# Torres Strait sea cucumber (Beche-de-mer ) survey 2019/20

## Mer Island Workshop

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**CSIRO OCEANS & ATMOSPHERE**
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Australian Fisheries Management Authority

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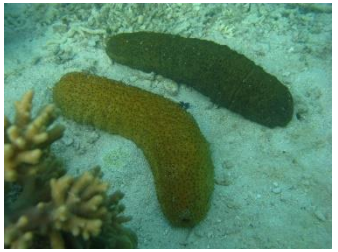
# 2019/20 Survey objectives

**Determine stock size and density trends for:**

- Current target species:
  - White teatfish (high priority)
  - Prickly redfish (high priority)
  - Curryfish (medium priority)





- Closed or reopening species:
  - Black teatfish (high priority)
  - Surf redfish (medium priority)


- Other species (low priority)

- Deeper water populations:
  - White teatfish (high priority)
  - Burrowing blackfish (low priority)
  - Other species (medium priority)

# Other objectives and outcomes

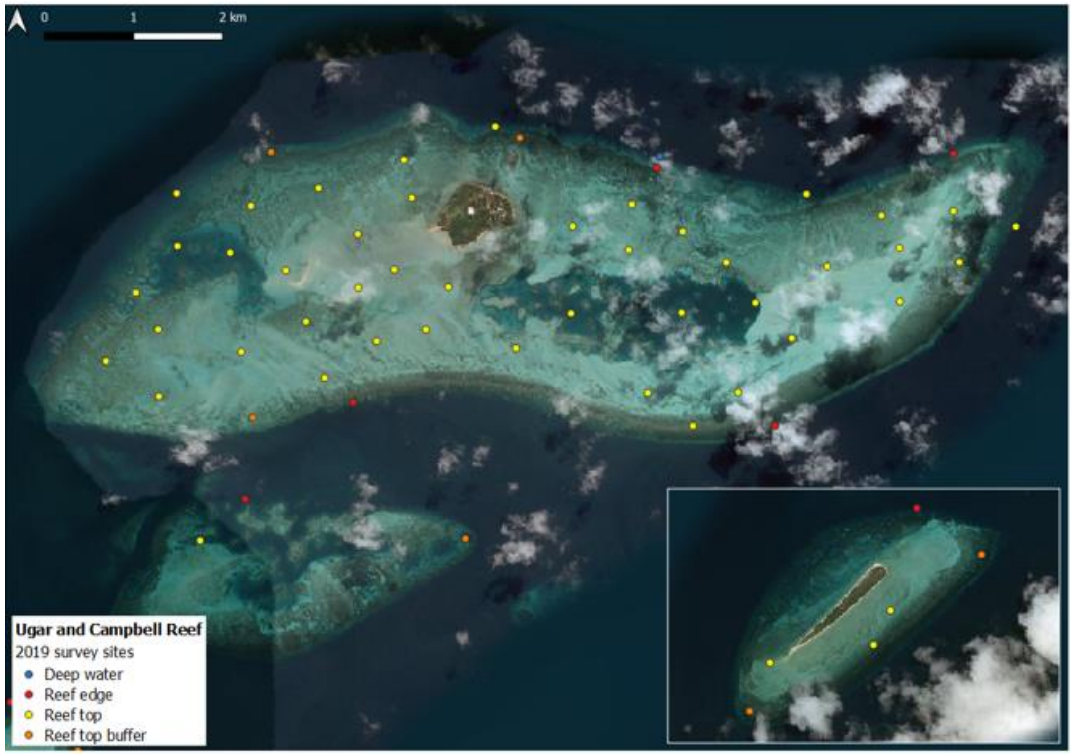
- Habitat trends and mapping
  - Seagrass, coral
  - Crown of thorns starfish
  - Clams, other species



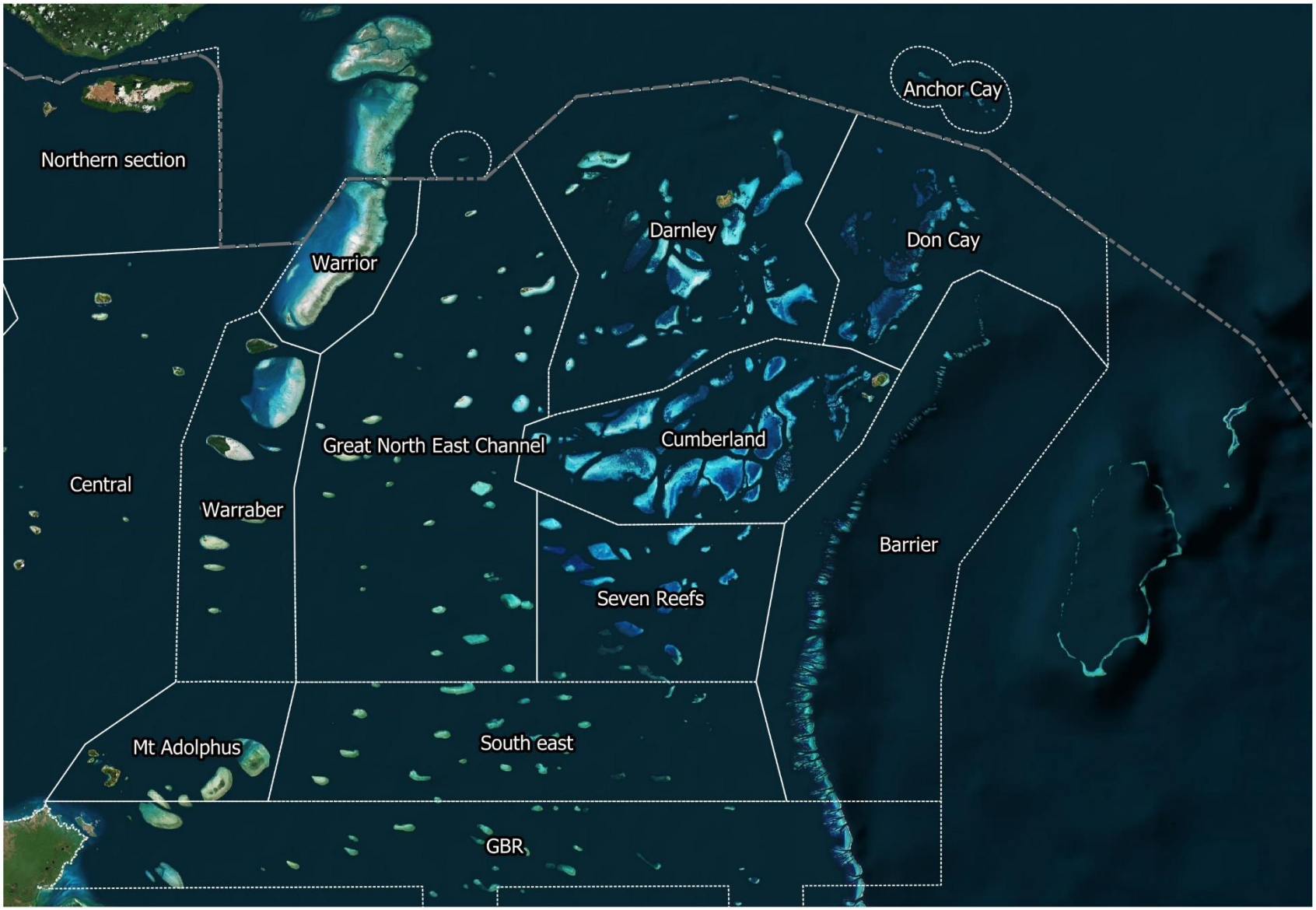
- General reef mapping
  - Reef mapping ground truthing (of new NERP reef map)
  - Better understanding of reef area and structure in Torres Strait

# Ugar survey

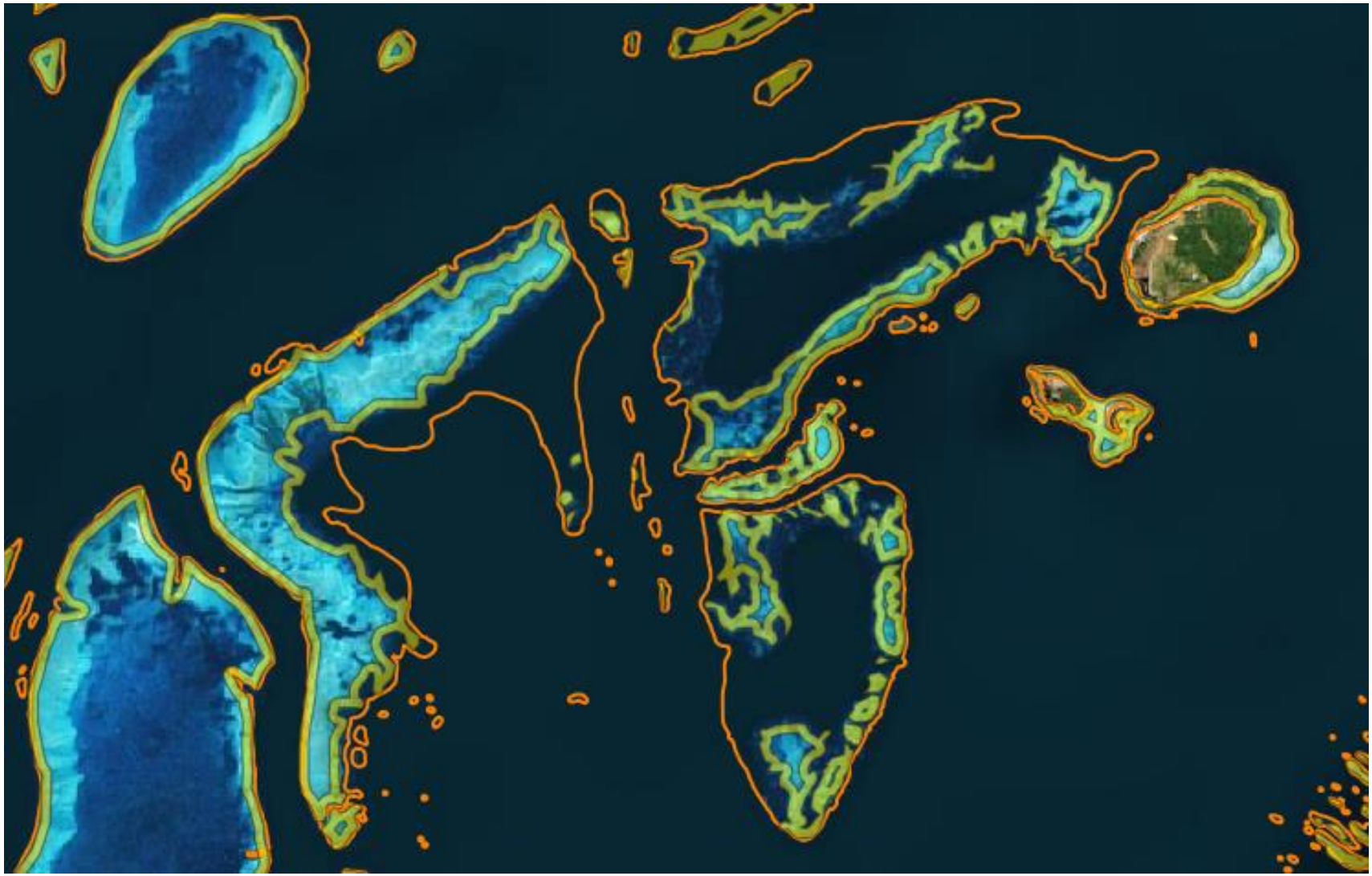
- Sea cucumber survey and reef mapping of Ugar and Campbell Reefs
- To support development of community sea cucumber aquaculture project
- Results provided to community



# Study area - Zones



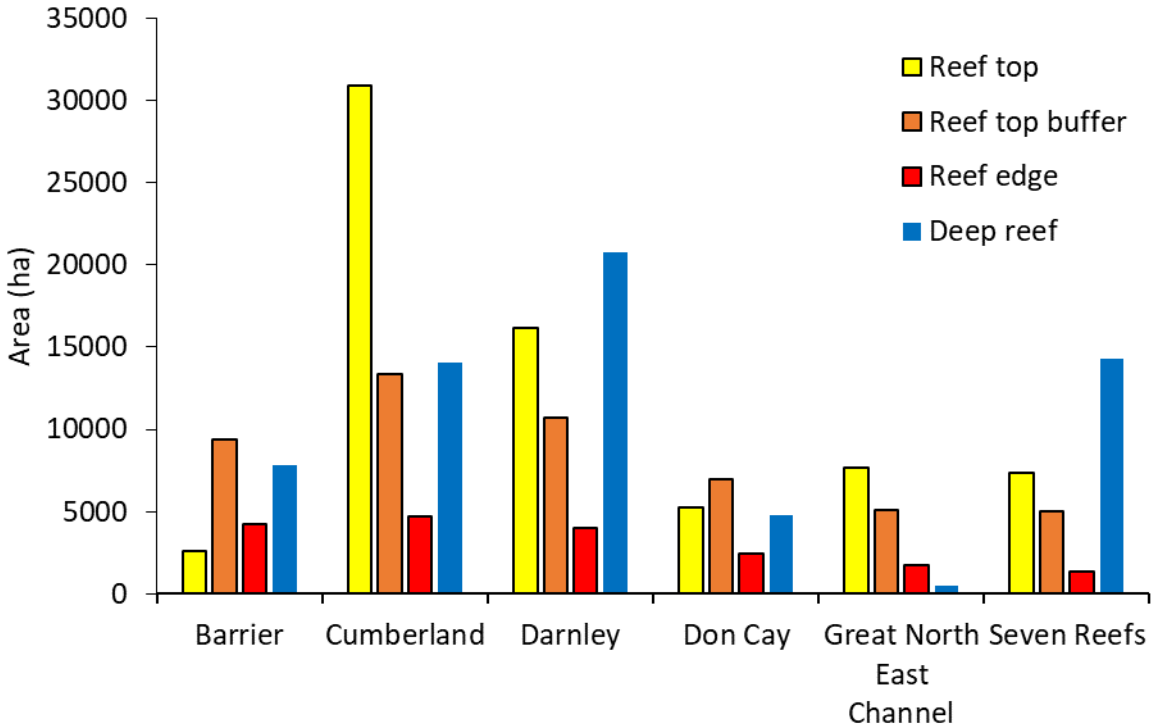
# Study area - strata



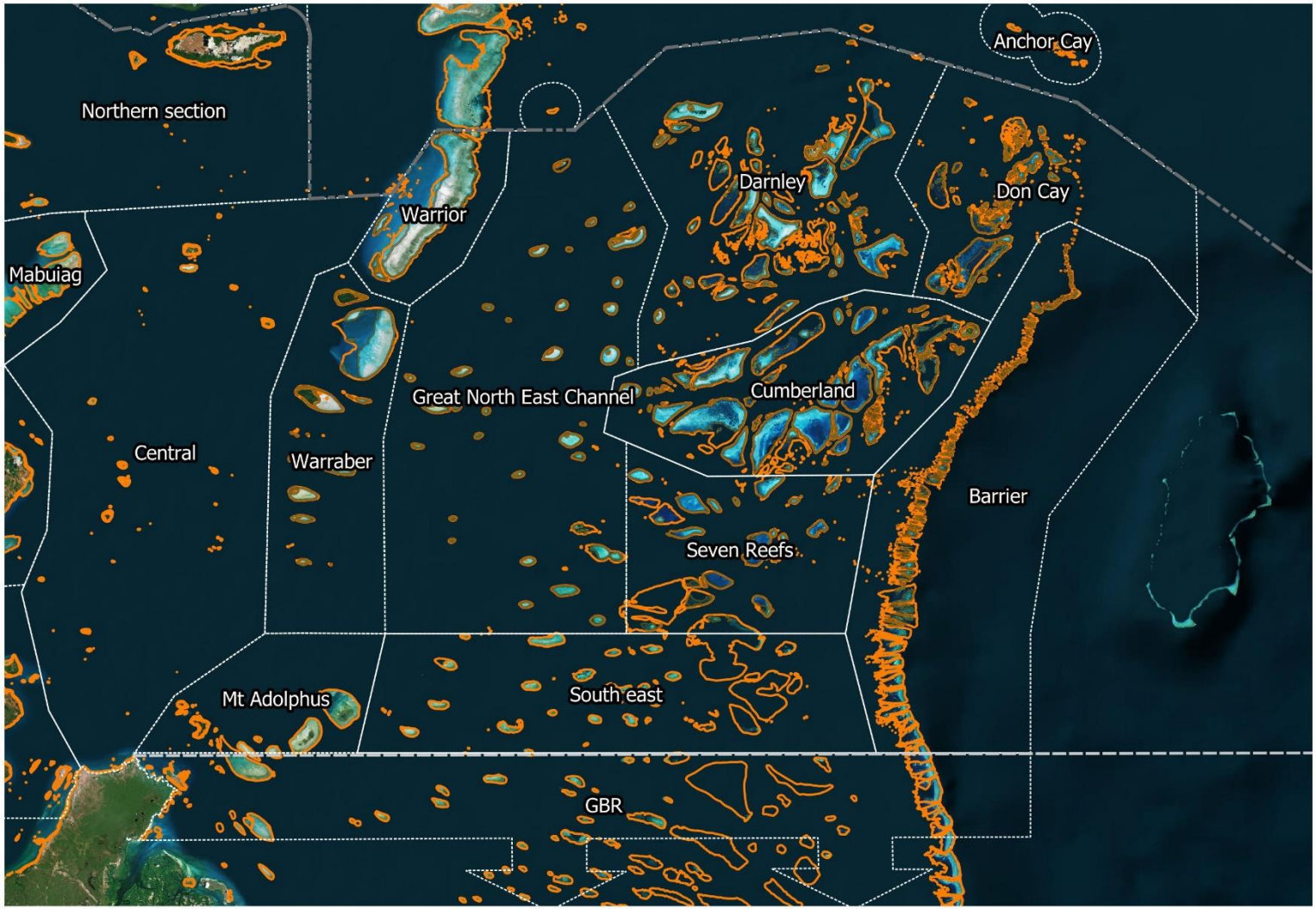
# Study area - strata

- 3 shallow reef strata
  - Reef top
  - Reef top buffer (200 m)
  - Reef edge (<20 m)
- Deep reef (20-50 m)
- Inter-reefal (20-120 m)

| Strata | Area (km2) |
|---|---|
| Reef top | 700.1 |
| Reef top buffer | 503.9 |
| Reef edge | 184.5 |
| Deep reef | 622.0 |
| Inter-reefal | 14,969.5 |
| Total area | 16,980.0 |

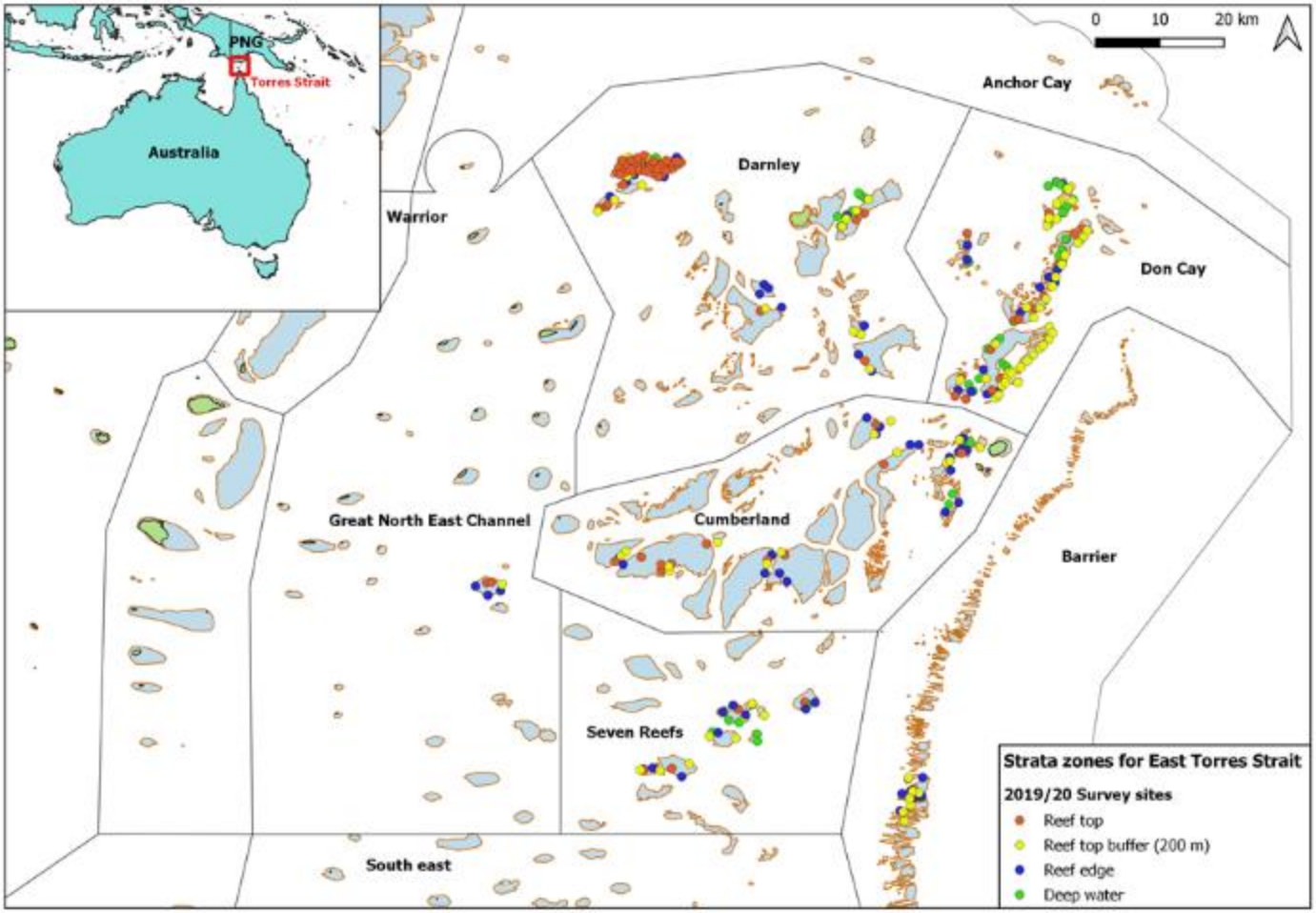


# Study area – Deep reef

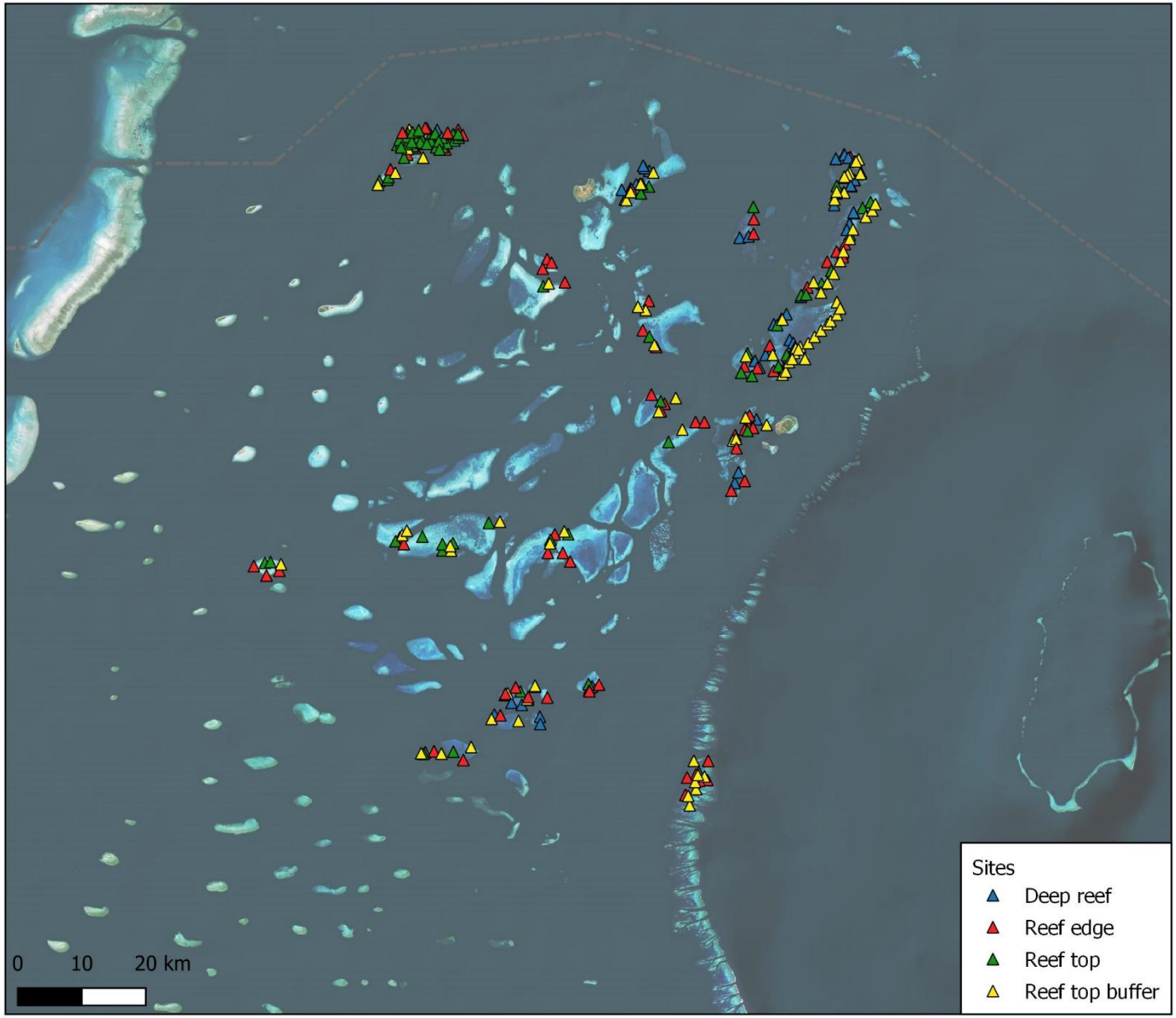


# Survey sites

| Year | Zones | Top | Buffer | Edge | Deep | Total |
|---|---|---|---|---|---|---|
| **1995/96** | 14 | 1089 | 164 | 365 | 0 | 1618 |
| **2002** | 6 | 136 | 139 | 159 | 0 | 434 |
| **2005** | 5 | 35 | 52 | 40 | 0 | 127 |
| **2009** | 5 | 33 | 25 | 45 | 0 | 103 |
| **2019/20** | 6 | 88 | 86 | 70 | 53 | 297 |

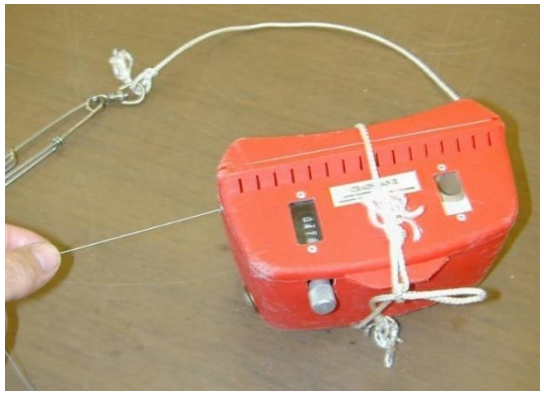


# Survey sites – 2019/20



# Survey methods – shallow reef (<20 m)

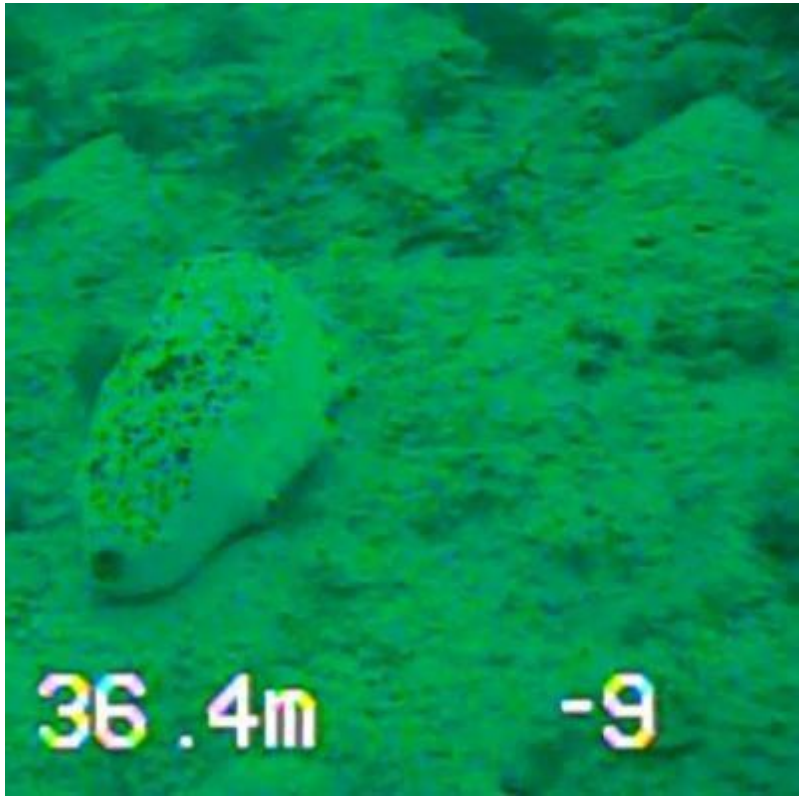
- Same methods used in all previous surveys
- 40 m to 100 m transects – snorkel or scuba
- Use GPS and chainman distance device
- Counted and collected sea cucumbers
- Recorded habitat and other biota
- Measured length and weight
- All sea cucumber returned to sampled habitat

