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Determining amount of substrate that is trimmed from stony corals in the Specialty Coral quota category

Validating a defensible and robust method for data collection, species composition and reporting the harvest of protected coral species from the Great Barrier Reef World Heritage Area

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2016-051 Validating a defensible and robust method for data collection, species composition and reporting the harvest of protected coral species from the Great Barrier Reef World Heritage Area is supported by funding from the FRDC on behalf of the Australian Government.

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Abbreviations

CITES – Convention on International Trade in Endangered Species of Wild Fauna and Flora

ERA – Ecological Risk Assessment

QCF - Queensland Coral Fishery

GBR – Great Barrier Reef

Executive Summary

Catch reporting in the Queensland Coral Fishery (QCF) has recently undergone reforms to increase data resolution and accuracy for improved management of the fishery. Importantly, this study seeks to rigorously estimate that amount of non-living substrate that is removed from corals. Industry successfully advocated that trimmed substrate should not be allocated to Specialty Coral quota and that 25.0% of the weight should be allocated to Other Coral. This allows the true value and accurate weight of Specialty Coral quota to be realized and the total weight accounted for in the TAC. However the 25.0% figure is based solely on industry experience and requires independent validation.

The purpose of this study was to rigorously estimate the overall percentage weight of substrate and dead coral skeleton that is removed from coral in the Specialty Coral category.

All stony corals in the Specialty Coral quota category were weighed regardless of whether these required trimming or not. Corals were weighed tray by tray, which generally consisted of 10-50 individuals of the same species. To calculate the amount that was trimmed from corals, all discarded skeletal material and material lost during the trimming process itself were combined where applicable and expressed as a proportion of the total intact coral weight.

A total of 7,422 individual corals were considered during the course of this study, with a combined weight of 1,146.79kg, all within the Specialty Coral category. The total weight of the material (almost exclusively carbonate material) that was trimmed and discarded was 291.24kg, representing 25.40% of the combined pre-cut weight of corals weighed during the course of the study.

This study supports the 25% percent reallocation of Specialty Coral quota to Other Coral, to reflect the overall percent offcut of substrate and dead coral skeleton, which is ultimately discarded.

Despite significant time and logistic constraints on this project, we sampled a total of 7,422 corals, representing 4.84% of the total recorded catch (153,123 pieces) for 2016/17. The proportional representation of taxa sampled in this study was broadly reflective of the taxonomic composition of catches across the entire industry, though *Acanthastrea* and *Scolymia* were significantly under-represented in the current sampling. However, these biases in sampling did not significantly alter the overall results.

It is recommended that the 25% reallocation of Specialty Coral quota to Other Coral be maintained at least until additional data is obtained that warrants changes in this reallocation.

Keywords

Queensland Coral Fishery (QCF), Specialty Coral, Scleractinia, offcut concession, coral weight

Introduction

The Queensland Coral Fishery

The QCF is a small scale, quota managed, hand harvest fishery. The QCF commenced as a licenced fishery on 1 July 2006, however it has operated under coral leases since the 1970s.

Commercial operators in the QCF collect coral from waters along the Queensland east coast between latitudes 10°41' S and 24°30' S (not including areas closed through general fisheries closures or marine parks zoning under the Great Barrier Reef Marine Park Act 1975 (Commonwealth) and the Marine Parks Act 2004 (Qld)).

An annual Total Allowable Catch of 200t applies whereby 30% (60t) may be collected as 'specialty coral', which comprises living coral specimens. The balance may be collected as 'other coral', which mostly comprises live rock with some collection of the fast-growing and abundant species of *Acropora* spp. and *Pocillopora* spp. for ornamental purposes.

Target species in the fishery are subject to a regular ERA, which determines the level of risk the actions of the fishery pose on their sustainability. The 2013 ERA workshop found that from a total 220 species assessed, there were no high risk species, 17 species at moderate risk, and 63 species at low risk in the fishery. Species greater than negligible risk are closely monitored through the PMS. No further management action is required to address this level of risk other than maintaining the current management regime.

