Victorian Abalone - Methods used for fishery assessment

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1 Executive Summary

The Victoria Fisheries Authority (VFA) has used multiple lines of evidence in assessing the state of the abalone resource and setting the annual total allowable commercial catch (TACC) for each of the three statutory commercial abalone zones over many years. Recently, it has also been progressively introducing empirically based harvest strategies to provide a more integrated and structured approach for assessing stocks and providing TACC management advice. Commencing in mid-2019, assessments of resource status and formulation of management recommendations will be conducted by external parties under formal agreements with the VFA. The VFA will continue to acquire and provide access to quality assured data required for scientific assessments. It will also oversee the conduct of the assessments by external parties by ensuring conformance with agreements, harvest strategies and subordinate analytical requirements through a combination of internal and external third-party reviews and audits.

This report focusses on describing details of the collection, storage, quality assurance and quality control (QAQC) of both fisheries dependent and independent data by the VFA for the abalone fishery. It provides a summary of information to be incorporated in the TACC setting process and serves as a basis for describing inputs to the harvest strategies and additional lines of evidence used as indicators of stock and fishery performance.

2 Introduction

The VFA has developed a process to conduct periodic, formal assessments of key marine and estuarine stocks and the fisheries they support, and which informs clear and accountable decision-making. For the abalone fishery in Victoria, this process involves:

- Evaluating available fisheries dependent and independent monitoring and research data
- Providing the opportunity to draw upon the knowledge of stakeholder groups
- Providing scientifically valid harvest strategies supported by multiple lines of evidence in determining the status of fish stocks
- Convening workshops for scientists, stakeholders and resource managers to assess the status of the stock or fishery, and provide advice used to set TACCs

Comprehensive methods for data collection, storage and analysis are required to be accurately documented, transparent, and defensible. This report details the methods used by the VFA for managing its data, and developing fishery assessment statistics and summaries, and inputs to harvest strategies to inform the setting of the TACC and provides a reference for future assessments.

3 Stock assessment data acquisition

3.1 Inputs for stock assessments

Annual TACC workshops and regular resource assessment meetings are used to facilitate stakeholder input to the TACC-setting and management decision-making processes. Following the annual TACC workshops the VFA subsequently proposes a draft TACC for each management zone (Western, Central and Eastern), which it releases for public consultation. Submissions received during this statutory consultation period are considered by the Minister (or delegate) who then declares the abalone TACC. The VFA then publishes the legal instrument setting the TACC, the Further Quota Order, in the *Victoria Government Gazette* and notifies stakeholders prior to the start of the new fishing year on 1 April.

The primary information providing guidance to stakeholder workshops and resource assessment meetings is outputs from the application of the empirically based harvest strategies applicable to each zone. These variously rely on fisheries dependent data (e.g. commercial catch and effort, size frequency, and spatial effort distribution), and fisheries independent data (e.g. abundance of pre-recruits and recruits, population size structure, growth, size-at-maturity), which also provide a series of secondary measures of fisheries performance considered alongside stakeholder observations, and fisheries management perspectives in recommending each annual TACC.

3.2 Data used for stock assessment

It is important to note that although the Victorian abalone fishery is data-rich at the scale of each management zone, it tends toward the data-poor end of the information spectrum at the reef code scale used for catch reporting. Industry associations also engage in collecting their own data which they manage themselves to increase the availability of spatially resolved information that can assist with non-statutory decisions about managing fishing operations at reef code scale. Grouping reef codes into spatial management units (SMUs) balances information richness with spatial resolution for effective statutory management decisions. It is equally important to recognise that all fisheries data have a degree of uncertainty and that the analytical techniques that are applied to draw inferences from the data should accommodate that uncertainty.

3.2.1 Fisheries dependent data

Catch and effort information collected and reported by commercial fishers is known as **Fisheries Dependent Data**. Fisheries dependent data provided to the VFA and used for abalone stock assessments include:

- Catch and Effort records– reported via catch returns
- Trend analyses of standardised CPUE
- Catch size structure – size frequency data collected from industry operated logging instruments

Daily catch and effort data are acquired from Abalone Quota Dockets both in digital and paper formats. Upon landing their catches, nominated commercial abalone divers are required to record their catch weight (in kg to the nearest 100 g) and effort time (in hours

and mins) for each reef code they visited along with other compliance related information. Weight is accurately determined using certified scales at the point of landing whereas effort is often an estimate. An integrated voice response system (IVR) linked to the VFA Fisheries Integrated Licensing System (FILS) database is accessed via telephone to report the individual diver's catch by reef code. Effort is subsequently transcribed from the dockets by VFA staff during a compliance checking procedure to complement the IVR facilitated catch and reef code records.

These data are then transmitted to VFA scientific staff with the compliance and personal data fields redacted. After receipt of the extracted data, diver personal file numbers (PFNs) are replaced with computer-generated unique pseudonyms which are randomly assigned to provide an additional layer of privacy and confidentially. This does not affect the analysis of the data. The data are stored in a secure SQL database on a web hosting platform (AWS) managed by the Department of Jobs, Precincts and Regions (DJPR)Technology Services. This is the same platform which hosts other secure VFA and Departmental databases. Computer programs are used to filter and extract the catch and effort data as required for analysis in accordance with a Standard Operating procedure (SOP).

3.2.2 Fisheries independent data

Targeted monitoring surveys or **Fisheries Independent Data** provide information that can be complementary to fisheries dependent data or useful when fishery-dependent data are unavailable or unsuitable.

Fishery independent surveys in the Victorian Abalone Fishery have been conducted at fixed sites along the Victorian coastline since 1989/90. The number of survey sites has increased over time to a peak of 204 sites in 2004 but was subsequently decreased to 143 sites from 2017 onward.

The surveys were designed to provide:

- Trends in pre-recruit abundance
- Trends in recruit abundance
- Length frequency statistics

The precise co-ordinates and characteristics of each fixed site are fully described and have been photographed both above and below the waterline. Most are located close to shore in depths ranging from about 5 to 18 metres, but some are located outside this range in accordance with the specific reef topography. At each site, all abalone are counted within six belt transects, which are strips of bottom 30 m long by one metre wide radiating out from a fixed central point marked by a buoyed shot-line. The transects are randomly selected from 12 cardinal directions spaced at 30-degree arcs commencing with due north (0 degrees). Research divers count abalone into three categories: Juveniles, Pre-recruits and Recruits. Juveniles are defined as < 80 mm shell length or 40 mm less than the LML specified in the Fisheries Regulations 2009 (whichever is lower). Pre-recruits are abalone with shell lengths between the juveniles and the LML specified in the legislation (this is always a 40 mm size class). Recruits are abalone above the legislated LML (120mm west of Lorne and east of Lakes Entrance, 100mm within Port Phillip Bay, and 110mm elsewhere). Counting commences 5-m from the shot weight at the central point creating a circular site 70 m in diameter or 3850 m^2 in area.

At the end of each transect 25 abalone are collected as far as possible without bias and brought aboard the boat where their shell lengths are measured to the nearest millimetre using an electronic measuring board which automatically logs the lengths along with date, time and GPS coordinates. As far as practicable, two research divers equally share the survey at each site to enable statistical comparison of diver performance.

These data are manually entered into MS Excel spreadsheets by VFA staff and checked in accordance with a SOP before transmission to the database manager for uploading.

4 Methods for data analysis

4.1 Catch per unit effort

Catch per unit effort (CPUE) data are available from 1979 (catch is available at State and zone scales back to 1969). CPUE is frequently used as an index of relative abundance in fisheries assessments where fishery independent data are unavailable. The usefulness and reliability of CPUE for this purpose is contingent, however, on catch rates being proportional to abundance across the entire range of abundance values and under all circumstances. In the case of greenlip abalone, recent data are too sparse to enable an informative analysis of CPUE and assessment for this species. State-wide catch history since 1969 is probably the most reliable indicator of greenlip abalone stock biomass.

CPUE is a cost-effective approach to monitoring fisheries. However, use of CPUE as a biomass proxy has some limitations, particularly for use in abalone fisheries where it can be hyper-stable i.e. insensitive to declining biomass, at least across a substantial part of the domain of stock biomass. CPUE can be influenced by changes in fishing practice and may not reflect the stock status as a result. For example, the capacity for a dive fishing fleet to effectively target aggregations of abalone and avoid spending time searching among sparsely distributed abalone on reefs, makes CPUE relatively insensitive to declining abundance until the exploitable biomass has become severely reduced.

CPUE is standardised (see the following sections) as a proxy for biomass and is analysed to determine the statistical significance of trends (positive or negative relative to a time series). This is one of the main lines of evidence now used in assessments.

A recent review of the Fisheries Independent Survey results by Hart (2016) illustrates a strong correlation between recent CPUE and the abundance of recruits measured by surveys. This correlation indicates that these independent indicators can be consistent when used to monitor declining abalone abundance. This corroboration has the potential to strengthen the reliability of evidence-based decisions if both indicators of performance are included in empirical harvest strategies.

4.1.1 Standardisation of CPUE

The use of raw data can be influenced by spatial and temporal factors such as area, depth and reef complexity, environmental and seasonal factors such as sea temperature and nutrient level, and human factors such as experience and skill of divers. Standardisation removes most of the variation not attributable to changes in abundance (Gavaris 1980; Maunder and Punt 2004; Shono 2008).