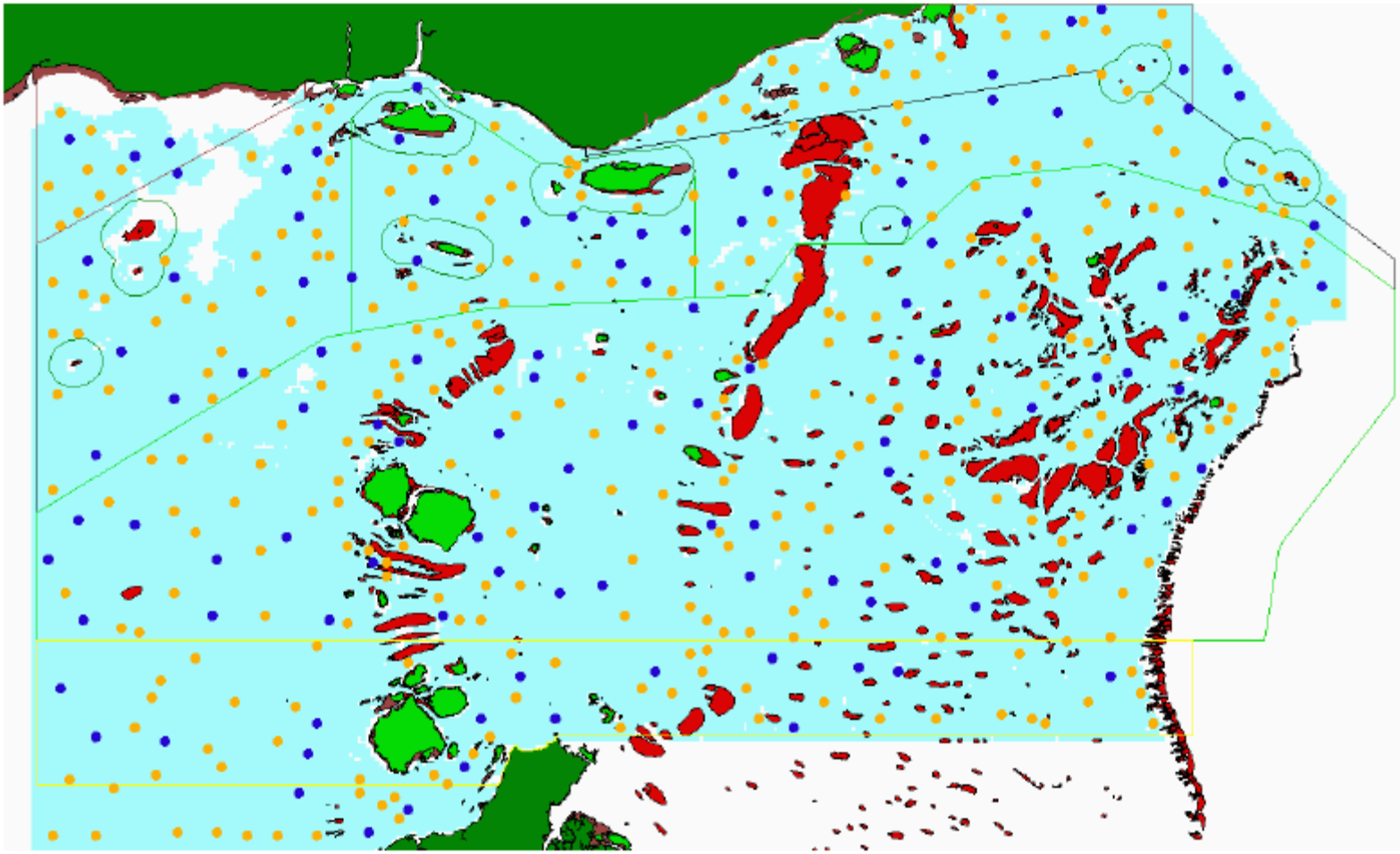
# Deep reef survey

- 20 m - 50 m deep
- 10 min drifts, 40 – 600 m
- TSRA camera system – *Thanks!*
- Deepest White teatfish 37 m



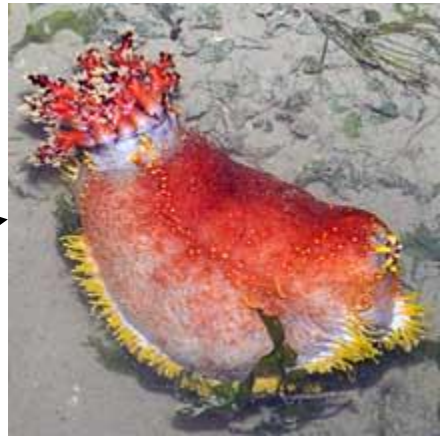


# Inter-reef habitat



# Inter-reef habitat

| Species | Sites observed | Biomass (t) |
|---|---|---|
| *Actinopyga lecanora* | 1 | - |
| *Cercodemas anceps* | 37 | 19.3 |
| *Cladolabes perspicillum* | 2 | - |
| *Cladolabes schmeltzi* | 2 | - |
| *Holothuria edulis* | 1 | - |
| *Pentacta australis* | 17 | - |
| *Cladolabes perspicillum* | 2 | - |
| *Pseudocolochirus violaceus* | 17 | 929.8 |
| *Stichopus horrens* | 21 | 314.1 |
| *Holothuria ocellata* | 50 | 69.8 |
| *Stichopus herrmanni* | 2 | - |
| *Holothuria atra* | 1 | - |
| *Holothuria lessoni* | 7 | - |
| *Stichopus ocellatus* | 1 | - |



# Analyses

## Stratified density

- Estimates of mean density - counts per hectare
- Used zones (logbook areas) and reef strata
- Represents physical size differences of different habitats for the surveys
  - *Note: Strata by Zone combinations – Great North East Channel + Deep reef and Barrier + Deep reef are not sampled*

## Density trends

- Compared survey sites within zones and strata sampled in previous years
- Four zones were sampled in 1995, 2002, 2009 and 2019/20: Cumberland, Darnley, Don Cay and Great North East Channel

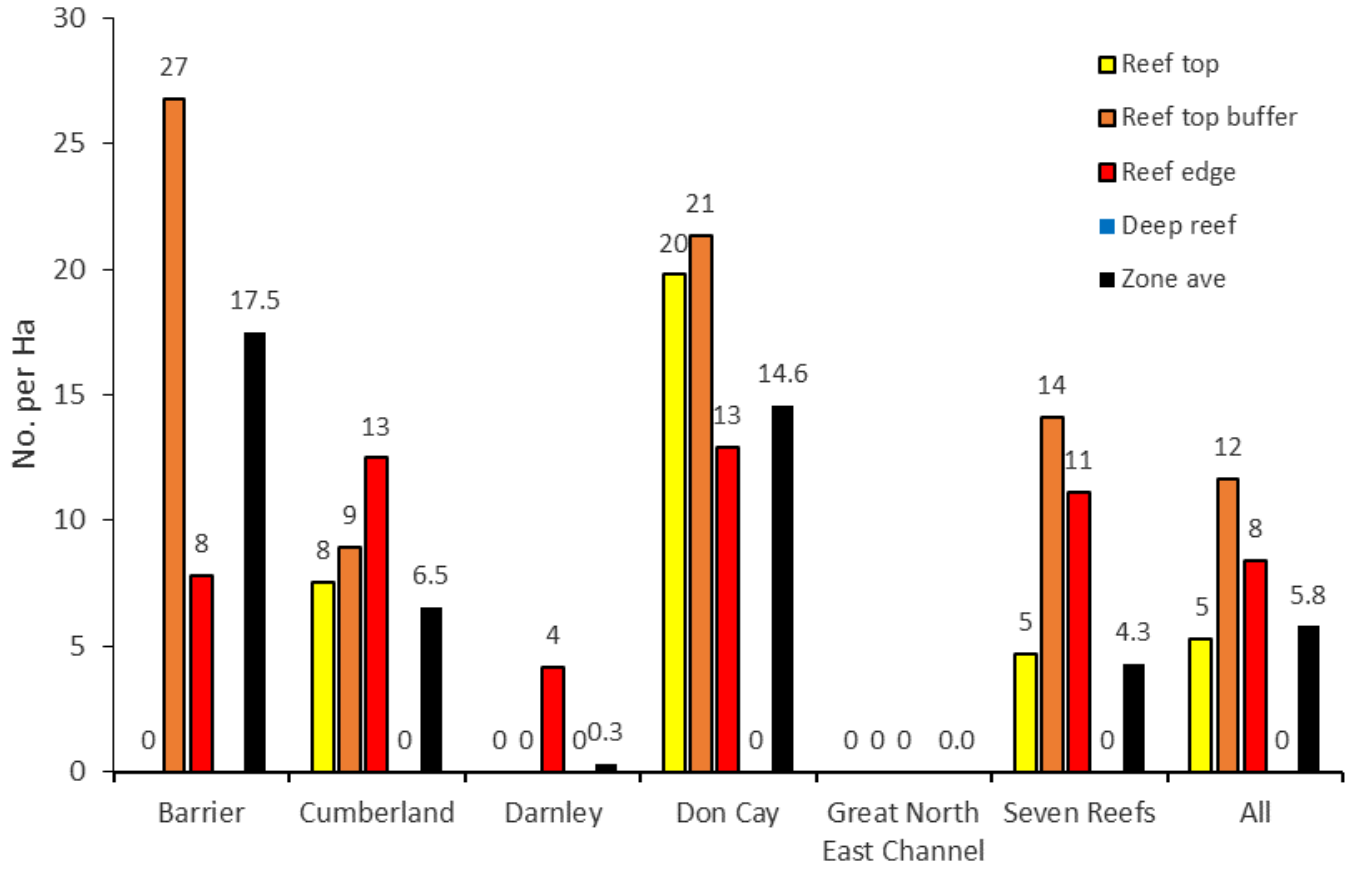
## Standing stock

- Calculated from estimates of density, reef area and average weight from size frequency data collected during the survey
- Suitable for calculating standing stock for the surveyed areas, but not for direct comparison between survey years

## Mirror-match bootstrapping

- Conservative stock estimate for formulating TAC recommendations
- Calculated bottom 90th percentile of the bootstrapped mean estimate of the distribution
- Assumes real estimate would be 90% certain of being greater than this value
- Approach is consistent with the new Harvest Strategy specification that the “Trial opening TAC needs to be set at a demonstrably conservative level” (AFMA, 2019)

# Black teatfish 2019/20




Fishery biomass estimate = 787 t
>MLS = 172 t

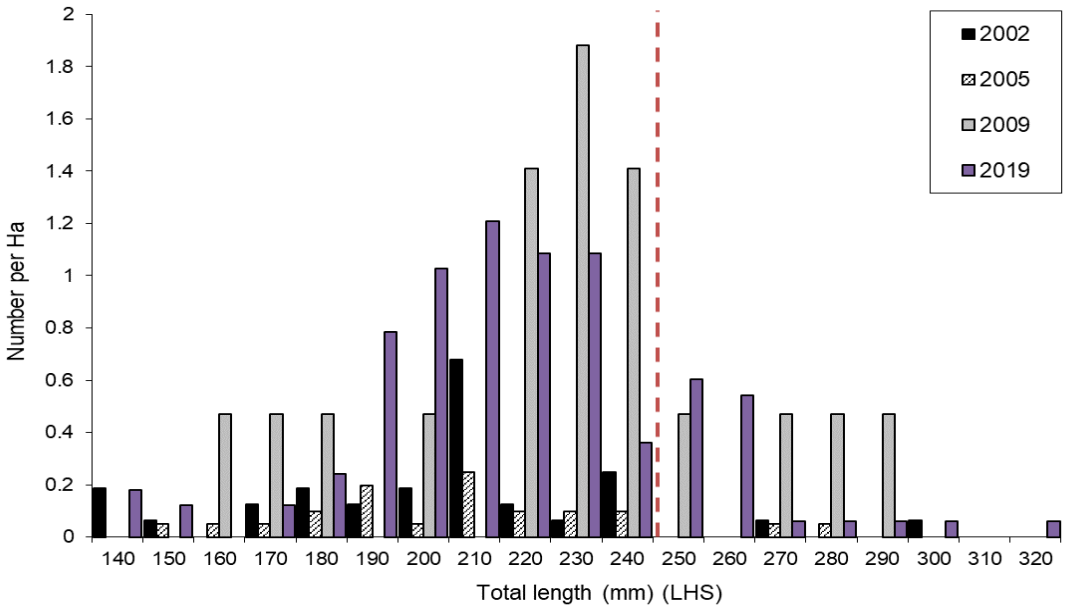
# Black teatfish – stock 2019/20

- Estimated fishery biomass 1,238 t (gutted wt)
- Bootstrapped lower 90th percentile of the fishery biomass was 787 t
- Bootstrapped lower 90th percentile of the fishery biomass >MLS was 172.3 t

| Zone | Sites | Mean density) | Var (st) | Stock (n) | Live wt (t) | B (t) | Live wt (t) L90th | B (t) L90th | B >MLS (t) L90th |
|---|---|---|---|---|---|---|---|---|---|
| Barrier | 15 | 17.8 | 118.3 | 288,273 | 470.5 | 318.5 | - | - | - |
| Cumberland | 50 | 6.5 | 17.7 | 412,235 | 672.8 | 455.5 | - | - | - |
| Darnley | 89 | 0.3 | 0.1 | 16,534 | 27.0 | 18.3 | - | - | - |
| Don Cay | 104 | 14.6 | 16.2 | 282,963 | 461.8 | 312.7 | - | - | - |
| GNE Channel | 6 | 0 | 0 | 0 | 0 | 0 | - | - | - |
| Seven Reefs | 33 | 4.3 | 3.4 | 120,489 | 196.7 | 133.1 | - | - | - |
| ETS | 297 | 5.8 | 3.0 | 1,120,493 | 1828.8 | 1238.1 | 1162.5 | 787.0 | 172.3 |

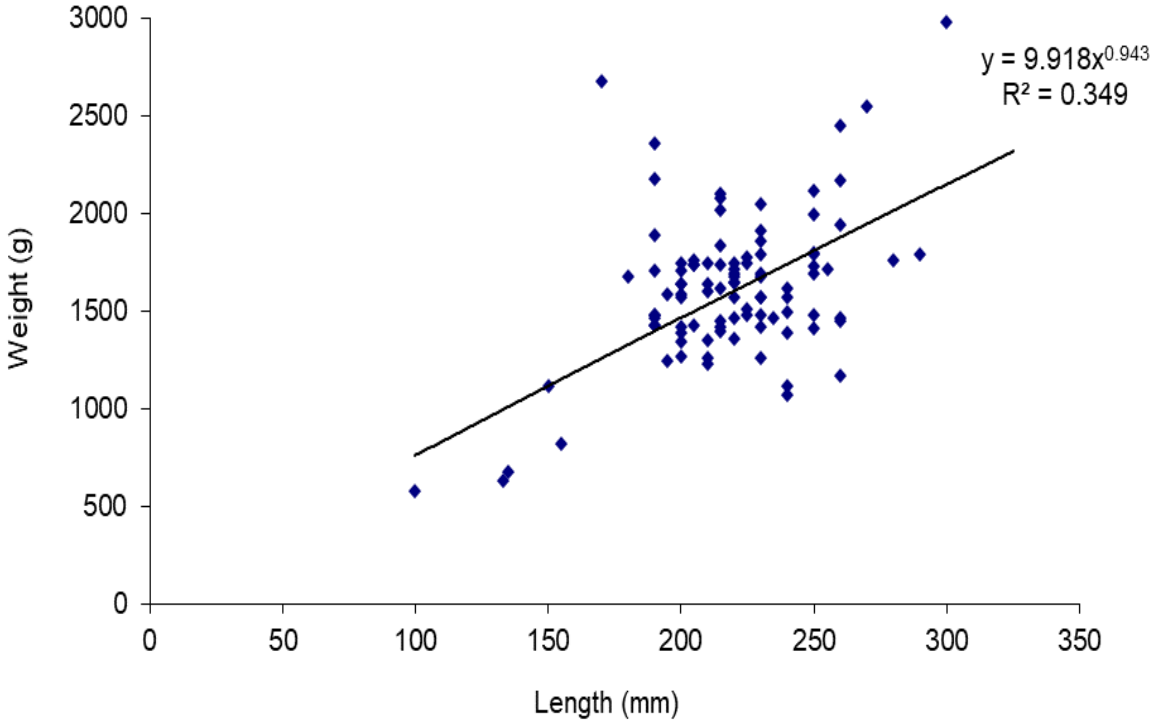
# Black teatfish - size

- Average size in 2019/20 was 219 mm (slightly smaller than 2009, but larger than other surveys)
- Slightly lower proportion of legal size animals compared to 2009
- Size at maturity: 220 - 260 mm
- Minimum legal size: 250 mm




# Black teatfish - weight

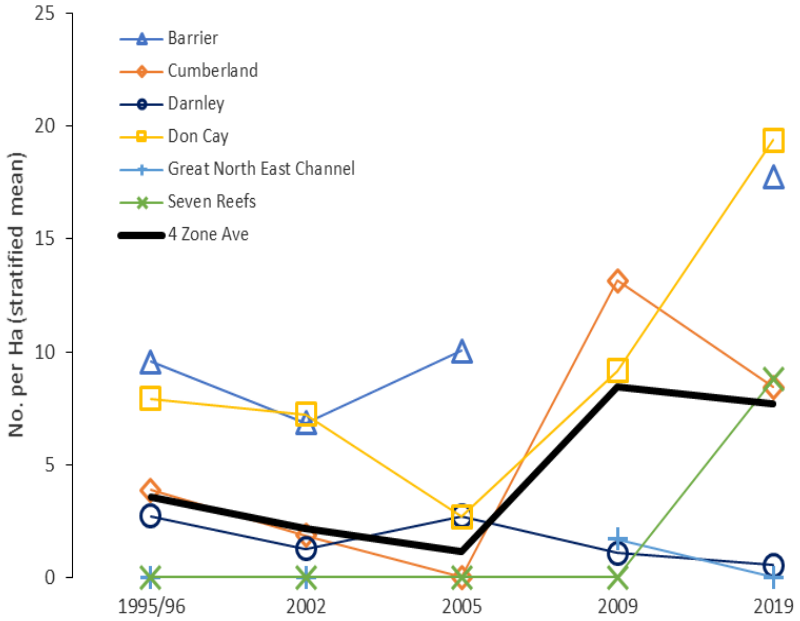
- Weight range: 580 g – 2,980 g (live wt)
- Average weight: 1,632 g
- Comparison - GBR survey (2015) average weight 1820 g and weight range 500 – 2900 g (Knuckey and Koopman, 2016)

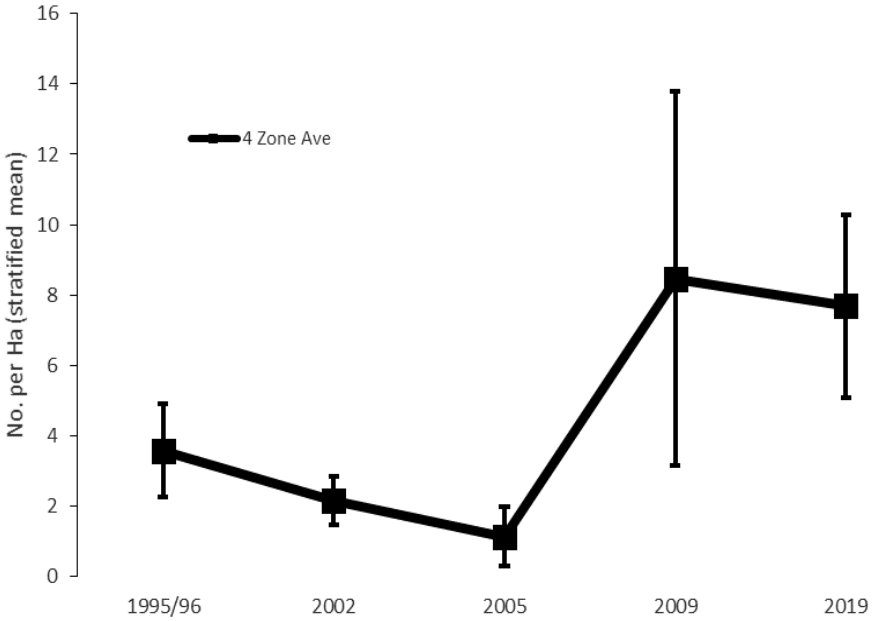


# Black teatfish – stock trends

## Density trends 1995 - 2019/20

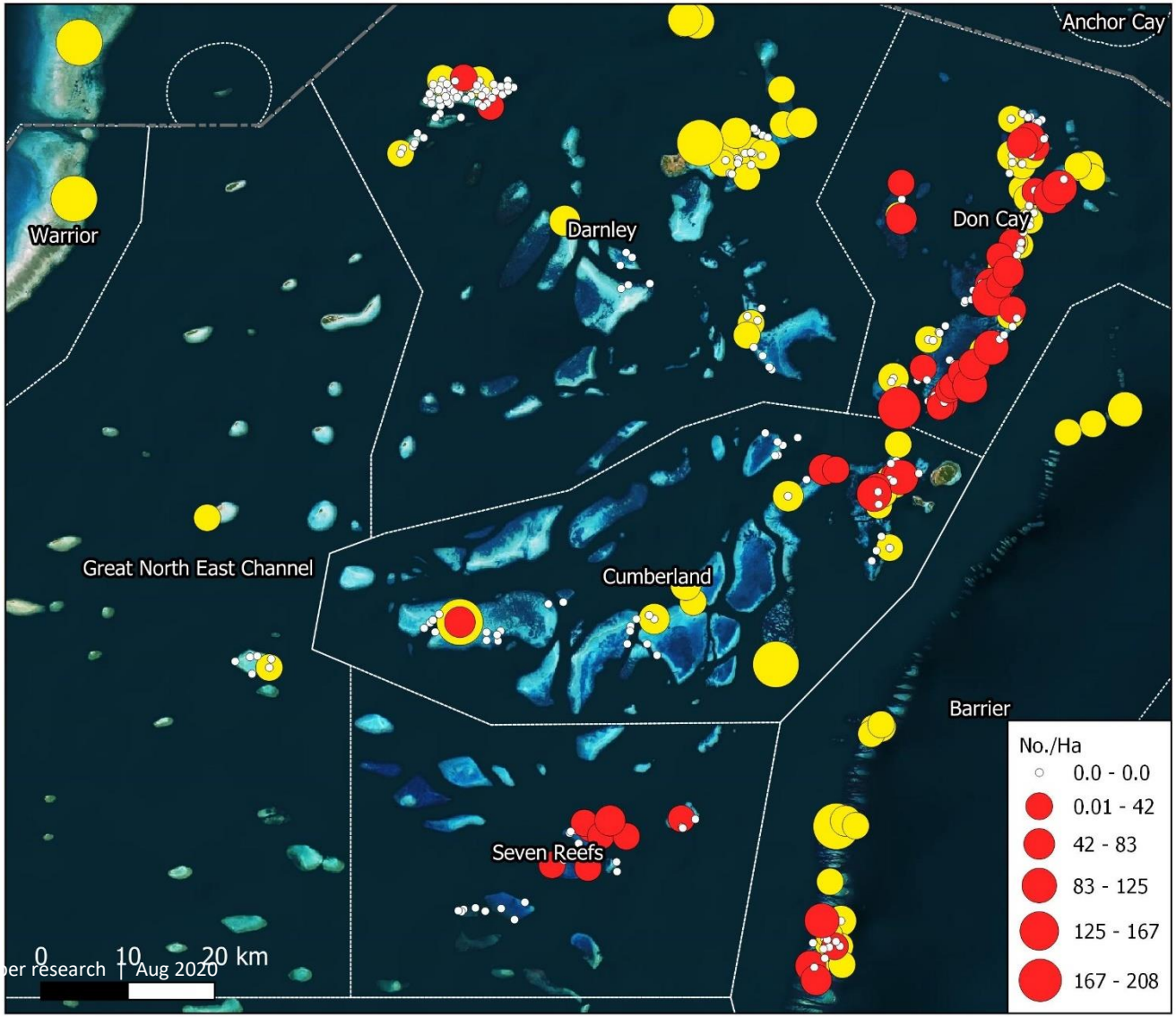
- 4 zones consistently sampled (Cumberland, Darnley, Don Cay and Seven Reefs)