Background

Catch reporting in the Queensland Coral Fishery has recently undergone reforms to provide accurate, high resolution data for the management of the fishery. A portion of the fishery targets living stony corals that are listed on CITES Appendix II. The obligatory CITES Non-detriment Finding that concludes that international trade in Appendix II species will not be detrimental to the survival of the species in the wild forms a significant adjunct to the assessment of environmental performance under the Environment Protection and Biodiversity Conservation Act for export eligibility of products from the fishery.

When the reforms were instituted, industry indicated that non-living substrate was removed from corals and that this trimmed potion should not count against the living coral component of the quota. In seeking to validate the extent of trimmed substrate, the aquarium supply industry peak body, Pro-vision Reef, the fishery manager from Fisheries Queensland and scientists from the ARC Centre of Excellence for Coral Reef Studies came together and worked positively and collaboratively to determine the scope and scale of the project, methods and contributions in order to make the project work.

The proposed project was presented to industry at the Pro-vision Reef Annual General Meeting where the costs and benefits were outlined and discussed. Pro-vision Reef subsequently further developed the project with the co-investigators and have worked together to refine the Expression of Interest to incorporate comments provided by the Queensland Fisheries Research Advisory Committee (QFRAC). The project will now provide assessments of ecological risk and environmental performance with more robust data upon which management of the fishery can move forward but achieve that without compromising the profitability of the sector.

Need

Major reforms were introduced to catch reporting in 2016 for the QCF. The reporting reforms will underpin assessments of ecological risk and environmental performance, the CITES non-detriment finding, and to maintain national and international market access.

The new measures require the reporting of total actual weights for CITES corals. However, it does not account for the weight of substrate attached to the actual coral when collected, which is typically removed after landing. Industry successfully advocated that trimmed substrate should not be allocated to Specialty Coral quota and that 25% of the weight should be allocated to Other Coral. This allows the true value and accurate weight of Specialty Coral quota to be realized and the total weight accounted for in the TAC. However the 25% figure is based solely on industry experience and requires independent validation. To ensure reporting is both accurate and has potential application to other fisheries, validating the quantum of trimmed substrate is critical. This project will provide this validation.

It is important that the proportion of trimmed substrate is validated through an independent scientific study for the following reasons: i) Continued social acceptance of the QCF ii) Fisheries Queensland and the Commonwealth Department of the Environment and Energy require that the trimmed substrate proportion is based on independent scientific data iii) The proportion must be fairly applied to all QCF collectors for quota equity purposes (i.e. it represents the current fishery and is not unfairly biased to any individual or region).

Objectives

The aim of the project is to accurately establish a representative and unbiased overall percentage of the amount of substrate that is trimmed from stony corals in the Specialty Coral quota category. This does not include corals from Acroporidae and Pocilloporidae families as these are already wholly allocated to the Other Coral quota category under arrangements commencing 1 July 2016.

Method

Establishing the amount trimmed from each individual coral.

To provide an accurate and unbiased estimate of the amount of substrate and dead coral skeleton trimmed from Specialty Corals across the entire QCF, we intended to visit two different businesses in Cairns, Mackay and Brisbane, thereby accounting for regional differences in the nature of the catches. Moreover, we hoped to visit each business more than once to assess variability among unloads. However, the limited time and logistic constraints on sampling meant that we were only able to sample four entire unloads across three different business (Table 1).

A total of 7,423 corals were weighed between December 2016 and April 2017 to assess the proportion of corals that is trimmed prior to sale. These corals represented the entirety of the take of Specialty Corals from four separate unloads. Potential regional variation in the amount of substrate trimmed from stony corals was established by comparing the trimming carried out by three different licenced Queensland coral collectors based in Cairns (northern GBR), Mackay (central GBR) and Brisbane (southern GBR) (Table 1).

