D'ENTRECASTEAUX CHANNEL SCALLOP SURVEY AND STOCK STATUS: 2017

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July 2017

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Table of Contents

Summary 1
Background 2
Methods 2
    Video survey 3
    Dive survey 5
    Comparison of survey methods 5
Results/Discussion 6
    Scallop densities 6
    Size structure 10
    Comparison of survey methods 10
    Cost-benefit comparison 13
Stock status – D'Entrecasteaux Channel Scallops 13
Conclusions 14

Summary

Commercial and Doughboy Scallops remain overfished and in very low densities in the D’Entrecasteaux Channel. Genetic studies suggest that the Commercial Scallop population in the Channel is heavily reliant on self-recruitment and as such it will be necessary to rebuild the adult stock significantly before any fishery for this species could be justified.

While moderate densities of Queen Scallops were present they appeared to be restricted to small and isolated beds in the central Channel region. There was evidence of a number of cohorts in the Queen Scallop population, suggesting some limited recruitment in recent years. The dominant size class was in the 80-90 mm range, with relatively few individuals larger than 100 mm.

The low standing stock of legal-sized Queen Scallops, overall limited area of the main beds and very low abundances of both Commercial and Doughboy Scallops provide no scientific basis upon which to expect any recovery of stocks that would justify a scallop fishery in the D’Entrecasteaux Channel for at least the next 3-5 years.

Background

Low stock levels and poor recruitment lead to the 2011 closure of the D'Entrecasteaux Channel recreational scallop fishery. This report summarises the findings of a survey of the D'Entrecasteaux Channel scallop stocks conducted in June 2017.

The primary objective was to provide a preliminary assessment of the status of the scallop stocks and determine whether there was evidence of recovery that would justify a more extensive survey and consideration of re-opening the area to fishing. A secondary objective was to assess the accuracy of a towed video methodology as a cost-effective alternative to the traditional diver survey methodology.

Methods

Sixty two sites throughout the D'Entrecasteaux Channel were surveyed annually between 2006 and 2012. A subgroup of 23 sites were selected for sampling in the 2017 survey on the basis of high historical scallop densities (Fig. 1). All sites were surveyed with a towed video camera, and a subgroup of sites were also surveyed by diver transect.