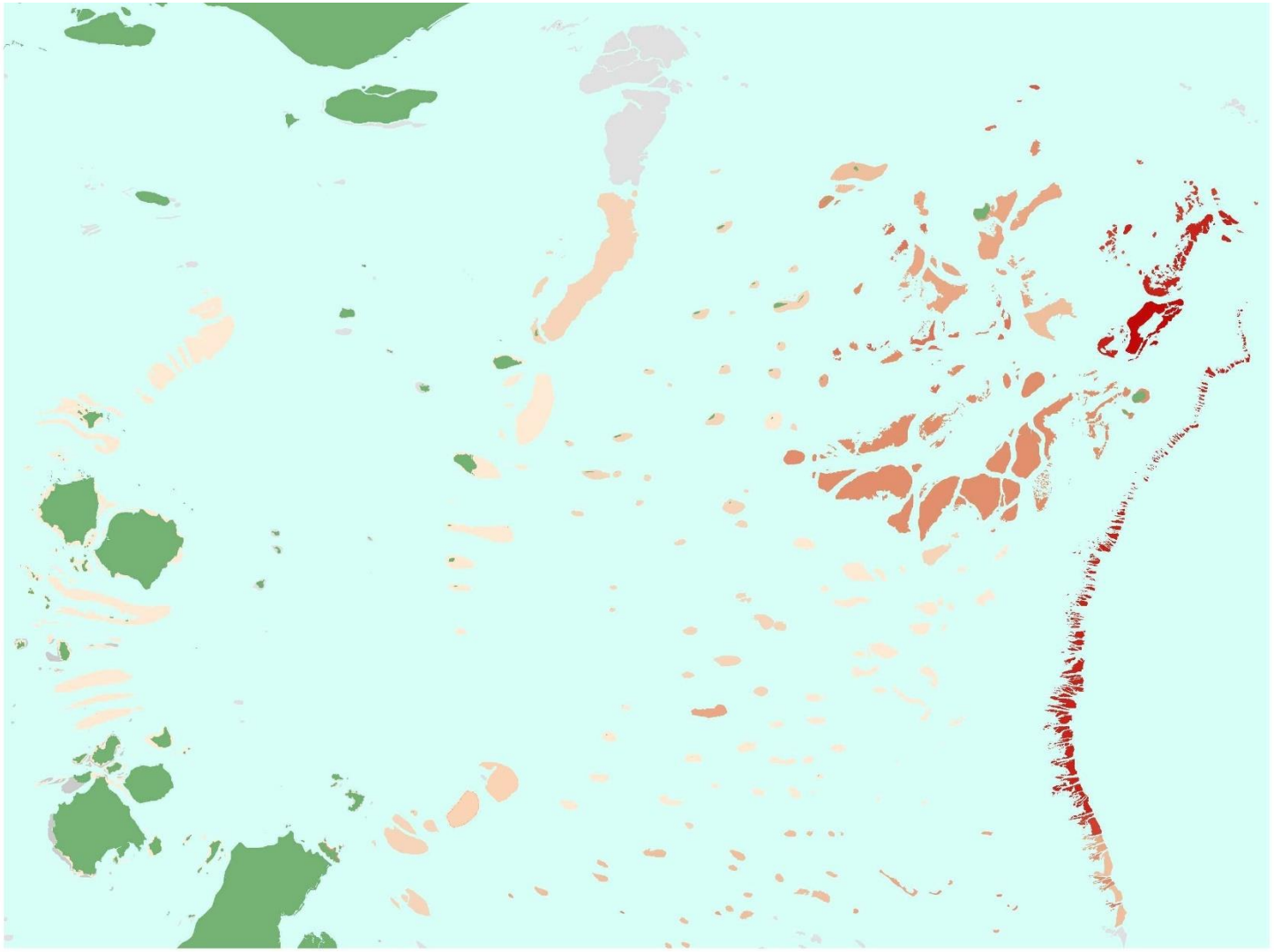
# Black teatfish – stock trends

Site density 2019/20 v previous



# Black teatfish – distribution

- Modelled from survey data 1995-2009 and biophysical correlates

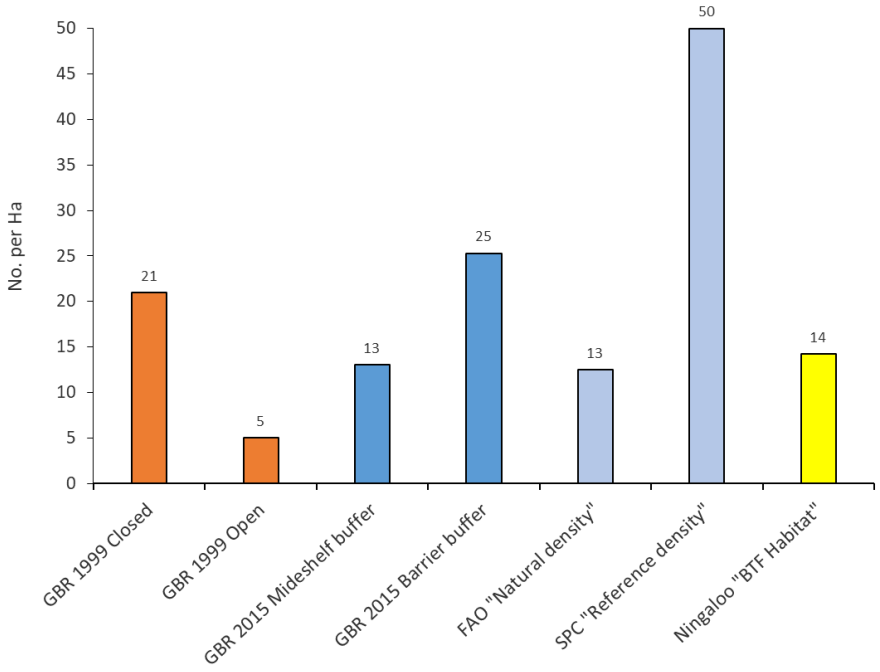


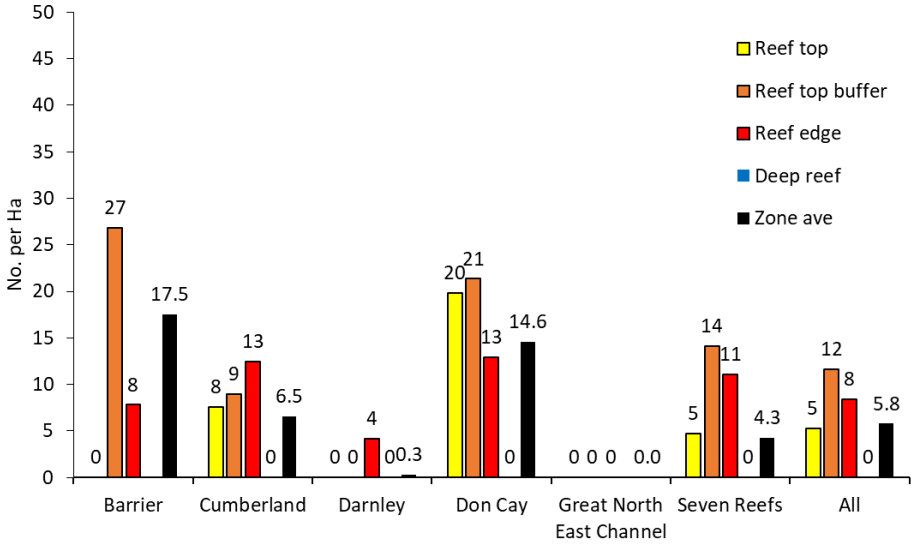
# Comparisons with other surveys

- Unbiased comparisons between locations is difficult
- Sea cucumber density varies across reef habitats and in relation to distance from terrigenous influence (across shelf)—and likely several other lesser known gradients
- Comparison depends on a clear delineation of the surveyed habitats
- Historic surveys in Torre Strait have been carried out using the same sample design and survey approach
- Sometimes survey delineations are poorly defined

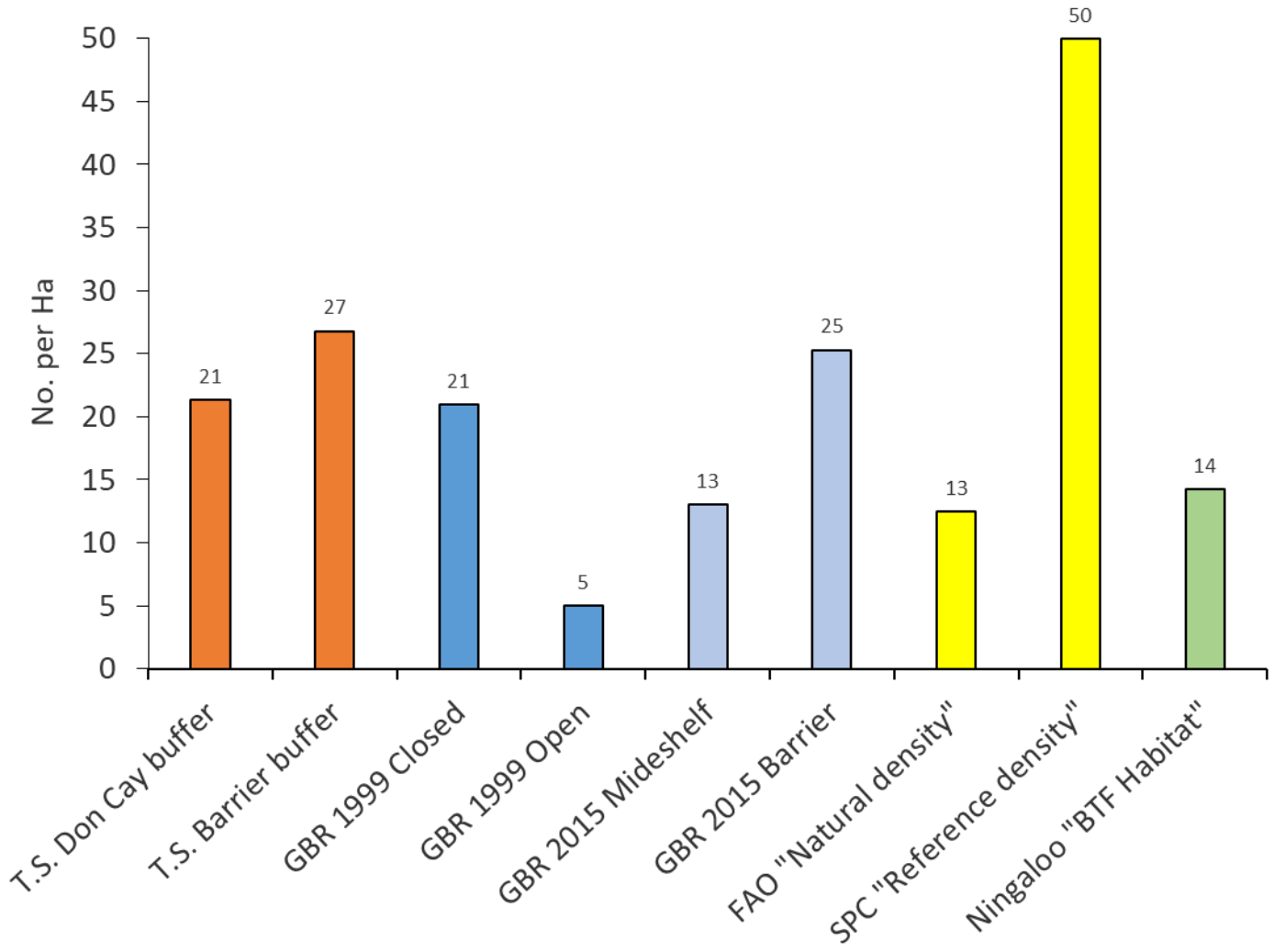
# Black teatfish – stock status

## Comparison to other studies



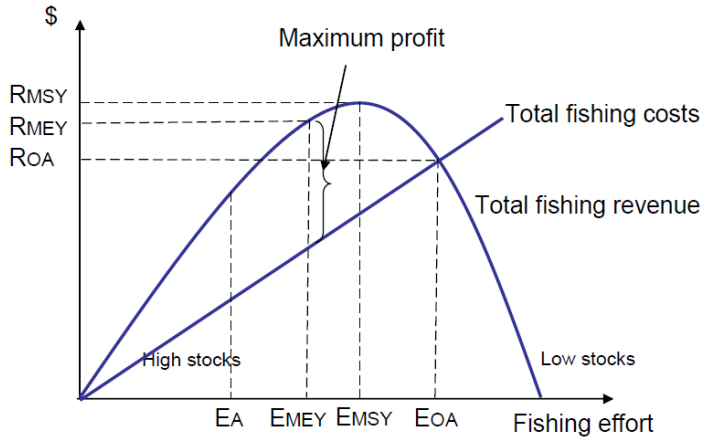



# Black teatfish – stock status



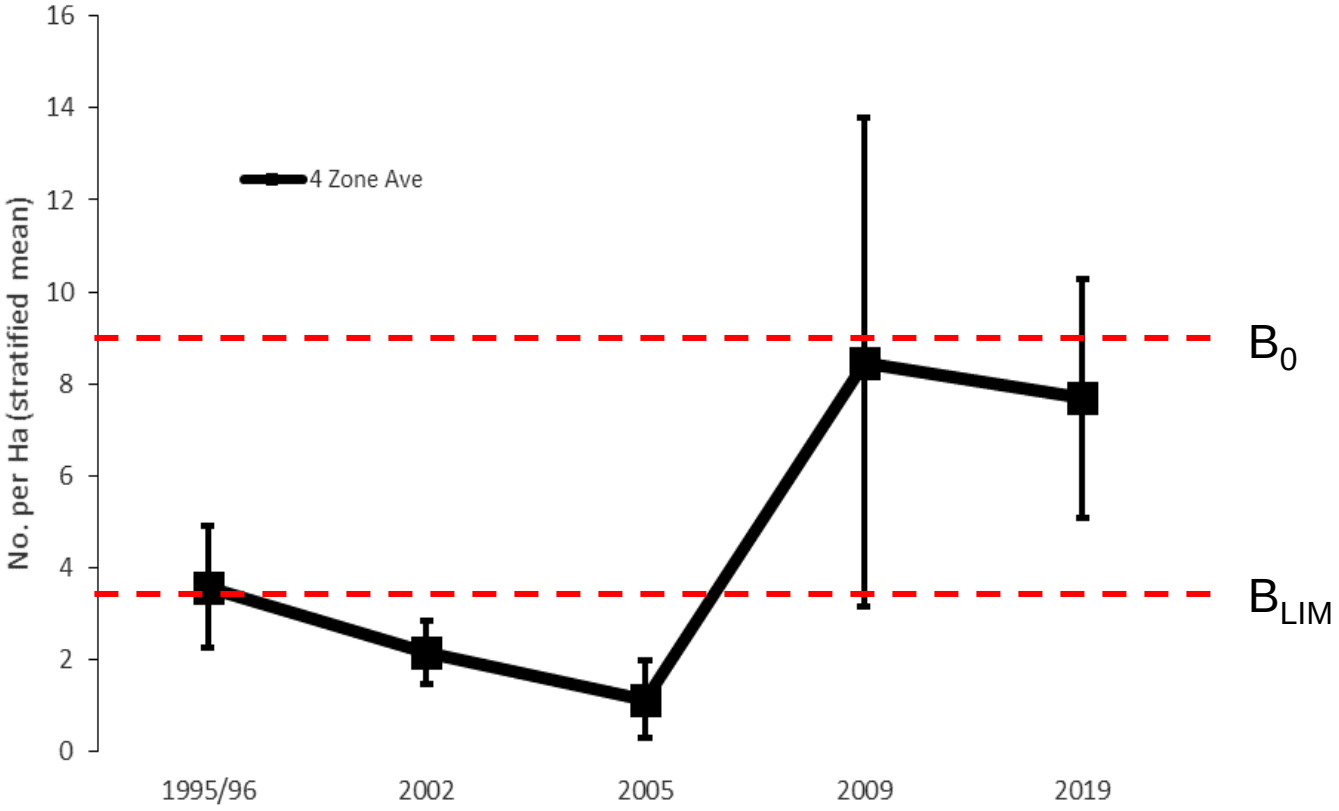
# Black teatfish – Reference levels

- Usually relative to virgin (before fishing) biomass ($B_0$ or K)
  - can be a difficult when species have variable recruitment or patchy distribution
- Fisheries depend on increases in productivity as populations are fished
  - maximum productivity at $B_{MSY}$
  - maximum economic yield at $B_{MEY}$ (=$B_{TARG}$)



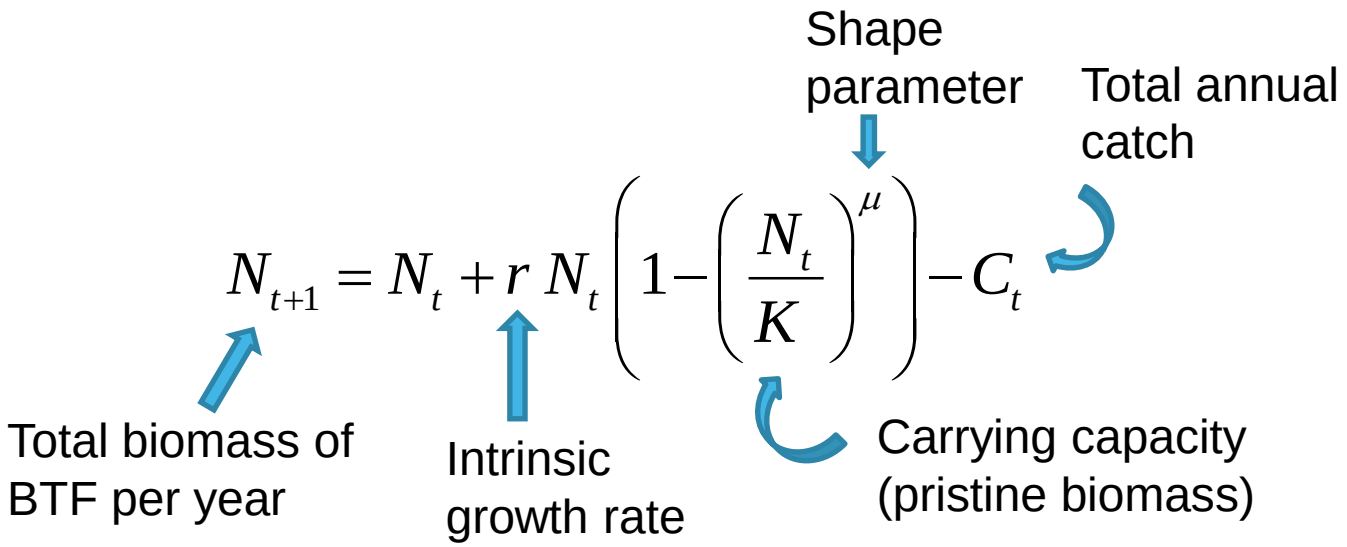

- Depletion to lower levels can eventually lead to recruitment impairment
  - unacceptably high danger of recruitment failure at $B_{LIM}$

# Black teatfish – Reference levels



# Black teatfish – Stock Modelling

- Objective way to explore population dynamics
- Provides a dynamic (i.e. changing over time) picture of a species and hence informs on not just standing biomass but also what the likely productivity (i.e. turnover rate) is to help inform on sustainable fishing levels



# Model limitations

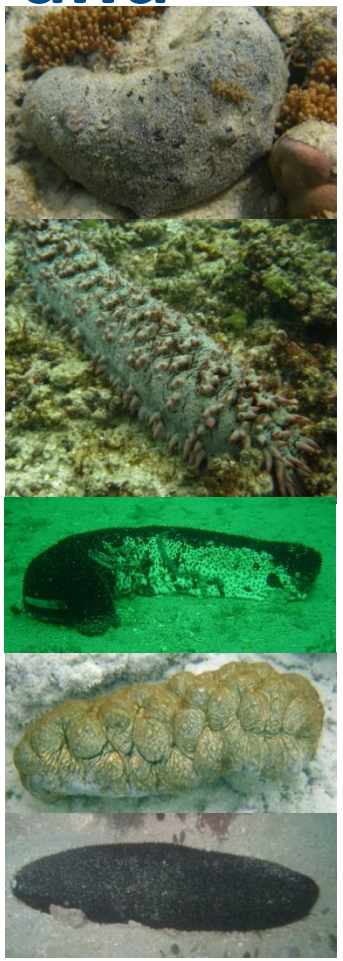
- As with any model, model outputs are only as good as the data that are used
- If we have less data then assessments need to be simpler and the harvest strategy needs to be more precautionary
- There are relatively few values in the BTF time series (i.e. 5 survey points) hence there is limited information to inform a model
- There is some contrast in the time series (i.e. a downward trend followed by a recovery) to estimate productivity
- Biomass dynamic models -> simple models (current)
- Age-structured spatial models -> better (future)
- MSE: Management Strategy Evaluation -> best (potential)

# How does the modelling relate to the new Harvest Strategy (HS)

- The modelling is used to corroborate or shed additional light on analyses of the survey data to provide insights into stock status and sustainable yield
- Consistent with the HS philosophy of using a precautionary starting TAC to re-open a fishery, the modelling can explore a range of alternative scenarios with different levels of precaution added
- Consistent with the HS philosophy of being able to improve and refine management advice as more data become available, models will also be able to refine and improve their estimates as more data become available

# Reminder: How does it work for different stocks with more or less information and data

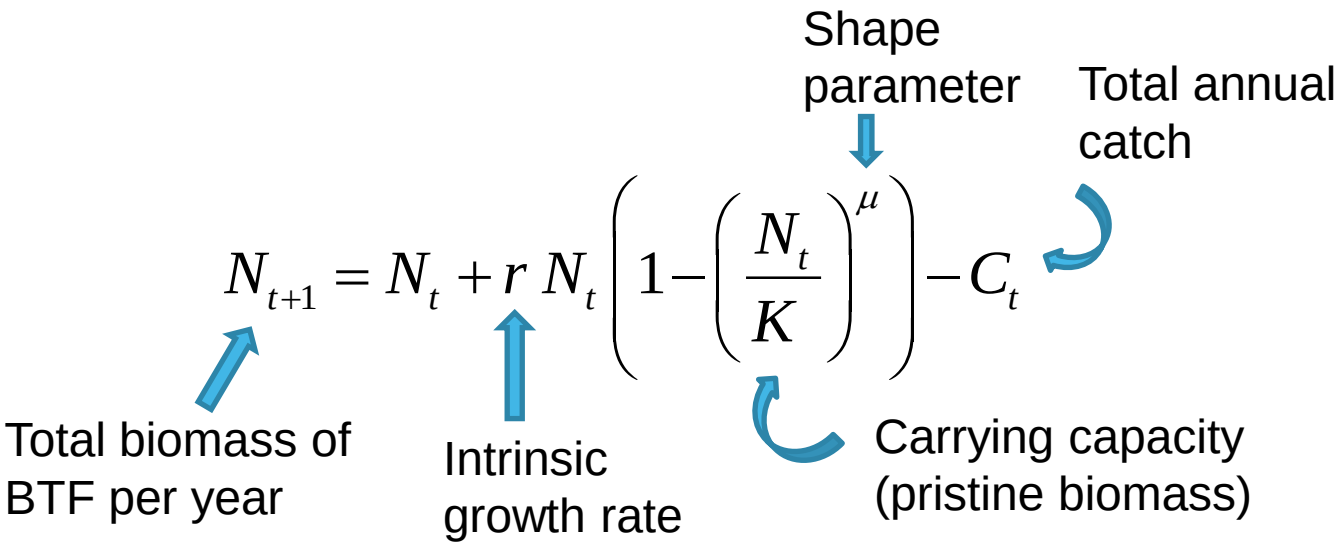
- If we have less data then assessments need to be simpler and the harvest strategy needs to be more precautionary
- With better information and data for a stock, a stock assessment model that uses all the information can be used
- But stock assessments also differ – can be high quality vs more uncertainty in stock assessment:
  - when more certain can approach more robustly
  - but when less certain about stock status then need to be more precautionary as you have less certainty about stock status



# Total Biomass vs Available biomass

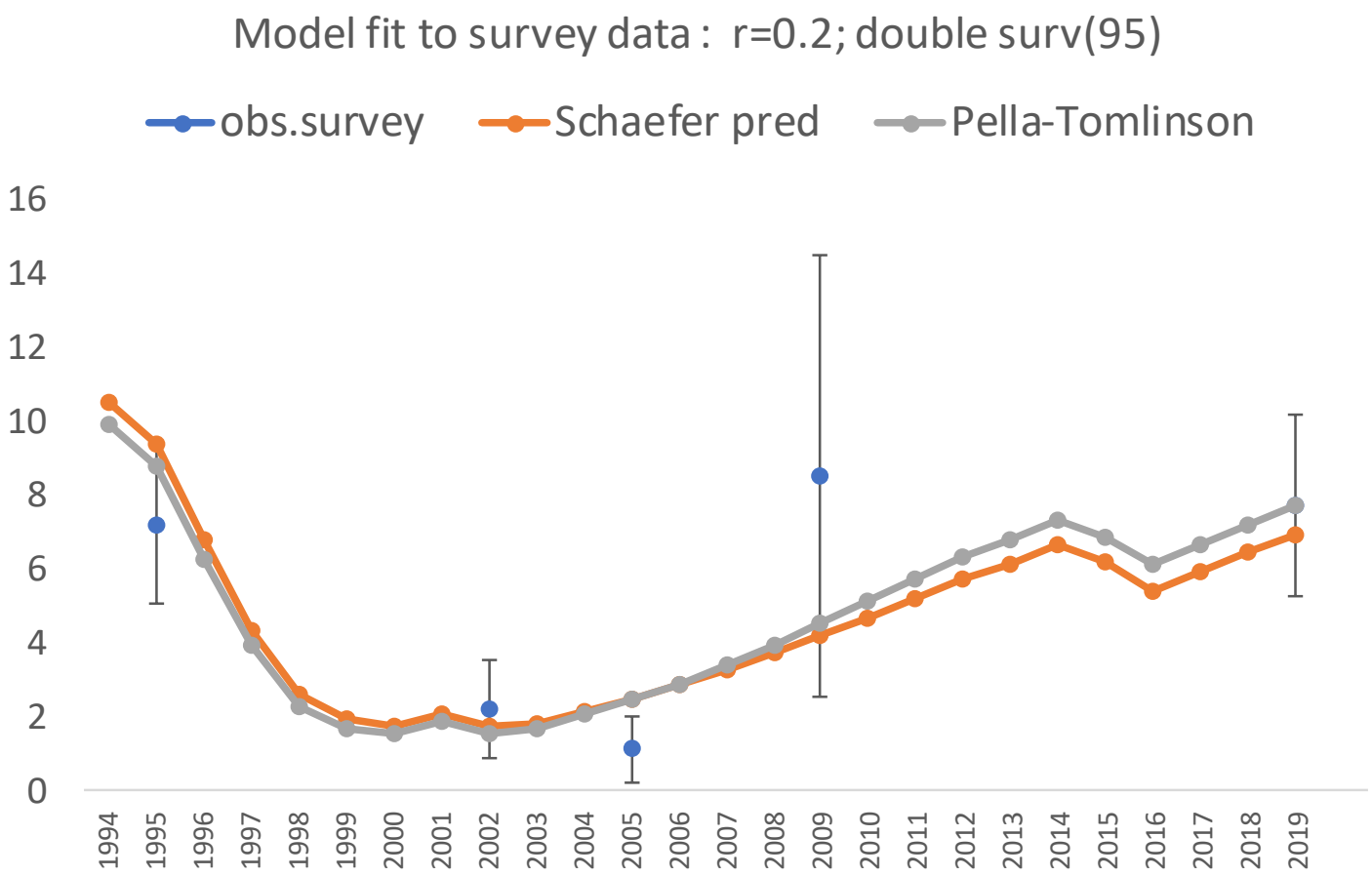
- The biomass of a fishery that is “available” to be caught is calculated as the biomass above the MLS (minimum legal size)
- If possible, this is the best quantity to use to calculate the sustainable yield, and is the biomass measure used in age-structured and size-structured fisheries models such as for TRL
- The biomass dynamics model used here can only consider total biomass but more complicated models can refine this
- Available biomass is a better measure than total biomass for stocks that are recovering because it takes into account the lag time for recovery to occur and hence for sufficient animals to grow larger than the MLS and be available to the fishery. If the age-structure is skewed towards incoming recruits, total biomass can overestimate the sustainable yield.