A review by the CSIRO (Haddon 2015) found that VFA's standardisation procedure is fundamentally sound but made a number of recommendations for improvement that have been progressively reviewed and incorporated as appropriate. These included standardising at the whole of zone and SMU rather than reef code scales; comparing and contrasting between scales; re-scaling transformed data and overlaying with the unstandardized series; producing diagnostic statistics; automating the analysis; noting caveats on data constraints; re-considering the complexity of breakpoint analysis; explaining trends over time; and formal documentation of methods and changes in analytical procedures.

Details about the standardisation approach are described below and in Giri and Gorfine (2019).

4.1.1.1 Standardisation models

The statistical models that are often used to standardise fisheries data include the log normal regression models, Generalized Linear Model (GLM), Generalized Linear Mixed Model (GLMM) etc. The GLMs and GLMMs are models where the expected value of a response variable is linked to the linear combination of explanatory variables (plus random effect variables for GLMM) by a link function and the response variable can take any distribution from the distributions of the exponential family (McCullagh and Nelder 1983). Normal, Poisson, Binomial, Gamma and Negative Binomial distributions are some of the members of the distribution of the exponential family and the selection of any of these distributions depends on the nature of the response variable at hand.

The linear mixed model (LMM) and Generalized linear mixed model (GLMM) are effective tools for capturing 'within diver and area, between times' variation by introducing appropriate random effects in the model (Venables and Dichmont 2004). The importance of mixed models can further be seen in Venables and Dichmont (2004), as the authors say "*One of the most important benefits of using mixed models is their capacity to 'borrow strength' from one part of the data to another, thus often providing a more realistic analysis of the large fragmentary data sets, which are the norm in fisheries research*"

In GLMM, the response variable Y_i with observed values y_i, for $i = 1, \dots, n,$ is from exponential family of distribution whose probability density function takes the general form

$$f(y_i|\theta_i, \phi) = \exp\left\{\frac{y_i\theta_i - b(\theta_i)}{a(\phi)} + c(y_i, \phi)\right\}$$

where θ is the canonical parameter representing the location, ϕ is the dispersion parameter representing the scale, and specific functions $a(\,), b(\,)\ and\ c(\,)$ are specified according to various members of the exponential family. The mean of y_i is related to the linear predictor η_i by using the *link function g* where

$$E[Y_i] = \mu_i = g^{-1}(\eta_i),\ \eta_i = g(\mu_i)$$

With *canonical link function g* , $\theta_i = \mu_i$. If β are fixed effects and γ are random effects, then

$$\eta_i = x_i^T\beta + z_i^T\gamma$$

where x_i and z_i are corresponding rows of design matrices, X and Z for respective fixed and random effects. Mostly random effects γ are assumed to be normally distributed.

4.1.1.2 Standardisation of commercial CPUE data using GLMM

The CPUE data are standardised by a Generalized Linear Mixed Model with **Gamma** as the response distribution and **logarithm** as the link function (Appendix I). In GLMM models, the standardized values are achieved by generating predicted means using only fixed effects (year coefficient for each year). By excluding all the random effects in the prediction, we can say that we have taken the random effects at their population means of zero. Such a prediction method in mixed models can be termed as marginal prediction (Welham et.al. 2004). The variability arising in CPUE or abundance values due to factors such as divers skill, seasonal factors and spatial location (and their interactions with quota year) can be thought of as random variability and thus treated as an error term while forming the predicted value for each year. Unlike conditional prediction, where random terms are included by averaging, the marginal prediction is more appropriate when inferences are required for the wider population of random factors.

The raw data that was used in standardisation excluded:

- Records with zero effort information while having positive blacklip catch
- Records with more than 400kg/hour CPUE (e.g. up to 8745 kg/h)
- Records with positive greenlip catch
- Records with no reef code information
- Records with zero catch

Inclusion of two-way interactions of month, diver and reef code with quota year was not only warranted by consideration of statistical significance, but also to capture the variability introduced in the CPUE data by these interactions. For example, not all divers have been diving from the beginning of the time series to the end of the time series, there are many divers who only worked for a couple of years and then left the industry. If you were to fit to the diver main effect only, then his\her effect will be computed for the whole time series rather than only in the years when he/she participated in the fishery. Similarly, months (seasonal) effects will also vary year by year. For example, in the Central Zone, the month of September had the highest CPUE in the 2014 quota year whereas in the quota year 2015, the highest CPUE was observed in June. Capturing this extra variability improves the predictive accuracy of the model (consequently standardised values).

4.2 Abundance

Abundance data are available from 1989/90 for fixed monitoring sites, or stations, which have been progressively increased in number to improve spatial coverage and replication until a reduction in the number sites from 204 (including 11 with marine parks) to 143 occurred in 2017. This reduction was partly a response to project resourcing issues and partly due to concerns expressed during meetings with Industry stakeholders that in their view many sites were no longer located where contemporary fishing occurs. The evidence for such claims is equivocal although those sites within marine parks were clearly in locations unavailable for legal harvest. In general, the sites that were eliminated from the surveys were those with much lower abundance, the exception being those within marine parks. Given the changes in the numbers of sites, bias may occur if any analysis of trend or inter-year comparison is undertaken which straddles the years listed in Table 1.

Table 1. Years when there were large changes in the number of fishery independent monitoring sites for blacklip abalone.

Year	Total	Central	Eastern	Western
1992	55	27	15	13
1995	82	35	30	17
2002	155	66	52	37
2003	176	66	73	37
2010	195	84	73	38
2016	204	84	81	39
2017	143	57	63	23

In addition to changes in the numbers of sites, changes in the survey method have also had an effect which may be difficult to accommodate via statistical standardisation. The major change was from collecting all abalone from within each transect and measuring them aboard the research vessel which served to provide both length frequency and count data, to counting the abalone regardless of size *in situ* and separately collecting length-frequency samples, to counting the abalone into three size categories *in-situ*. One advantage of the former method of collecting within transects was that counts could be readily subset into any size category of interest without assumptions and potential bias. Nevertheless, disruptive approaches to sampling are better suited to randomised rather than fixed site designs, which is why the fixed site survey design was changed from collecting to counting *in situ* in 2000–01.

Despite the cost of collection, fishery independent surveys (FIS), are less affected by hyperstability and more likely to detect serial depletion and declining trends much sooner than relying on CPUE to respond to changes in abundance and/or biomass. FIS also have the capacity to detect changes in the abundance of sub-legal sized abalone, whereas CPUE is confined to monitoring the exploitable biomass. Pre-recruit abundance whilst not a measure of population recruitment *per se*, nonetheless provides an early indication of future numbers likely to grow to recruit to the stock several years later. Low or declining numbers of pre-recruits can provide an early warning of the need to reduce catches from specific areas and increasing trends can provide support for increasing catches. The main challenges in interpreting these data are choice of an appropriate scale and having a sufficiently long time-series to analyse.

4.2.1 Standardisation of transect count (abundance) data

A preliminary analysis of the transect count data indicated the Negative Binomial distribution would best fit to data because it resulted in the smallest deviance. White and Bennetts (1996) highlighted two potential advantages of the negative binomial distribution over the Poisson distribution for representing skewed distribution of count data. Firstly, variance does not have to be equal to the mean (a separate parameter to model variance), and secondly, samples are not required to be independent.

The **pre-recruit** and **recruit** classes of abalone count data are standardised separately using a generalised linear mixed model (GLMM) with the negative binomial distribution for the response variable and a natural logarithm link function (Appendix I).

The structure of the survey design is reflected in the random model. Sites are nested within a reef code, and reef codes are nested within an SMU. Site effects are allowed to

vary by quota year. The transect count surveys are mostly done by the same divers at similar times of the year. Unlike CPUE data, diver by quota year and months by quota year interactions are not statistically significant. This is expected because most of the divers conducting these surveys are the same and there is little year to year variability in their skills. Similarly, for most years' surveys are completed during the same months (or very close to the previous year's survey month) thus the quota year by month interaction term is also not expected to be statistically significant.

4.2.2 Trend Analyses in standardised abundance Index

Trend (or breakpoint) analysis is a method used to determine statistically significant changes in standardised trends over different time scales. It provides an additional level of information about when changes may have occurred, and in which direction. Trend analysis provides a defensible statistical method for ascertaining whether a trend is positive, negative or neutral.

The breakpoint in standardised CPUE and abundance (transect survey) trends for various reef codes or spatial management units are analysed using piecewise or segmented regression where the relationship within segments was estimated by linear regression. To do this we used the R package 'Segmented' (Muggeo 2008) which has an iterative algorithm with a first-order Taylor expansion (Muggeo 2003) to estimate the breakpoints in the trend, essentially partitioning the independent variable (Quota Year) into intervals, and a segmented relationship between CPUE or abundance (Y) and the time variable Quota Year (X) was fitted as:

$$Y = \alpha X + \beta(X - \varphi)I(X - \varphi)$$

where φ is the break point, $I(A)$ is the indicator function that is $I(A) = 1$ if $A \geq 0, I(A) = 0$ otherwise, α is the slope of the line segment before breakpoint that is for $X \leq \varphi$, β is the difference in slope parameter, and $\alpha + \beta$ is the slope for the line segment after the breakpoint. This R package needed starting value(s) to be provided for the breakpoint parameter and it was able to estimate several breakpoints efficiently. When there was no breakpoint, a linear regression model was fitted to evaluate the overall long-term linear trend.

4.3 Length frequency from surveys and commercial catch sampling

Commercial length data for legal size abalone is acquired digitally using an electronic shellfish measuring board that records date, time and GPS location for each logged measurement except where sampling occurs in a factory and GPS coordinates are not relevant.

