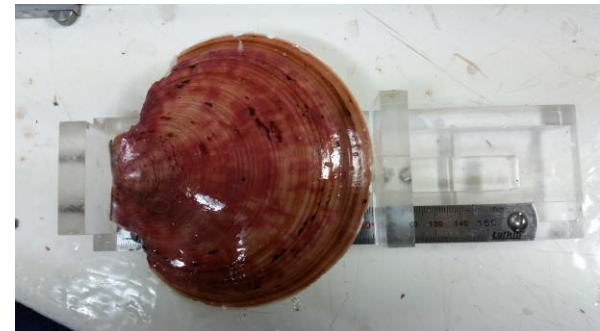# 2019 Queensland saucer scallop fishery-independent survey

Objective

Produce an index of the relative abundance of 0+ and 1+ scallop age classes that can be compared with previous surveys

Survey design

Based on the Dichmont *et al.* (2000) survey but modified over time due to:

➢ TEDs and BRDs mandatory after 2000 (no TEDs or BRDs in survey from 1997-2000)

➢ GBRMP boundary and closure changes (i.e. 2004 RAP areas)

➢ change in spatial extent of scallop fishery (extending southwards??)

2019 survey key features
- Stratified random survey design
- 17 survey strata
- 330 x 1-nm sites trawled (including 11 calibration sites)
- 3 commercial trawlers chartered
- 30 Sep - 13 October 2019

2 0 JAN 2013

THE FIRST LARGE-SCALE FISHERY-INDEPENDENT SURVEY OF THE SAUCER SCALLOP, *AMUSIUM JAPONICUM BALLOTI* IN QUEENSLAND, AUSTRALIA

CATHY M. DICHMONT,* MIKE C. L. DREDGE, AND KATE YEOMANS

732   DICHMONT ET AL
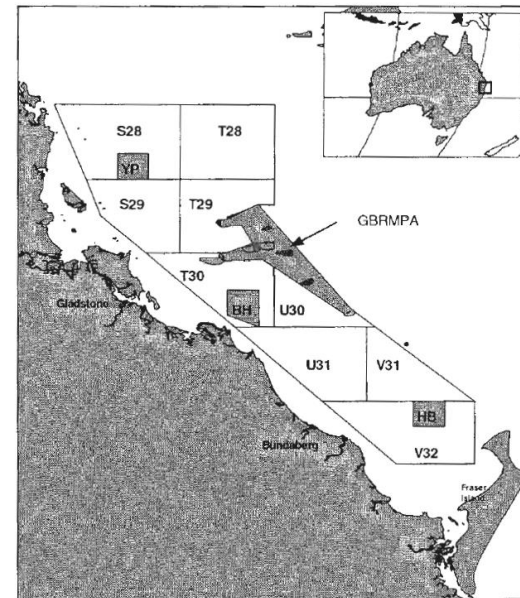

Figure 1. Map of saucer scallop survey area as well as nearest local towns and strata areas and codes within the survey. The arrow indicates the Capricorn–Bunker reserve area of the Great Barrier Reef Marine Park Authority (GBRMPA) that was not included in the survey. Shaded strata (YP, BH, and HB) are the scallop preservation zones. Inset shows survey position within Australia. T28 is 30 × 30 min grid.

Allocating survey sampling effort for the stratified random survey design

STRATA	Mean catch per unit effort (CPUE, kg/hr) *	Strata area (ha)	Area x CPUE	Adjusted proportion (not less than 2% rule)	Number of sampling sites
Bustard Head A	18.5	31,499	583,663	2.0	7
Bustard Head B	16.0	31,516	503,782	2.0	7
Hervey Bay A	19.1	31,401	598,765	3.2	11
Hervey Bay B	10.5	31,419	330,150	2.0	7
Maheno Inner	51.9	28,181	1,461,577	4.0	13
Maheno Outer	43.6	22,921	999,839	2.7	9
S28	21.1	183,241	3,874,269	10.2	34
S29	14.5	191,804	2,772,124	7.0	23
Sunshine Region	22.9	221,741	5,080,401	13.4	45
T28	25.6	198,971	5,090,930	13.4	45
T29	15.6	186,374	2,903,104	7.0	23
T30	15.4	158,398	2,438,633	6.2	21
U30	25.2	97,682	2,464,648	6.2	21
U31	14.4	167,061	2,411,224	6.2	21
V31	11.1	113,676	1,265,569	3.5	12
V32	10.2	231,827	2,370,384	6.5	22
Yeppon A	29.2	31,725	925,561	2.5	8
Yeppon B	16.8	31,680	530,654	2.0	7
Totals		1,991,114	36,605,276	100	335 **