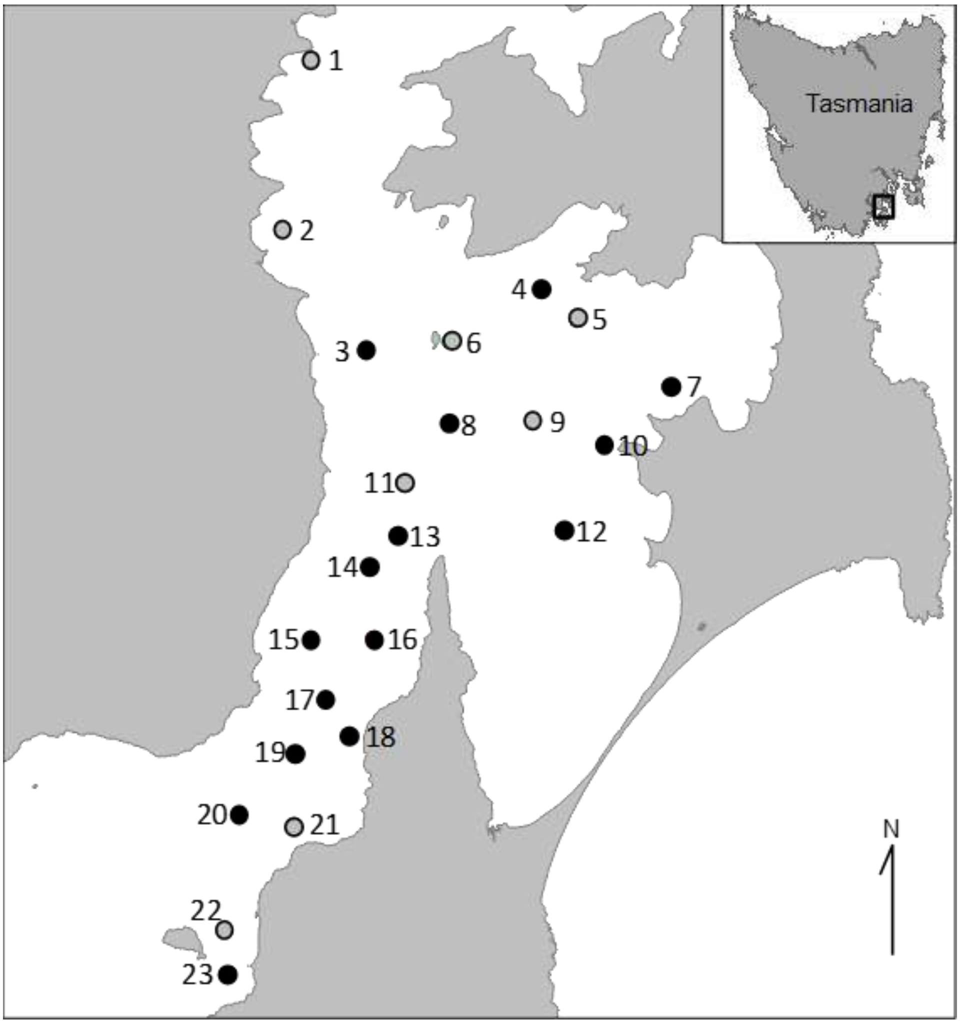

Fig. 1: D'Entrecasteaux Channel indicating survey locations. Video and dive sites (black circles), video only sites (grey circles).

Video survey

Twenty-three video tows were conducted using the IMAS towed video camera unit which incorporates a high definition handycam video camera, LED lighting and 2 parallel scaling lasers at a separation of 150 mm (whose beams contact the seafloor in the centre of the video field) (Fig. 2). Tows were accomplished with the camera approximately one metre above the seafloor and at a speed-over-ground of around 1.2 knots. Tows were around 400 m in length, with each tow recorded as a track on the vessel GPS.

Fig. 2: IMAS towed video camera unit.

Video footage was viewed to determine the abundance of Commercial Scallops (*Pecten fumatus*), Queen Scallops (*Equichlamys bifrons*), Doughboy Scallops (*Mimachlamys asperrimus*) and other benthic taxa using video analysis software Transect Measure (SeaGIS). The start and end time of the benthic footage analysed for each site was recorded from the video time code and was used to truncate the site GPS track to determine the actual length of each transect.

Scallops and other taxa were counted only if:

1. they crossed the centre line of the video frame (i.e. a horizontal line passing through both laser points) and within 250 mm of either side of the centre point between the two scaling laser points (i.e. representing 0.5 m transect width) (Fig. 3)
2. they crossed the centre line from beyond the laser points (i.e. mobile species swimming across the line from behind the camera were not counted).

Segments in transects where the video field was less than 0.5 m wide or where the video left the seafloor sufficiently to preclude recognition of scallops were excluded from the analysis to minimise bias. These segments were excised based on their video timecodes cross referenced to the GPS track to ensure transect areas reflected valid video segments.

In every video frame in which a scallop was counted, a pixel to millimetre calibration was applied using the scaling lasers (150 mm) and the width of the scallop was measured in millimetres. Where scallops were orientated with their width close to parallel to the centre line accurate measurements of their width were possible (Fig. 3). However, where scallops were not orientated in this way, measured widths would be an underestimate due to the perspective effects produced by the angle of incidence of the camera on the seafloor (approximately 30°). Further, this angle may vary throughout a transect with fluctuations in depth, tow speed, current, and benthic topography. Consequently, to minimise this bias, Queen and Commercial Scallops were measured on either their width or height axes (Figs. 3 and 4) on the basis of which axis was more closely aligned to the video centre line. Height measurements were converted to expected widths using a height/width linear regression derived from measurements of commercial scallops captured in Great Oyster Bay (N=971, R^2=0.91), and from Queen scallops sampled in this survey by divers (N=149, R^2=0.68).

The density of scallops from the video survey was calculated as the ratio of the abundance of counted scallops and the transect area (ie. 0.5 m*transect length). The size structure of counted scallops was estimated from measured widths and expected widths (calculated from measured heights).

Fig. 3: Frame from video footage showing scaling lasers (green dots), pixel to millimetre calibration (red line), video centre line (orange line), transect width (orange line is 500mm long and centred at the centroid of the scaling lasers), and a scallop width measurement (blue line) orientated at 10° to the centre line**.**

Fig. 4: Close-up from a frame of video footage showing a scallop height measurement (blue line) orientated parallel to the centre line.

Dive survey

Fifteen of the 23 sites were also surveyed by diver transects. At each of these sites a weighted 100 m strip transect line was deployed in a haphazard direction (or following the depth contour on sloping bottom). Two divers swam along either side of the transect line collecting all scallops within one meter of the line, representing a total searched area of 200 m^2. Any scallops encountered within the searched area were brought to the surface, identified to species and shell width was measured before being returned to the water.

The density of scallops from the dive survey was calculated as the ratio of the abundance of counted scallops and the transect area (200 m^2). The size structure of the counted scallops was derived by directly measuring shell widths.

Comparison of survey methods

Any future decisions to open the D'Entrecasteaux Channel fishery to exploitation need to be predicated on both the availability of a sufficiently large standing crop of scallops above the legal size limit to justify fisher effort, and on evidence of future recruitment to the exploited stock. Thus, to adequately inform management, fishery independent surveys should provide size-specific abundance estimates at representative sites throughout the fishery.