Size information has been collected from the commercial catch during the past 10–15 years. However, the Eastern Zone information has been derived from factory sampling and so lacks precision in spatial resolution. The Central Zone data has only been provided by Industry from between 2002–2006. The Western Zone data was only sporadically provided prior to 2006, and no recent data has been provided since 2012. The inconsistent catch information provided by industry limits the use of these data, although they can be used to determine catch selectivity for reef codes and years where enough data exist. The quality of these data varies, mostly due to errors arising from the measuring boards and their in-built GPS but, in some cases, the operator. Capacity to verify the authenticity of these data is low as there is no independent information to connect the data to the fishing event.

Data on the size structure of populations are also obtained during fishery independent surveys in which the first 25 abalone encountered beyond the end of each transect (i.e. up to 150 abalone per site, per year). Where densities of abalone are low, the number collected is the maximum located during a five-minute search period. This includes undersize as well as legal size animals.

Length-frequency data facilitates comparison of proportions above or below various shell lengths of interest such as size limits or estimates of size-at-maturity. At reef code scale, graphs summarising these data are generally used for qualitative rather than quantitative analysis.

4.4 Quality assurance

The VFA follows a process of continual improvement and periodic review which is continuing to evolve from an informal to highly formalised and clearly documented approach. It is important to note that although the Victorian abalone fishery is data-rich at the scale of each management zone, it tends toward the data-poor end of the information spectrum at the reef code scale used for catch reporting. This presents challenges for finer-scale approaches to assessment and management. Grouping reef codes into SMUs is intended to balance information richness with spatial resolution. It is equally important to recognise that all fisheries data have a degree of uncertainty and that the analytical techniques that are applied to draw inferences from the data accommodate that uncertainty.

On-going QA/QC of data management and methods of analysis used to determine the status of the abalone stocks and inform management responses is undertaken and reported on annually. The following sections describe the procedures followed to ensure the production of high-quality assessments.

4.4.1 Fisheries dependent data

An initial check of the data occurs in Fisheries Integrated Licensing System (FILS) during the compliance process VFA employs to reconcile the digital records captured by the IVR with the information recorded on quota dockets. Data imported from FILS into the abalone assessment database are checked and assessed using a number of routines. Data filtering is used to identify and remove outliers in the dataset.

Data records are excluded when either of the following conditions are met.

- Effort recorded is less than one minute;
- Records with no reef code identified; and
- Catch rates greater than or equal to 400kg/hr.

Reef Report Cards are compiled to provide data summaries and charts of catch, effort, CPUE (standardised and nominal), length frequency distribution, pre-recruit and recruit abundance. Charts and data are compared with previous reports to identify any inconsistencies at Zone, SMU and reef code level. If inconsistencies are detected, then data treatment is progressively investigated until the errors are found and rectified. The aim is to detect any potential errors or anomalies prior to undertaking more complex analyses so as to avoid additional costs and delays arising for having to repeat the analyses with corrected data. Nevertheless, situations can arise where it is not until the analytical results are scrutinised that anomalies become apparent.

4.4.2 Fisheries independent data

A standard operating procedure includes comprehensive QA/QC for receiving and entering data acquired from abalone fishery independent surveys.

Data are also checked for inconsistencies, missing data, aberrant data, and outliers within the abalone assessment database. Error checking procedures coded in Structured Query Language (SQL) are applied to scrutinise the data. Outputs from this quality auditing are provided in the form of tables, charts and maps, and include:

- Site location check – VMS records for survey contractors' vessels are downloaded from AFMA's secure website and checked against the fixed site co-ordinates for sites recorded on datasheets to confirm that the vessels were at the specific sites on the recorded dates and times.
- Transect number check: Survey data are collected from each site and each year. Within each site 6 dive transects are conducted. If summaries of numbers of observations indicate that 6 transects have not been completed at one or more sites, then original datasheets are checked. In addition, about 10 – 20 % of datasheets are checked at random to ensure agreement with the electronically stored data. Data are corrected in the database whenever any errors are found.
- Duplicate surveys: Survey data are imported into the database and checked to ensure that these have not already been entered.
- Divers with one or more transects missing: This routine checks for instances where transect counts are present but length frequency data are missing and vice versa. Each output of length frequency should have associated abundance data; and abundance data has associated length frequency data for each given year and site, except in specific instances such as at sites within marine protected areas. This routine checks for inconsistencies for each combination of year and site number.
- Comparison of the relative proportion of juveniles, pre-recruits and recruits counted from transects each year with the relative proportion of juveniles, pre-recruits and recruits counted from length frequency data. The correlation between these should be similar for each site, but not identical because they come from different samples i.e. within transects and from the ends of transects.
- Length frequency distribution charts are plotted by site and by year for all sites to determine whether erroneous data are visually apparent. Note that not all sites are reported in Reef report cards which only include the first and last three years in each series for comparison.
- If inconsistencies are detected, then data treatment is progressively investigated until the errors are found.

Building protocols to check data is an evolving process with the continuing addition of computer coded routines designed to identify potential errors.

Comparing current datasets with data received historically can become problematic in many instances. Changes in reef codes (splitting and merging), and incorporating and removing reef codes from Spatial Management Units will influence how some survey sites are used in subsequent analyses e.g. a survey site might be in SMU A in 2010 but since the SMU was redefined for 2016, it now belongs to SMU B. Consequently, a survey

dataset summarised by SMU might only be applicable in 2016 and not for preceding years when the grouping of sites differed.

Further complicating this has been the addition of new survey sites so that the numbering is no longer geographically sequential. In a very small number of instances old site numbers have been used in error and since corrected.

The type of electronic measuring machine used has created differences in how length-frequency data is managed and merged with historic data. The latest machine has several mechanical and firmware limitations, although the latter have been mostly remedied after extensive discussion with the manufacturer.

A recent report titled “A review of Abalone Survey Data” (DEDJTR 2016c) assesses the quality of independent survey data collected in 2014/15 and 2015/16. Information from data sheets for 368 survey transects was compared with corresponding data stored from the abalone data base. Results indicate that all pre-recruit and recruit numbers were correct and one juvenile abalone was incorrectly recorded. The proportion of errors for the number of juveniles recorded during 2014–15 was 0.003 (0.3%) with 95% confidence interval (-0.002, 0.008).

Length frequency information from data sheets recorded at 44 sites surveyed in 2014–15 were compared with corresponding data from the abalone database. An error of 1.1% was calculated for 2314 records, with lower limit being 0.5% and upper limit being 1.5%.

In summary, the report illustrated that very few errors existed in the dataset, and the impacts of these on analytical outputs were negligible.

4.4.3 Improvement of methods and quality

Continual improvement has been achieved through the engagement of external specialists with expertise in fisheries analysis to review VFA methods for data processing and analysis, as well as continuing to check and correct any anomalies that become apparent in our datasets.

For example, recent reviews upon which VFA has acted to refine its abalone assessments have included:

- Review of Standardization Methods used on Relative Abundance Index data for the Victorian Abalone Fishery (Haddon 2015).
- Technical review of the Victorian abalone stock assessment model of 2015 (Dichmont 2016).
- Standard Operating Procedure - Data Processing for Abalone Fishery Independent Surveys (Fisheries Victoria 2015)
- Review of fixed site surveys used by the Victorian abalone science program (in prep, Hart 2016)

As well as the continued production of an annual QA/QC report, it is intended that third party audits will be conducted periodically to ensure external oversight that the processes conducted by VFA staff and contractors conform to the documented specifications and SOPs, and that where necessary procedures will be amended to deliver improvement in both process efficacy and outcome.

4.5 Future Directions - Harvest strategy development & implementation

A major focus of the current management plan is rebuilding the abalone biomass through the implementation of appropriate harvest strategies for each zone with decision rules that provide clear guidance for future management actions and a formalised approach to setting TACC. This includes comprehensive monitoring programs involving data acquisition and analysis for assessing stock status and for evaluating the performance of the harvest strategies. It is recognised that performance indicators, and each harvest strategy, must be tested over several years to evaluate their effectiveness. This may lead to future changes in the types of data collected and the sampling/survey design.

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APPENDIX I – Data cleaning & GENSTAT model statements

CPUE

SQL data cleaning model statement

```
SELECT [Date]
    ,[Month]
    ,[QuotaYear]
    ,[Zone]
    ,[ReefCode]
    ,[Diver]
    ,[Blacklip]
    ,[Greenlip]
    ,[Effort]
    ,[CPUE]
  FROM [Abalone].[Modelling].[FilteredZoneCPUE]
  order by Zone, [ReefCode], Date
```

Where FilteredZoneCPUE query is

```
SELECT Date, MONTH(CONVERT(DATE, Date, 103)) AS [!Month], QuotaYear AS [!QuotaYear], Zone,
ReefCode AS [!ReefCode], Diver AS [!Diver], Blacklip, Greenlip, Effort, Blacklip / Effort AS CPUE
FROM    Catch.ZoneCatchHistory
WHERE  (Blacklip > 0.0) AND (Blacklip / Effort < 400.0) AND (Effort > 1 / 60.0) AND (NOT (Greenlip > 0.0))
```

GENSTAT model statement

The GLMM model used for CPUE standardization at zone level has the following GenStat code:

Method: Marginal model, c.f. (Breslow and Clayton 2003)

Response variate: CPUE

Distribution: gamma

Link function: logarithm

Random model: Month + DiverID + ReefCode + QuotaYear + (Month.QuotaYear) + (DiverID.QuotaYear) + (ReefCode.QuotaYear)

Fixed model: Constant + QuotaYear

```
GLMM [PRINT=model,monitor,components,vcovariance,means,backmeans,effects,wald;
DISTRIBUTION=gamma;LINK=logarithm; DISPERSION=*; FIXED=QuotaYear;
```

*RANDOM=(Month+DiverID+ReefCode)*QuotaYear; CONSTANT=estimate; FACT=9; PSE=differences,estimates; MAXCYCLE=20; FMETHOD=fixed; MVINCLUDE=*; CADJUST=mean] CPUE*

Abundance

Data cleaning explanatory notes:

1. The filtering. Survey.ResearchDiver.IsValid = 1 - Only use approved divers.

2. The LegislatedSizes establishes the 1992 sizes used to determine the size classes (Rec/Pre/Juv) from the Length Frequency.

