rapid Head	No	2005	9
Gulf St Vincent	Cable Hut	-35.7327	138.0191	Sponge Gardens	Yes	2005	5

Gulf St Vincent	Grassy Knoll	-35.7239	137.9882	Sponge Gardens	No	2016	1
Gulf St Vincent	Hoggs Point	-35.7197	137.9645	Sponge Gardens	No	2005	4
Gulf St Vincent	Pancake Rock	-35.7408	138.0399	Sponge Gardens	Yes	2016	1
Gulf St Vincent	Penneshaw Pub	-35.7163	137.939	Sponge Gardens	No	2016	1
Gulf St Vincent	Puzzle Rock	-35.7215	137.9805	Sponge Gardens	No	2016	1
Gulf St Vincent	Snapper North	-35.7498	138.0554	Sponge Gardens	Yes	2005	4
Gulf St Vincent	The Bird	-35.7568	138.0653	Sponge Gardens	Yes	2016	1
Murat	East Bay	-32.5028	133.3089	Isles of St Francis	Yes	2015	1
Murat	Egg Beater	-32.4704	133.3192	Isles of St Francis	No	2015	1
Murat	Evans Island	-32.3686	133.4812	Isles of St Francis	No	2009	2
Murat	Evans Slide	-32.3735	133.4852	Isles of St Francis	No	2015	1
Murat	Hat North	-32.5199	133.3035	Isles of St Francis	Yes	2015	1
Murat	Lacy Boulders	-32.3926	133.3803	Isles of St Francis	No	2015	1
Murat	Lacy Island	-32.3934	133.3769	Isles of St Francis	No	2009	2
Murat	Masillon Island	-32.5566	133.294	Isles of St Francis	Yes	2015	1
Murat	Petrel Cove East	-32.5011	133.3028	Isles of St Francis	Yes	2009	2
Murat	St Francis Inside North Point	-32.4933	133.2885	Isles of St Francis	Yes	2009	2
North Spencer Gulf	Black Point	-32.9923	137.7218	Cuttlefish Coast	Yes	2009	1
North Spencer Gulf	Fenceline West	-32.9966	137.7506	Cuttlefish Coast	No	2017	1
North Spencer Gulf	Ledges	-32.995	137.7406	Cuttlefish Coast	Yes	2017	1
North Spencer Gulf	Stony Point	-32.9964	137.7564	Cuttlefish Coast	No	2017	1
North Spencer Gulf	Tanked	-32.9957	137.7702	Cuttlefish Coast	No	2017	1
North Spencer Gulf	Third Dip	-32.9944	137.7326	Cuttlefish Coast	Yes	2009	1
Otway	Doorway Rock	-37.1589	139.7428	Cape Dombey	Yes	2012	1
Otway	Goat Island 1	-37.1767	139.7346	Cape Dombey	No	2012	1
Otway	Robe Control 10	-37.1665	139.7393	Cape Dombey	No	2014	1
Otway	Robe SZ 10	-37.1564	139.7421	Cape Dombey	Yes	2014	1
Spencer Gulf	Baudinet	-34.2287	137.4891	Cape Elizabeth	No	2017	1
Spencer Gulf	Cape Elizabeth North	-34.1293	137.4375	Cape Elizabeth	No	2005	3

Spencer Gulf	Cape Elizabeth Site2	-34.2124	137.4816	Cape Elizabeth	No	2013	1
Spencer Gulf	Coopers Bar	-34.1635	137.4516	Cape Elizabeth	No	2017	1
Spencer Gulf	Ham Sandwich	-34.1803	137.4615	Cape Elizabeth	Yes	2017	1
Spencer Gulf	High Dunes	-34.1943	137.4748	Cape Elizabeth	Yes	2017	1
Spencer Gulf	Honeycomb	-34.1733	137.4585	Cape Elizabeth	Yes	2017	1
Spencer Gulf	Scrubby Dunes	-34.1875	137.4676	Cape Elizabeth	Yes	2017	1