Table 1 Number of corals weighed at the three different facilities during each unload.

Unload Date	Collector	Location	No corals weighed
9 Dec 2016	Cairns Marine	Cairns	462
10 Mar 2017	Great Barrier Reef Marine	Brisbane	1488
20 Mar 2017	Corals Downunder	Mackay	933
11 Apr 2017	Cairns Marine	Cairns	4540

All stony corals in the Specialty Coral quota category were weighed regardless of whether these required trimming or not. Corals were weighed tray by tray, which generally consisted of 10-50 individuals of the same species. Trays were drained prior to processing to allow most of the water in the coral tissue to be expelled in order to achieve the best possible level of accuracy. Draining time varied between species from approximately 1 to 10 minutes depending on the amount of water retention in the tissue.

For individuals requiring trimming, all corals from Great Barrier Reef Marine, Corals Downunder and a subset of 489 corals from Cairns Marine were also weighed prior to trimming to assess what proportion of the coral was lost during the process of trimming itself. We expected this to vary between collectors owing to differences in the method and equipment used to trim corals. Following the trimming of each coral, the retained (live) coral

and discarded pieces were weighed separately on two 3-5kg electronic scales and photographed, and the weights were recorded to the nearest gram (Fig 1).

Fig 1 Weighing of a *Goniopora* spp. post-trimming, with the retained (live) coral on the left scale and the discarded piece(s) on the right.

Assessing regional variation in the overall amount trimmed from stony corals.

Industry feedback indicates that the extent of trimmed substrate is spatially variable throughout the fishery area. Specifically, the proportional weight of offcuts is purported to be much higher for corals harvested from the southern GBR, especially where corals are growing on granitic substrates.

To account for spatial variation in the extent of substrate that is trimmed from stony corals, every effort was made to ensure equal representation of coral collectors operating in different regions of the Great Barrier Reef. Importantly, scientists visited facilities in Cairns, Mackay and Brisbane, though the limited duration of this study and additional logistical constraints on the conduct of this study (e.g., Cyclone Debbie) prevented multiple visits to individual businesses and severely restricted the number of businesses (3) that were engaged in this project.

If there is significant and consistent regional variation in the proportion of material (carbonate or granitic substrate) that is trimmed from corals in the Specialty Coral category, the weighted average of proportional offcut will be weighted by the volume of Specialty Coral unloaded and the number of unloads at each port available from Fisheries Queensland logbook and quota datasets for the current quota year.

Assessing variation in the amount trimmed from different coral taxa.

To calculate the amount that was trimmed from corals, all discarded skeletal material and material lost during the trimming process itself were combined where applicable and expressed as a proportion of the intact coral weight. Due to time constraints and the volume of corals to process at Cairns Marine, only 487 corals could be weighed prior to trimming, which represented 22.17% of all trimmed corals from both unloads. Based on these 487 corals, we established that trimming caused on average 3.53% of the material to be lost, which is within the range of the percentage that is lost during the trimming at Great Barrier Reef Marine and Corals Downunder (Table 2). This percentage was therefore, added to the live coral and discarded rock weights of all trimmed corals that were not weighed prior to the trimming process to establish their estimated intact weight.

Table 2 Number of corals that were weighed prior to trimming and the average percent per coral that was lost during the trimming at the three different facilities.

Collector	n	Average % lost
Cairns Marine	487	3.53% ± 0.17%
Corals Downunder	933	3.88% ± 0.14%
Great Barrier Reef Marine	1488	3.11% ± 0.10%

The percent offcut was then based on the following proportion:

$$\text{Proportional offcut} = \frac{\text{Intact weight - retained (live) piece(s)}}{\text{Intact weight}}$$

The percent offcut was established based on both trimmed and untrimmed corals for all three collectors as an average per coral, and an overall total for all corals collected.

The average percent offcut per coral was also calculated for each taxonomic category. To test for differences between the average percent offcut between collectors and taxonomic groups, a negative binomial model was from the pscl R-package (Version 1.4.9) was fitted to the data.