*Average CPUE based on last 12 years of logbook and VMS data (2007-2018)
** 330 sites successfully completed
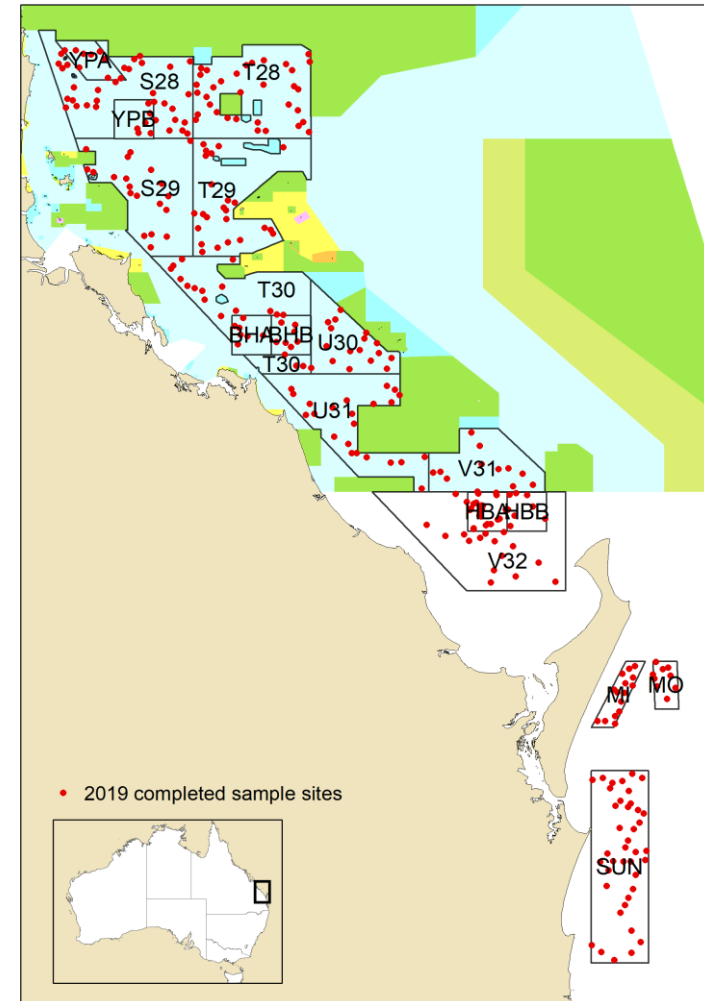
# Calibrating for differences between survey vessels

- compares catch rates of vessels participating in survey
- uses total number of scallops caught per hectare swept by nets to adjust catch rates
- adjusts catch rates to be equivalent to a single vessel doing whole survey (i.e. Vessel 1)
- does not adjust for differences between years (only within each year)
- Vessel 1 (C-King) has participated in every survey (i.e. 13 surveys)

Year	Vessel name	Strata	Number of Trawls	Mean 0+ Density (Number/ha)	0+ standard error	Mean 1+ Density (Number/ha)	1+ standard error	Mean Total Density (Number/ha)	Total standard error	Calibration Factor
2019	C-King	HBA	11	8.3	2.7	161.1	44.4	169.5	46.0	1.0
2019	Joseph-M	HBA	10	12.3	5.3	138.3	46.5	150.6	49.7	1.2
2019	Silda	HBA	11	14.5	3.9	139.0	40.9	153.4	43.4	1.1

<u>Calibration model applied each year</u>

$$Log(Total\ Count) \sim (Vessel\ Name * X_1 + Site\ Number * X_2) * log(Swept\ Area)$$

```
factor [modify=yes; reference ="Vessel 1"] Vessel_name
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 Total_Shell_Count
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FPROB=yes; TPROB=yes; FACT=9]\
 Vessel_name + SiteNumber
```
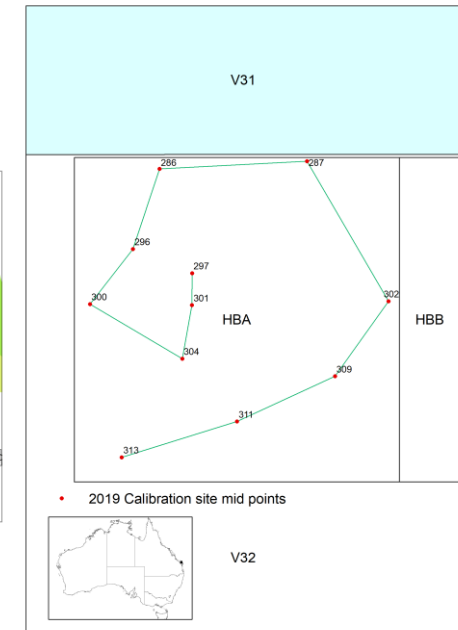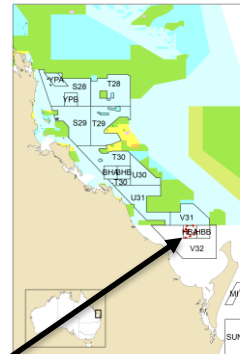

All 3 vessels trawled the same 11 sites in the Hervey Bay A scallop replenishment area on the first night

2019 survey results

- **Density is number of scallops caught in the area swept by the survey trawl nets**
- **0+ scallops are less than one year old and <78 mm SH (born winter 2019)**
- **1+ scallops are more than one year old and >=78 mm SH (mainly born in winter 2018 and 2017)**