Consequently, to evaluate the efficacy of the towed video method in assessing the status of the scallop stocks the following questions need to be addressed:

1. Does the towed video method detect the same abundance of scallops as dive transect methods?

2. Are there biases in the video-measured size structure that preclude the detection of future recruits and/or determining the proportion of the population above the minimum size limit (MSL)?

Scallop densities derived from video and dive transects were compared at the fifteen sites at which both methods were used. Size structure was also compared between methods at these sites.

Due to the oblique camera angle and variation in the angle of presentation of scallops in the video field, video size measurements are likely to be biased towards under-sizing. To investigate and potentially minimise this bias, scallop width measurements in a subgroup of seven video sites were rated on the basis of their orientation to the video centre line. For this comparison, the size structure derived from the subset of scallops whose measurement axis lay within 15^{o} of the video centre line were compared with diver derived size structure.

Results/Discussion

The towed video method provided footage of sufficient resolution to allow species identification and size measurements of scallops for all sites; with an average transect area of 212 m^2 per site. Diver transect surveys provided accurate scallop densities and size structure for 15 sites which encompassed a range of scallop densities. Consequently, data useful for both assessing the status of scallop recruitment and providing a measure of the accuracy of video survey methods were achieved by this study.

Scallop densities

Commercial Scallop densities based on the video method were very low throughout the Channel, with maximum densities of 0.023 and 0.015 scallops per m^2 based on all sizes classes and those > 100 mm, respectively (Table 1).

The densities of Queen Scallops were also very low at the mid-Channel (sites 1 to 12, Fig. 1), with maximum densities of 0.05 and 0.013 scallops per m^2 for all size classes and those > 100 mm, respectively (Table 1). The density of Queen Scallops in areas of higher current flows (Middleton to Gordon, sites 13 to 20; and between Satellite Island and Alonnah, sites 22 and 23), yielded generally higher densities (average 0.52 scallops/m^2) (Fig.5). Densities of Queen Scallops larger than 100 mm were, however, low (average 0.09 scallops/m^2) in these areas (Fig. 6).

The densities Doughboy Scallops were low at all sites (average 0.03 and 0.01 scallops/m^2 for all size classes and > 80 mm, respectively).