3. The analysis of Quota (survey) Year off the date of survey - Different for each dataset

ie....

```
WHEN(YEAR(Date) < = 1999
    AND MONTH(Date) >= 12)
   OR (YEAR(Date) >= 2000
      AND MONTH(Date) >= 9)
THEN YEAR(Date) + 1
ELSE YEAR(Date)
```

4. The old survey dataset is based on old site codes, so there is a translation (underlined below)

```
 FROM Modelling.Transect99
        INNER JOIN Modelling.LengthFreq99 ON Modelling.Transect99.Date =
Modelling.LengthFreq99.Date
                                AND Modelling.Transect99.Site =
Modelling.LengthFreq99.Site
                                AND Modelling.Transect99.Diver =
Modelling.LengthFreq99.Diver
                                AND Modelling.Transect99.Direction =
Modelling.LengthFreq99.Direction
        INNER JOIN Survey.Site ON Modelling.Transect99.Site =
Survey.Site.Oldsitenumber
        INNER JOIN LegislatedSizes ON LegislatedSizes.ReefCode =
Survey.Site.ReefCode
```

5. Catch.ReefSetReportYears.ReportYear = 2019 -- This establishes the reef allocation to Blocks which can change over time. So we use the most recent allocation. (My Blocks are ReefSets!)

6. In summary, there are three separate dataset queries for the three collection types (LF only, Collections on transect, collections at end of transects). The Union ALL just joins them all into one set. See full query below.

SQL data cleaning model statement

```
WITH LegislatedSizes
    AS (SELECT Quota.SizeLimit.ReefCode,
            Size AS LegislatedSize
        FROM Quota.SizeLimit
        WHERE(Year = 1992)
            AND (Species = N'Black'))

/* < 2000 series data... Uses Length Frequencies to obtain the transect size class counts - Join is on OldSite number!!
*/

        SELECT Date,
            CASE
                WHEN(YEAR(Date) < = 1999
                    AND MONTH(Date) >= 12)
                    OR (YEAR(Date) >= 2000
                        AND MONTH(Date) >= 9)
                THEN YEAR(Date) + 1
                ELSE YEAR(Date)
            END AS QuotaYear,
            Site,
            ReefCode,
            Diver,
            Direction,
            SwimLength,
            ISNULL([Juveniles], 0) AS [Juveniles],
            ISNULL([Prerecruits], 0) AS [Prerecruits],
            ISNULL([Recruits], 0) AS [Recruits],
            1 AS Methodology,
            NULL AS Depth
        FROM
        (
            SELECT Modelling.Transect99.Date,
                Survey.Site.Number AS Site,
                Survey.Site.Latitude,
                Survey.Site.Longitude,
                Survey.Site.ReefCode,
                Modelling.Transect99.Diver,
                Modelling.Transect99.Direction,
```

```
            Modelling.Transect99.SwimLength,
            CASE
               WHEN(Modelling.LengthFreq99.Length < LegislatedSizes.LegislatedSize - 40)
               THEN 'Juveniles'
               WHEN(Modelling.LengthFreq99.Length BETWEEN LegislatedSizes.LegislatedSize - 40 AND
LegislatedSize - 1)
               THEN 'Prerecruits'
               ELSE 'Recruits'
            END AS BinLength,
            Modelling.LengthFreq99.Frequency
         FROM Modelling.Transect99
            INNER JOIN Modelling.LengthFreq99 ON Modelling.Transect99.Date =
Modelling.LengthFreq99.Date
                                    AND Modelling.Transect99.Site = Modelling.LengthFreq99.Site
                                    AND Modelling.Transect99.Diver = Modelling.LengthFreq99.Diver
                                    AND Modelling.Transect99.Direction = Modelling.LengthFreq99.Direction
            INNER JOIN Survey.Site ON Modelling.Transect99.Site = Survey.Site.Oldsitenumber
            INNER JOIN LegislatedSizes ON LegislatedSizes.ReefCode = Survey.Site.ReefCode
      ) AS SizeData PIVOT(SUM(Frequency) FOR BinLength IN([Juveniles],
                                          [Prerecruits],
                                          [Recruits])) AS PivotTable
UNION ALL

/* 2000 series data... Uses the ratios from the Length Frequencys to obtain the transect size class counts
NB.  missing 2000-02-19 00:00:00.000 Site 22 Length Frequency. ie. There is a Survey, but no LF
*/
      SELECT Date,
         CASE
            WHEN(YEAR(Date) <= 1999
               AND MONTH(Date) >= 12)
               OR (YEAR(Date) >= 2000
                  AND MONTH(Date) >= 9)
            THEN YEAR(Date) + 1
            ELSE YEAR(Date)
         END AS QuotaYear,
         Site,
         Latitude,
         Longitude,
         ReefCode,
         Diver,
```

```
    Direction,
    SwimLength,
    ISNULL([Juveniles], 0) AS [Juveniles],
    [Prerecruits],
    [Recruits],
    2 AS Methodology,
    NULL AS Depth
FROM
(
  SELECT SiteSizeCounts.Date,
      SiteSizeCounts.Site,
      Survey.Site.Latitude,
      Survey.Site.Longitude,
      Survey.Site.ReefCode,
      SiteSizeCounts.Diver,
      SiteSizeCounts.Direction,
      SiteSizeCounts.SwimLength,
      SiteSizeCounts.BinLength,
      SiteSizeCounts.SizeCount
  FROM
  (
    SELECT Modelling.Transect2000.Date,
        Modelling.Transect2000.Site,
        Modelling.Transect2000.Diver,
        Modelling.Transect2000.Direction,
        Modelling.Transect2000.SwimLength,
        Modelling.Transect2000.AbaloneCount * SiteRatios.Ratio AS SizeCount,
        SiteRatios.BinLength
    FROM
    (
      SELECT SiteSums.Date,
          SiteSums.Site,
          SiteSums.BinLength,
          CAST(SiteSums.Frequency AS FLOAT) / CAST(Totals.Frequency AS FLOAT) AS Ratio
      FROM
      (
        SELECT Modelling.StockAssesment.Date,
            Modelling.StockAssesment.Site,
            SUM(Modelling.LengthFreq2000.Frequency) AS Frequency
        FROM Modelling.LengthFreq2000
```

```
                    INNER JOIN Modelling.StockAssesment ON
Modelling.LengthFreq2000.StockAssessmentID = Modelling.StockAssesment.StockAssesmentID
                GROUP BY Modelling.StockAssesment.Date,
                    Modelling.StockAssesment.Site
            ) AS Totals
            INNER JOIN
            (
                SELECT StockAssesment_1.Date,
                    StockAssesment_1.Site,
                    CASE
                        WHEN(LengthFreq_1.Length < LegislatedSizes.LegislatedSize - 40)
                        THEN 'Juveniles'
                        WHEN(LengthFreq_1.Length BETWEEN LegislatedSizes.LegislatedSize - 40 AND
LegislatedSizes.LegislatedSize - 1)
                        THEN 'Prerecruits'
                        ELSE 'Recruits'
                    END AS BinLength,
                    SUM(LengthFreq_1.Frequency) AS Frequency
                FROM Modelling.LengthFreq2000 AS LengthFreq_1
                    INNER JOIN Modelling.StockAssesment AS StockAssesment_1 ON
LengthFreq_1.StockAssessmentID = StockAssesment_1.StockAssesmentID
                    INNER JOIN Abalone.Survey.Site ON Abalone.Survey.Site.Number =
StockAssesment_1.Site
                    INNER JOIN LegislatedSizes ON LegislatedSizes.ReefCode = Survey.Site.ReefCode
                GROUP BY StockAssesment_1.Date,
                    CASE
                        WHEN(LengthFreq_1.Length < LegislatedSizes.LegislatedSize - 40)
                        THEN 'Juveniles'
                        WHEN(LengthFreq_1.Length BETWEEN LegislatedSizes.LegislatedSize - 40 AND
LegislatedSizes.LegislatedSize - 1)
                        THEN 'Prerecruits'
                        ELSE 'Recruits'
                    END,
                    StockAssesment_1.Site
            ) AS SiteSums ON Totals.Site = SiteSums.Site
                    AND Totals.Date = SiteSums.Date
        ) AS SiteRatios
        INNER JOIN Modelling.Transect2000 ON SiteRatios.Date = Modelling.Transect2000.Date
                            AND SiteRatios.Site = Modelling.Transect2000.Site
    ) AS SiteSizeCounts
    INNER JOIN Survey.Site ON SiteSizeCounts.Site = Survey.Site.Number
```

```
    ) AS TheData PIVOT(SUM(SizeCount) FOR BinLength IN([Juveniles],
                                        [Prerecruits],
                                        [Recruits])) AS PivotTable
    UNION ALL
    SELECT Survey.Survey.Date,
        CASE
            WHEN(YEAR(Date) <= 1999
                AND MONTH(Date) >= 12)
               OR (YEAR(Date) >= 2000
                  AND MONTH(Date) >= 9)
            THEN YEAR(Date) + 1
            ELSE YEAR(Date)
        END AS QuotaYear,
        Survey.Survey.SiteID,
        Site_1.Latitude,
        Site_1.Longitude,
        Site_1.ReefCode,
        Survey.Survey.ResearchDiverID,
        Survey.Transect.Direction,
        30 AS SwimLength,
        Survey.Transect.Juveniles,
        Survey.Transect.Prerecruits,
        Survey.Transect.Recruits,
        3 AS Methodology,
        Survey.Transect.Depth
    FROM Survey.Transect
        INNER JOIN Survey.Survey ON Survey.Transect.SurveyID = Survey.Survey.ID
        INNER JOIN Survey.Site AS Site_1 ON Survey.Survey.SiteID = Site_1.Number
) AS TheData
INNER JOIN Survey.Site ON TheData.Site = Survey.Site.Number
INNER JOIN Catch.Reef ON Survey.Site.ReefCode = Catch.Reef.Code
INNER JOIN Survey.ResearchDiver ON TheData.Diver = Survey.ResearchDiver.Number
INNER JOIN Catch.ReefSetReefs ON Catch.Reef.Code = Catch.ReefSetReefs.ReefCode
                        AND Catch.Reef.Code = Catch.ReefSetReefs.ReefCode
                        AND Catch.Reef.Code = Catch.ReefSetReefs.ReefCode
INNER JOIN Catch.ReefSet ON Catch.ReefSetReefs.ReefSetID = Catch.ReefSet.ID
                    AND Catch.ReefSetReefs.ReefSetID = Catch.ReefSet.ID
                    AND Catch.ReefSetReefs.ReefSetID = Catch.ReefSet.ID
                    AND Catch.ReefSetReefs.ReefSetID = Catch.ReefSet.ID
INNER JOIN Catch.ReefSetReportYears ON Catch.ReefSet.ID = Catch.ReefSetReportYears.ReefSetID
```

```
                AND Catch.ReefSet.ID = Catch.ReefSetReportYears.ReefSetID
WHERE Survey.ResearchDiver.IsValid = 1
    AND (Catch.ReefSetReportYears.ReportYear = 2019)
ORDER BY Site,
        QuotaYear,
        Diver,
        Direction,
```