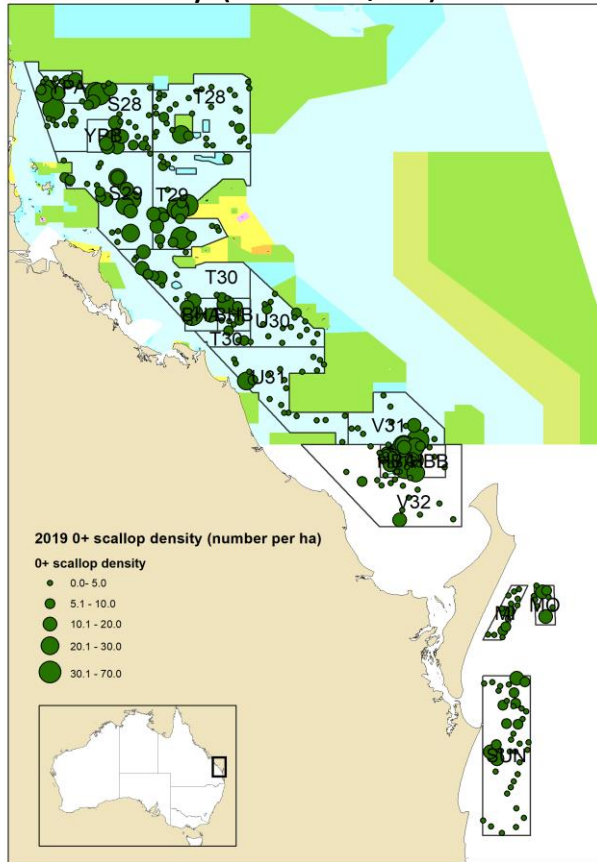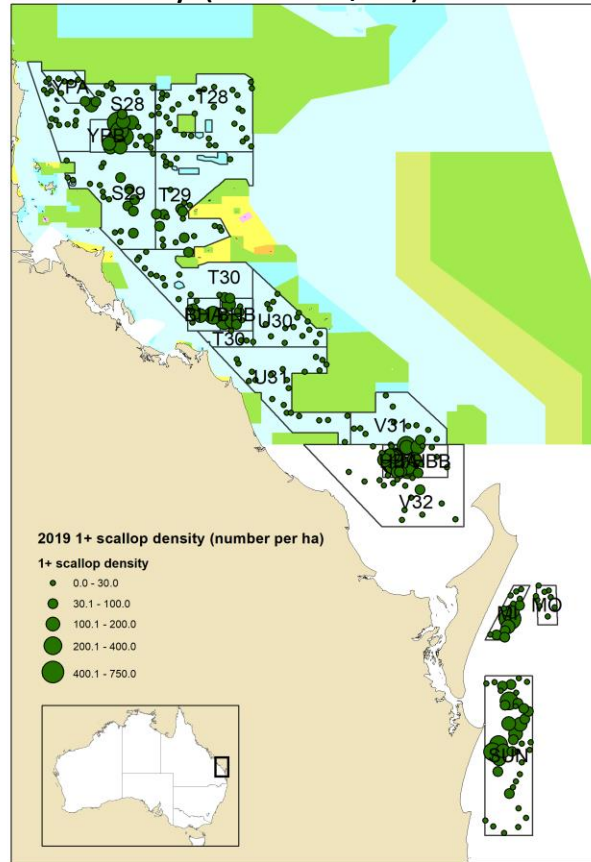|	Adjusted mean 0+ density	Standard error	Adjusted mean 1+ density	Standard error	Adjusted mean total density	Standard error
BHA	33.0	20.5	24.3	22.2	48.7	33.7
BHB	9.5	5.2	130.5	34.7	141.0	35.9
HBA	20.6	4.7	235.1	33.7	287.1	36.3
HBB	9.7	5.4	29.0	15.3	38.9	18.1
Maheno	4.2	1.9	64.2	12.3	68.6	12.9
S28	12.5	3.1	37.1	8.3	49.8	9.9
S29	12.1	3.5	30.4	9.0	42.9	11.0
Sunshine Region	4.1	1.6	78.7	12.8	83.4	13.0
T28	2.8	1.2	2.6	1.9	5.4	2.8
T29	15.7	4.2	22.6	7.8	37.9	10.4
T30	5.9	2.7	29.4	10.0	35.6	11.2
U30	1.6	1.4	2.5	2.9	4.3	4.0
U31	2.3	1.7	3.0	3.0	5.4	4.2
V31	6.6	3.4	7.0	5.8	13.6	8.2
V32	3.7	2.3	12.6	6.8	17.3	8.3
YA	10.8	4.3	66.6	17.7	78.0	19.5
YB	19.4	7.9	253.5	45.5	280.7	49.1

· 2019 completed sample sites
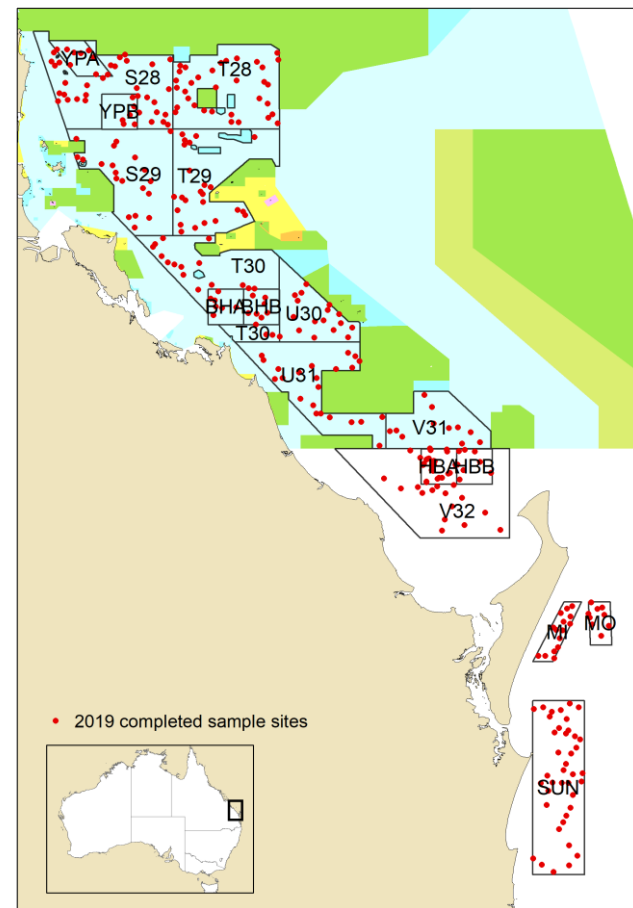
Main findings

1) Highest total scallop densities are in scallop replenishment areas (SRAs) – BHB, HBA and YB