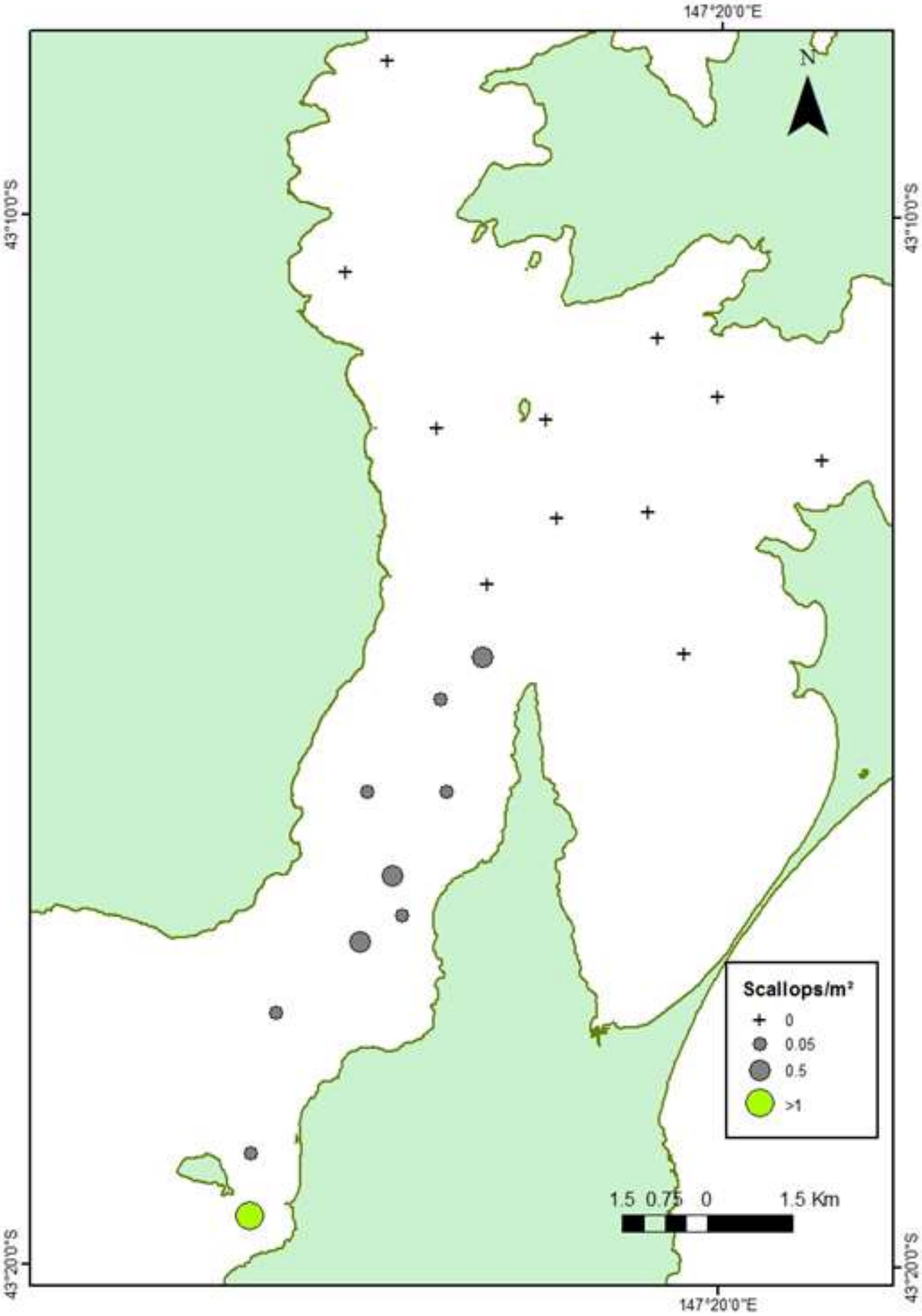

Fig. 5: Queen Scallop densities (abundance per m²) by site.

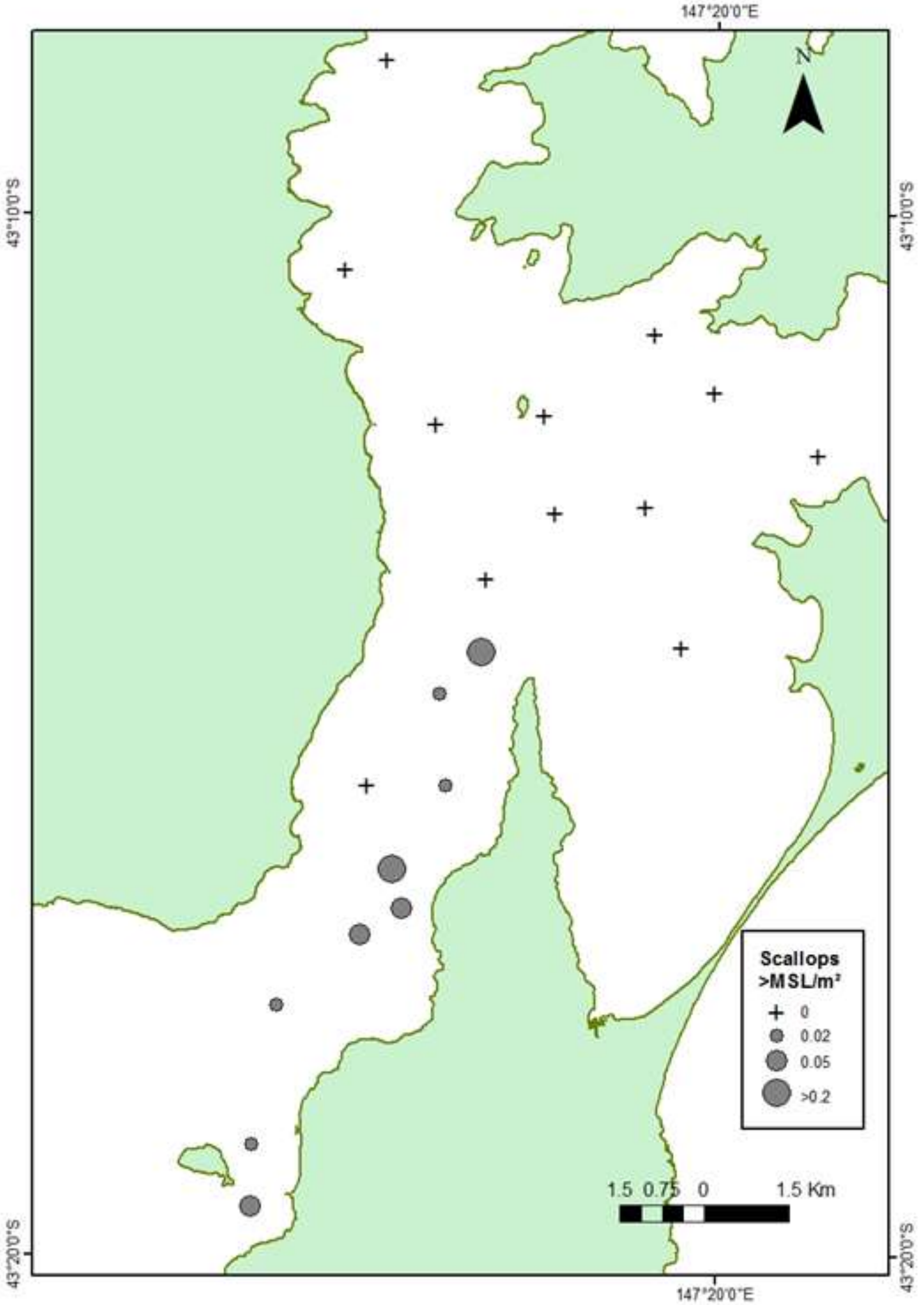

Fig. 6: Legal size queen scallop densities (abundance >MSL per m²) by site.