# Pella-Tomlinson equation

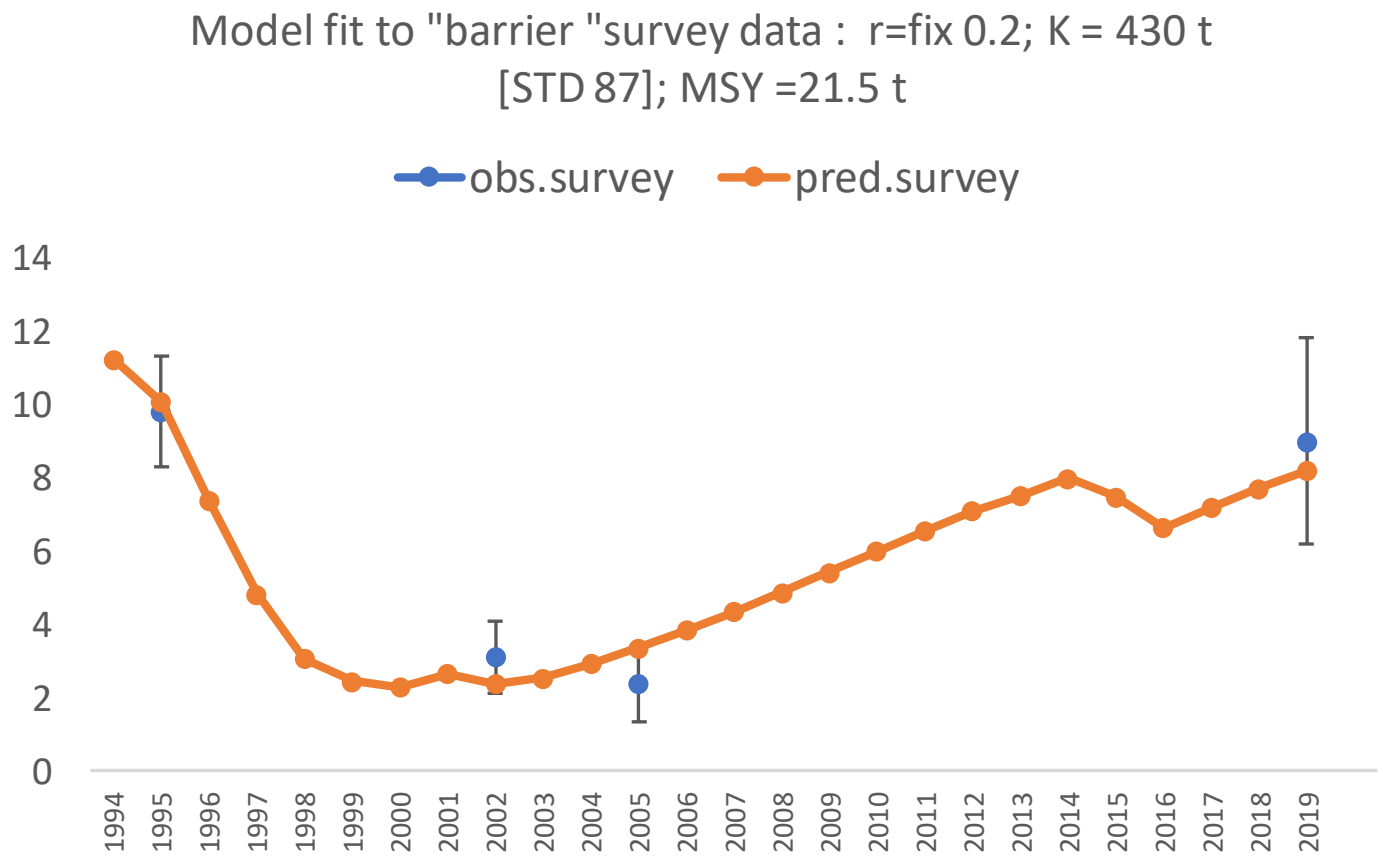



- Lumped biomass model
- Assumes growth is density-dependent
- The combination of *r* and *K* is more robust than these parameters on their own and informs on sustainable/replacement yield
- Implemented in ADMB

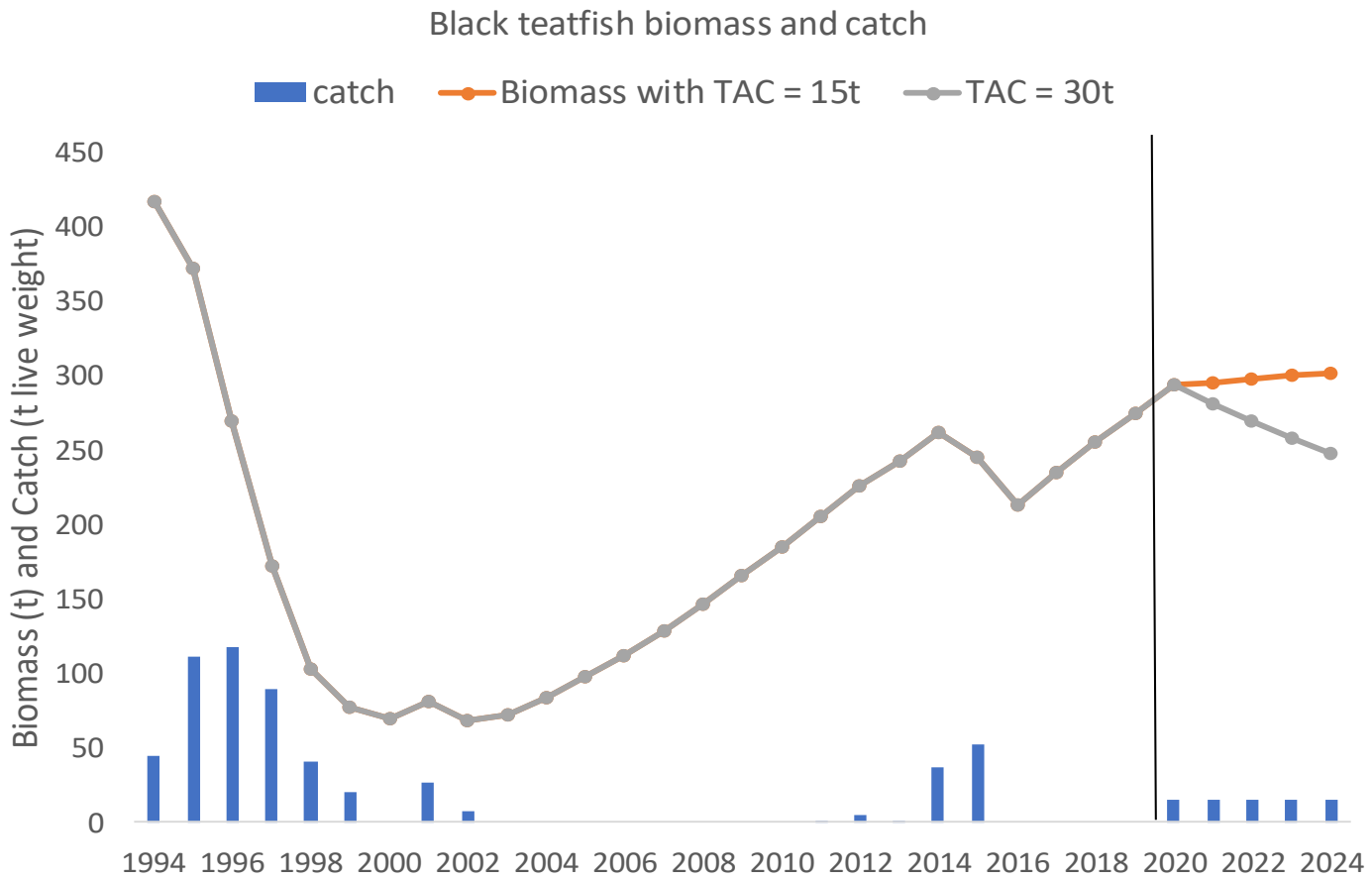
# Model fit to survey data



# Use survey series that includes outer barrier (less variable as less fishing there, but no data for 2009)



# Base-case model estimated biomass trajectory and forward projection



# Model Results Summary: MSY

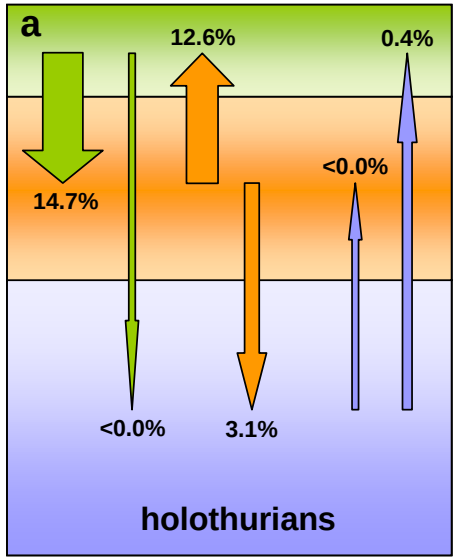
| | Description | MSY (t) | BMSY (t) | B(2019) (t) | B2019/BMSY |
|---|---|---|---|---|---|
| Model 1 | S; fix r | 18.5 | 245.4 | 336.9 | 1.37 |
| Model 2 | double surv(95) | 16.9 | 225 | 242.3 | 1.08 |
| Model 3 | S; fix r | 15 | 300.5 | 385.7 | 1.28 |
| Model 4 | S; fix r; dbl | 20.8 | 208.3 | 274.7 | 1.31 |
| Model 5 | S; est r,K | 28.5 | 195.8 | 344.3 | 1.75 |
| Model 6 | S; est r,K; dbl | 24.6 | 197.8 | 308.2 | 1.56 |
| Model 7 | P; est r,K,mu; dbl; mu=3.5 | 49.7 | 257.4 | 308.2 | 1.19 |
| Model 8 | Fix K, est r | 19.9 | 410.2 | 647.8 | 1.57 |

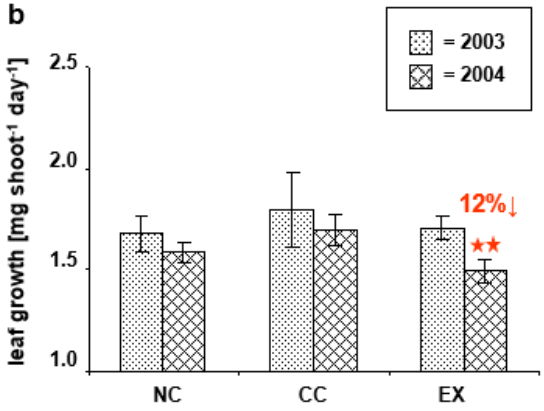
# Summary

- Across most model versions, projections suggested that a constant annual TAC of 30t may not be sustainable, whereas a TAC of 20 t was sustainable across all model versions run.
- The base-case model estimate of MSY was 21 t, which is slightly higher than the 15 t precautionary TAC that is currently recommended by the Harvest Strategy.
- As more data become available, it will be possible to refine and substantially improve modelling results.
- It wasn't possible to reconcile the absolute biomass estimates with the trends in the survey data, suggesting e.g. that spatial aspects need to be accounted for in the modelling

# Sustainable fishing – ecosystem role

- Important benthic environmental role
  - ➢ Bioturbation
  - ➢ Nutrient cycling




- Environmental MSY may be smaller than stock MSY due to adverse environmental impacts

# GBR Black teatfish

**1999**

- "Area of the fishery" (12-19° S—Princess Charlotte Bay to Lucinda)
- Focused on the "main habitat for Black teatfish" on reef flat with <40%
- Density on 'closed reefs' was **20.97** per Ha
- Density on 'open reefs' was **5.01** per Ha

- The fishery was closed in 1999

- The biomass estimate for the "fishery area" was **5,585** t.

(Benzie and Uthicke, 2003; Uthicke and Benzie, 2000)

# GBR Black teatfish

**2015**

- Similar area (14-19° S—Cape Melville to Lucinda) as the 1999 survey
- Focused on the 200 m reef edge buffer on the weather (SE facing) side of reefs > 1km$^2$
- Mid-shelf reefs

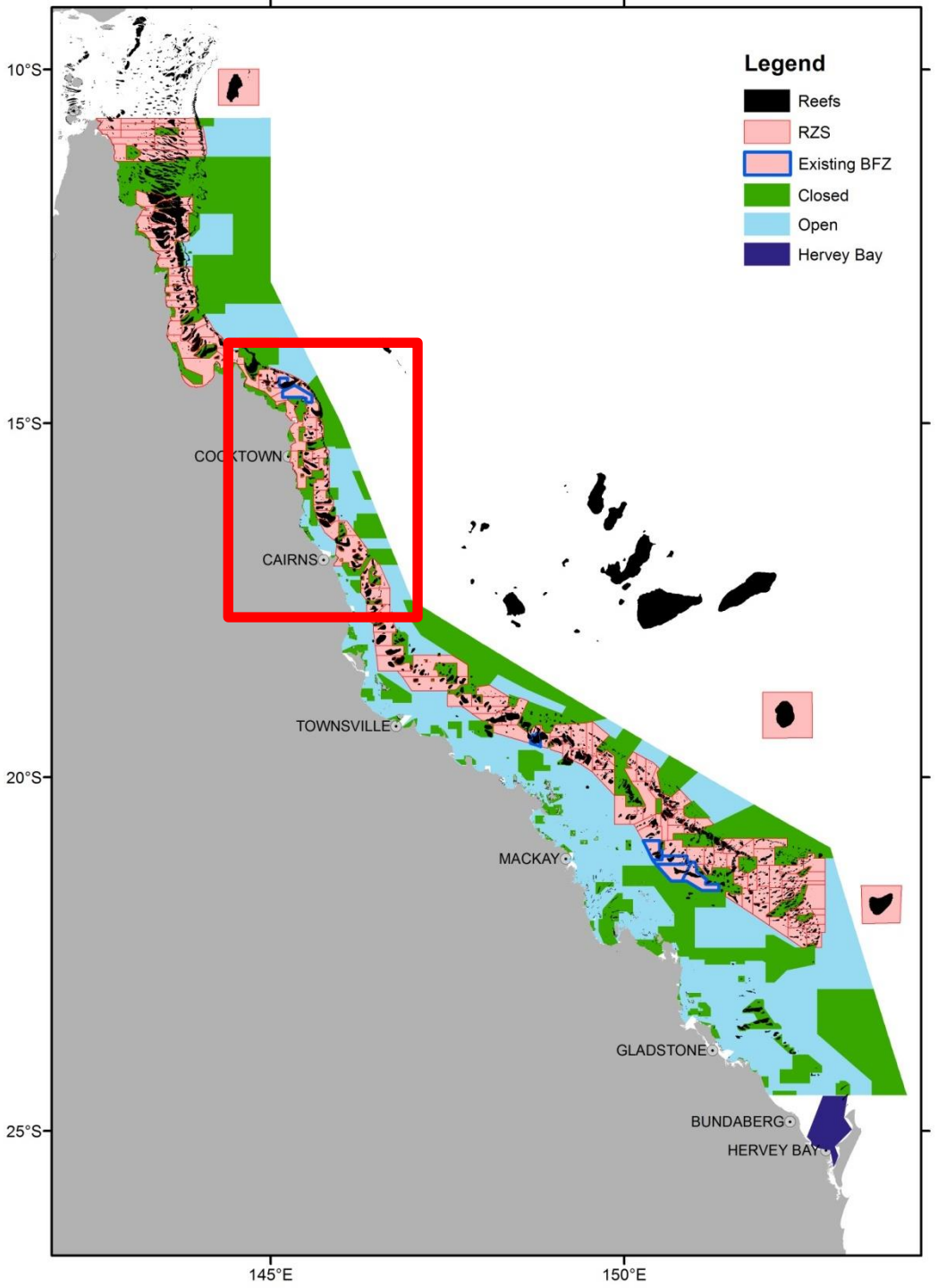
  **13.5** per Ha (closed reefs) and **12.5** per Ha (open reefs)
- Barrier reefs

  **27.0** per Ha (closed reefs) and **23.6** per Ha (open reefs)
- Population deemed to have recovered to >70% $B_0$
- The biomass estimate for the surveyed area was **379** t
- The fishery was opened in 2019 with a 30 t TAC

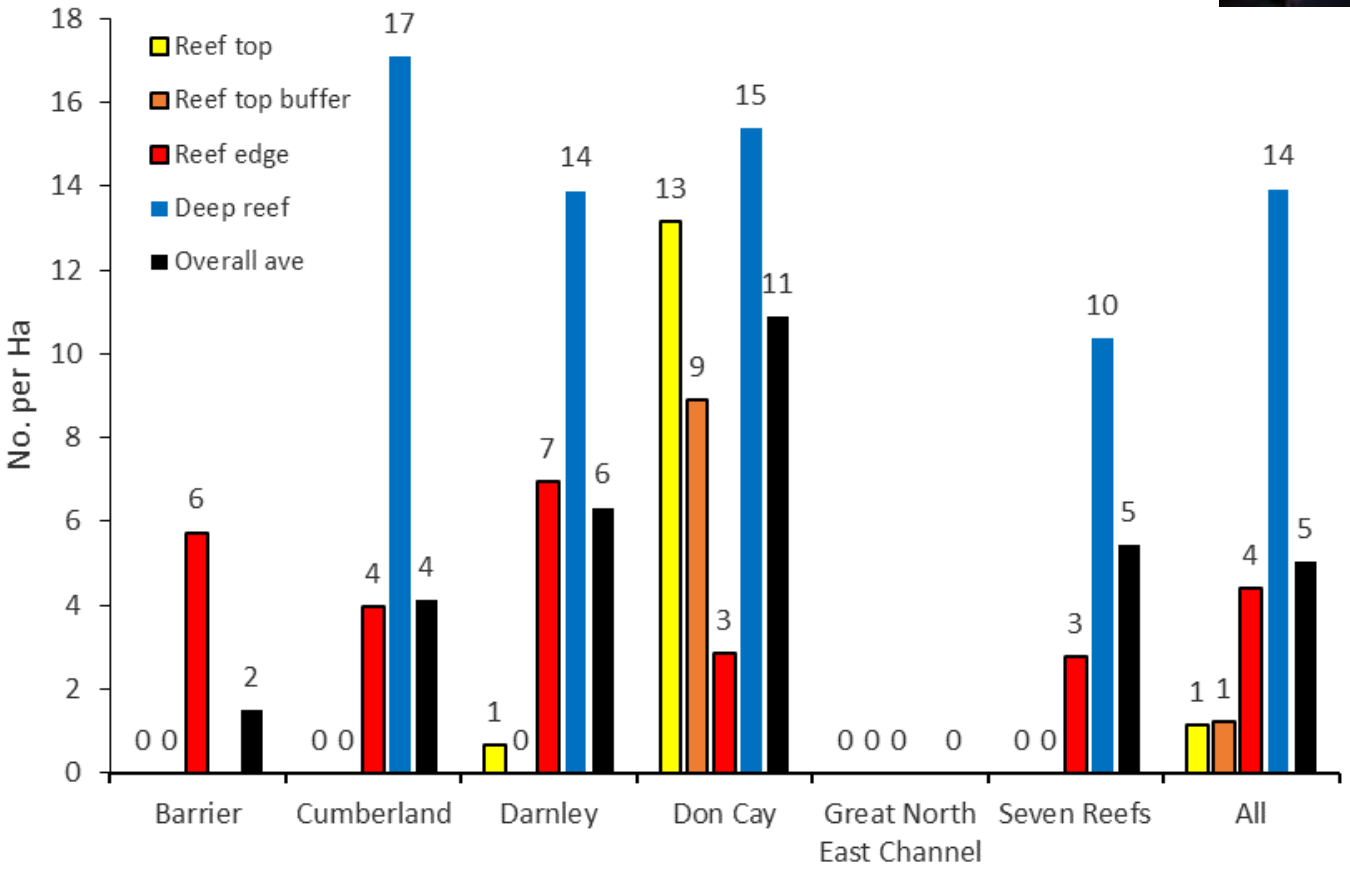
(Knuckey and Koopman, 2016; Koopman and Knuckey, 2020)

# Qld E.C Fishery (GBR)

| | |
|---|---|
| Total reef area | 26,373 km$^2$ |
| Total “dry reef” area | 6,363 km$^2$ |
| 1999 survey area (5,585 t) | 2,242 km$^2$ |
| 2015 survey area (379 t) | 184 km$^2$ |
| Closed to fishing | 36% |
| <u>Torres Strait</u> | |
| Reef area | 2,426 km$^2$ |
| (1,238 t) | (9.2%) |



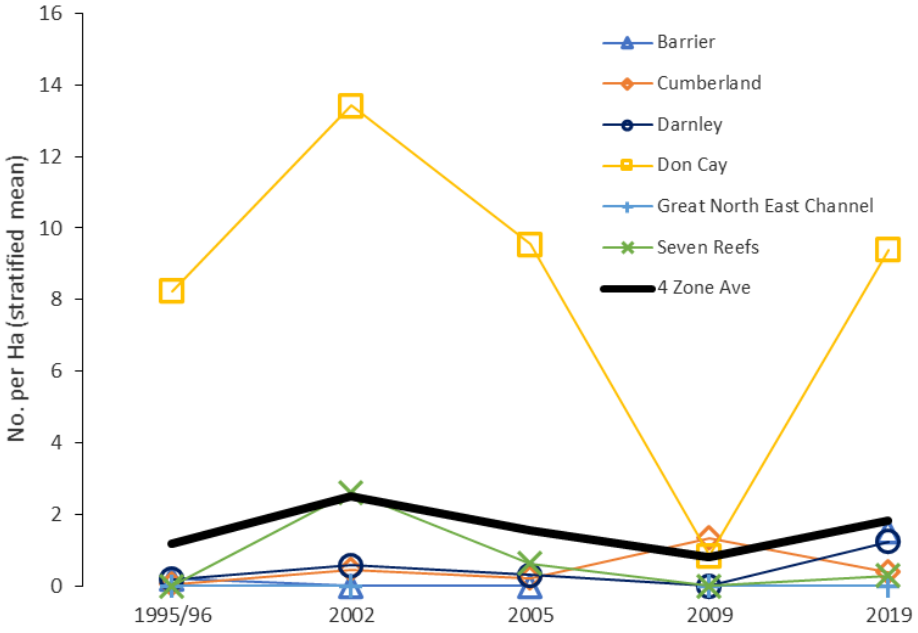
# White teatfish

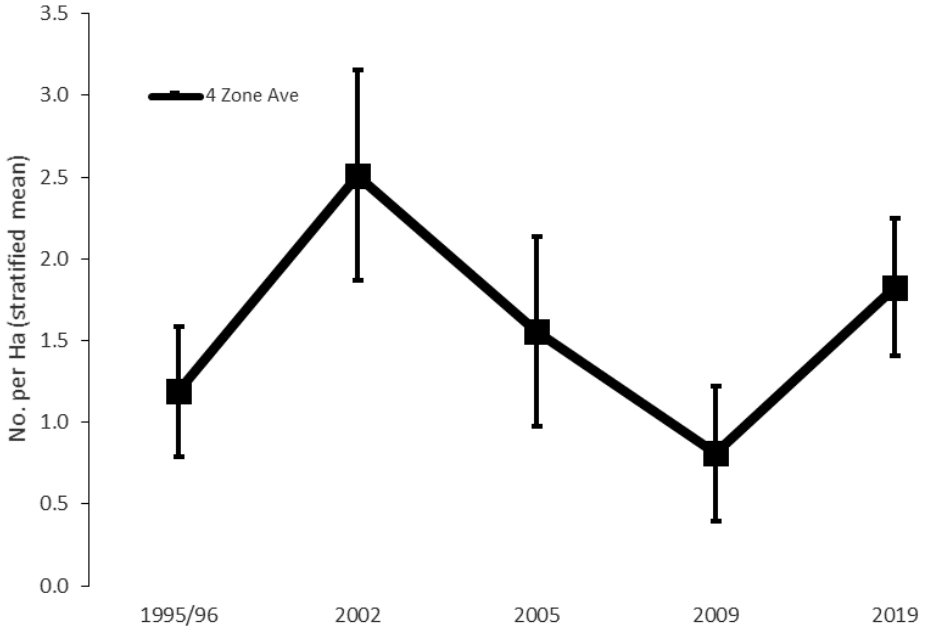



Fishery biomass estimate = 871 t

>MLS = 141 t

# White teatfish

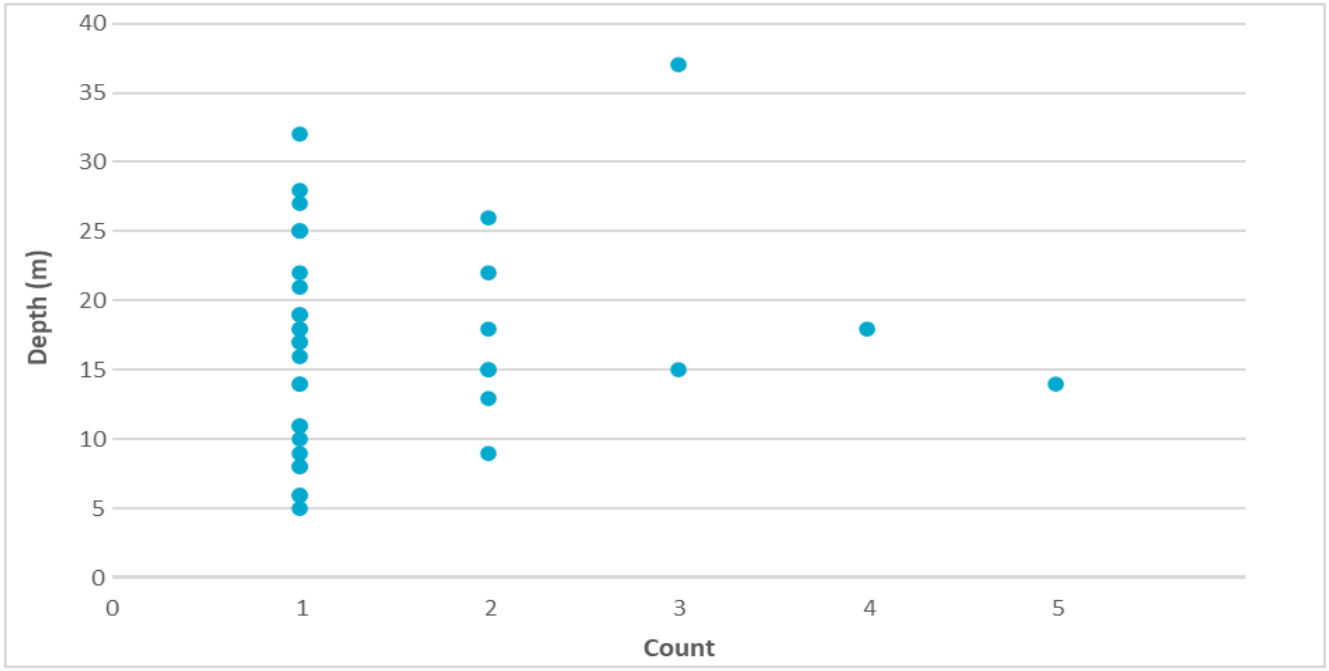


# White teatfish

## Depth profile

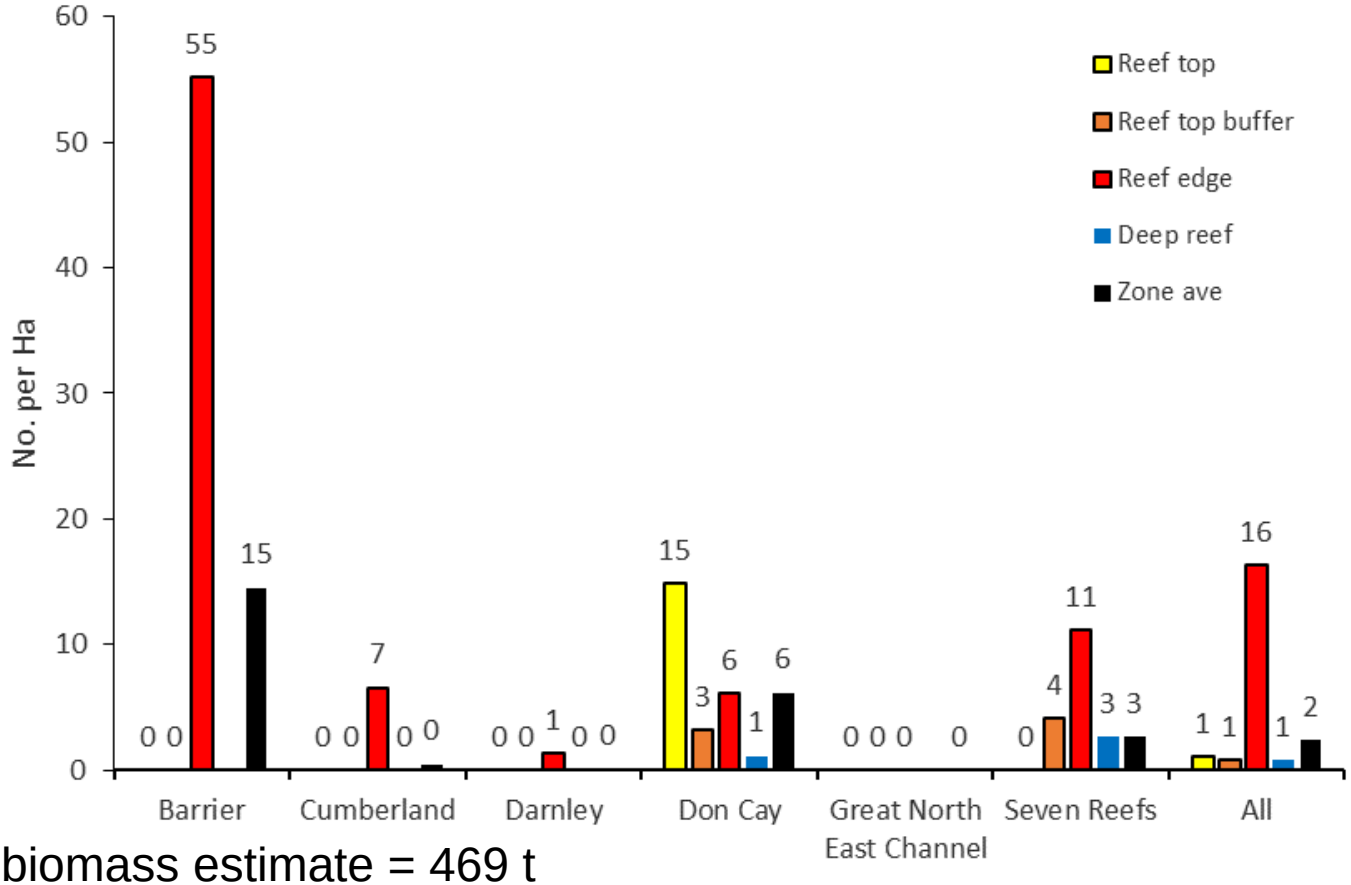
- Majority found between 5 m and 30 m depth
- Typically one teatfish found on a survey transect