GENSTAT model statement

Method: Marginal model, c.f. (Breslow and Clayton 2003)

Response variate: Pre-recruits/Recruits

Distribution: negativebinomial

Link function: logarithm

Random model: Diver + Month + SMU + (SMU.ReefCode) + (SMU.ReefCode.SiteID) + (SMU.ReefCode.SiteID.QuotaYear)

Fixed model: Constant + QuotaYear

```
GLMM [PRINT=model,monitor,components,vcovariance,means,backmeans,effects,wald;
DISTRIBUTION=negativebinomial;LINK=logarithm; DISPERSION=*; FIXED=QuotaYear;
RANDOM=Diver+Month+ NEWSMU/ReefCode/SiteID+
NEWSMU.ReefCode.SiteID.QuotaYear;AGGREGATION=1; CONSTANT=estimate; FACT=9;
PSE=differences,estimates; MAXCYCLE=20;FMETHOD=fixed; MVINCLUDE=*; CADJUST=mean] Pre-
recruits
```

APPENDIX II – Standard Operating Procedures for 'Data Collection and Management' and 'Conducting Abalone Surveys: sampling and returning abalone to survey sites and recording data'

VICTORIAN FISHERIES AUTHORITY

STANDARD OPERATING PROCEDURE

Abalone Data Processing and Database Management

INTRODUCTION

This Standard Operating Procedure (SOP) outlines the process for receiving and entering abalone assement data acquired from the VFA Fisheries Integrated Licencsing System (FILS) and Fishery Independent Surveys (FIS). The objectives of this document are to:

1. provide direction to VFA staff and contractors receiving, processing and entering or uploading data into a secure abalone assessment database, and
2. manage that database including the storage and retrieval of data, and maintenance of functionlity,

in conformance with contractual specifications. It also seves as a basis for formally auditing confromance with these processes. The means of analysis and use of these data in the management of Victoria's abalone fishery is described elsewhere (eg VFA 2019 Abalone Methods Report).

SCOPE

This procedure applies to VFA Staff, Casual Staff and Contractors employed to process abalone assessment data.

DEFINITIONS and BACKGROUND

The aim of data collection about Victorian abalone populations and the commercial fishery they support is to provide time series of catch rate, relative abundance and size structure that can be aggregated and analysed for defined Spatial Management Units (SMU). Catch and effort data have been consistently reported at reef code scale since the late 1970s and fisheries independent surveys have been conducted at fixed monitoring locations or sites since 1989/90, although the number of sites surveyed, the survey design and the data colletion method have changed over time.

Catch and effort

The following procedure describes the standard operating procedure for processing and checking abalone catch and effort data acquired from docket (log) books prior to extracting the required fields and forwarding these to VFA science staff for uploading into the abalone assessment database. There is a total of 176 active reef codes grouped into 23 spatial management units among the three zones (Central Zone 94, Eastern Zone 44 including 10 Mallacoota Airport codes, and Western Zone 38).

DATA ENTRY & VERIFICATION (DOCKETS & ATC's)

The screens for data entry are on the AQMS menu, listed as **Docket Transaction** and **ATC Transaction**.

Abalone Dockets

Specific docket books are allocated to each Access Licence Holder/diver (see the Abalone Docket Book section of the procedures for sending out supplies). The diver fills in Parts A and B of the white (original) copy of the docket and the AR fills in Part C of the yellow (duplicate) copy.

- Enter the docket number in the Docket Serial No field. The other docket fields will then be shown on the screen.
- Enter any information on the docket that is not already displayed for the licence (not all the information is recorded electronically (eg bin tag numbers, name of transporter) and check any information displayed against what has been recorded on the docket.
- In the Docket Status area of the docket screen there is a field to select if the Diver and/or the Receiver have signed the docket. A tick will appear in the box and default of No will change to Yes once you click the mouse in the small field next to each option.
- Also in the Docket Status area there is drop down menu against Diver and Receiver, the options to select here are Not Received (the default), Received – Not Verified and Received – Verified. If the docket has been signed and all the information on the docket for either Diver or Receiver is correct select Received – Verified for the relevant copy of the docket.

- If there is any information that has not been completed, does not match the reported information or is anomalous select Received – Not Verified for the relevant copy of the docket. You will need to send a letter to the diver or receiver to get verification of the correct information.
- For those dockets that haven't been received by AQMS (eg there is a gap in the sequence and the date is more than 2 weeks ago) write a letter and fax to the relevant diver or AR requesting they forward the docket or a copy.

Replies to letters sent out by AQMS & alterations to AQMS

You may receive a fax or letter (and sometimes both) advising of an error that has been made with respect to AQMS documentation (eg an ATC or an abalone docket) from either an AR or a diver.

Letters sent out are kept in 2 files, one for Abalone Access Licences and one for ARs. The letters are filed in licence number and AR name order respectively.

- Stamp the document with the date received
- Count up the amount of errors/documents the letter is explaining for, and take that amount of photocopies
- Stamp the photocopies with the COPY stamp and tick the original letter to indicate that copies have been made and attached/filed
- All original letters are attached to the docket/ATC UNLESS it is a stat dec, or if it relates to more than 2 or more docs/ATC's
- We need to ensure we have a letter attached to the doc/ATC, and ensure a letter is attached to the requesting letter and filed in the correspondence file of the diver/processor
- See if there is a letter in 'awaiting reply' docket/ATC folder, if so, attach and file in correspondence. Also go into excel 'aqms logbook' (either ATC errors or docket errors) and complete column F (date of reply)
- Amend on AQMS, and remember to change to 'verified' on the system. REMEMBER ONLY CHANGE WEIGHTS IF YOU HAVE A STATUTORY DECLARATION.

CHECKING ABALONE DOCKETS AND ATC'S

Checking Abalone Dockets

- Enter any outstanding dockets for the licence.
- Create and print a Catch Report by Licence:
  Go to the AQMS Menu, click on **AQMS**
  Click on **Diver/Docket Reports**
  Click on **Catch report by Licence**
  Number = **enter the licence number** (numbers only)
  Start Date **= 01/04/??** (beginning of this quota year)
  End Date = **31/03/??** (end of this quota year)
  Then select **Ok** (to process the report)
- This report will now be displayed on the screen. Click in the report and then **CtrlP** to print. If there has been more than one dive operator on the licence for the quota year the report will have separate pages for each one.
- Check and tick off the report: the diver net weight, tare weight and total estimated weight on the report, against the weights on the dockets for any dockets that have not yet been checked (those in front of the orange cardboard), place a tick against each weight if correct.
- If a weight is not correct send a letter to the diver to get verification via a stat dec of the correct weight (however a stat dec is not required if the weight difference is under 1kg)
- For those dockets that haven't been received by AQMS write a letter and fax to the relevant diver or AR requesting they forward the docket or a copy.
- Move the orange cardboard so that it is placed in front/on top of the most recent docket you have checked and file the Catch Report you have ticked in front of the orange card.

Fishery independent surveys

Whereas 73 fixed sites have been surveyed annually since 1995, during 2015/16, 204 sites were surveyed in total. Currently 143 sites are surveyed with 57 in the Central Zone, 63 in the Eastern Zone, and 23 in the Western Zone.