C. Importing data from the University of Tasmania (UTas) national database

A set of standardised tables is taken from the national database for import to DEWNR's UVC dataset, at any time that DEWNR require updates as a result of changes to the SA component of the national dataset (e.g. following new surveys, or following any corrections to the data). In particular, this would occur as soon as practical after annual surveys are complete and the data has been uploaded to the UTas databases. Regular (annual) imports would include the following tables:

- Combined RLS and MPA fish and mobile invertebrate data extract
- UTas species table
- RLS photoquadrat data

In addition, a 'one off' import of the baseline MPA algal quadrat data is required. This import would be repeated only if further surveys using the MPA method are carried out in the future. Due to the differing needs of RLS and DEWNR, a mechanism for storage and import of lobster and abalone size data is still being developed (currently stored locally in parallel with the processes described here).

Data imported into the DEWNR data storage structure (Item 8 in Figure 2) are brought into a 'back-end' MS Access database which stores the 'core' data tables (Figure 3). A second 'front-end' database containing a number of custom queries links to tables within the 'back-end' database. Eventually, 'core' data tables will be stored corporately in Oracle format and linked directly to the 'front end' database (for analysis and reporting; see Items 12–13 in Figure 2) as well as a number of standard products (see Items 9–11 in Figure 2).

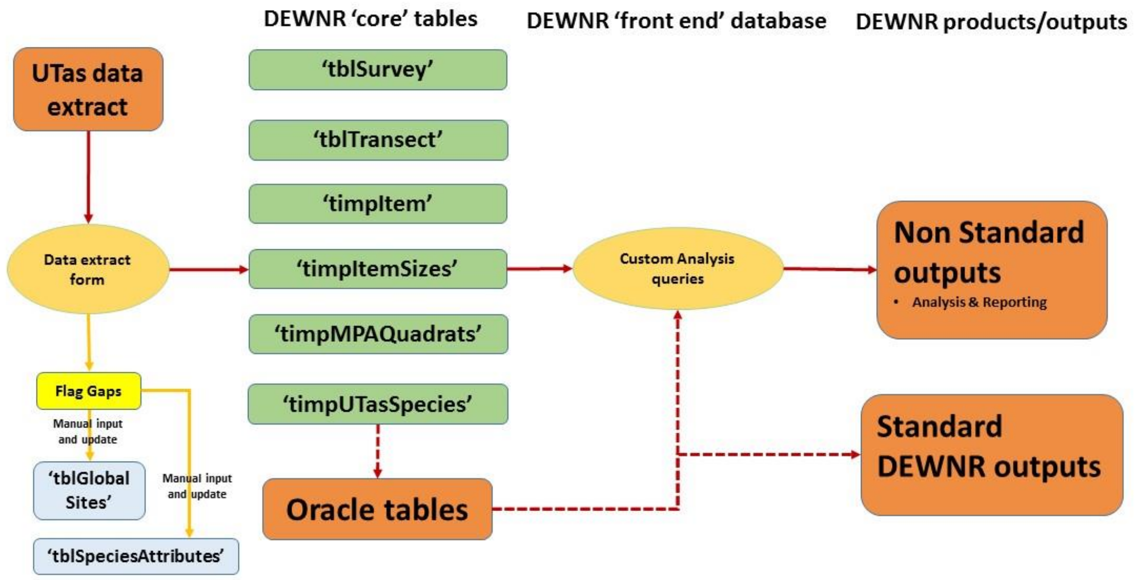

Figure 3. Import steps and 'core' data tables stored on DEWNR's corporate network.
A UTas data extract is prepared and imported by a custom MS Access database to produce DEWNR's 'core' tables (green items, currently in an MS Access database). Ultimately these tables will be stored as Oracle data tables and stored corporately (dashed lines represent 'aspirational' structures). These 'core' data will ultimately linked directly to the 'front end' database (for analysis and reporting) and standard DEWNR reporting outputs (see Figure 2). Dashed lines represent data structures that will be developed.