Results, Discussion and Conclusion

A total of 7,422 individual corals were considered during the course of this study, with a combined weight of 1,146.79kg, all within the Specialty Coral category. 3,862 out of 7,422 corals (52.03%) were trimmed. The total weight of the material (almost exclusively carbonate material with very limited live coral) that was trimmed and discarded (across all three businesses) was 291.24kg, representing 25.40% of the combined pre-cut weight for all corals. The average amount of material that was trimmed from each coral (including those corals that were not trimmed) was 17.23%. The apparent discrepancy between the average percentage of material that was trimmed (17.23%) versus the overall percentage that was trimmed (25.40%) is due to the fact that there is a disproportionate amount of trimming for larger corals, such that taking an average across all corals (small and large) underestimates the overall percentage of material that is removed.

Regional variation in the overall amount trimmed from Specialty Coral

The average and overall precent of offcut from corals varied among the three businesses (Table 3), but there was no systematic variation in the extent of the offcut in northern versus southern Great Barrier Reef (Table 4). The highest recorded offcut (45.46%) was recorded for Corals Downunder (in Mackay), whereas the overall percent offcut 21.48% for Cairns Marine (in Cairns) and 26.94% for Great Barrier Reef Marine (in Brisbane). Despite initial intentions to sample multiple unloads in each location, Carins Marine was the only business we visited more than once, and the two different unloads were very different; The overall percent offcut for the first unload was 33.86% compared to 18.70% for the second unload, such that the average (unweighted) across the two different unloads (26.28%) was very similar to that of Great Barrier Reef Marine.

Table 3 Analysis of variance table to show variance due to business versus taxonomic groupings, based on a negative binomial GLM run in R. While there was significant variation in average percent offcut among the three businesses, the greatest variation was due to taxonomic differences in the extent of trimming.

Factor	df	Deviance	p
Business	2	209.1	>0.001
Species group	39	8491.1	>0.001

Table 4 Number and weight of corals weighed at the three different businesses in Cairns (Cairns Marine), Mackay (Coral Downunder) and Brisbane (Great Barrier Reef Marine), as well as the average and overall offcut recorded at each location.

Business	No. of corals	Total weight	Average offcut	Overall offcut
Cairns Marine	5,001	494.76kg	13.14%	21.48%
Corals Downunder	933	282.97kg	34.45%	45.46%
Great Barrier Reef Marine	1,488	358.23kg	20.18%	26.94%
Total	**7,422**	**1,146.79kg**	**17.23%**	**25.40%**

Significant and obvious variation in the overall percent offcut among businesses reduces confidence that the overall percent offcut (25.40%) is reflective and representative of the QCF industry as a whole. However, there was much greater variation in percent offcut from different corals by a given business (e.g., each business consistently cut a greater proportion of substrate and dead coral skeleton from *Euphyllia* corals than for *Turbinaria*), than there were among businesses (Fig 3). Importantly, the mean percent offcut recorded for both Cairns Marine and Corals Downunder is within the range of values recorded for Great Barrier Reef Marine.