The surveys are designed to provide analytical data for:

- Statistical trends in emergent (pre-recruit) blacklip abalone population abundance
- Trends in recruit abundance
- Population length frequency statistics
- Ecological and habitat information

The precise co-ordinates and characteristics of each site are fully described and have been photographed both above and below the waterline. Most are located close to shore in depths ranging from about 5 to 18 metres, although there are exceptions at both ends of this range where the underwater terrain supports predominantly shallower or deeper populations. At each site all abalone are counted within six belt transects, which are strips of bottom 30 m long by one metre wide radiating out from a fixed central point marked by a buoyed shot-line. Transects directions are selected at random from 12 cardinal radii spaced at 30 degree arcs from due north (0 degrees). Each transect survey commence at 5-m distance from the central point such that the diameter of the survey site is effectively 70 m and its area is 3850 m^2. Research divers count abalone into three categories: juveniles under 80 mm (or 70 mm) shell length, and larger abalone below and above the legal minimum length. At the end of each transect 25 abalone are collected as far as possible without bias and brought aboard the boat where their shell lengths are measured to the nearest millimetre using an electronic shellfish measuring machine. As far as practicable, two research divers equally share the survey at each site to facilitate statistical analyses that account for variation among observers.

DATA PROCESSING SAFETY WARNINGS

- Ensure long periods at the computer entering data are avoided, to minimise fatigue and repetitive strain injuries.
- Ensure correct posture while entering data i.e. computer screen should be at eye level, feet flat on the floor, back straight and supported.

PRINCIPLES AND STANDARDS

- It is the Leading Scientist's responsibility to ensure that the procedure is followed correctly.
- Staff must adhere to the Safety Warnings outlined in this SOP.
- Supervisors are responsible for ensuring all measures are in place before staff are directed to perform the described task.
- Staff are primarily responsible for their own health when performing tasks.
- Be aware of possible fatigue.
- Be aware of any risks of repetitive strain injuries.

EQUIPMENT:

- Datasheets (may be received as electronically scanned versions)
- Computer with high speed internet access
- Metal ruler, pens, pencils, erasers.
- Appropriate handouts/stickers, check lists.
- Equipment for receiving and validating data: Date received stamp and a **red** pen for any corrections.
- Equipment for data entry: computer, adjustable seating, mouse pads, wrist rests, screen covers etc.
- Data checking: printouts from the relevant data/database and sticky labels.
- Copies of relevant procedures.

BEFORE CHECKS

The Leading Fisheries Scientist must ensure:

- Staff have completed Departmental Induction Course.
- Staff are aware of Departmental Occupational Health and Safety Procedures.
- Expertise and personal skills match the task at hand.

- Staff are provided with the equipment as listed in the above Equipment List.

Data Manager must ensure:

- Equipment has been provided for receiving and validating data as listed in the above Equipment List.
- Equipment has been provided for data entry: computer, adjustable seating, necessary mouse pads, wrist rests, screen covers etc.

CHECKING PROCEDURE

Data manager must undertake a consistency cross check of cover sheets against data sheets for survey dates, site order, logged times and site numbers; additionally checking for changes in site numbers (a post-entry data filter based on an appropriate algorithm can be applied to check for duplicate site numbers on different dates and then cross check these against logged GPS coordinates).

Data manager must be aware of the two most common kinds of errors in measurement associated with Scielex Shellfish Measuring Machines:
i) one associated with vibration depending on the variation from stop tolerance that has been set (default 4 mm recommended); this can result in a number of measurements 1 mm (or larger) greater than the width of the stop plate.
Vibration errors at the start or end of a site are easily identified and filtered during the uploading process. However, clusters of spurious measurements do not always occur at the start of a site and up to 6 mm of jaw movement can be recorded erroneously.

ii) a succession of length registrations in between measurements of unexplained origin. In the field the operator records the observation number that they see on the screen associated with the first and last abalone measured at a site, giving a running total, and on some occasions additional measurement inadvertently occurs in between these. These additional logged lengths are seen in the data when the csv file is opened using Excel where the row numbers do not match observation numbers recorded on the datasheets.
These mismatches in the data are more problematic errors that must be assessed and filtered manually.

Data Manager advises Data Entry Contractor of required corrections to data sheets to, and ABase Manager of required corrections to length files, sending excel files of logger data with comments/corrections changes to be made identified by highlighting: red to delete, yellow to change.

PROCEDURE

Who	Tasks	Notes/Details
Data Manager (VFA)	**1. DATA PROCESSING/CHECKING:** **Data sheets and Measurement Data from Dive Surveys** • Check datasheets are complete and as accurate as possible. Check site details, diver name, and date on each page and ensure handwriting is legible. • Cross check datasheets with Daily Activity Sheet; site details (names and numbers) and date of survey. • Check length data in csv files for error types as above, by opening in Excel and cross checking length record numbers and values on datasheets against values in excel file. • On completion of data validation, record datasheets received on Project Management Data tracking excel file, including Survey file name and type e.g. Port Fairy1.csv, data type, e.g. LF, Date of receipt of file, Contractor, and Sites for which data and/or datasheets have been received. Additionally note	

Who	Tasks	Notes/Details
	null abalone sites, and comments.. • Forward datasheets with inconsistencies/errors/corrections noted to Data Entry Contractor and excel files with inconsistencies/errors/corrections to Database Manager by email as soon as possible. • Contractors follow up using their logbooks for reference. • Report/follow up on any issues experienced and actions undertaken in response.	
Office Staff	**2. DATA ENTRY** • Open appropriate database. • Ensure comfortable posture in front of the computer. • Mark any changes to data with red pen, initial and date. • Give eyes regular breaks from the screen by looking off into the distance, and walk around at least once an hour for a couple of minutes. • When completed entering a survey for one site, diver, or a whole day, stamp the Daily Activity Sheet with the *Entered* stamp, current date and initials. • Record data entry activity in logbook for future audit. • Return entered sheets to Departmental Abalone Research Staff for filing.	
Office Staff	**3. QUALITY ASSURANCE OF DATA ENTRY PROCEDURE** • Twenty percent of data will be randomly re-checked annually. • Printouts will be provided for validation. Any corrections need to be marked/highlighted using red pen. • Place a tick to right of line when data has been checked. • Write "*Checked*" with your initials and the date at the bottom of each Datasheet and Daily Activity Sheet. • When corrections are made to the relevant database, initial and date each record on the printouts in another colour pen or pencil. • Store printouts in a folder and label as "*Data checking printouts"* once corrections have been made. • All data are backed up to Departmental server.	
Office Staff	**5. DATA FILING** • Collate Survey data sheets by Zone, Day, Month and Year and file in folders by month in dedicated storage area.	
Data Manager (VFA)	**5. DATA TRANSFER & UPLOAD TO DATABASE** • Submit digital data via electronic transmission to the contracted Database Manager to enable uploading into the Abalone Assessment Database on AWS.	

Who	Tasks	Notes/Details
Data Manager (VFA)	**6. DATA SECURITY** • Original datasheets are to be stored in a secure dedicated location at the Fisheries Victoria Queenscliff site (currently Room where Catch and Effort returns are archived) and scanned copies stored in a suitable format (protected pdf) on a Departmental server. • Data are not to be shared with unauthorised users and external requests for data, notwithstanding FOI requests, shall follow a prescribed procedure currently under review by Fisheries Victoria.	
Data Manager (VFA)	**7. NON-CONFORMANCE** • Instances of contractor non-conformance with procedures for data recording, transfer, entry, checking and record keeping must be recorded. • A performance summary is to be drafted by the Data Manager and sent to the Leading Scientist for follow-up action.	

RELATED DOCUMENTS

- VFA Quality Policy
- DJPR - VFA Core Values and Behaviours
- DJPR - VFA Occupational Health and Safety Policy
- DJPR - VFA First Aid Procedure
- DJPR - VFA Occupational Health and Safety Incident Reporting Procedure
- DJPR - VFA Fatigue Management Procedure
- DJPR - VFA Job Safety Analysis and Standard Operating Procedure

FURTHER INFORMATION

Enquiries regarding this procedure should be directed to:

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Approval date:	**30 JUNE 2019**
Review Due Date:	**30 JUNE 2022**

REVISION

Section Revised	Change (describe)	Who	Date	Authorised By:
Comprehesive	Update & addition of fishery dependent data procedures & dockets	Harry Gorfine	21 June 2019	Simon Conron

APPENDICES

- Fishery dependent data —
    - processing and checking procedure for the Abalone Quota Management System (AQMS) in the Fisheries Information and Licensing System (FILS)
    - Abalone dockets
- Fishery independent data —
    - User Guide - Data Entry and Validation for the Victorian Abalone Fishery– Independent Research Surveys
    - Field datasheets

APPENDICES

Fishery dependent data

Examples of dockets are included as canned images on the following pages; the ABALONE DOCKET (eastern zone) differs from the ABALONE DOCKET (western zone) in that it only has proiiovision for recording blacklip abalone catch and effort information. The Centeral Zone docket has an indentical format to the Western Zone docket.