The import process is as follows:

1. User clicks button on form to import the UTas Combined RLS MPA fish and mobile invertebrate data extract
2. The site list from the extract is compared against the DEWNR site list, and the user has the opportunity to confirm new sites or link them to existing sites
3. User clicks button to import the UTas Species list. The DEWNR species list is updated accordingly, and the user is warned that there are attributes that need completion (which is optional).
4. User clicks button to parse the UTas Combined RLS MPA fish and mobile invertebrate data extract. The following tables are re-populated:
   - 'timpSurvey' – containing site, date, and number of transects
   - 'timpTransect' – containing timpSurvey ID, depth, local transect number (e.g. 1, 2, 3, 4 for 200 m surveys), which methods were done and visibility
   - 'timpItem' – containing timpTransect ID, method, block (for RLS), diver, recorded species, total abundance, total biomass (for fish)
   - 'timpItemSizes' – containing timpItemID, size class, abundance, biomass (for fish).
5. User clicks button to import and parse the UTas MPA quadrat and photoquadrat data extracts.

The structure for the 'core' or 'back-end' database is shown in Figure 4.

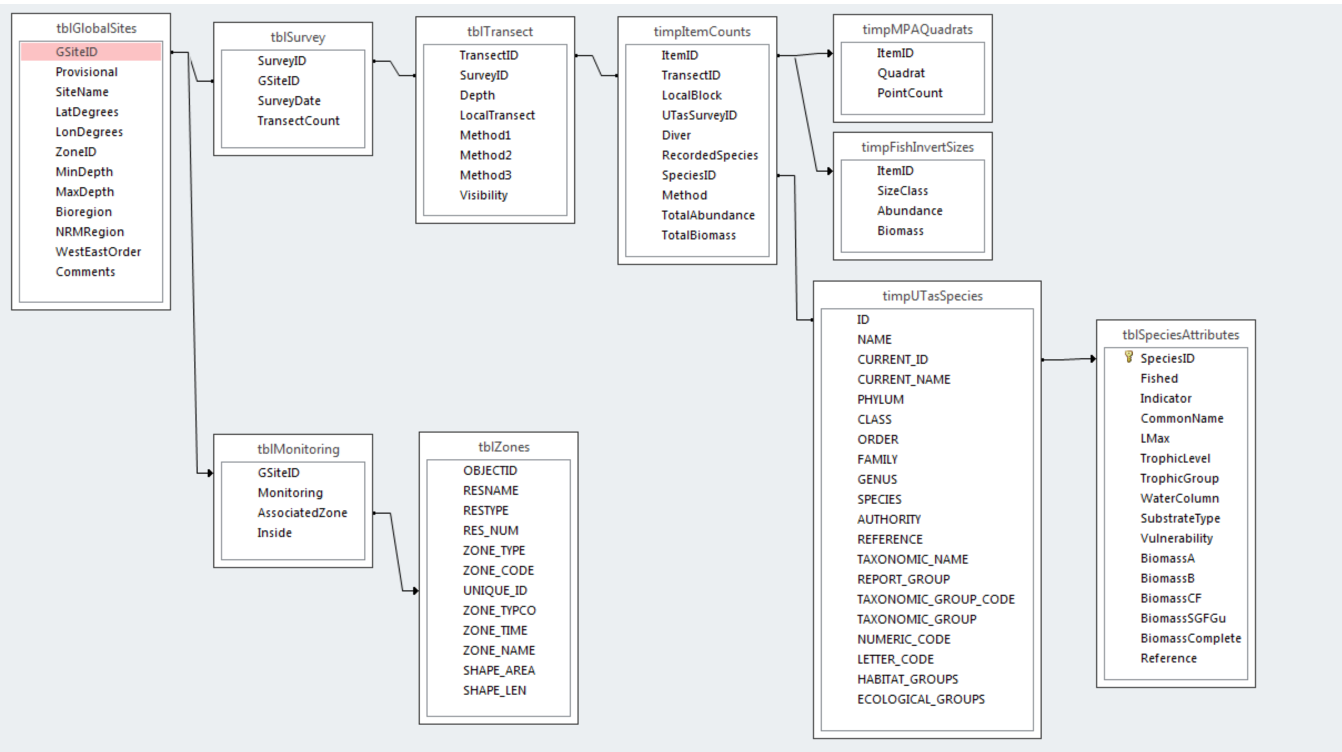

Figure 4. A detailed representation of the incoming data (from UTas) and the extraction process using the 'core' database

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