# White teatfish – distribution

- Modelled from survey data 1995-2009 and biophy

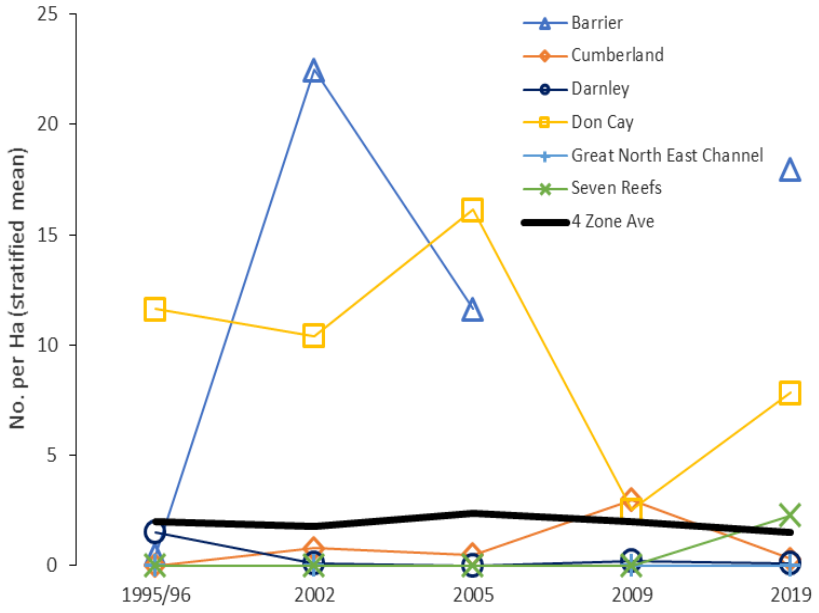
# Prickly redfish

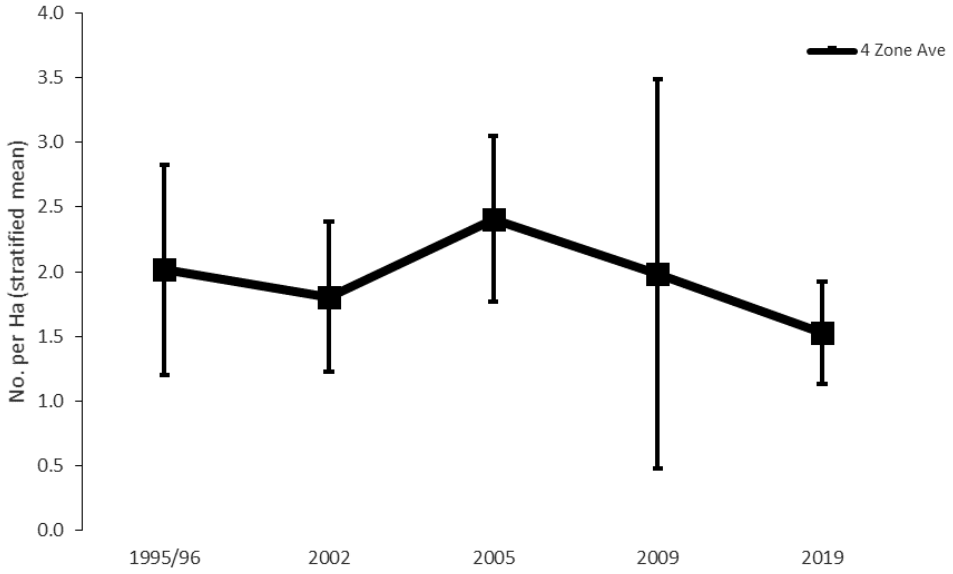



Fishery biomass estimate = 469 t

>MLS = 257 t

# Prickly redfish

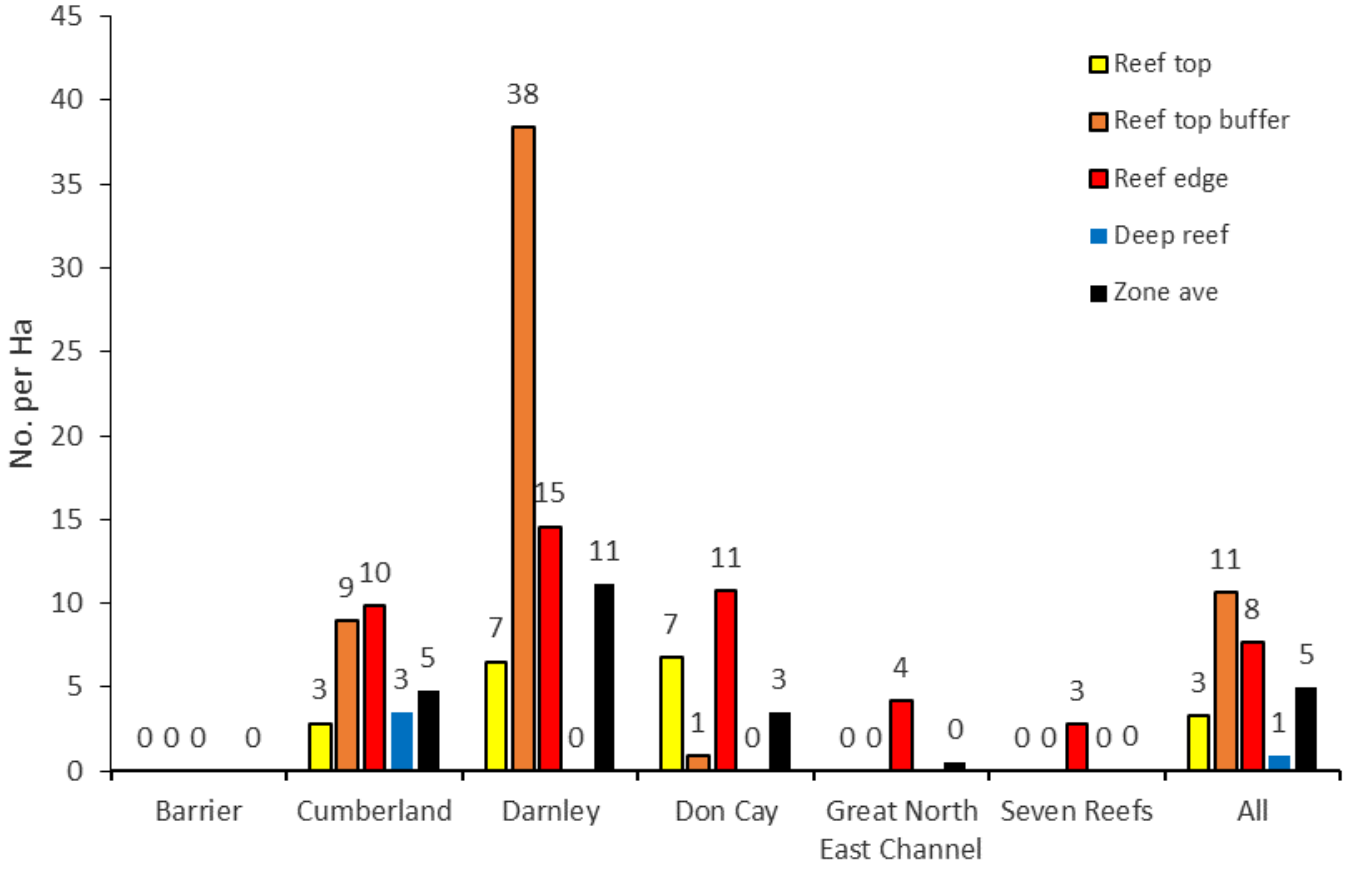


# Prickly redfish – distribution

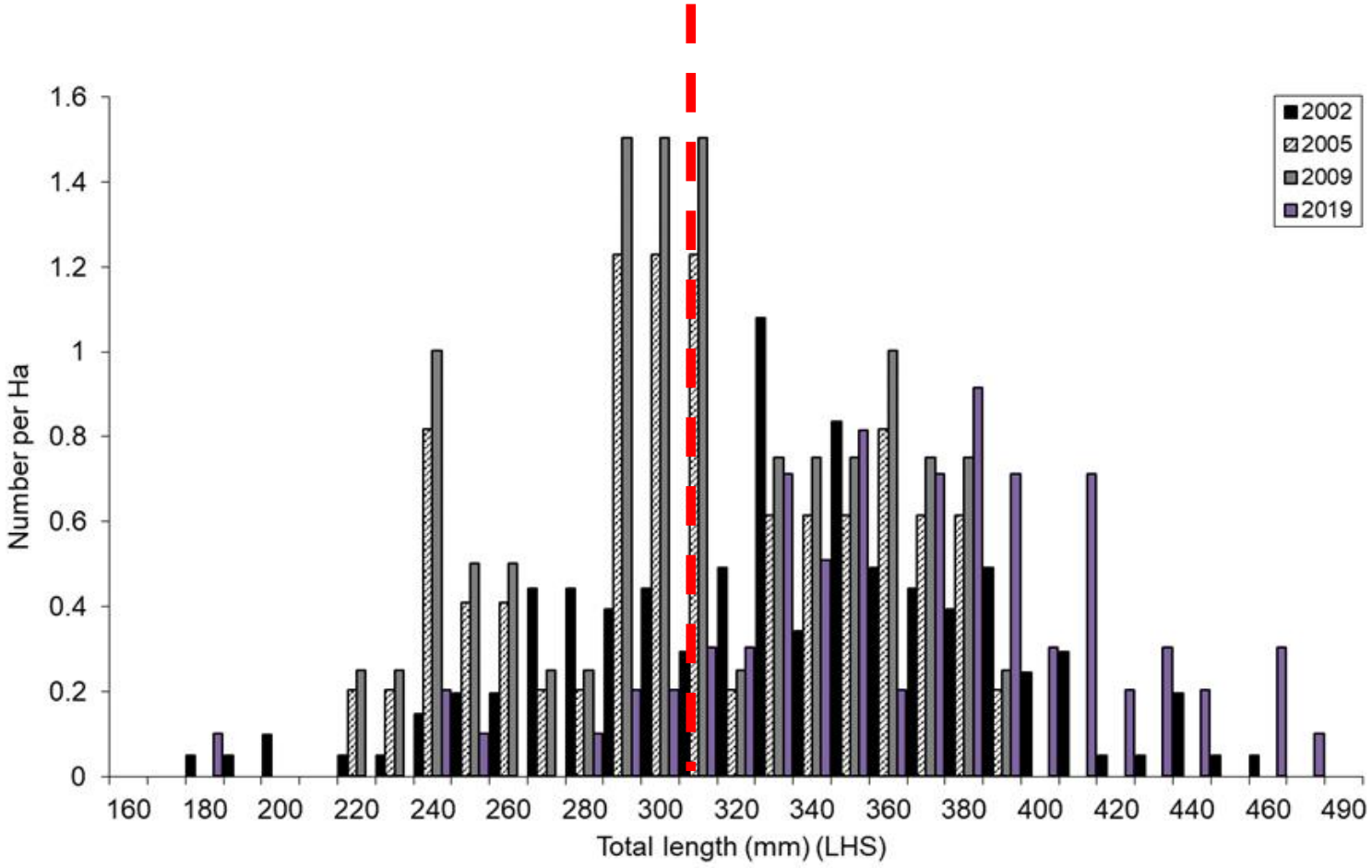
- Modelled from survey data 1995-2009 and biophysical correlates

# Curryfish (common)

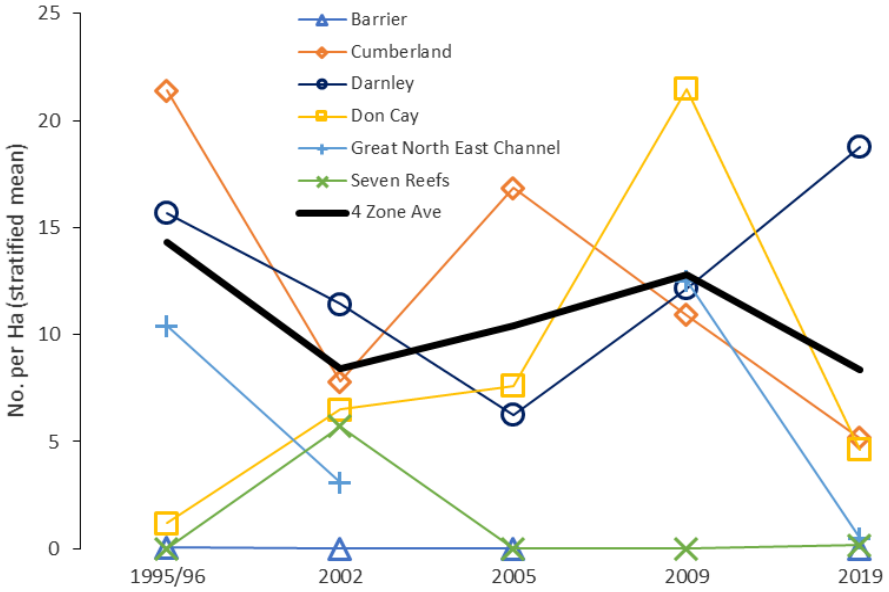


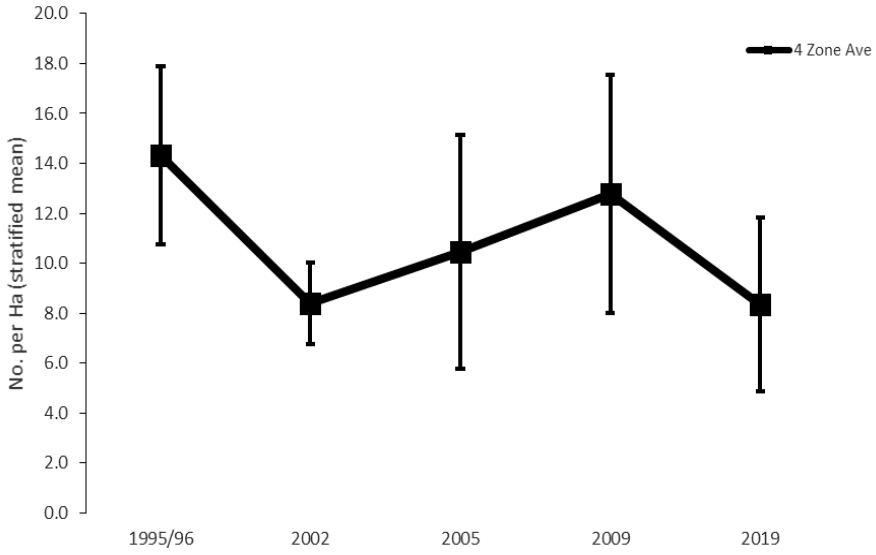

Fishery biomass estimate = 682 t
>MLS = 647 t

# Curryfish (common)



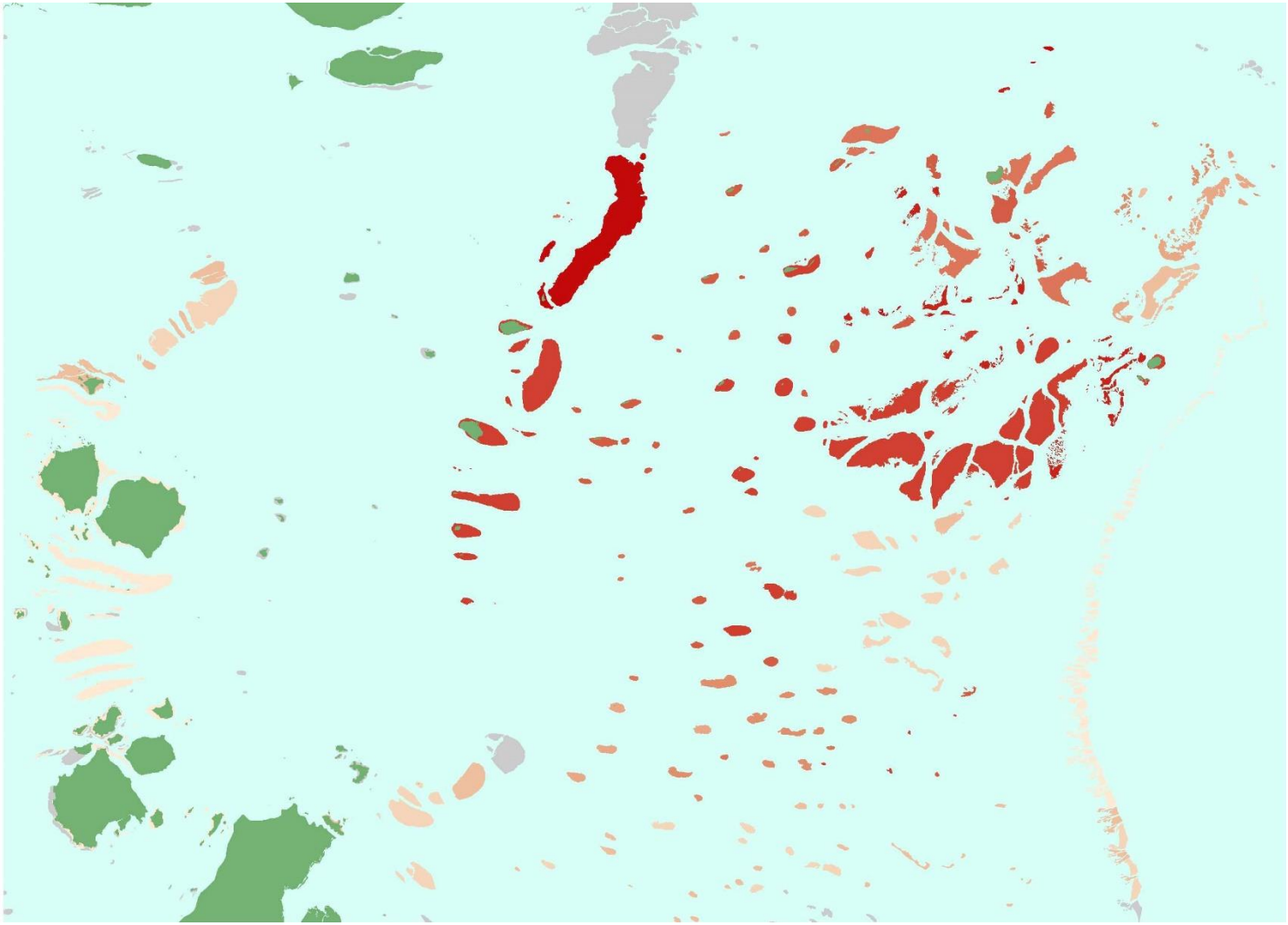
# Curryfish (common)



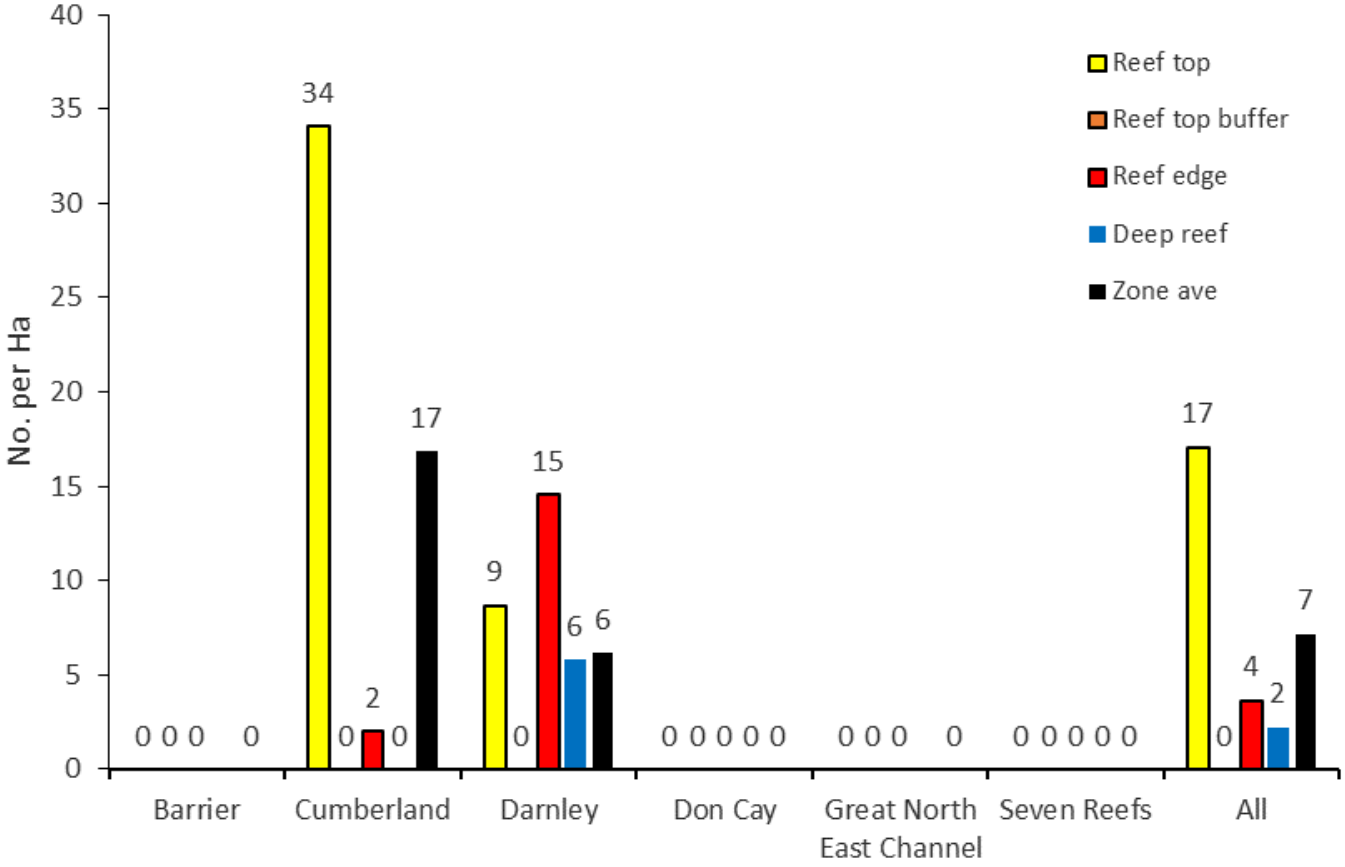



# Curryfish (common) – distribution

- Modelled from survey data 1995-2009 and biophysical correlates



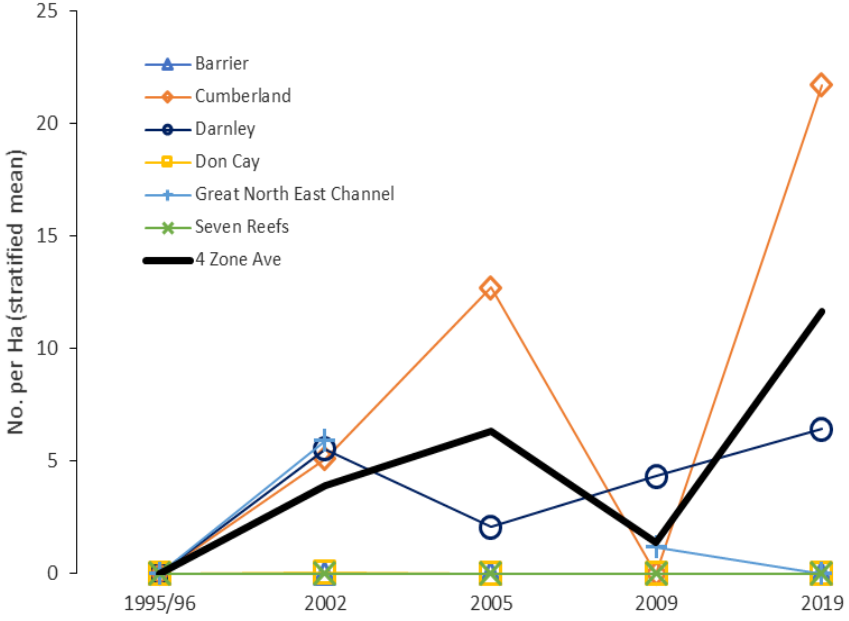
# Curryfish (vastus)

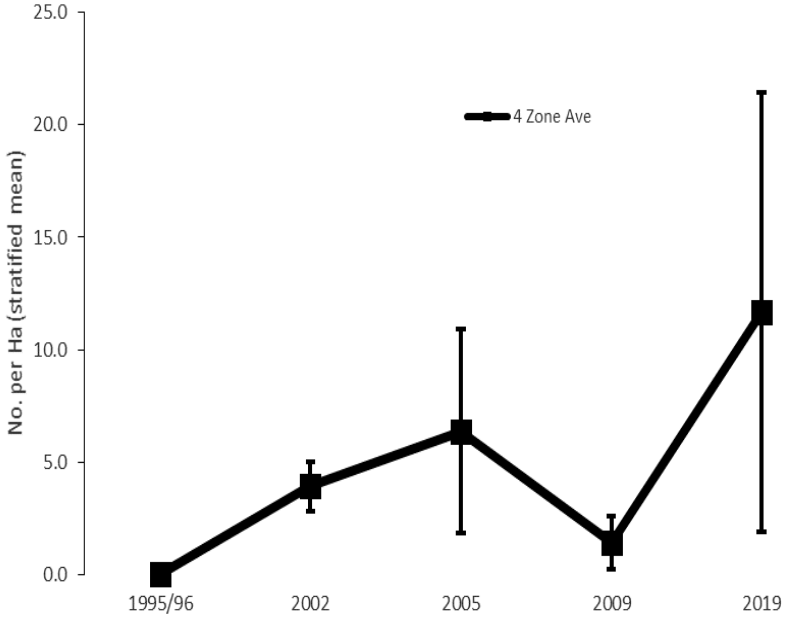



Fishery biomass estimate = 171 t

>MLS = 171 t

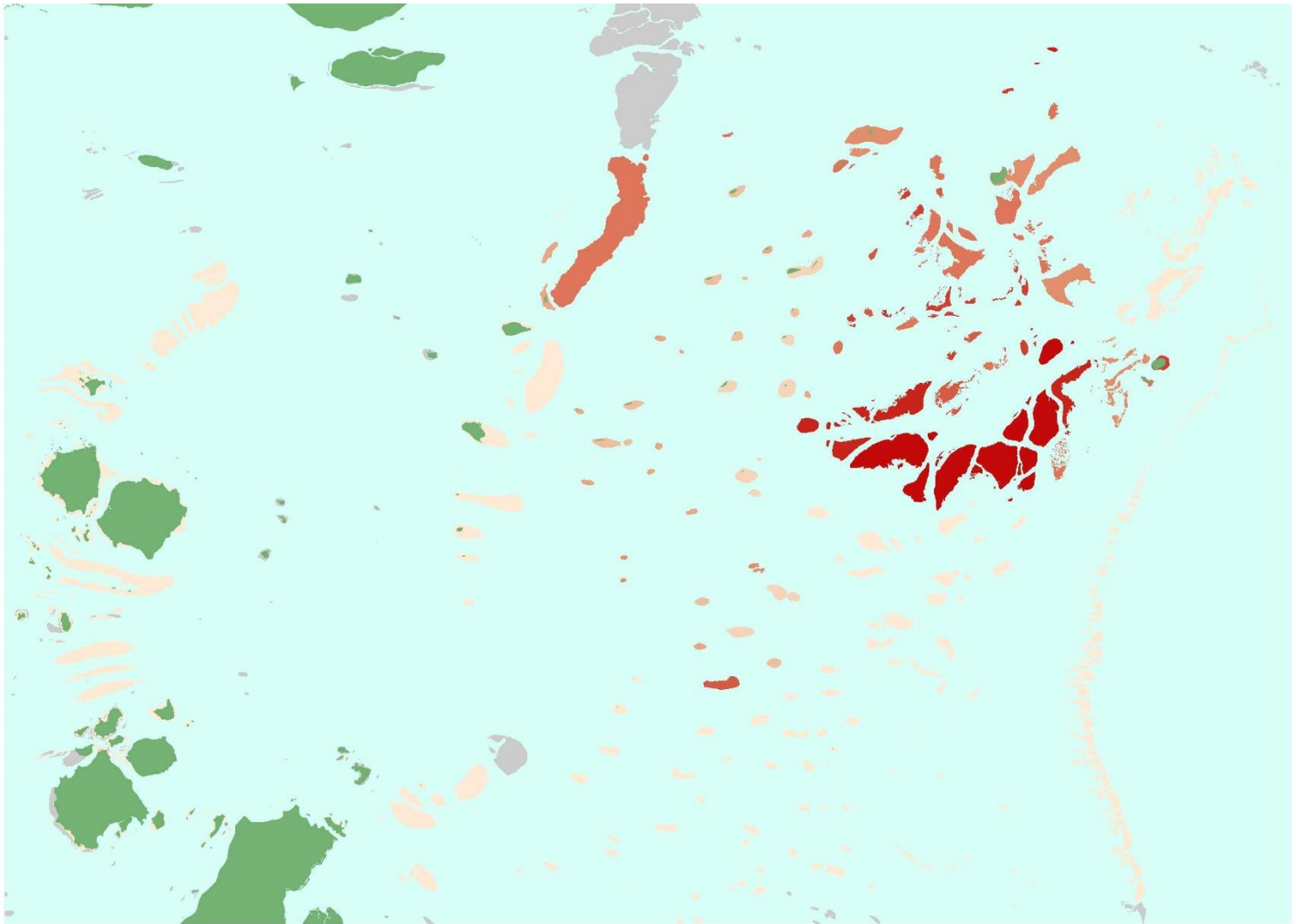
# Curryfish (vastus)