Table 1: Video and dive survey scallop densities (scallops per m²) by site. Minimum size limit (MSL) is 100 mm for Commercial and Queen Scallops and 80 mm for Doughboy Scallops. – indicates not surveyed**.**

Site	Video transect area	Total density						Density >MSL					
		Queen		Commercial		Doughboy		Queen		Commercial		Doughboy	
		Video	Dive	Video	Dive	Video	Dive	Video	Dive	Video	Dive	Video	Dive
1	175.0	0	-	0	-	0	-	0	-	0	-	0	-
2	186.1	0	-	0	-	0	-	0	-	0	-	0	-
3	204.5	0.01	0.005	0.005	0.005	0	0.005	0	0	0	0.005	0	0
4	215.5	0	0	0.005	0.005	0.009	0	0	0	0	0.005	0.005	0
5	215.4	0	-	0.023	-	0.0186	-	0	-	0.009	-	0.005	-
6	194.1	0	-	0	-	0.005	-	0	-	0	-	0	-
7	192.4	0	0	0	0	0	0.005	0	0	0	0	0	0.005
8	172.5	0.006	0	0.0232	0.01	0	0	0	0	0	0.01	0	0
9	220.6	0	-	0.009	-	0	-	0	-	0	-	0	-
10	200.0	0.03	0.015	0	0	0.16	0.16	0	0	0	0	0.105	0.11
11	228.7	0.05	-	0	-	0.004	-	0.013	-	0	-	0	-
12	219.4	0.0045	0.005	0.004	0.005	0.209	0.135	0	0	0.005	0	0.128	0.07
13	184.3	0.776	0.68	0.0108	0.005	0.163	0.05	0.081	0.075	0	0.005	0.022	0.005
14	187.4	0.336	0.41	0	0.005	0.048	0.05	0.048	0.065	0	0.005	0.011	0.02
15	236.0	0.178	0.245	0	0.01	0	0	0.017	0.065	0	0.01	0	0
16	237.4	0.345	0.445	0.0211	0.01	0.0168	0.02	0.029	0.045	0	0.01	0.004	0
17	244.3	0.843	0.735	0	0.005	0.004	0	0.258	0.325	0	0.005	0.004	0
18	204.4	0.387	0.295	0	0.01	0.044	0.025	0.083	0.055	0	0.01	0.010	0
19	227.0	0.802	0.855	0.004	0.015	0.0132	0	0.17	0.22	0.004	0.015	0.004	0
20	173.7	0.1382	0.2	0	0	0	0.02	0.028	0.04	0	0	0	0
21	300.1	0	-	0	-	0	-	0	-	0	-	0	-
22	215.6	0.1852	-	0	-	0	-	0.023	-	0	-	0	-
23	240.0	1.1832	1.04	0	0	0.004	0	0.091	0.035	0	0	0	0

Size structure

The dive transect survey of 15 sites (total transect area of 3000 m^2) yielded width measurements from 1097 scallops. Commercial Scallops were rare and were predominantly larger than 100 mm (N = 17, range 36 - 124 mm, mean 105 mm). This size structure suggests that recruitment has been very low in recent years. Doughboy Scallops were also in low abundance and most were smaller than 80 mm (N = 94, range 24 – 99 mm, mean 77 mm).

Queen Scallops were relatively abundant in the areas of the Channel that experience higher current flows but were predominantly below 100 mm in size (N = 986, range 37 – 128 mm, mean 86 mm) (Fig. 7B). The size distribution of Queen Scallops suggests at least three cohorts, with shell widths of around 40, 65, and 85 mm are present (Fig. 7B) which, when compared with 2016 data provide some evidence of modal progression (Fig. 7) as well as a reduction in the proportion of the population above 100 mm.