Serial Number 111451 **ACCESS LICENCE NUMBER A**

ABALONE DOCKET (eastern zone)

PART A- RESOURCE MANAGEMENT - TO BE COMPLETED BY AN ABALONE FISHERY ACCESS LICENCE HOLDER OR ANY PERSON AUTHORISED TO ACT UNDER THAT LICENCE

IF AN AIRPORT DAY PLEASE TICK THE BOX ☐

REEF CODE	ESTIMATED DIVING TIME per reef code		NUMBER OF **BINS** of BLACKLIP per reef code	**ACTUAL NET WEIGHT** OF BLACKLIP ABALONE IN KILOGRAMS per reef code
	HOURS	MINUTES		

PART B - QUOTA MANAGEMENT - TO BE COMPLETED BY AN ABALONE FISHERY ACCESS LICENCE HOLDER OR ANY PERSON AUTHORISED TO ACT UNDER THAT LICENCE

NOMINATED DIVER'S NAME _____ NOMINATED DIVER'S PERSONAL FILE NUMBER _____

TIME OF LANDING _____ (24 HOURS) DATE OF LANDING _____ BOAT REGISTRATION _____

PLACE OF LANDING _____ FULL NAME OF DECKHAND/S _____

NUMBER OF BINS OR BAGS OF ABALONE LANDED _____ FIGURES _____ WORDS

TOTAL TARE WEIGHT (IN KILOGRAMS) OF BINS OR BAGS (INCLUDING BIN LIDS & INSERTS)

_____ FIGURES _____ WORDS

SERIAL NUMBERS OF BIN TAGS AFFIXED TO BINS OR BAGS OF ABALONE LANDED _____

FULL NAME OF PERSON OR CARRIER TRANSPORTING ABALONE _____

ABALONE IS TO BE DELIVERED TO _____
Full name of licensed fish receiver (abalone) to whom abalone is being delivered

TIME OF WEIGHING _____ (24 HOURS) TOTAL NET WEIGHT OF UNSHUCKED ABALONE (IN KILOGRAMS) _____ FIGURES

_____ WORDS

NOTIFICATION SERVICE DETAILS: CONFIRMATION NUMBER _____

I CERTIFY THAT THE INFORMATION PROVIDED IN PARTS A & B OF THIS DOCKET IS TRUE AND CORRECT IN EVERY DETAIL.

SIGNED _____ DATED _____

PART C - TO BE COMPLETED BY LICENSED FISH RECEIVER (ABALONE)

NOTIFICATION SERVICE DETAILS: CONFIRMATION NUMBER _____

ABALONE FIRST RECEIVED BY _____ TRADER NUMBER _____

AT _____ TIME OF RECEIPT _____ (24 HOURS) DATE OF RECEIPT _____
To be completed if abalone not received at licensed premises

TIME & DATE ABALONE ENTERED LICENSED PREMISES _____ (24 HOURS) ON _____

TOTAL NET WEIGHT OF UNSHUCKED ABALONE (IN KILOGRAMS)

_____ FIGURES _____ WORDS

I CERTIFY THAT THE INFORMATION PROVIDED IN PART C OF THIS DOCKET IS TRUE AND CORRECT IN EVERY DETAIL.

SIGNED _____ (print full name) _____ DATED _____

INSPECTION DETAILS: LICENCE NUMBER OF ENTITY INSPECTED _____ DATE OF INSPECTION _____

NAME OF AUTHORISED OFFICER _____ SIGNATURE _____

Serial Number 77301

ACCESS LICENCE NUMBER A

ABALONE DOCKET (western zone)

PART A- RESOURCE MANAGEMENT - TO BE COMPLETED BY AN ABALONE FISHERY ACCESS LICENCE HOLDER OR ANY PERSON AUTHORISED TO ACT UNDER THAT LICENCE

LML PRIOR REPORT NUMBER/S _____

REEF CODE	ESTIMATED DIVING TIME per reef code		NO. OF BINS of **BLACKLIP** per reef code	ACTUAL WEIGHT OF BLACKLIP ABALONE IN KILOGRAMS per reef code	NO. OF BINS of **GREENLIP** per reef code	ACTUAL WEIGHT OF GREENLIP ABALONE IN KILOGRAMS per reef code
	HOURS	MINUTES				

PART B - QUOTA MANAGEMENT - TO BE COMPLETED BY AN ABALONE FISHERY ACCESS LICENCE HOLDER OR ANY PERSON AUTHORISED TO ACT UNDER THAT LICENCE

NOMINATED DIVER'S NAME _____ NOMINATED DIVER'S PERSONAL FILE NUMBER _____

TIME OF LANDING _____ (24 HOURS) DATE OF LANDING _____ BOAT REGISTRATION _____

PLACE OF LANDING _____ FULL NAME OF DECKHAND/S _____

NUMBER OF BINS OR BAGS OF ABALONE LANDED _____ FIGURES _____ WORDS

TOTAL TARE WEIGHT (IN KILOGRAMS) OF BINS OR BAGS (INCLUDING BIN LIDS & INSERTS)

_____ FIGURES _____ WORDS

SERIAL NUMBERS OF BIN TAGS AFFIXED TO BINS OR BAGS OF ABALONE LANDED _____

FULL NAME OF PERSON OR CARRIER TRANSPORTING ABALONE _____

ABALONE IS TO BE DELIVERED TO _____
Full name of licensed fish receiver (abalone) to whom abalone is being delivered

TIME OF WEIGHING _____ (24 HOURS) TOTAL NET WEIGHT OF UNSHUCKED ABALONE (IN KILOGRAMS) _____ FIGURES

_____ WORDS

NOTIFICATION SERVICE DETAILS: CONFIRMATION NUMBER _____

I CERTIFY THAT THE INFORMATION PROVIDED IN PARTS A & B OF THIS DOCKET IS TRUE AND CORRECT IN EVERY DETAIL.

SIGNED _____ DATED _____

PART C - TO BE COMPLETED BY LICENSED FISH RECEIVER (ABALONE)

NOTIFICATION SERVICE DETAILS: CONFIRMATION NUMBER _____

ABALONE FIRST RECEIVED BY _____ TRADER NUMBER _____

AT _____ TIME OF RECEIPT _____ (24 HOURS) DATE OF RECEIPT _____
To be completed if abalone not received at licensed premises

TIME & DATE ABALONE ENTERED LICENSED PREMISES _____ (24 HOURS) ON _____

TOTAL NET WEIGHT OF UNSHUCKED ABALONE (IN KILOGRAMS)

_____ FIGURES _____ WORDS

I CERTIFY THAT THE INFORMATION PROVIDED IN PART C OF THIS DOCKET IS TRUE AND CORRECT IN EVERY DETAIL.

SIGNED _____ (print full name) _____ DATED _____

INSPECTION DETAILS: LICENCE NUMBER OF ENTITY INSPECTED _____ DATE OF INSPECTION _____

NAME OF AUTHORISED OFFICER _____ SIGNATURE _____

Fishery independent data

User Guide
Data Entry and Validation for Victorian Abalone Fishery — Independent Surveys

Abalone abundance surveys are carried out at multiple locations during the same day with each trip typically taking several successive days. Sea conditions and diving (hyperbaric) exposure are key limiting factors. Data are collected by trained research divers in accordance contract specifications, a SOP and safety considerations.

General comment. Data entered into the databases needs to be spelt exactly the same way each time for things that are the same. For example, if Port Phillip Bay is sometimes spelt Port Phillip bay, with a lower case b, then the water body will be recognised as different. Correct spelling is essential for data extraction and analysis. All fields on each datasheet must be completed, including recording *Nil* or *NA* where approriate. There should be no blank fields on the forms.

General validation rules.

- Validate data using a red pen ONLY.
- Write "Validated" then Date and initial front of Daily Activity Sheet when all information for that day have been validated.
- Subsequent validations need to be dated and initialled using a different colour pen at the bottom of the page.
- Check *Dates, Start* and *Finish* times, *Sites, Direction*s, *Divers*, and *Contractor check* details are completed.
- Change times to 24 hour clock if they aren't already.

An example of the datasheet competed by research diving contractors dyring field surveys is on the following page. The data sheets are printed on water proof synthetic sheets and filled out using a greylead pencil.

Fishery Independent Abalone Survey *Checked by contractor rep: _____* *Signed: _____* *Date: ___/___/ 20___*

Location	Site # ____ Site name _____			Date: _____ Start: _____ h Finish: _____ h		
Diver	#			#		
Transect counts	1 Dir _____ °	2 Dir _____ °	3 Dir _____ °	4 Dir _____ °	5 Dir _____ °	6 Dir _____ °
• Recruit abalone						
• Pre-recruit abalone						
• Juvenile abalone						
• Empty ab shell						
• Black urchins (EZ only)						
Length Frequency (Log/Manual)	Qty: Min:	Qty: Min:	Qty: Min:	Qty: Min:	Qty: Min:	Qty: Min:
Location	Site # _____ Site name _____			Date: _____ Start: _____ h Finish: _____ h		
Diver	#			#		
Transect counts	1 Dir _____ °	2 Dir _____ °	3 Dir _____ °	4 Dir _____ °	5 Dir _____ °	6 Dir _____ °
• Recruit abalone						
• Pre-recruit abalone						
• Juvenile abalone						
• Empty ab shell						
• Black urchins (EZ only)						
Length Frequency (Log/Manual)	Qty: Min:	Qty: Min:	Qty: Min:	Qty: Min:	Qty: Min:	Qty: Min:
Location	Site # _____ Site name _____			Date: _____ Start: _____ h Finish: _____ h		
Diver	#			#		
Transect counts	1 Dir _____ °	2 Dir _____ °	3 Dir _____ °	4 Dir _____ °	5 Dir _____ °	6 Dir _____ °
• Recruit abalone						
• Pre-recruit abalone						
• Juvenile abalone						
• Empty ab shell						
• Black urchins (EZ only)						
Length Frequency (Log/Manual)	Qty: Min:	Qty: Min:	Qty: Min:	Qty: Min:	Qty: Min:	Qty: Min:

Note: do not leave any blank cells; write NA or Nil if the field does not apply or there are no data. “Log/Manual” strike one whichever does not apply.
Ver. 2019 1.1

VICTORIAN FISHERIES AUTHORITY

STANDARD OPERATING PROCEDURE

Conducting Abalone Surveys: sampling and returning abalone to survey sites and recording data

INTRODUCTION

This Standard Operating Procedure (SOP) outlines the process for sampling and returning abalone to suitable habitat after being measured aboard the vessel during Abalone Fishery Independent Surveys. The objectives are to provide direction under an SOP and verification of the divers' adherence to survey protocols and research permit conditions via sampling of video recordings. It is important to standardise the use of the video cameras and the type of footage taken, how this video footage is delivered to Victorian Fisheries Authority and the process used to check the video file imagery. The checking and auditing process of the data sheets and video footage is also outlined for quality assurance.