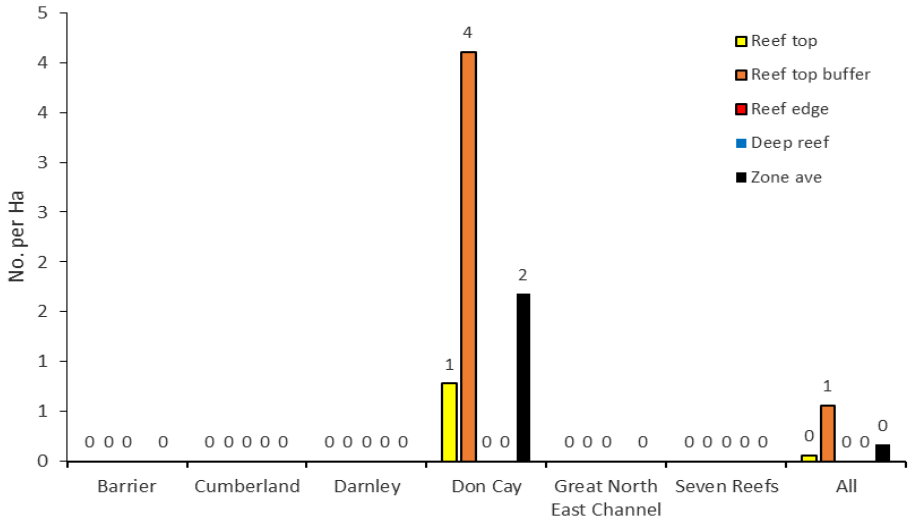



# Curryfish (vastus) – distribution

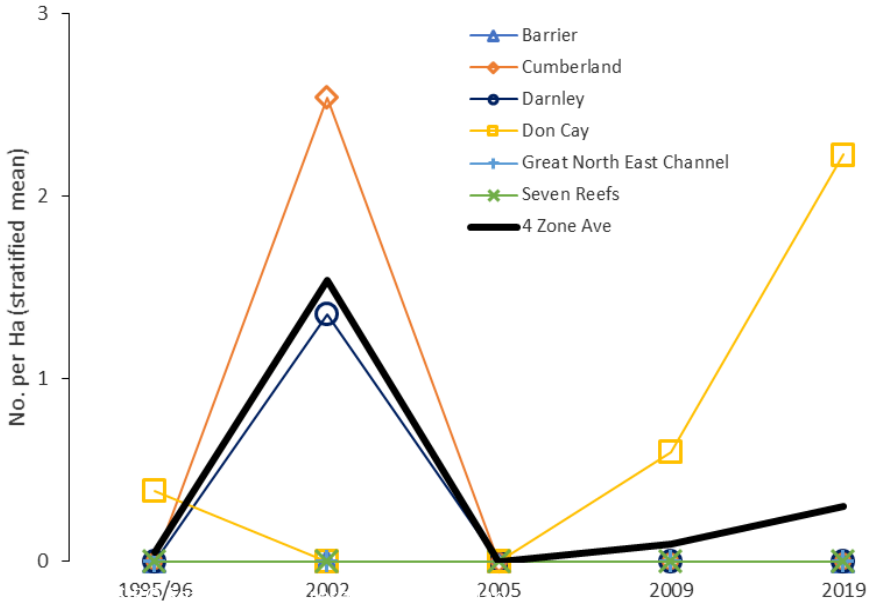
- Modelled from survey data 1995-2009 and biophysical correlates

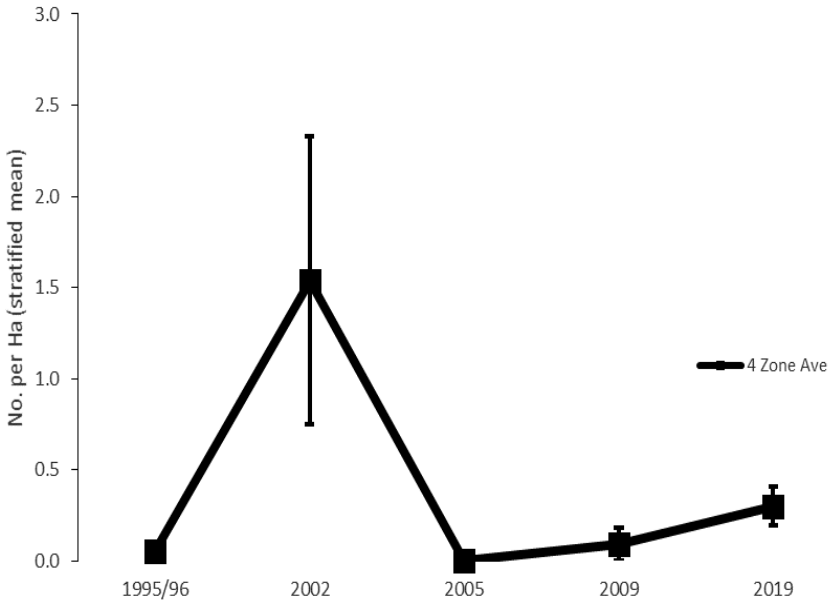


# Surf redfish

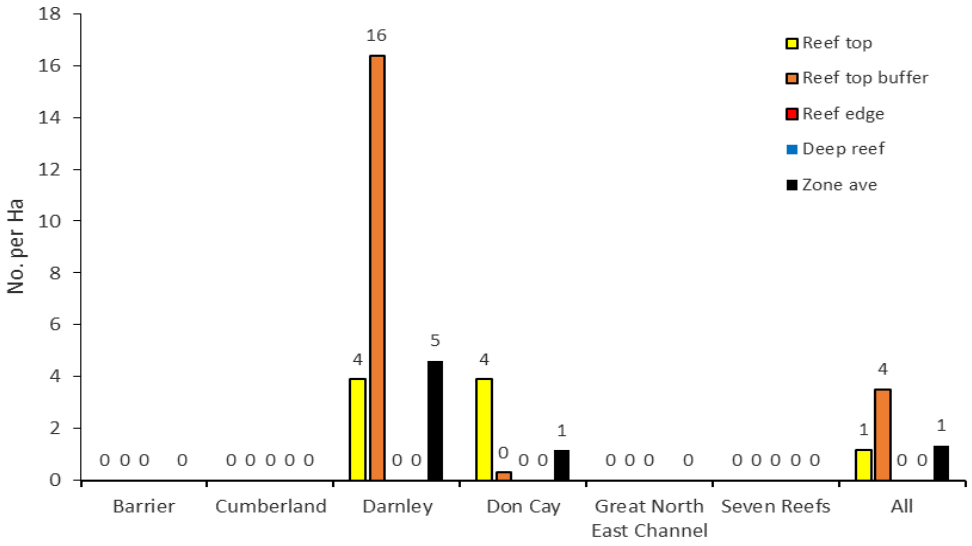



Fishery biomass estimate = 14 t
>MLS = 7 t

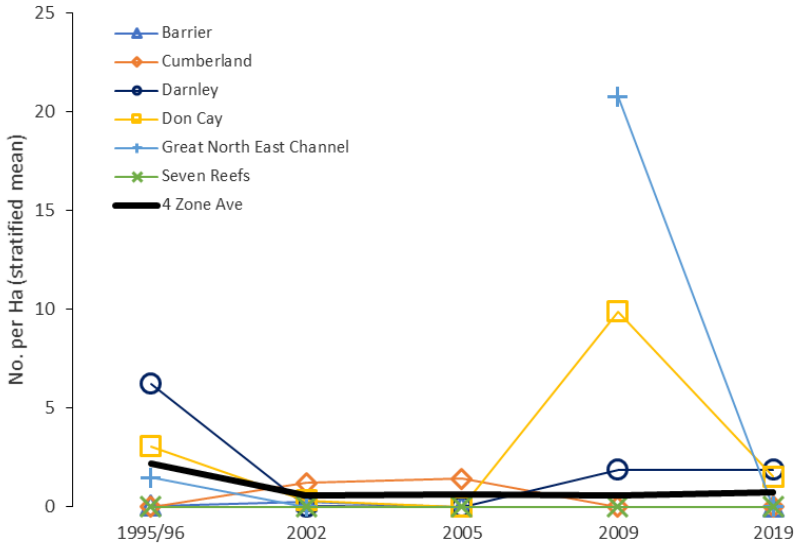


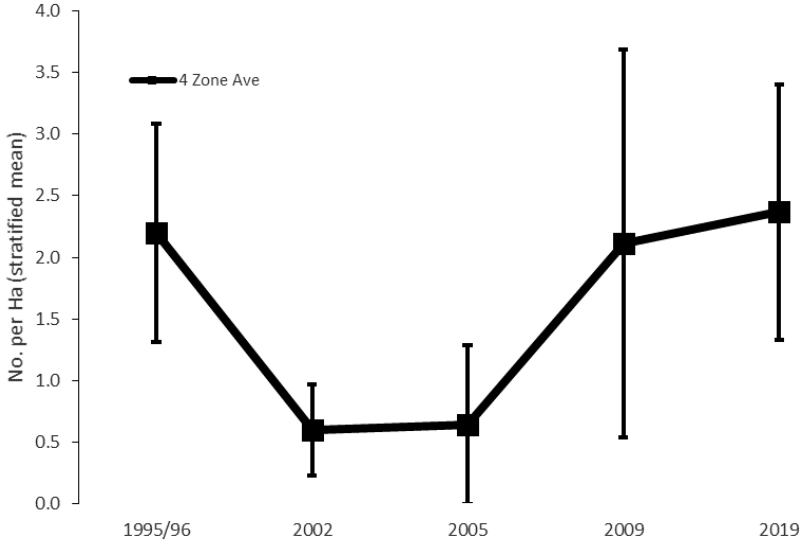



# Deepwater redfish

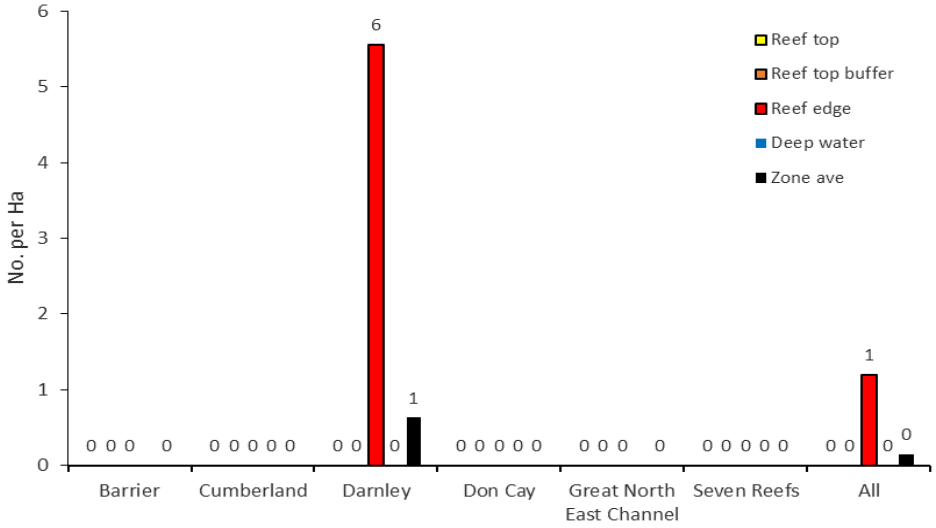



Fishery biomass estimate = 66 t
>MLS = 55 t

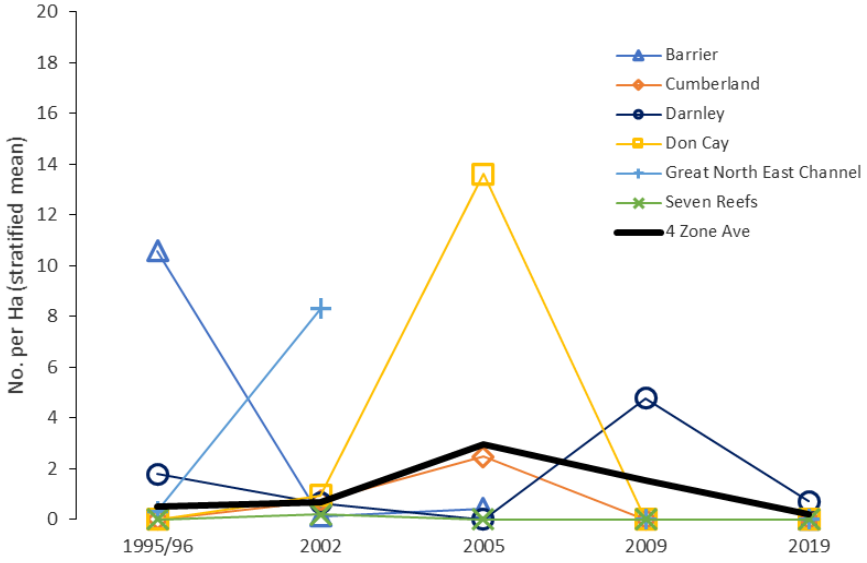


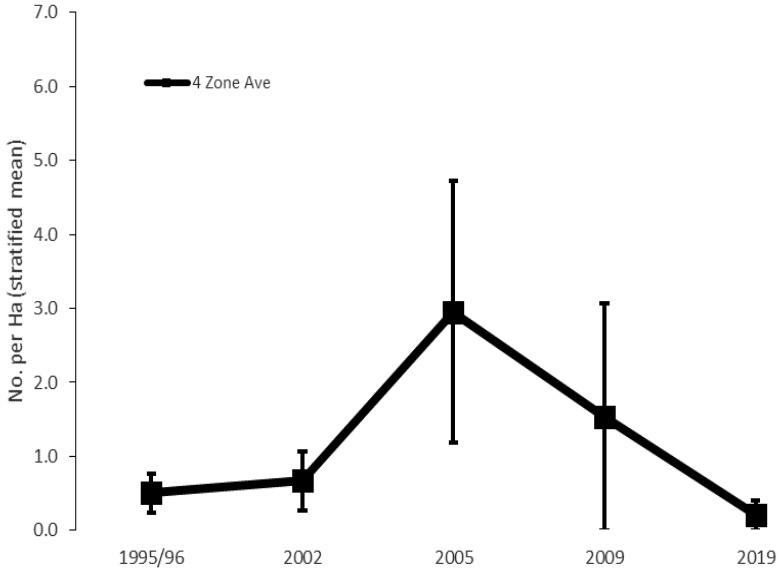



# Hairy blackfish



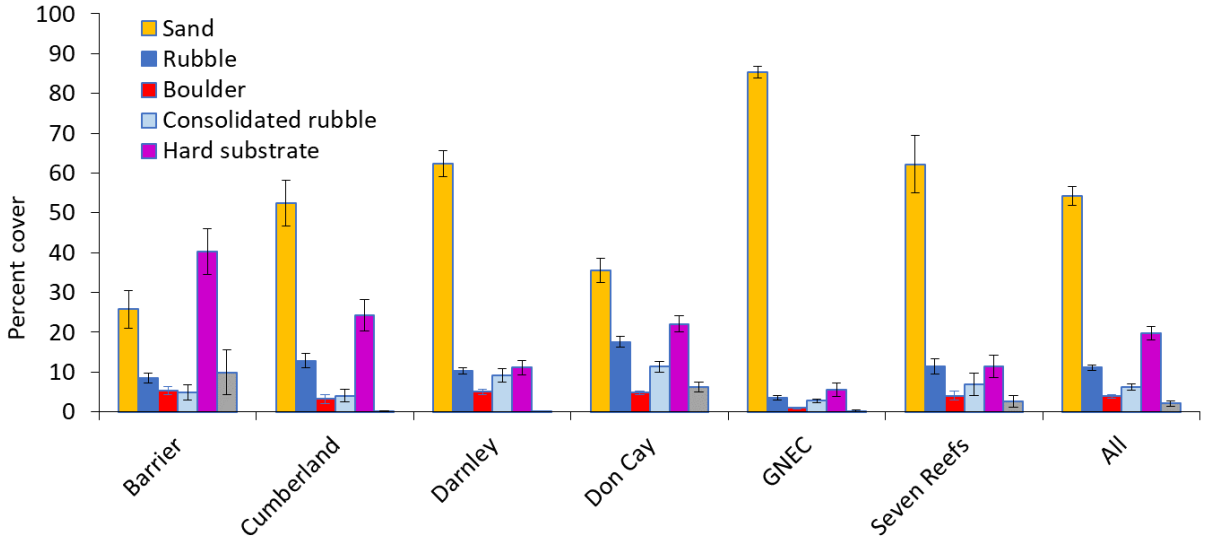

Fishery biomass estimate = 15 t (gutted weight)