2) Densities in the Maheno and Sunshine Coast region have improved

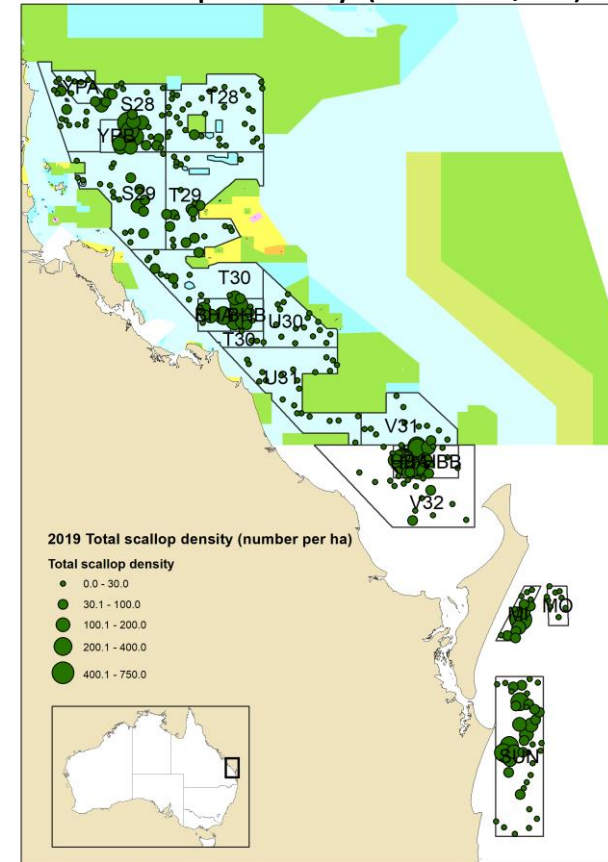3) Densities in the S28, S29 and V32 have decreased significantly compared to 2017 and 2018

0+ density (number/ha)

2019 0+ scallop density (number per ha)

0+ scallop density

- 0.0- 5.0
- 5.1 - 10.0
- 10.1 - 20.0
- 20.1 - 30.0
- 30.1 - 70.0

1+ density (number/ha)

2019 1+ scallop density (number per ha)

1+ scallop density

- 0.0 - 30.0
- 30.1 - 100.0
- 100.1 - 200.0
- 200.1 - 400.0
- 400.1 - 750.0

Total scallop density (number/ha)

2019 Total scallop density (number per ha)

Total scallop density

- 0.0 - 30.0
- 30.1 - 100.0
- 100.1 - 200.0
- 200.1 - 400.0
- 400.1 - 750.0

- 14 of 17 strata show decline in 0+ density from 2018 to 2019
- These scallops will mainly contribute to commercial catches in 2021 fishing year (i.e. Dec 2020 – April 2021)

Note low scale values for 0+ densities

- Very high 1+ densities at YB, HBA, BHB
- High 1+ densities at Sunshine and Maheno
- Remaining strata have poor 1+ densities
- These scallops will mainly contribute to commercial catches in 2020 fishing year (i.e. Dec 2019 – April 2020)

Comparison with previous surveys (1997-2019)

- **1997-2000 no TED or BRD in survey (nets were pooled)**

- **2001-2004 some nets with TED only, some with both TED and BRD, some nets with neither. Reduced strata and sampling sites (reduced funding)**

- **2005 and 2006 all nets with TED and BRD. Reduced strata and sampling sites – limited mainly to SRAs (funding)**

- **No survey data 2007-2016**

- **2017, 2018 and 2019 all nets with both TED and BRD. Survey design includes all strata and large number of sites (nets are pooled)**

- **Total of 4855 observations from individual nets and pooled nets over 13 survey years**

<u>Given these differences, how do we compare survey results between years?</u>

<u>Answer: generalised linear models (GLM) used to derive adjusted mean scallop densities</u>

<u>Scallop survey model</u>

```
MODEL [DISTRIBUTION=poisson; LINK=logarithm; DISPERSION=*; OFFSET=Log_Swept_Area] Calibrated_Total_Shell_Count
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 Year+Strata+LunarPhase+TimeofNight+Strata*Year
PREDICT [PRINT=description,predictions,se; COMBINATIONS=full; ALIAS=ignore; OFFSET=0;\
 BACKTRANSFORM=link; ADJUST=marginal] Year,Strata,TimeofNight,LunarPhase; LEVELS=*,*,!(1),!(4)
```

*****The effect of TEDs and BRDs were not significant so dropped from model*****
****Predictions are made for each year and strata, holding lunar phase fixed at waxing and the time of night fixed at 10pm to 12am****

Comparison between 2017, 2018 and 2019 scallop surveys

	Adjusted mean total density in 2017	Standard error	Adjusted mean total density in 2018	Standard error	Adjusted mean total density In 2019	Standard error
BHA	78.3	24.47	332.4	70.31	48.7	33.71
BHB	60.9	22.14	556.6	60.55	141.0	35.93
HBA	155.8	22.46	348.5	41.49	287.1	36.32
HBB	41.4	30.12	17.6	11.74	38.9	18.06
Maheno	29.8	22.07	20.1	6.77	68.6	12.90
MNP-24-1173 (Green Zone)	136.7	55.76	Not sampled		Not sampled	
MNP231169 (Green Zone)	48.5	16.26	Not sampled		Not sampled	
S28	166.3	27.77	126.9	16.53	49.8	9.9
S29	74.3	20.77	75.1	13.28	42.9	11.01
Sunshine Region	120.0	14.45	32.4	7.33	83.4	13.01
T28	60.2	12.32	12.2	3.47	5.4	2.79
T29	7.7	6.39	29.5	7.53	37.9	10.41
T30	21.6	8.12	26.5	10.33	35.6	11.19
U30	2.4	4.55	14.9	6.64	4.3	3.95
U31	64.4	22.85	152.8	30.20	5.4	4.18
V31	12.1	12.86	33.9	13.90	13.6	8.15
V32	267.4	52.77	126.7	25.30	17.3	8.34
YA	217.7	45.36	143.2	34.76	78.0	19.48
YB	294.4	81.75	179.1	37.11	280.7	49.06
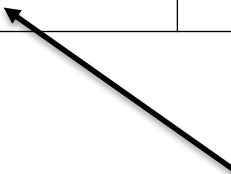
- **11 of 17 strata show decline in adjusted total mean scallop density from 2018 to 2019**