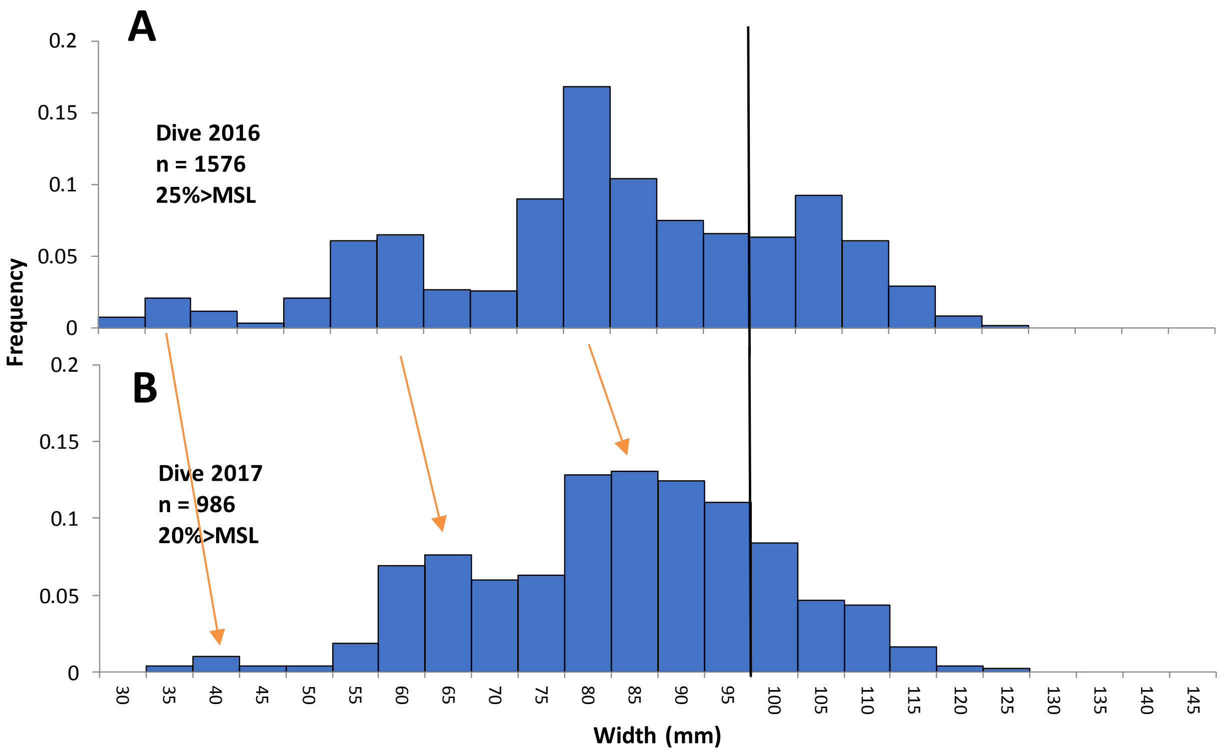

Fig. 7: Queen Scallop size distributions based on dive surveys conducting in 2016 (A) and 2017 (B). The vertical black line indicates the minimum legal size limit (MSL=100 mm) and the percentage indicates the proportion of scallops above the MSL by method. Orange arrows indicate evidence of modal size progression.

Comparison of survey methods

Comparisons of density and size structure between towed video and dive transect methods were limited to Queen Scallops due to the very low densities of the other species.

Regression analysis confirmed that there were no significant differences in total densities of Queen Scallops between video and dive methods based on the 15 sites in which both methods were applied (P = 0.2, df=14) (Fig. 8). Importantly, this finding indicates that the video method is not under-representing the numbers of smaller scallops and thus is capable of providing evidence of future recruitment to the fishery. The towed video method did, however, record significantly lower densities of scallops above 100 mm (P=0.003, df = 14), particularly at the higher density sites (Fig. 9). This discrepancy can be largely explained by a bias in video size measurements of scallops that are not orientated parallel to the video centre line (refer below), resulting in fewer scallops exceeding the MSL.

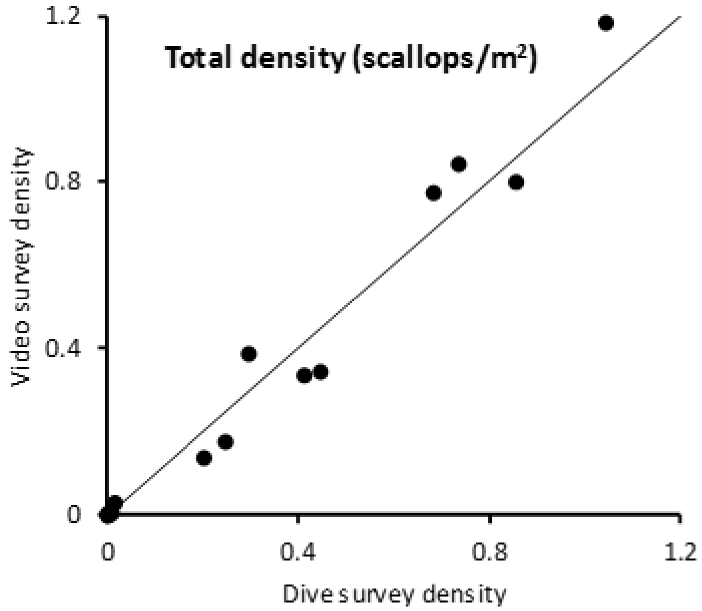

Fig. 8: Correlation plot of total queen scallop density derived from dive survey and towed video methods by site. The black line indicates unity slope.