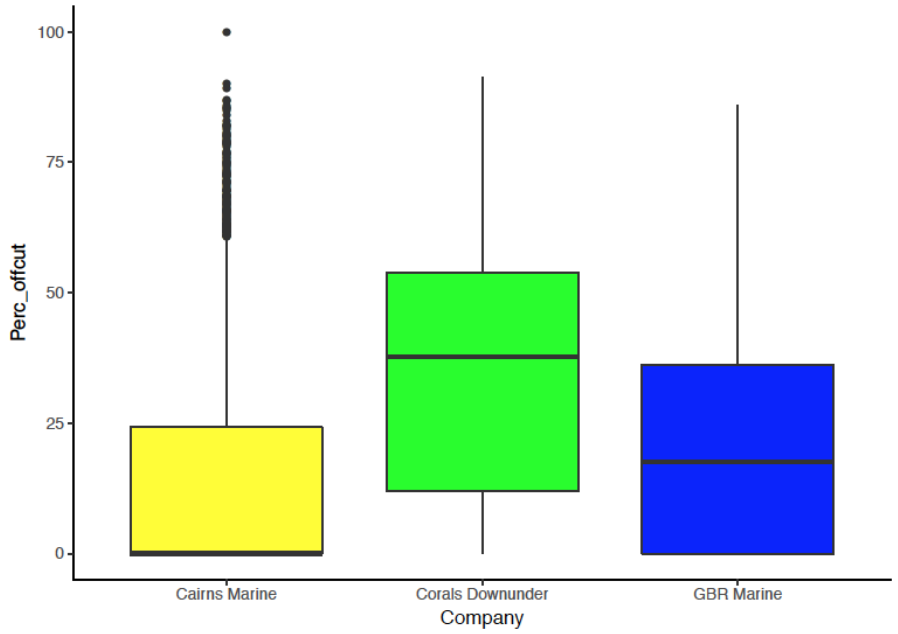

Fig 2 Box plots showing the mean, variance and range of percentage offcut for individual corals, showing that there is considerable variation in the percent offcut from different corals by each business (largely due to differences among taxa, which is discussed later).

Taxonomic variation in the percentage offcut from corals

The percent of offcut from corals varied significantly among taxa, ranging from 43.51% (1.50SE) for *Plerogyra* to 0% for a range of coral taxa including *Caulastrea*, *Trachyphyllia*, and most Fungiidae (Fig 3). Aside from *Plerogyra*, the taxa for which the average percent offcut was >20% included *Euphyllia* (other than *E. parancora*), *Physogyra*, *Blastomussa*, *Goniopora* and *Alveopora*, *Lopophyllia*, and most Faviidae.

Variation in the overall percent offcut recorded across the three different businesses was readily explained by differences in the taxonomic composition (Fig 3). More specifically, the relative contribution (by weight) of corals for which the average percent offcut was >20% versus the combined weight of corals for which there was no trimming had a major bearing on the overall percent offcut (Fig 4). For Cairns Marine, the combined weight of two different unloads was dominated (63% by weight) by corals (e.g., *Plerogyra*, *Blastomussa* and *Lobophyllia*) for which the overall percent offcut is >20%. However, this is offset by significant volume and weight of corals for which there was no trimming (Fig 3). For Corals Downunder, the catch composition was dominated by corals for which the percent offcut was >20% and there was only negligible weight of corals for which there was no trimming. For this reason the overall percent offcut (45.46%) was higher than recorded for other businesses. For Great Barrier Reef Marine there was approximately equal weight of corals that generally require >20% overall percent offcut versus those with only moderate (<20%) percent offcut, and limited weight of corals that are generally not trimmed.

There have been industry reports that amount of offcut from specific coral taxa (e.g., *Trachyphyllia* and *Catalaphyllia*) varies by region, and that the proportional weight of offcut is particularly high for corals that are harvested from granitic substrates in the southern Great Barrier Reef. However, given limited overlap in catch composition among the three businesses (e.g., the only *Trachyphyllia* considered in this study were harvest by Cairns Marine in the northern Great Barrier Reef) were there was limited opportunity to test for regional variation in the precent offcut within individual taxa. It was apparent however, for *Catalaphyllia*, that there was variation in the percent offcut across the three businesses. Notably, the percent offcut for Catalaphyllia was 0% for Cairns Marine, compared to 49.40% for Corals Downunder and 40.09% for Great Barrier Reef Marine. Similar differences are purported to occur for other taxa (e.g., *Trachyphyllia*), but there was not sufficient overlap in the composition of catches across the three businesses to make meaningful comparisons across individual species groups.