- **Significant declines in total mean densities in BHA, BHB and V32 from 2018 to 2019 (V32 continual decline from 2017, BHA density has declined below 2017)**

- **Scallop densities dominated by the 1+ age class. Young scallops (i.e. 0+ age class) appear to have low catchability in survey trawl nets**

Queensland scallop survey

Annual mean total scallop density (calibrated data)

Year	Number of observations	Mean Total Density (number/ha)	Standard error	Comment
1997	441	71.6	5.6	No TED or BRD
1998	480	74.0	4.0	No TED or BRD
1999	538	71.5	6.0	No TED or BRD
2000	457	69.9	5.8	No TED or BRD
2001	606	198.5	11.2	Mainly limited to SRAs
2002	341	59.7	4.4	Mainly limited to SRAs
2003	329	88.8	5.7	Mainly limited to SRAs
2004	327	141.4	11.6	Mainly limited to SRAs
2005	169	61.3	6.7	Mainly limited to SRAs
2006	163	99.1	15.0	Mainly limited to SRAs
2017	341	52.3	6.0	With TED and BRD
2018	333	75.3	6.9	With TED and BRD
2019	330	**51.0**	5.2	With TED and BRD

Poor overall mean scallop density in 2019

Scallop survey trends over all years and strata
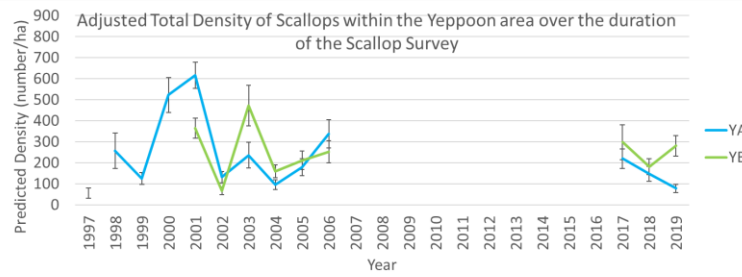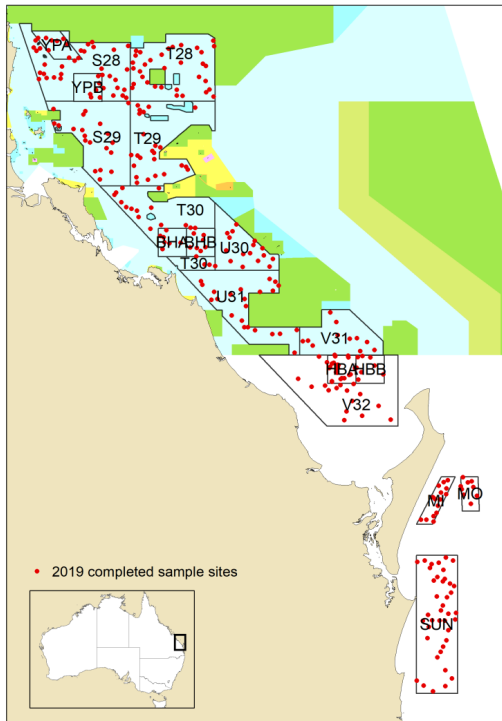
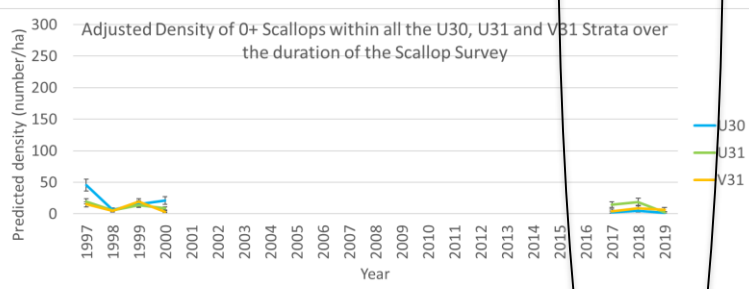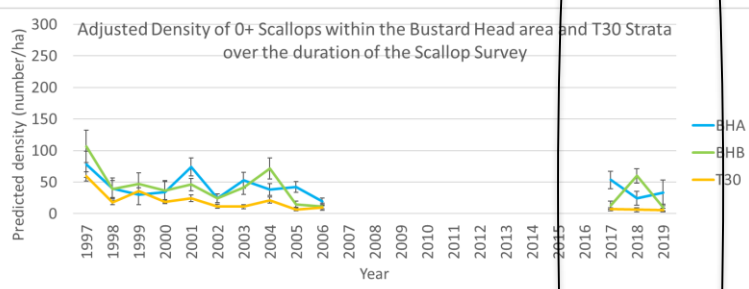## Adjusted total mean density
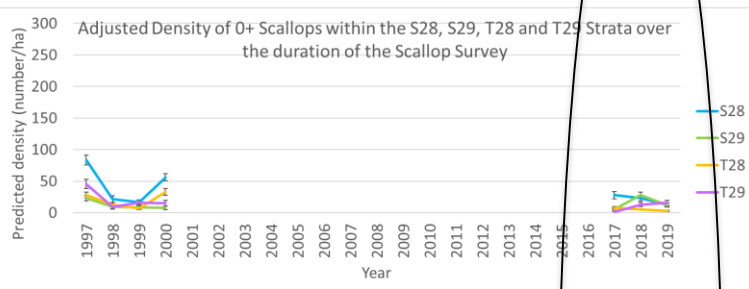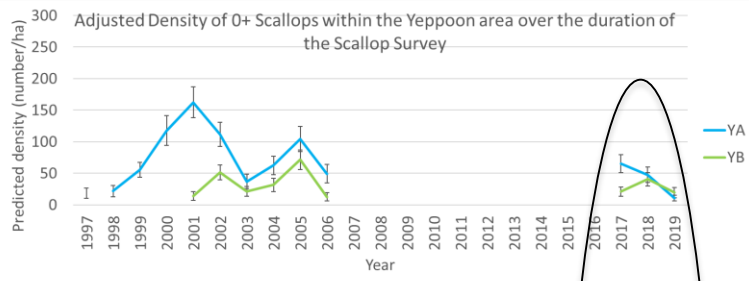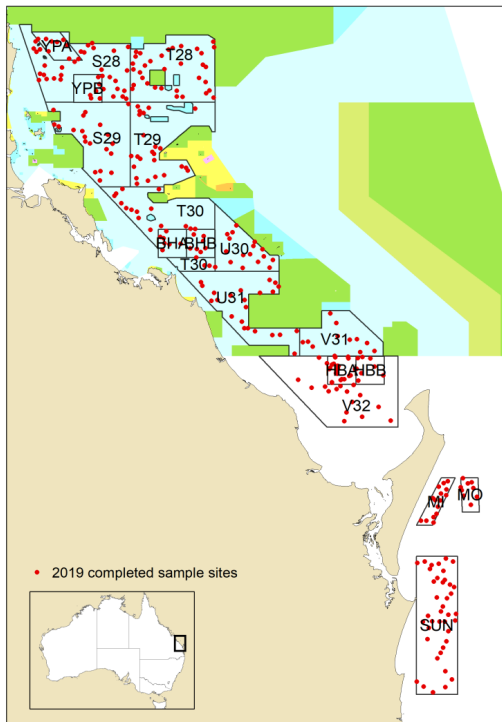
Increase in YB in 2019 compared to 2018