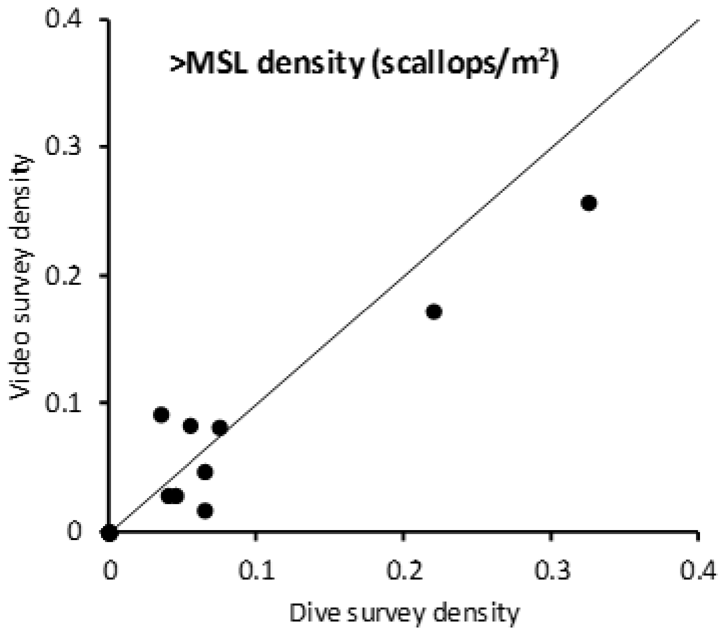

Fig. 9: Correlation plot of the density of queen scallops above the MSL derived from dive survey and towed video methods by site. The black line indicates unity slope.

A comparison of the size structure of dive transect and video measured scallops indicates some bias in the latter, in particular in defining the cohort structure in the smaller size classes but also in representing proportions above and below MSL (Fig. 10). This measurement bias issue was explored by comparing the size distribution for a subgroup of video measured scallops whose measurement axis lay within 15º of the video centre line (Fig. 10). Restricting measurements to "well-aligned" scallops increased the proportion of individuals above the MSL from an under-representation (15%) in the video measurements to 23% which more closely aligns with the accurate measure from the dive transects (20%) (Fig. 10). While a similar minimum size was recorded in this comparison, video measurements from the well-aligned subgroup appear to have reduced the proportion of small scallops (< 60 mm) in the size distribution. Neither of the video size distributions clearly defined the 65 mm cohort evident in the dive transect distribution. The bias against well-aligned small scallops may be due to the more haphazard orientations that small scallops are observed to occupy on the seafloor.