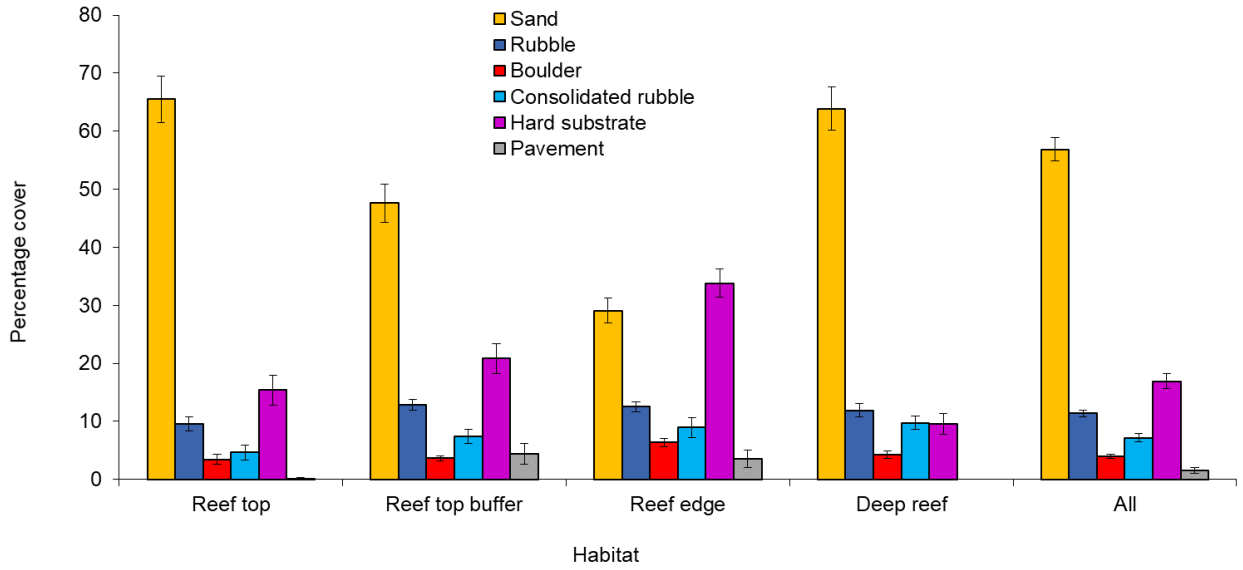


# Environmental

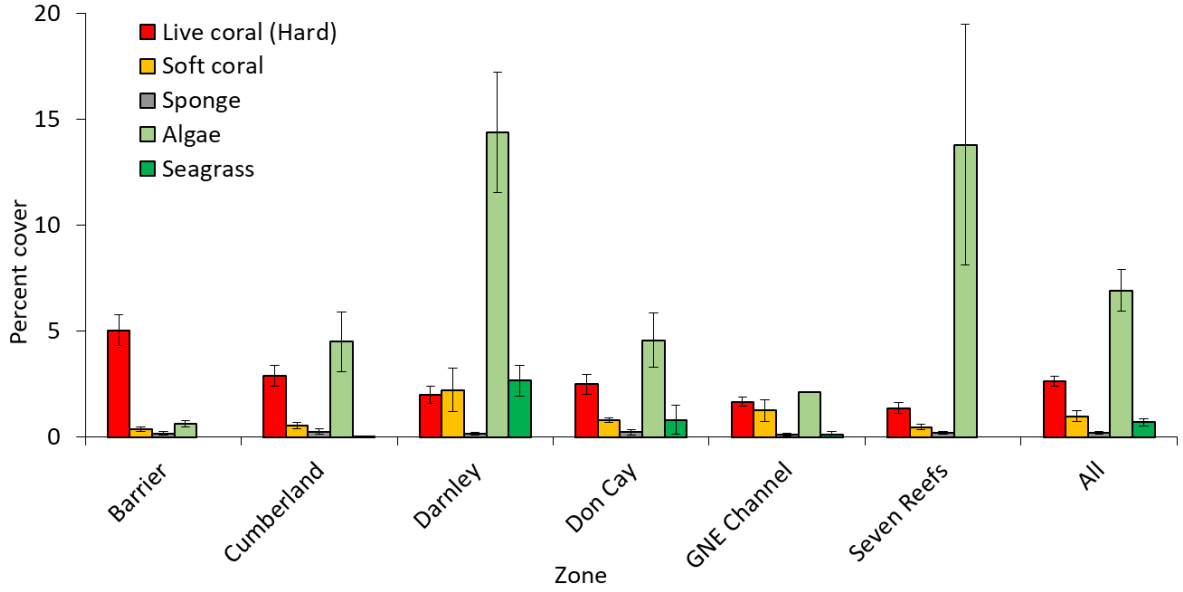
## Substrate

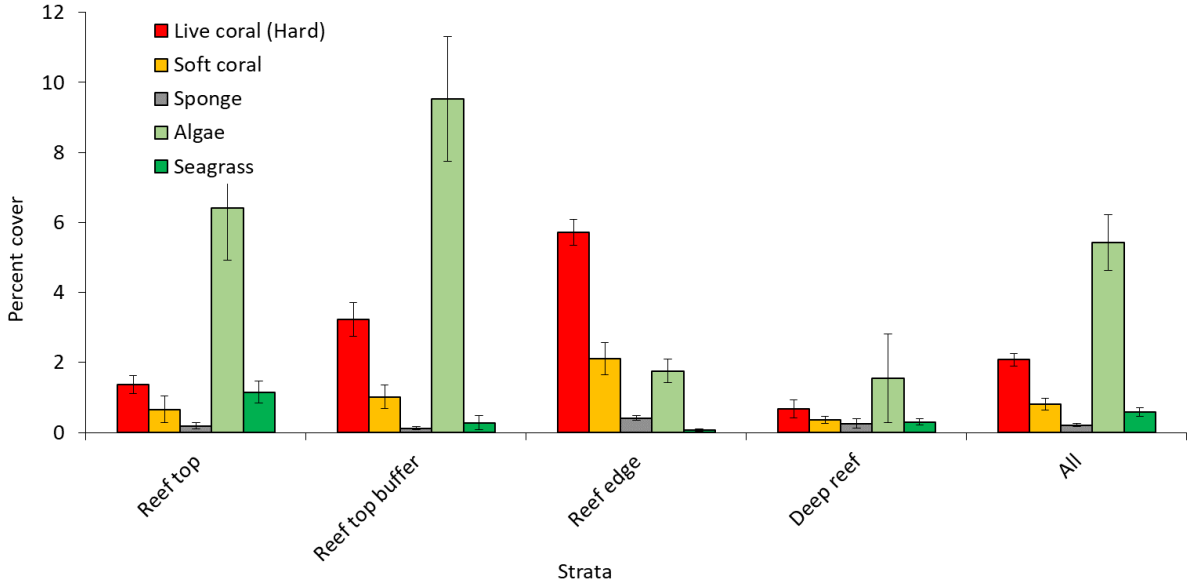


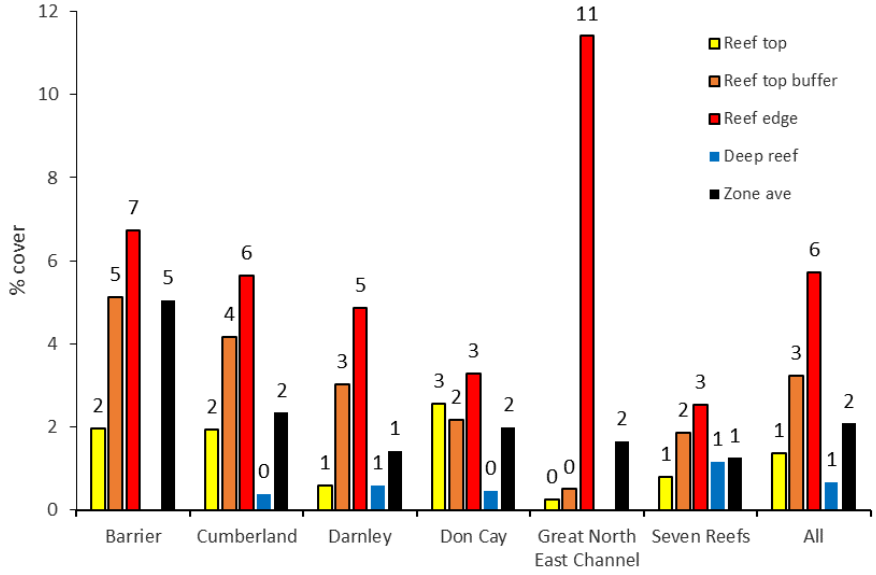
# Environmental

## Biota

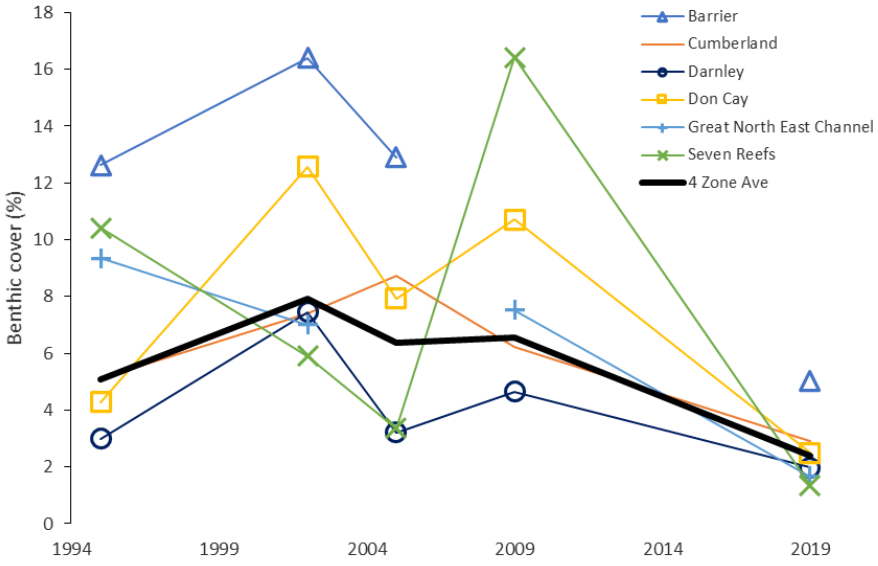


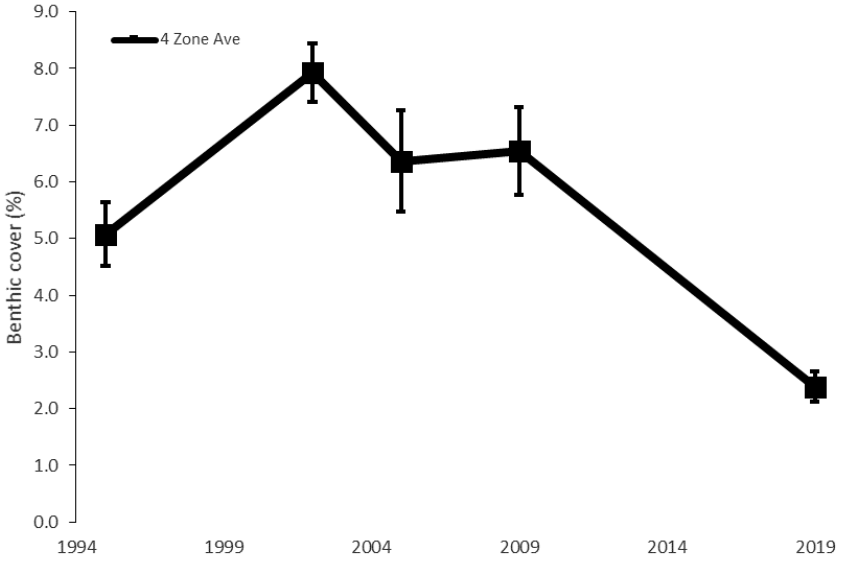



# Environmental – Coral

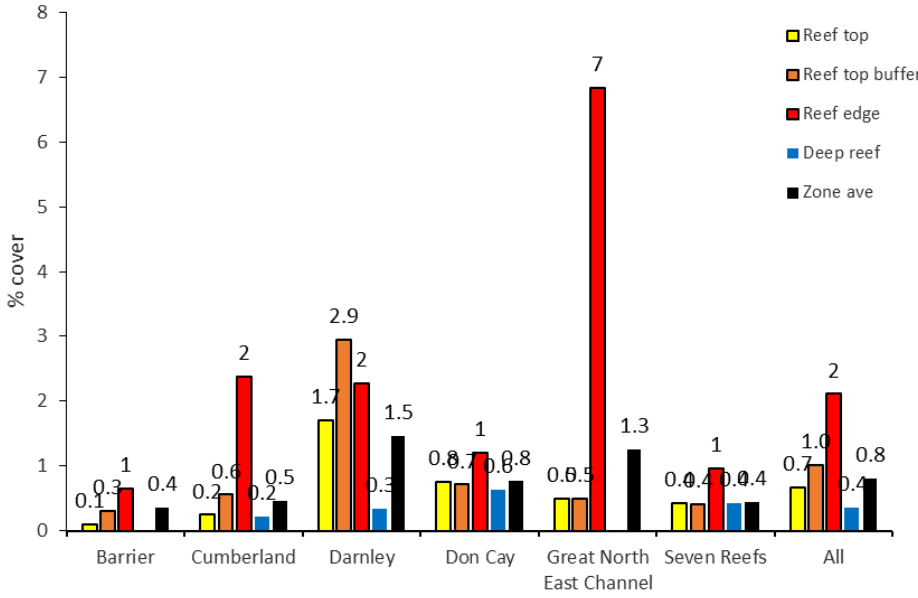



Total area = 4005 Ha

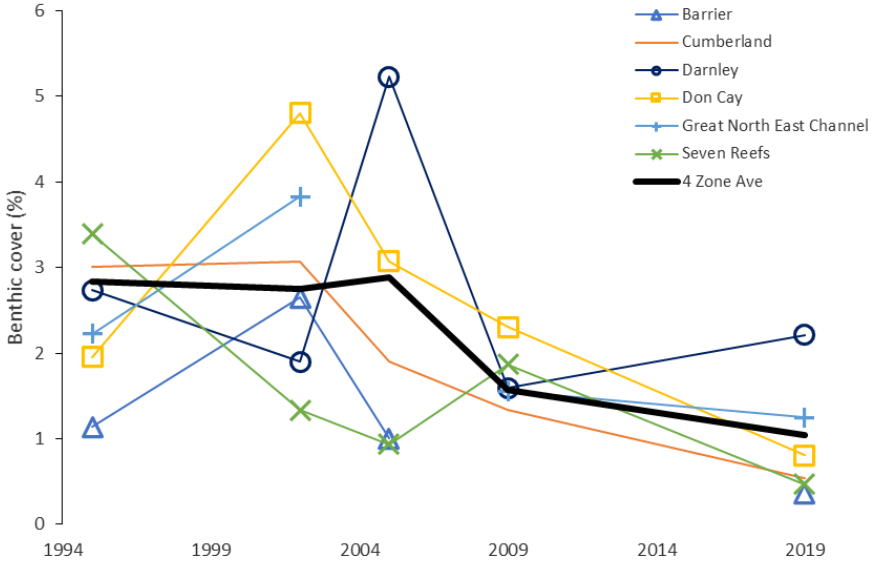


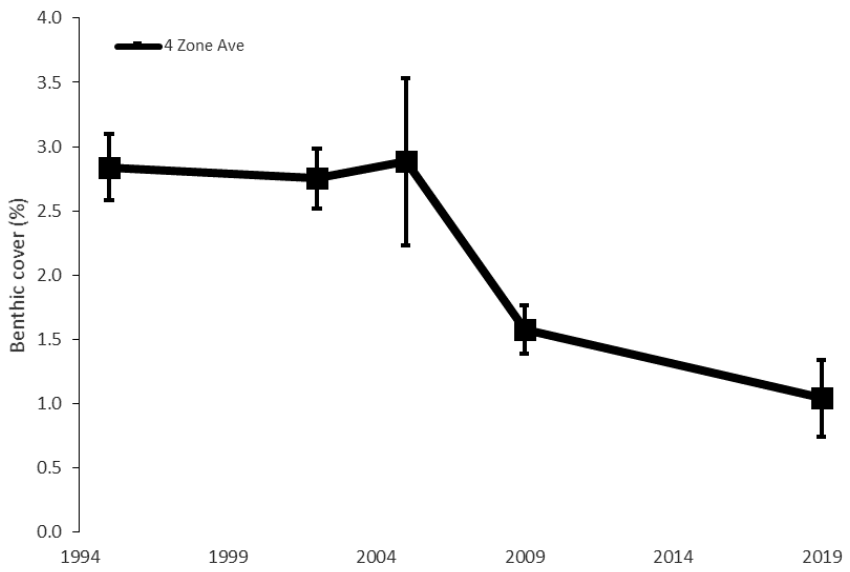



# Environmental – Soft Coral

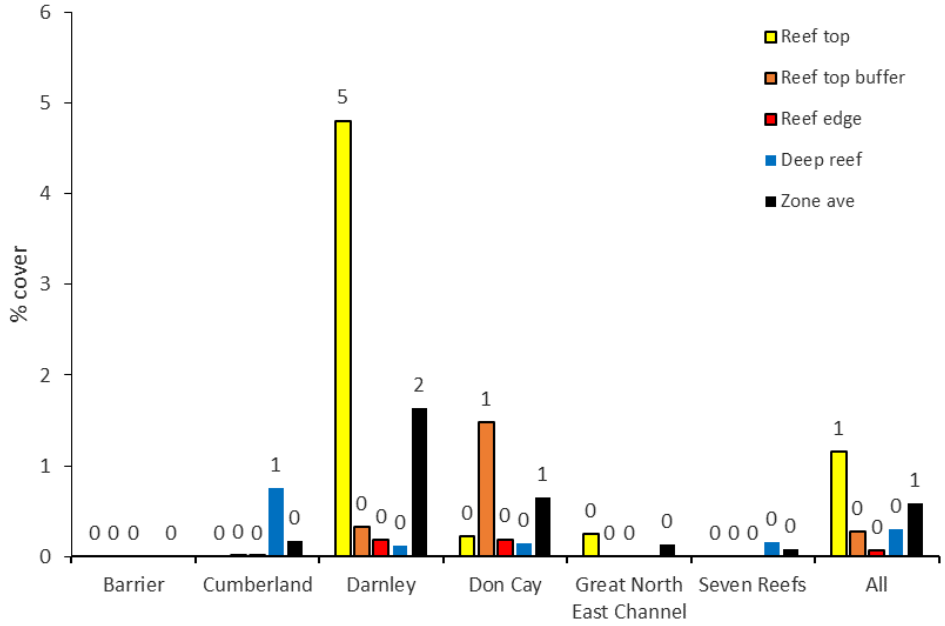



Total area = 1558 Ha

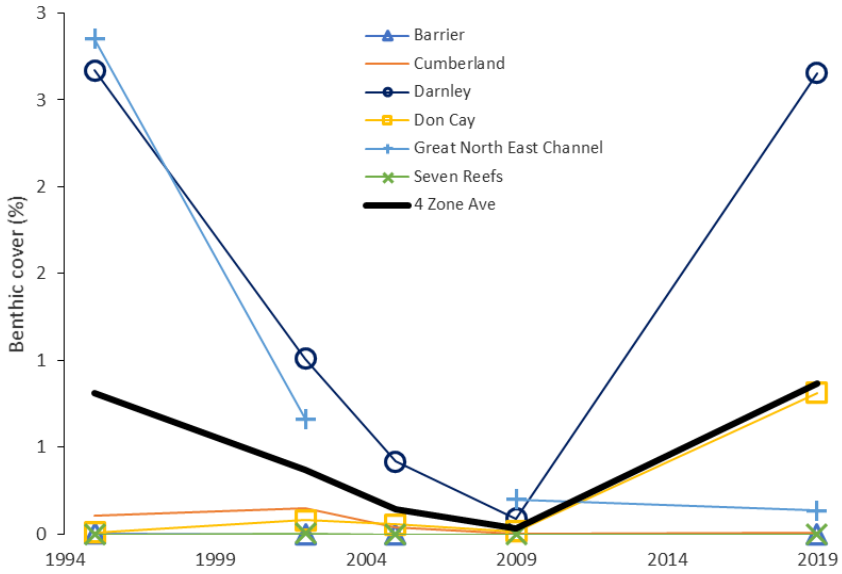


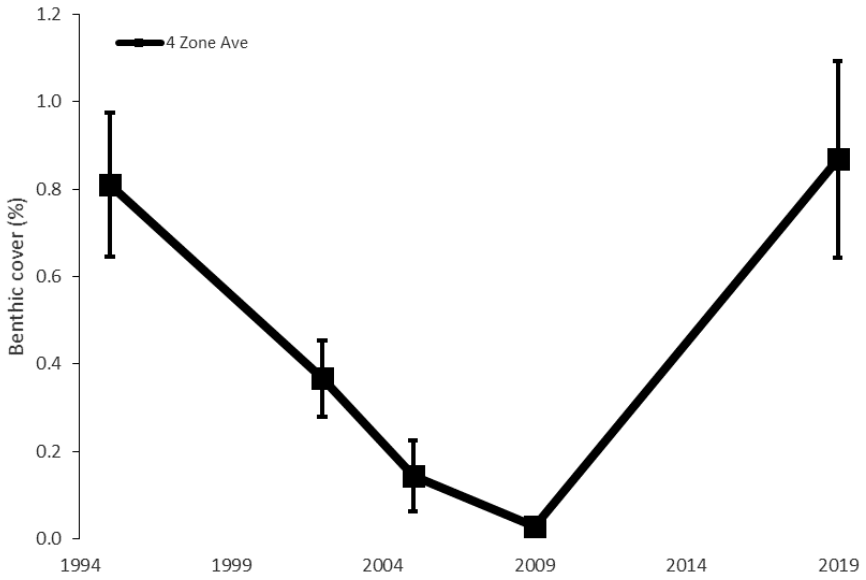



# Environmental – Seagrass

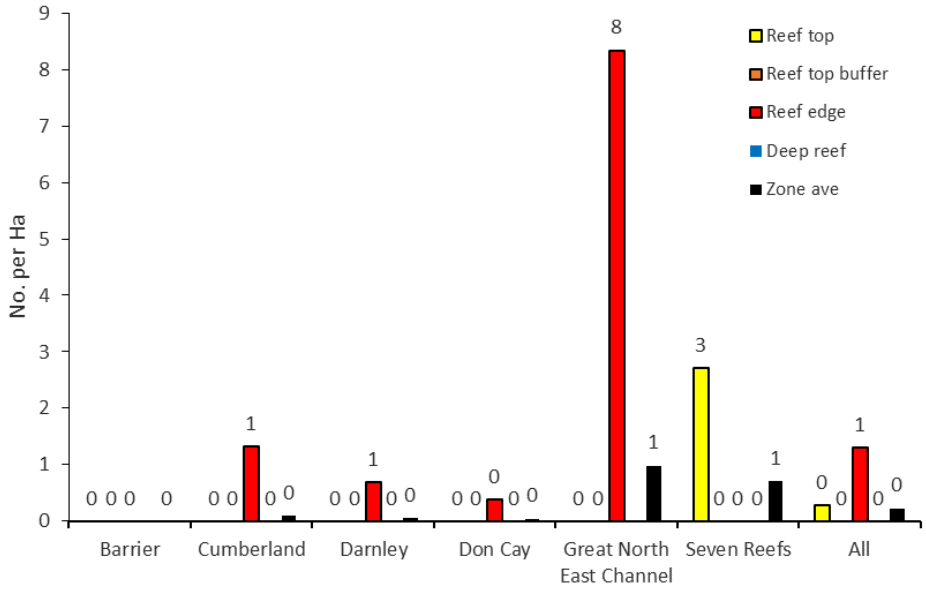



Total area = 1119 Ha



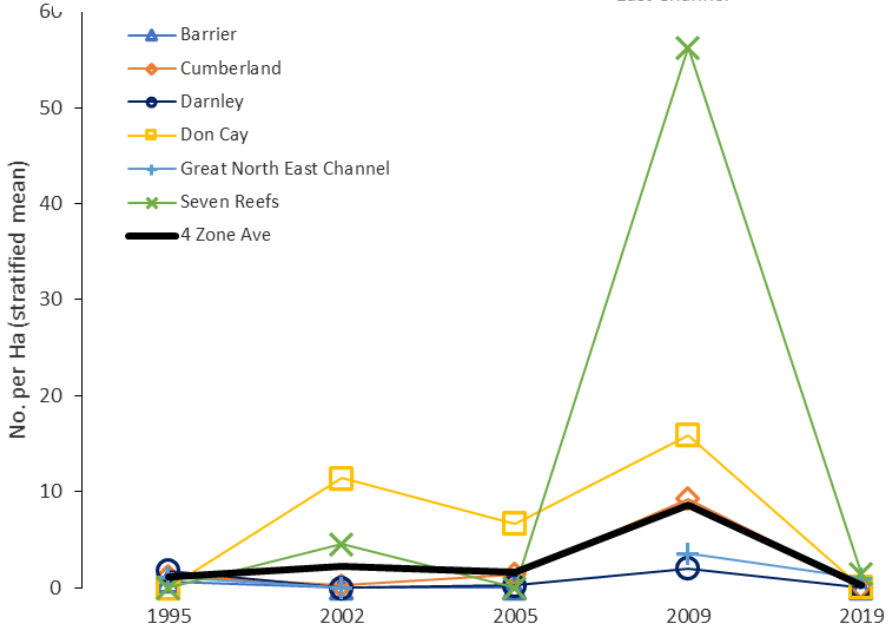



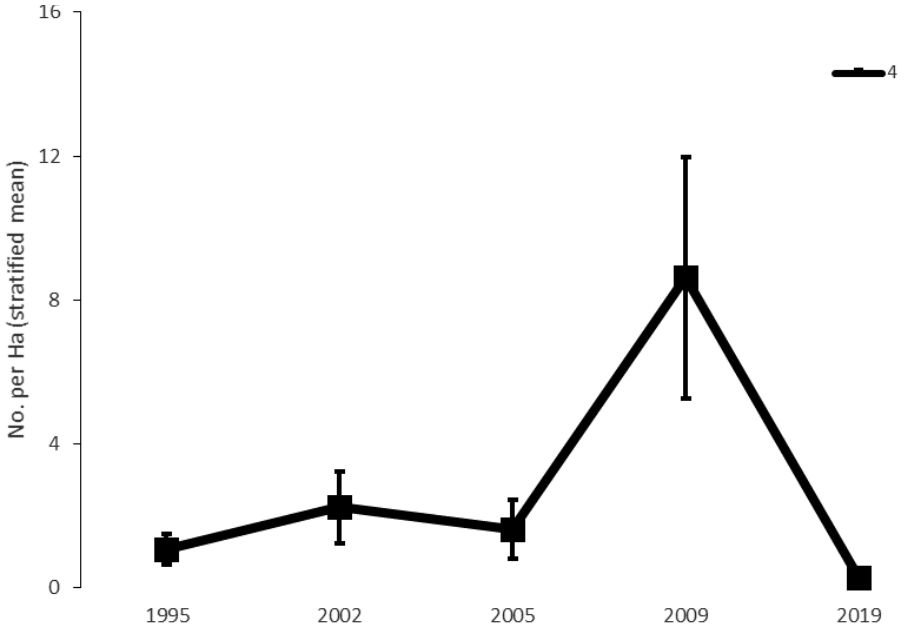
# Crown of Thorns starfish



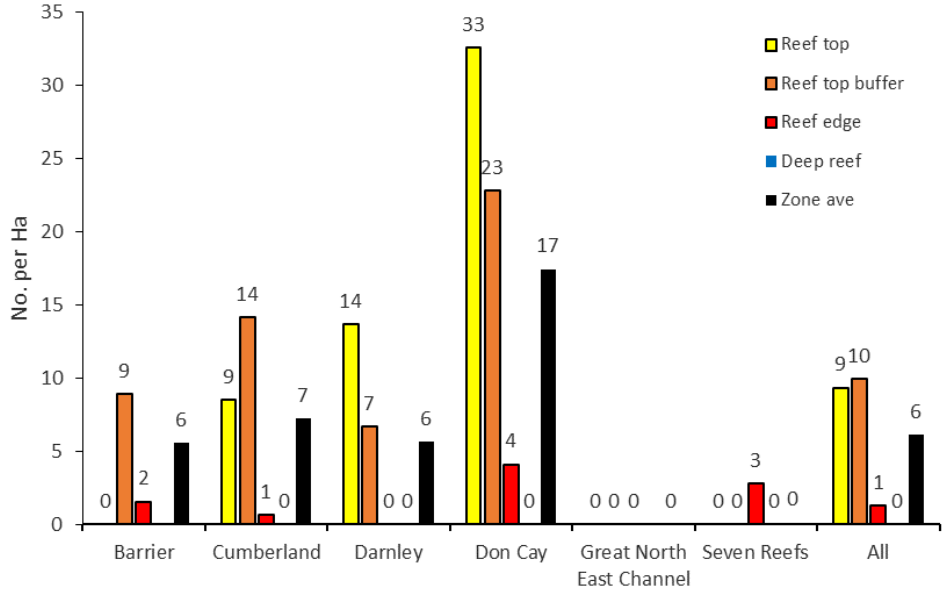

2019/20 Population estimate: 44,199

2009 Population estimate: 825,060

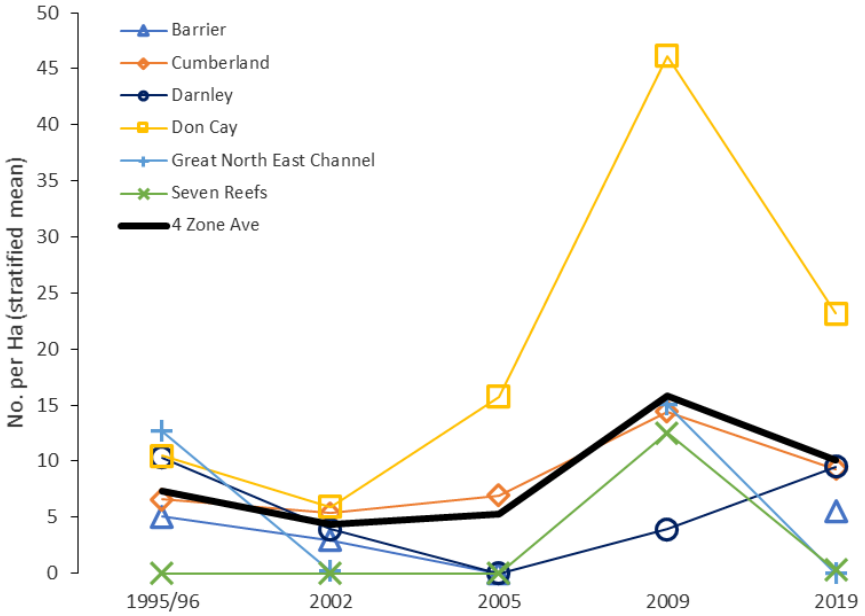


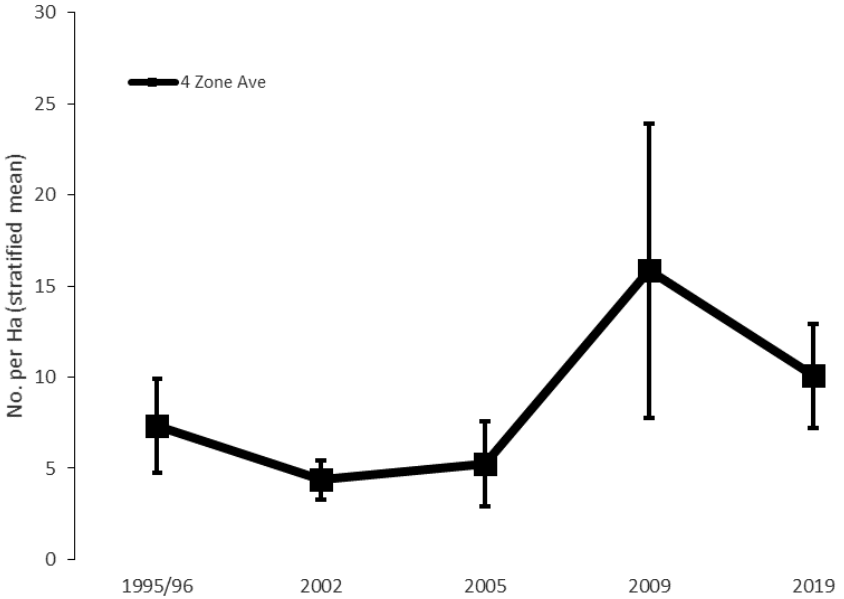



# Giant clams (T. gigas)

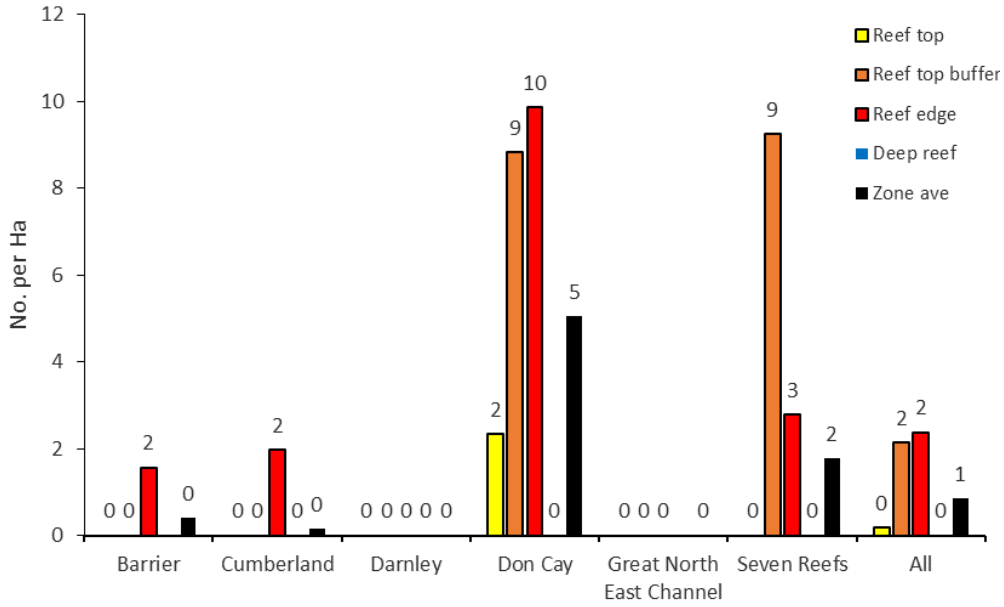



2019/20 Population estimate: 1,180,489

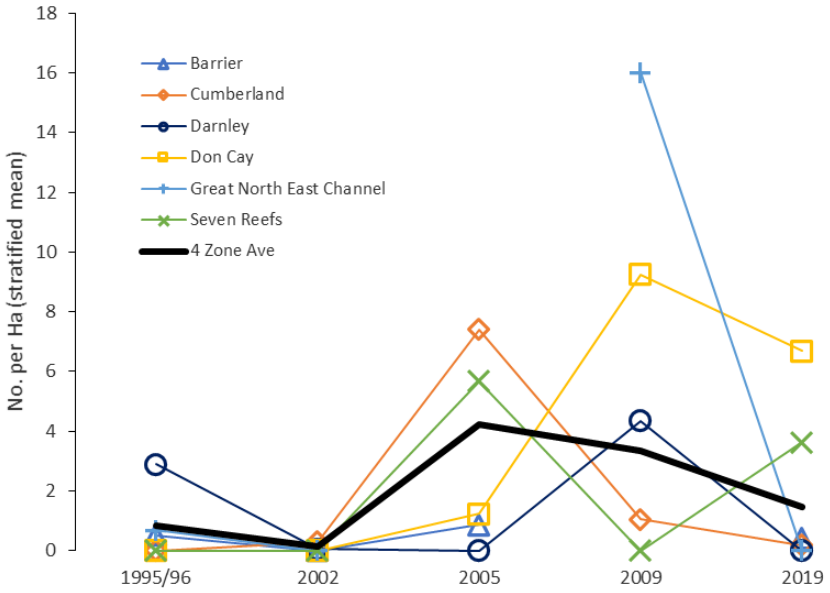


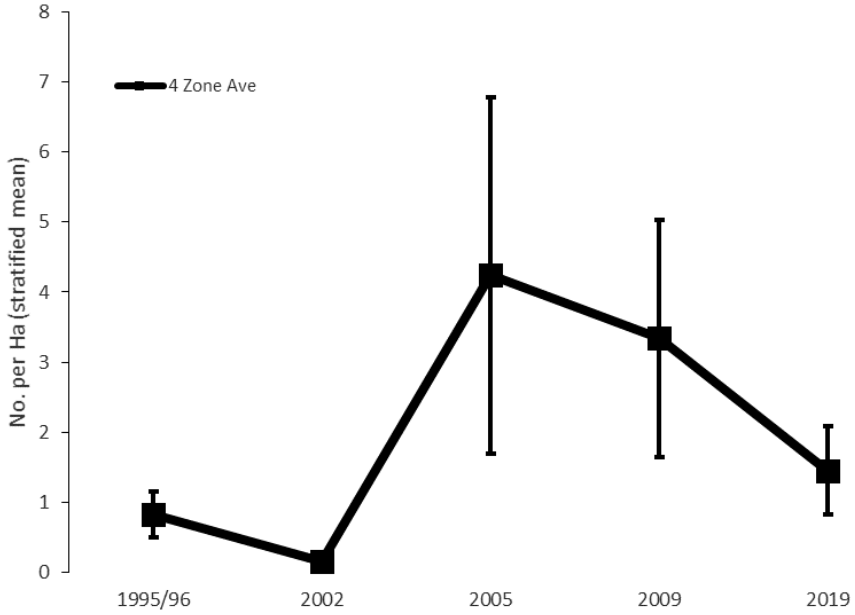



# Trochus




2019/20 Population estimate: 163,622



# Bêche-de-mer Taxonomy

- Morphology characteristics

Cuverian tubules

Anus nearly dorsal (towards top)

Podia (tube like feet, underside)

Papillae (conical)

Anus terminal (towards belly)

Teats (pointed lateral protrusions)

Papillae (stout)

Anal teeth

Deep wrinkles

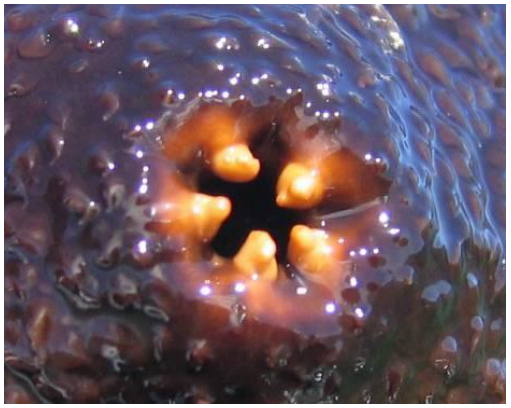
Papillae (thin)

Dorsal (top) Ventral (underneath) Lateral (side)

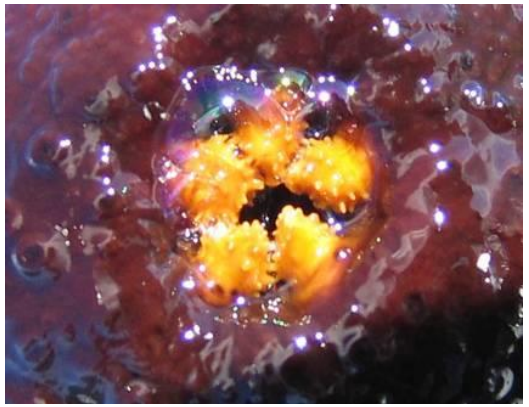
Tentacles

# Blackfish

- Hairy blackfish
  (*A. miliaris*)



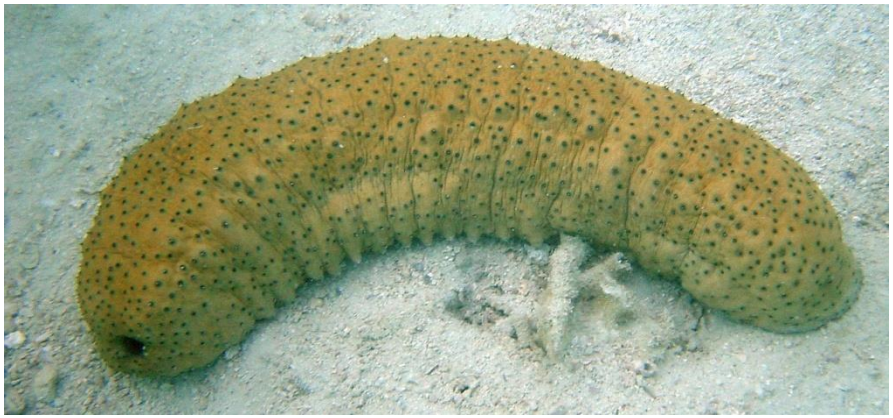
- Burrowing blackfish
  (*A. spinea*)