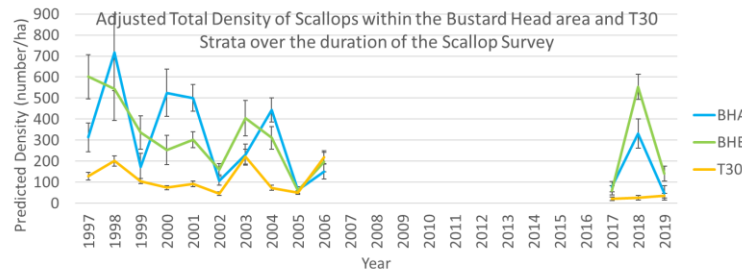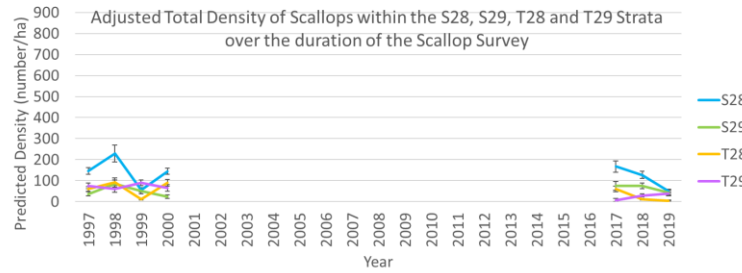
Marked decrease in BHB and BHA in 2019 compared to 2018
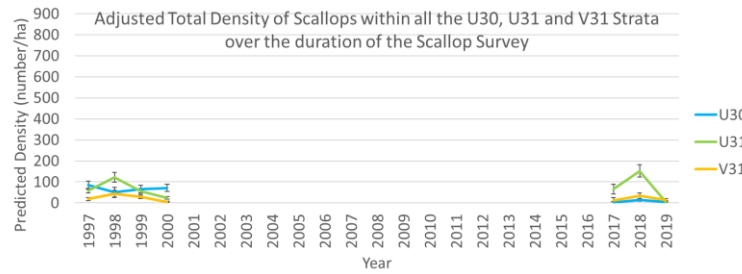
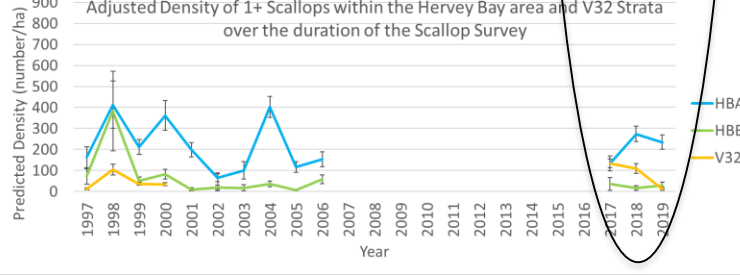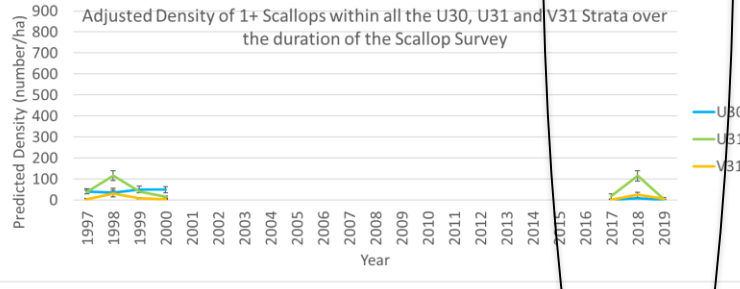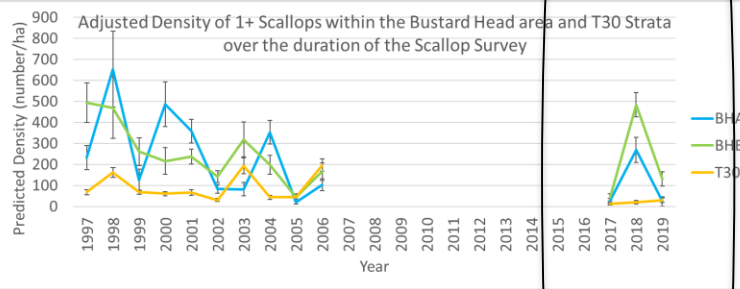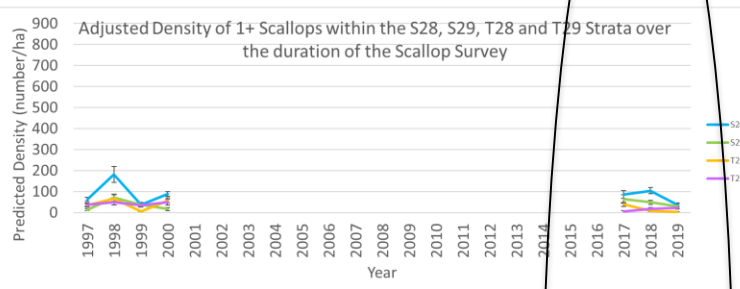**General decrease in total mean densities for the whole scallop fishery in 2019 compared to 2018**
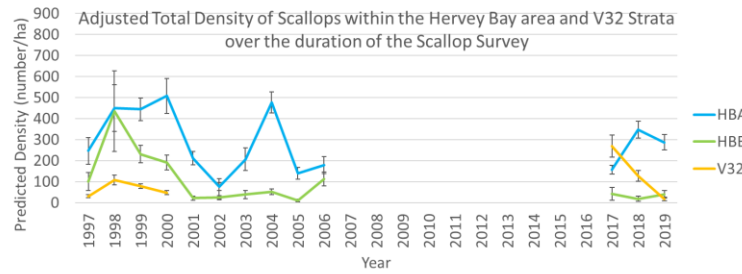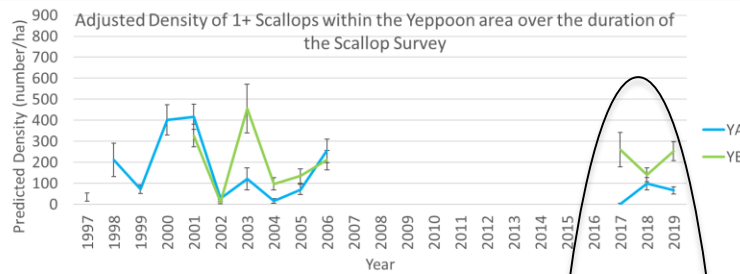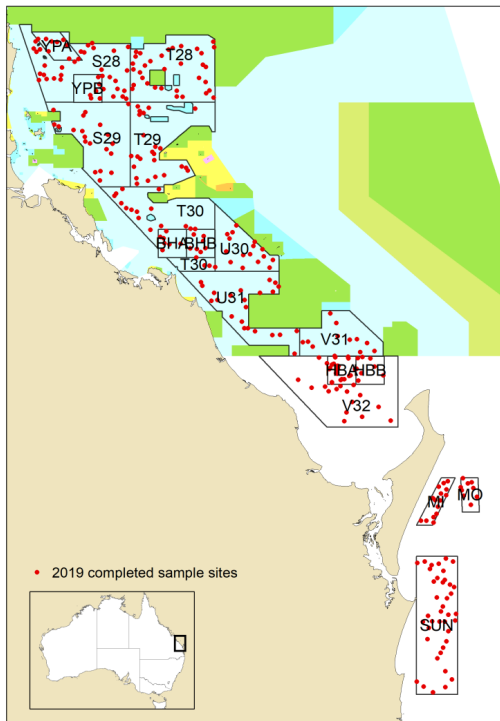
Scallop survey trends over all years and strata
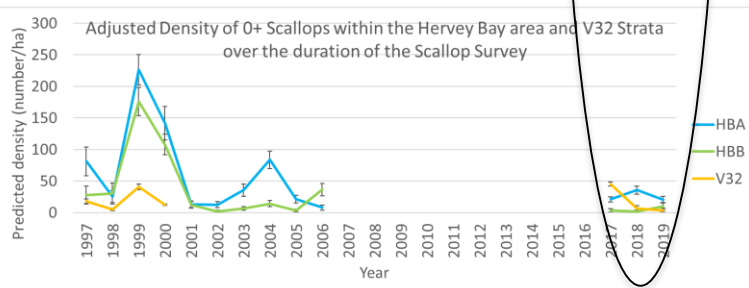
Adjusted 0+ mean density