SCOPE

This procedure applies to Contractors and Victoria Fisheries Authority staff employed to monitor, undertake and survey the information gathered during Abalone Fishery Independent Surveys.

DEFINITIONS and BACKGROUND

The aim of fishery independent surveys of Victorian abalone populations is to provide a time series of relative abundance and size structure at each survey site that can be aggregated and analysed for defined Spatial Management Units (SMU). Fisheries independent surveys have been conducted since 1989/90, although the number of sites surveyed and the survey method have changed over time. Whereas 57 fixed sites have been surveyed annually since 1992, 204 sites were surveyed from 2004 until 2017 when the number was reduced to 143 in total.

The surveys are designed to provide analytical data for:

- Statistical trends in emergent (pre-recruit) Blacklip abalone population abundance
- Trends in recruit abundance
- Population length frequency statistics
- Ecological and habitat information

At the end of each transect 25 abalone are collected as far as possible without bias and brought aboard the boat where their shell lengths are measured to the nearest millimetre. As far as practicable, two research divers equally share the survey at each site to facilitate statistical analyses that account for variation among observers.

This SOP is to ensure that any stress to the Abalone is minimised during the time of measurement and redeloyment back to the survey site. The procedures and process will be outlined so that periodic quality assurance checks can also take place.

RETURNING ABALONE SAFETY WARNINGS

- Contractors to follow the commercial diving standards that satisfy the requirements of AS/NZ 2299.1:2007;
- Divers are to adhere to no decompression bottom time limits for each dive;
- Ensure divers are well hydrated, have adequate thermal protected, and are fit to dive.

PRINCIPLES AND STANDARDS

- Contracters and staff must adhere to the Safety Warnings outlined in this SOP;
- Contracters and staff are primarily responsible for their own health when performing tasks;
- Contractors shall maintain awareness of diving and boating related injuries and be vigilant to changing conditions whilst at sea;
- Health and safety considerations take absolute priority over any other requirement in this SOP.

EQUIPMENT:

- Go Pro Camera or equivalent;
- Go Pro or equivalent accessory attachments to provide Point Of View (POV) recording;
- Back-up memory Card and Camera battery;
- Datasheets (may be received as electronically scanned versions);
- Electronic measuring board;
- USB memory sticks to save video footage;
- Transect line;
- Float line;
- Container for carrying abalone.

PRE-SURVEY CHECKS

Contract cruise leader must ensure that:

- Video camera equipment is prepared according to manufacturer's instructions;
- There is adequate storage space on the memory card;
- The camera batteries are fully charged and there are spare batteries;
- All diving equipment and survey equipment is aboard and in good working condition;
- Staff are aware of Departmental Occupational Health and Safety Procedures;
- A dive plan has been completed in accordance with AS/NZ 2299.1:2007;
- Expertise and personal skills and capabilities match the task at hand.

Victorian Fisheries Authority Technical Officer must ensure that:

- VFA has received a copy of the video footage within two weeks of the field trip and receipt is acknowledged to the contractor and recorded in a manner suitable for reporting using the DJPR Contract Managment System &/or Contract Managment Interface as appropriate;
- This footage is to be saved to the B Fish drive on DJPR intranet within two days of receiving the footage.

CHECKING PROCEDURE

VFA Data Manager must undertake a consistency cross check of cover sheets against data sheets for survey dates, site order, logged times and site numbers; additionally checking for changes in site numbers (a post-entry data filter based on an appropriate algorithm can be applied to check for duplicate site numbers on different dates and then cross check these against logged GPS coordinates). This information is checked against the video file names.

PROCEDURE

Who	Tasks	Notes/Details
Cruise Leader and Diver	**1. PRE DIVE CHECK** • Check dive and surface supply equipment; • Establish a planned bottom time taking into account the no decompression limit, tasks involved and the environmental conditions; • Ensure that the diver understands the dive plan; • Check the camera has the correct settings with adequate memory available on the data card and time remaining on the battery; • Check video settings: Frames per Second 24. Video Resolution 1080 FOV - W • Ensure that the drop line is securely on site and the vessel is displaying a Type A dive flag.	
Cruise Leader and Deckhand	**2. MEASURING OF ABALONE ON VESSEL** • Abalone are to be kept moist and as much as possible shaded from direct sunlight during the measuring process; • Whilst waiting for the diver to re-deploy the abalone back to the survey site, the abalone are to be kept in seawater ; • Have camera clipped to the bag containing the abalone.	
Diver	**3. RETURNING ABALONE BACK TO THE SITE OF ORIGIN** • Ensure the camera is recording; • Write on slate to label > date, and site; • Video Label; • Slowly and carefully video the crevice prior to replacing the abalone; • Return the abalone back to suitable habitats such as crevices at the survey site; • Ensure the abalone are carefully placed onto the substrate with the foot down; • Write on slate to label > date, and site; • Video new label; • Slowly and carefully video the crevice after replacing back the abalone; • Return to the vessel.	
Cruise Leader and diver	**4. POST DIVE** • Check that the camera has successfully recorded the work; • Complete all fields in the survey data sheet; • Set up the camera for the next dive.	
Cruise Leader	**5. POST TRIP** • Download and name the video files; • Naming convention for video file **yymmdd-site#-FIS-LF-ARSS or KINA ;** • Copy Video files onto USB stick Send the USB to **Kylie Hall,** Fisheries Scientist, Victorian Fisheries Authority, **VFA, PO Box**	

Who	Tasks	Notes/Details
	114, 2A Bellarine Highway Queenscliff, Victoria 3225. T: 03 5258 0281 M: 0409 279222 within **10 working days.**	
VFA Technical Officer	**5. PROCESSING VIDEO DATA** • Make a copy of the video files and save to **FILE NAME;** • Use video program to capture Five (**5**) **s**till images of diver returning abalone after each transect line; • Make notes about the images **USING DATA SHEET;** • Save this data sheet **FILE NAME;** • **Send copies of QA notes and summaries to Fisheries Scientist.**	
Leading Practising Scientist	**6. NON-CONFORMANCE** • Instances of contractor non-conformance with procedures for data recording, transfer, entry, checking and record keeping must be recorded. • A performance summary is to be drafted by the Data Manager and sent to the Leading Scientist for follow-up action including written notification of contractors and documentation of any remedial action.	
VFA Contact Administrator	**7. CONTRACT MANAGEMENT** • QA documents summarising contract compliance and instances of non-conformance with SOP or contract specifications to be uploaded to the DJPR Contract Management Interface CMI); • Ensure that data are not sent for data entry or Abase upload until QA checks completed; • Email sent to Leading Practising Scientist to confirm each instance of receipt of valid datasheets; video; size frequency data; as well as summaries from periodic cross-checking to confirm compliance with contract specifications**.**	

Key Performance Indicators

Indicator	Target	Achieved	Future Measure(s) to Achieve KPI's
Transect counts of abalone	The 80th percentile of the mean of the differences between any pair of divers during the same survey season shall not exceed 10% of the largest of each pair of values.		
Number of shell length measurements	Where less than 150 abalone have been measured in any site during a single survey-season, the number measured should be in relative proportion to the abundance total for that site.		
Recording of information	All data sheets should be completed accurately, legibly and in full in the field.		All data sheets will be double-checked by contractor, and then double-checked again with particular attention to possible typo errors in directions of transect counts.
Electronic shellfish measuring boards & calipers maintained in serviceable condition	Evidence that the protocols for testing, operating and maintaining this equipment are followed precisely, documented, dated and signed by an authorised representative of the contractor.		These cannot be observed until files are downloaded and checked upon return to the Contractor's office. Any machine software errors will be notified with Scielex (the machine manufacturer and software provider).

RELATED DOCUMENTS

- Victoria Fisheries Authority Quality Policy
- VFA Core Values and Behaviours
- VFA Occupational Health and Safety Policy
- VFA First Aid Procedure
- VFA Occupational Health and Safety Incident Reporting Procedure
- VFA Fatigue Management Procedure
- VFA Job Safety Analysis and Standard Operating Procedure

FURTHER INFORMATION

Enquiries regarding this procedure should be directed to:

Mr Simon Conron, Leading Fisheries Scientist,
Victorian Fisheries Authority

Manager:	**SIMON CONRON**
Writer:	**BRENT WOMERSELY**
Owner:	**SIMON CONRON**
Reviewer(s):	**SIMON CONRON, JUSTIN BELL, PAUL HAMER**
Approver:	**SIMON CONRON**
Approval date:	
Review Due Date:	**As required**

REVISION

Section Revised	Change (describe)	Who	Date	Authorised By:
Fisheries Victortia DEDJTR references & logo to VFA & DJPR Added Contractor KPIs	changed to VFA JAMES ANDREWS changed to SIMON CONRON Shaded in blue to assist field observer	Harry Gorfine	21 June 2019	Simon Conron