- Deepwater blackfish
  (*A. palauensis*)

# Curryfish

Curryfish *(Stichopus herrmanni)*



Dinosaur curry*(Stichopus vastus)*

Pinapple curry*(Stichopus ocellatus)*

# Redfish

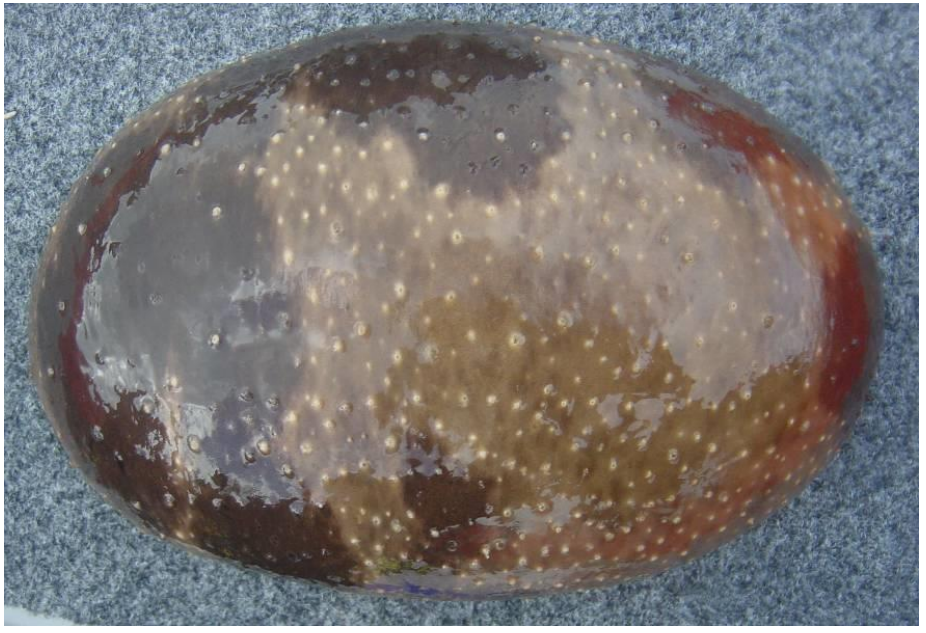
Deepwater redfish (*A. echinites*)

Surf redfish (*A. mauritiana*)

# Surf redfish (*A. mauritiana*)




# Stonefish (*A. lecanora*)



# Hybrids!

# Hybrids!

# Beche-de-mer ID guide

**Summary table of species**

| | COMMON NAME | SCIENTIFIC NAME | COMMERCIAL VALUE | MINIMUM SIZE LIMITS (MM)* | TOTAL ALLOWABLE CATCH (TAC) (TONNES) |
|---|---|---|---|---|---|
|  | Sandfish | *Holothuria scabra* | High | 180 | Closed |
|  | Surf redfish | *Actintopyga mauritiana* | High | 220 | Closed |
|  | Black teatfish | *Holothuria whitmaei* | High | 250 | Closed |
|  | White teatfish | *Holothuria fuscogilva* | High | 320 | 15 |
|  | Prickly redfish | *Thelenota ananas* | Medium | 300 | 20 |
|  | Hairy blackfish | *Actinopyga miliaris* | Medium | 220 | Part of 80t limit |
|  | Curryfish | *Stichopus herrmanni* | Medium | 270 | Part of 80t limit |
|  | Elephants trunkfish | *Holothuria fuscopunctata* | Low | 240 | Part of 80t limit |
|  | Iollyfish | *Holothuria atra* | Low | 150 | Part of 80t limit |

| | COMMON NAME | SCIENTIFIC NAME | COMMERCIAL VALUE | MINIMUM SIZE LIMITS (MM)* | TOTAL ALLOWABLE CATCH (TAC) (TONNES) |
|---|---|---|---|---|---|
|  | Deepwater redfish | *Actintopyga echinites* | Medium | 120 | Part of 80t limit |
|  | Curryfish | *Stichopus vastus* | ? | | Part of 80t limit |
|  | Burrowing blackfish | *Actinopyga spinea* | Medium | | Part of 80t limit |
|  | Deepwater blackfish | *Actinopyga palauensis* | High | | Part of 80t limit |
|  | Golden sandfish | *Holothuria lessoni* | High | | Part of 80t limit |
|  | Brown sandfish | *Bohadschia vitiensis* | Medium | | Part of 80t limit |
|  | Leopardfish | *Bohadschia argus* | Medium | | Part of 80t limit |
|  | Greenfish | *Stichopus chloronatus* | Medium | | Part of 80t limit |
|  | Stonefish | *Actinopyga lecanora* | lecanora | | Part of 80t limit |

*Size limits off PZJA website – http://pzja.gov.au/the-fisheries/torres-strait-beche-de-mer-fishery/

# Beche-de-mer ID Guide

Burrowing blackfish (Island name: Aospir Aber)

*Actinopyga spinea* (Cherbonnier, 1980)

Animal forms odd shape out of water

Long cylinder shape in water

Nodular teeth that are close together

Deepwater blackfish (Island name: Goleh-Goleh Aber)

*Actinopyga palauensis* (Panning, 1944)

Protruding 'mouth' (proboscis) in water

Oval shape above water

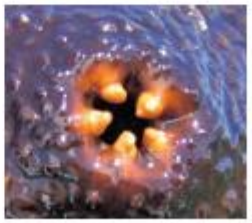
Serrated teeth with spaces between

Hairy blackfish (Island name: Musmus Aber)

*Actinopyga miliaris* (Quoy and Gaimard, 1833)

Ball shape above water and 'hairy' looking

Slimy surface, often with globs of debris on top



Cone shaped (smoother) teeth with spaces between

# Key survey outcomes

Black teatfish

- Black teat fish stocks likely near virgin biomass levels
- Preliminary sustainable yield recommendation of 20 t per yr

White teatfish

- Successfully surveyed white teatfish in deep (20-50 m) reef
- Although we surveyed habitat down to 60 m, we did not observe White teatfish deeper than 37 m
- The density (14 per Ha) and population (72%) of White teatfish in the deep-reef habitat was the highest of any of the sampled strata
- This information could justify an increase in the current 15 t TAC – still working through implications

- Outcomes of the 2019/20 survey have supported the current CITES *Non-Detriment* Finding for the Torres Strait Beche-de-mer Fishery

# Key survey outcomes

- Curryfish and Prickly redfish - small declines, however survey estimates suggest current catch limits are sustainable

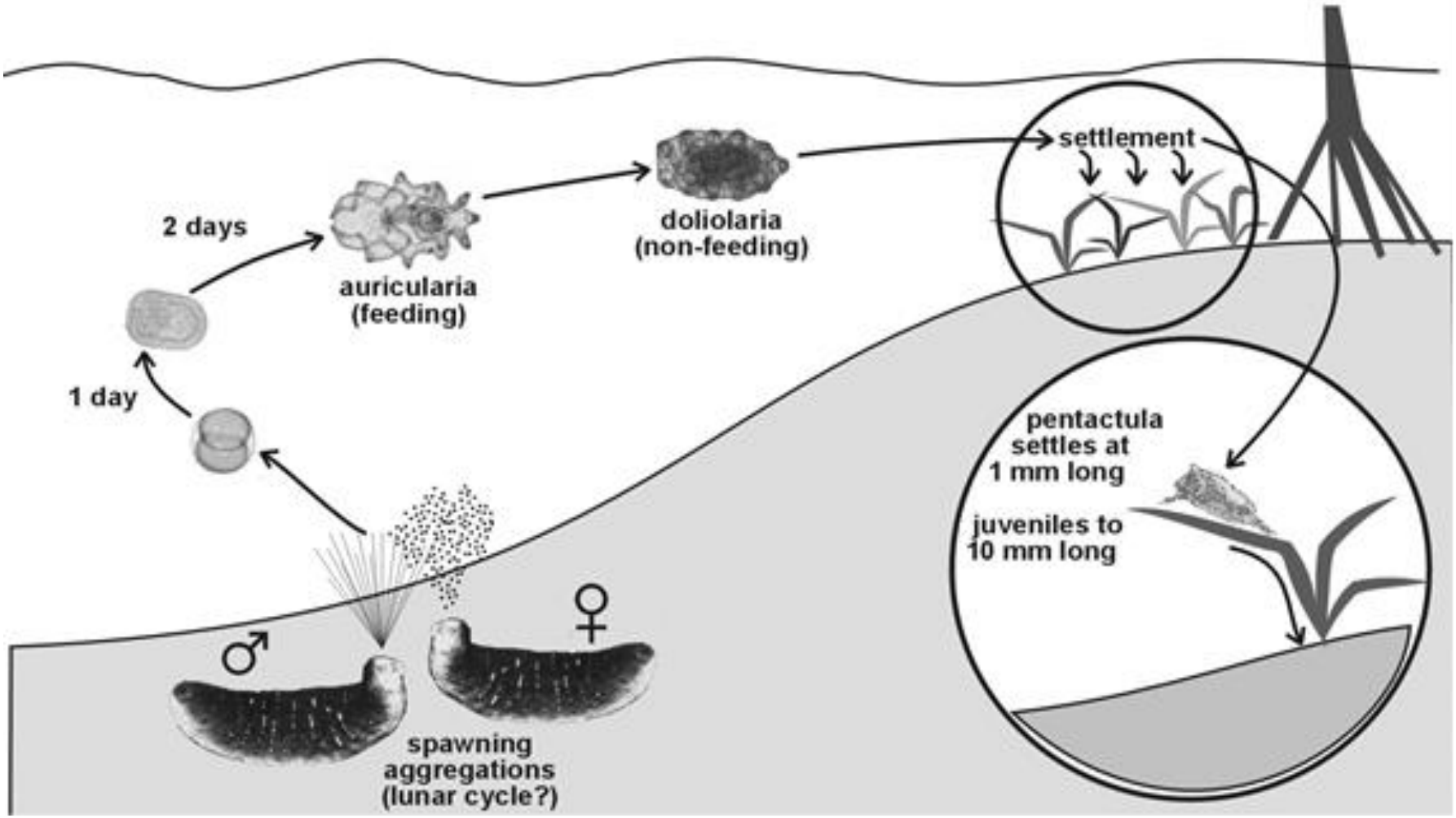
- Surf redfish were found in higher numbers relative to previous surveys, which supports species recovery, but still not enough information available to reopen fishery

- Hairy blackfish and Deepwater redfish densities were lower than in previous surveys - may be due to their natural patchy distribution, or may indicate a possible decline

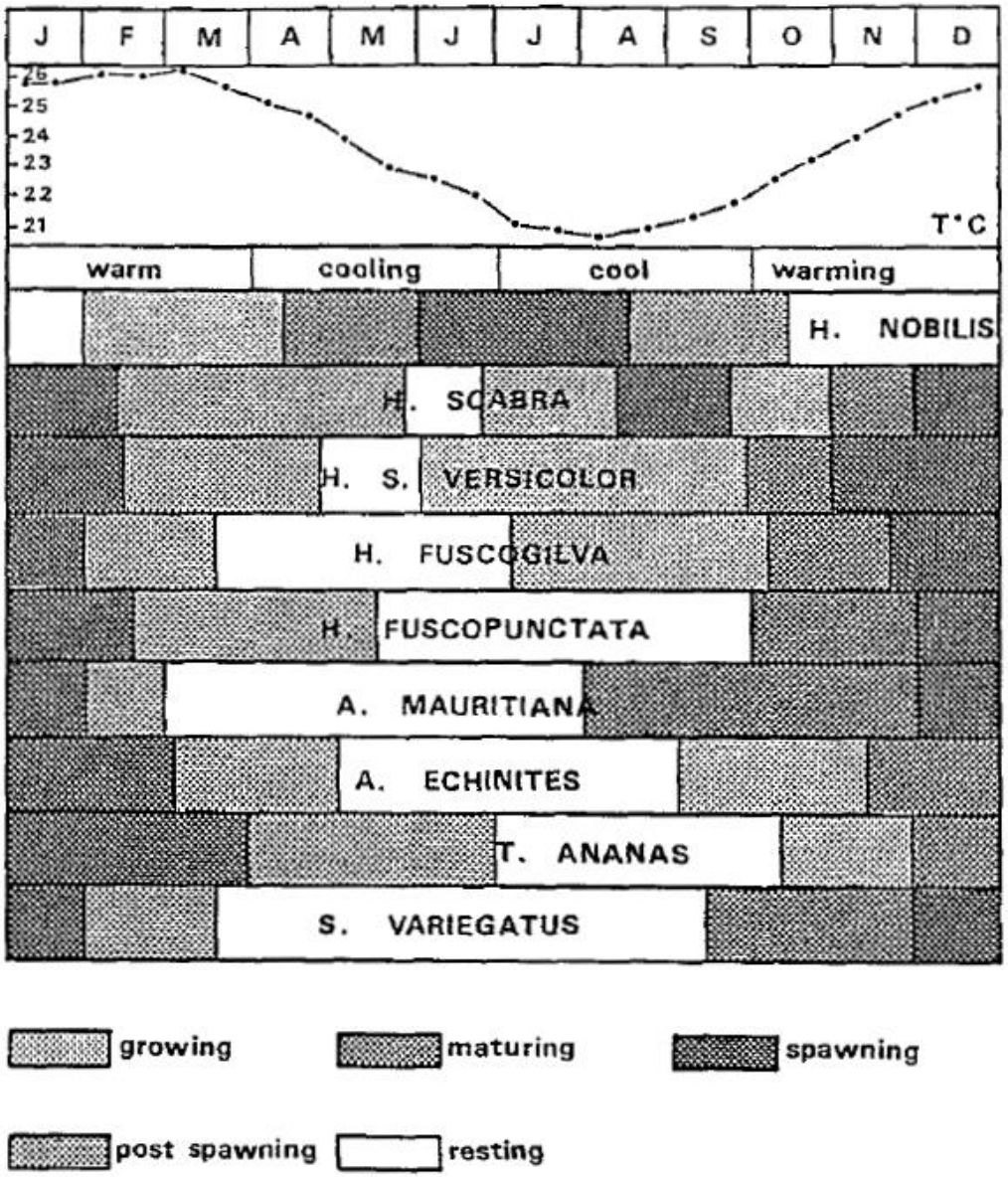
# Biology

- Reproduction
  - Sexes separate
  - Broadcast synchronous spawners
  - Summer spawners (except black teatfish)
  - Short larval life (~2 weeks)
  - Reefs mainly self recruiting
  - Recovery of depleted populations hampered by dilution (Allee) effects
- Recruitment
  - Appears to be sporadic and unpredictable
  - Depleted populations can be very slow to recover, 7-20 years
  - Fishing to extinction rare
  - An effective breeding population is generally over a large area (100s kilometers).

# Life cycle of sandfish



# Biology - reproduction



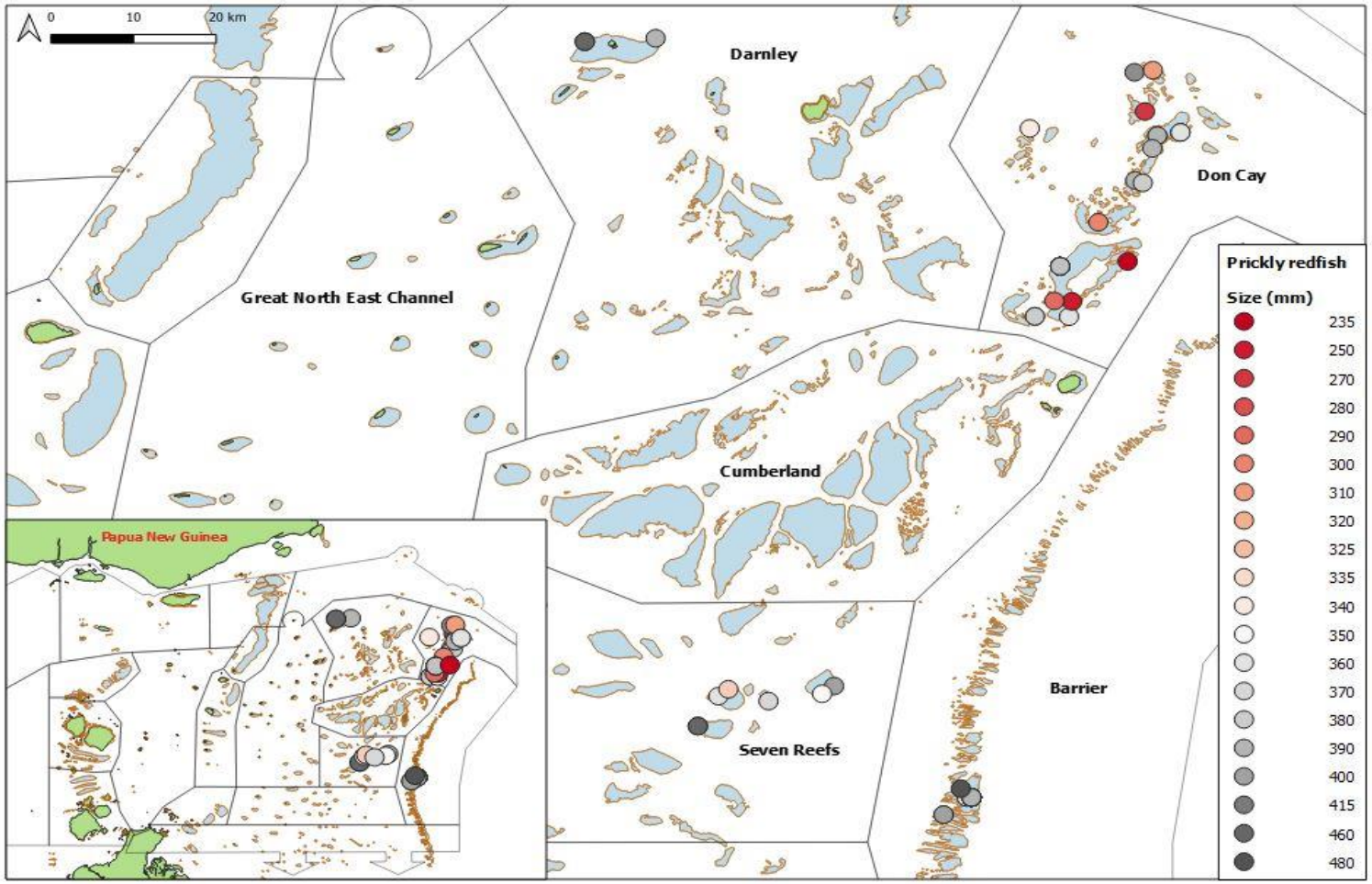

Conand, 1993

# Future research

- Better population modelling
  - Could model all key species, with age structure and spatial component and bound the range of uncertainties
  - A tool to more comprehensively evaluate the risks of different TAC alternatives
  - Can explore how adding data reduces uncertainty and hence consequences for management recommendations
  - More broadly can contribute to aspirational development of an integrated ecosystem model that incorporates climate change
  - A tool to validate the new Harvest Strategy (HS) and help implement rules such as how best to use indicators to adjust TACs e.g. size measurements used to inform on ae structure and hence available biomass
- Conversion ratios
  - Curryfish

# Spatial fishing strategies

Fishers have good knowledge of juvenile and adult areas for sea cucumber species



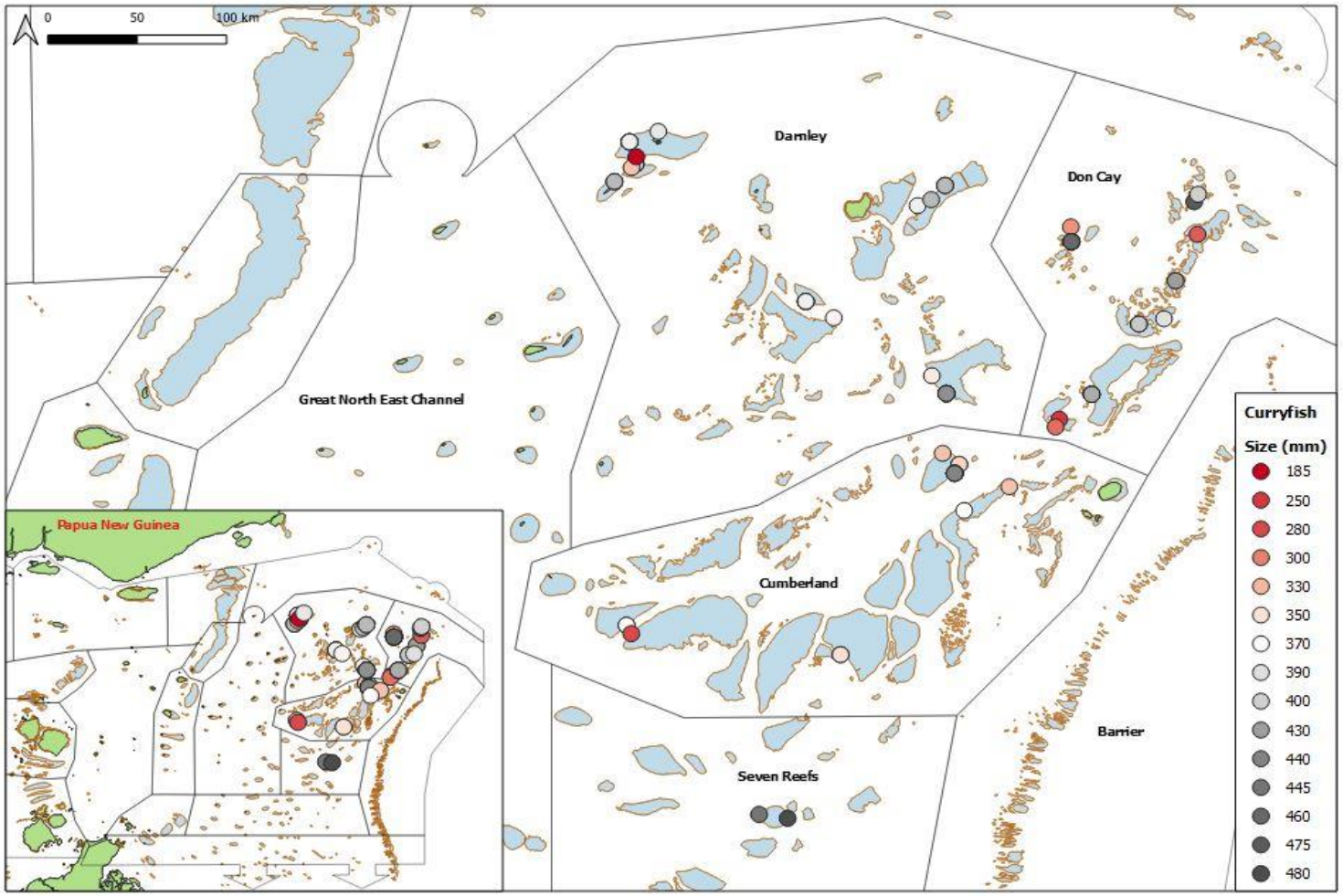

**Prickly redfish**

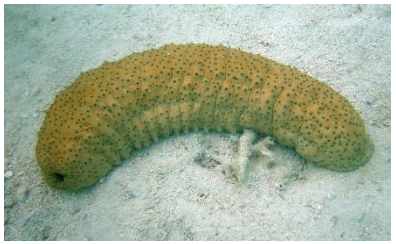
Size measurements across survey sites

Of note – Barrier and Seven Reefs

# Rotational fishing

- Choose not to fish areas where individuals are known to be smaller in size
- Grounds that have been recently fished are avoided to shift effort



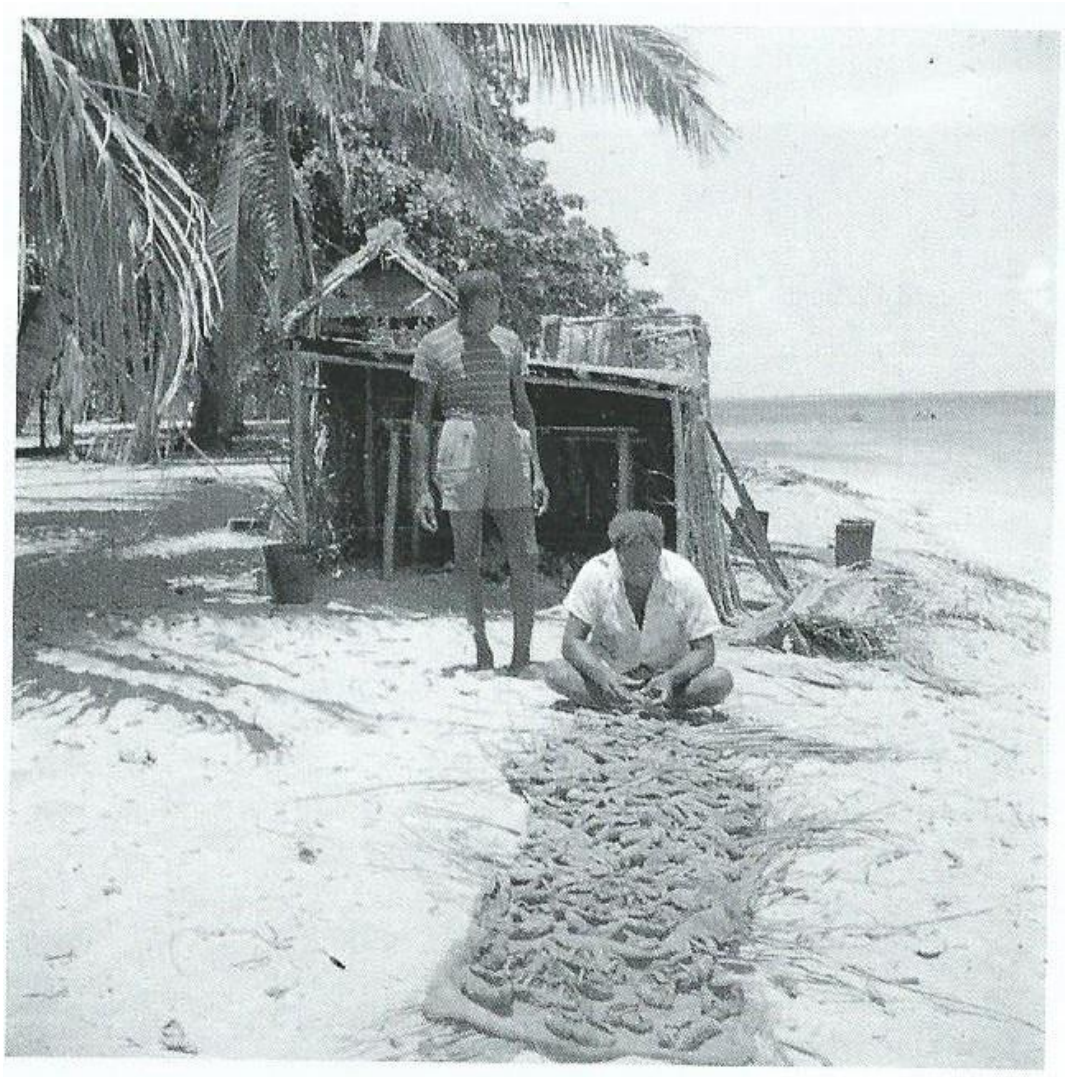



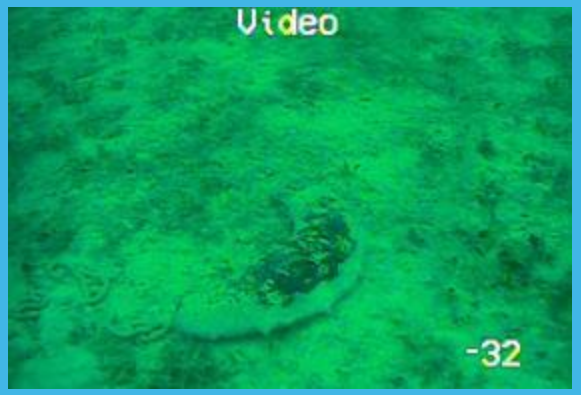
**Curryfish (common)**

Size measurements across survey sites

Of note – Darnley and Don Cay

# Beche-de-mer fishing on Murray Island 1960






# Thank you

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