**General decline in 0+ densities across the fishery from 2018 to 2019**

Scallop survey trends over all years and strata

2019 completed sample sites

Adjusted 1+ mean density

Adjusted Density of 1+ Scallops within the Yeppoon area over the duration of the Scallop Survey

Adjusted Density of 1+ Scallops within the S28, S29, T28 and T29 Strata over the duration of the Scallop Survey

Adjusted Density of 1+ Scallops within the Bustard Head area and T30 Strata over the duration of the Scallop Survey

General decrease in 1+ scallop densities across the fishery from 2018 to 2019

Adjusted Density of 1+ Scallops within all the U30, U31 and V31 Strata over the duration of the Scallop Survey

Adjusted Density of 1+ Scallops within the Hervey Bay area and V32 Strata over the duration of the Scallop Survey

Scallop survey length-frequency distributions consistently show smaller 0+ mode compared to 1+ age class
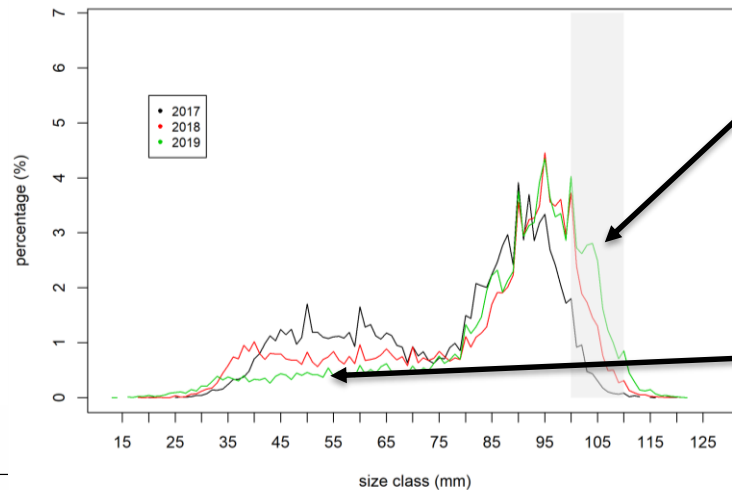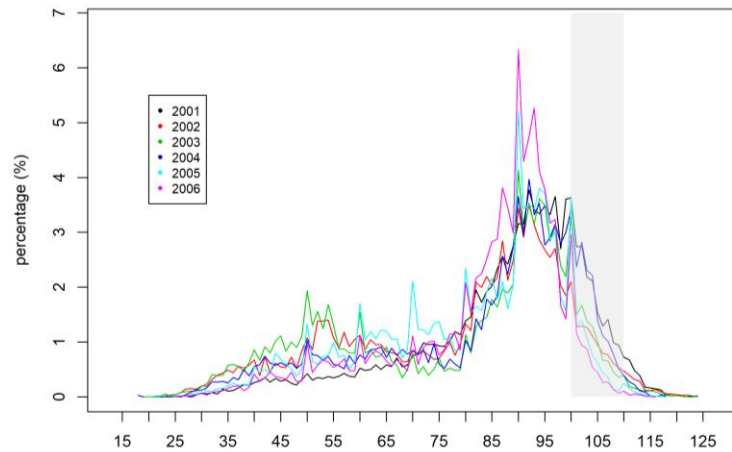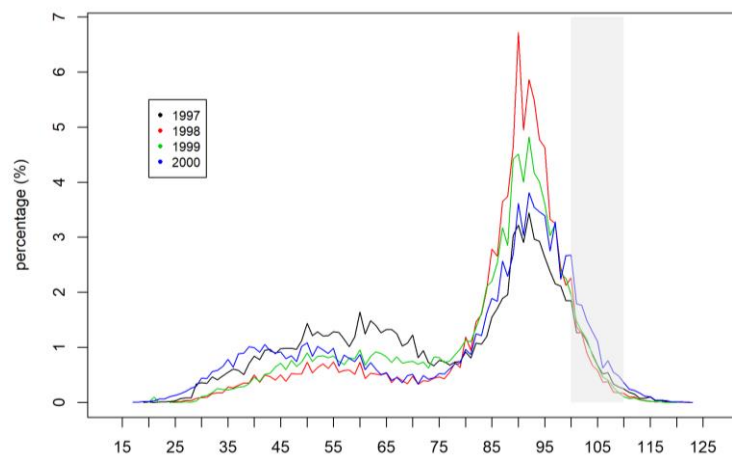
0+ probably has lower catchability when using trawl gear, compared to 1+

Higher proportion of 1+ in the sampled population in 2019 compared to 2017 and 2018 (Possibly from larger, older scallops inside SRAs)

Lower proportion of 0+ age class in 2019 compared to 2017 and 2018

2019 scallop fishery survey conclusions

Overall survey mean total scallop density of 51.0 scallops per ha is very low

Based on adjusted mean scallop densities from GLM
- ➤ 11 of the 17 strata show a decrease in adjusted mean total scallop density compared to 2018
- ➤ 10 of the 17 strata show a decrease in adjusted mean total scallop density from 2017
- ➤ 4 of the 6 SRAs show a decrease in adjusted mean total scallop density compared to 2018
- ➤ 4 of the 6 SRAs show a decrease in adjusted mean total scallop density compared to 2017
- ➤ Marked decline in adjusted mean total scallop density in V32 compared to 2018
- ➤ Marked increase in adjusted mean total scallop density in YB compared to 2018
- ➤ Increase in adjusted mean total density in Maheno and Sunshine strata compared to 2018
- ➤ 14 of the 17 strata show a decline in adjusted mean 0+ density compared to 2018
- ➤ 13 of the 17 strata show a decline in adjusted mean 0+ density compared to 2017
- ➤ Relationship between 0+ density in year n with 1+ density in year n+1 is unclear
- ➤ Modelling adjusted means has been improved by the addition of explanatory terms (lunar phase and time of night that survey trawls was undertaken)
- ➤ TED and BRD effects on survey scallop catch rates were not significant