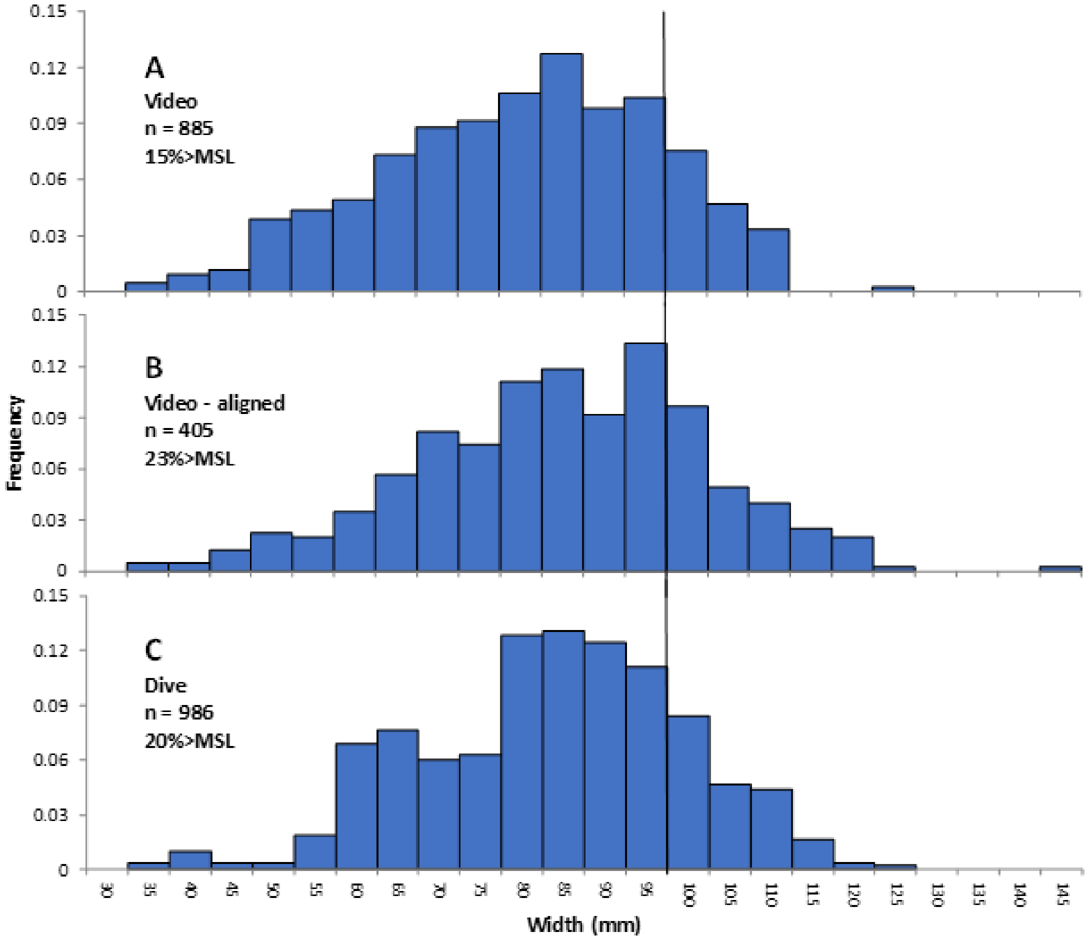

Fig. 10: Queen Scallop width distributions from the 15 sites which hosted both video and dive transect methods. Size data is presented from video methods (A), from video methods but only including scallops orientated within 15º of the video centre line (B), and from dive transects (C). The vertical black line indicates the minimum legal size limit (MSL=100 mm) and the percentage indicates the proportion of scallops above the MSL.

Cost-benefit comparison

The towed video method represents a more rapid method (about half the time) and thus cost saving approach to surveying large areas of seafloor (Table 2), having the additional advantage of mitigating risks associated with diving operations. As noted above, however, there is trade-off in terms of precision in size structure estimation but not overall abundances.

While the initial expenditure required to purchase the towed video equipment compares favourably against the expenses involved in purchasing and maintaining diving equipment and diver training, the extent to which these costs impact an agency will be dependent on the relative extent to which research projects utilise these methods.

Table 2: Staff hours required for dive transect and towed video methods of surveying scallop densities for transects of around 200 m^2.

Method	Staff hours			
	Sampling	Measurement onboard	Video scoring	Total for 23 sites
Dive transect	3	1	-	92
Towed video	1	-	1	46

Stock status – D'Entrecasteaux Channel Scallops

The stock status of the scallop populations in the D'Entrecasteaux Channel have been assessed using national stock status categories and now applied for Tasmanian fisheries. These categories define the assessed state of stocks in terms of recruitment overfishing. Recruitment overfishing occurs when the mature adult (spawning biomass) is depleted to a level where it no longer has the reproductive capacity to replenish itself. Recruitment overfished stocks have not necessarily collapsed but do have reduced recruitment capacity.

The findings of current survey, in particular density and size composition information (indicators of adult abundance and recruitment success), and consideration of dive surveys conducted during the mid- to late-2000s, represent the key inputs into the determination of stock status.

Species	Status	Comments
Commercial Scallop *Pecten fumatus*	OVERFISHED	Species has a long history of boom and bust fisheries in the Channel. Heavy fishing and poor recruitment lead to the closure of the fishery in 2011. No evidence of recovery or recruitment since the fishery was closed.
Doughboy Scallop *Mimachlamys asperrima*	OVERFISHED	Species has a long history of exploitation in the Channel, although not usually a major target species. No evidence of recovery or recruitment since the fishery was closed in 2011.
Queen Scallop *Equichlamys bifrons*	TRANSITIONAL RECOVERING	Some evidence of rebuilding since the fishery was closed with several discrete cohorts (including pre-recruits) present in a relatively small, high density bed. Representation of older adult individuals (> 100 mm) low relative to the smaller size classes.

Conclusions

This study demonstrated that towed video can be used instead of diver surveys, at least in years when density is too low to consider any harvesting. Video data was faster to collect than traditional diver surveys and appears well-suited as a rapid assessment tool to determine overall scallop densities. Size structure data could be collected by video although had some limitation in resolving detailed cohort structure, especially amongst smaller scallops.

The low standing stock of legal-sized Queen Scallops, overall limited area of the main beds and very low abundances of both Commercial and Doughboy Scallops provide no scientific basis upon which to expect any recovery of stocks that would justify a scallop fishery in the D'Entrecasteaux Channel for at least the next 3-5 years.

It is recommended that future decisions to open the fishery be informed by detailed surveys that fully map the extent of the main scallop beds and, if possible, provide an index of abundance against which the effects of fishing could be assessed. Furthermore, since the recreational sector has the capacity to reduce legal size biomass to very low levels within a relatively short period it will be essential that sufficient adult stock is protected, this could involve setting an appropriate minimum size limit. It is also desirable that the stocks include multiple years cohorts since these will be required to replenish the adult population and safeguard against future variability recruitment.