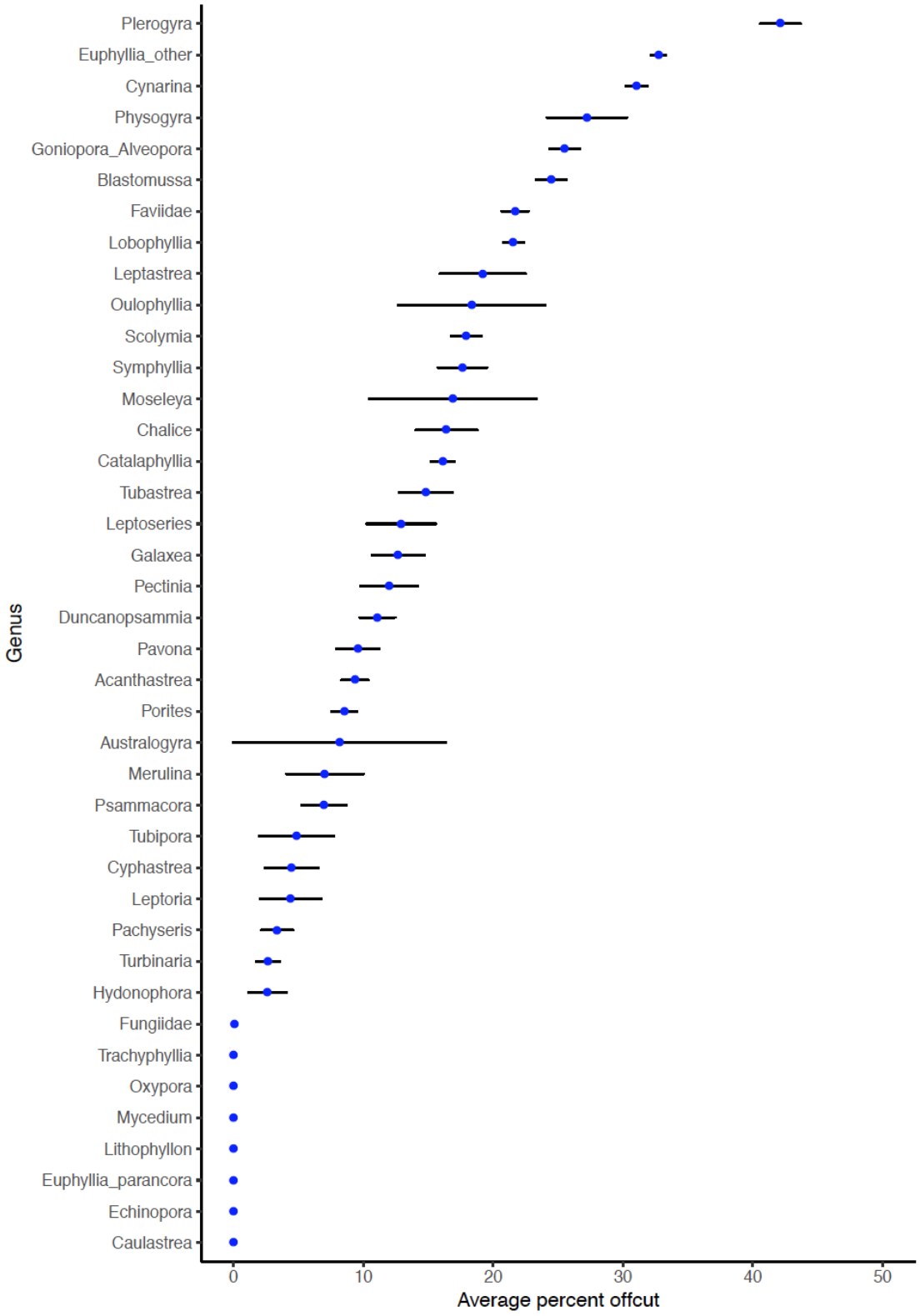

Fig 3 Average (±SE) weight of offcut for each coral taxa, ordered according to the average percentage offcut.

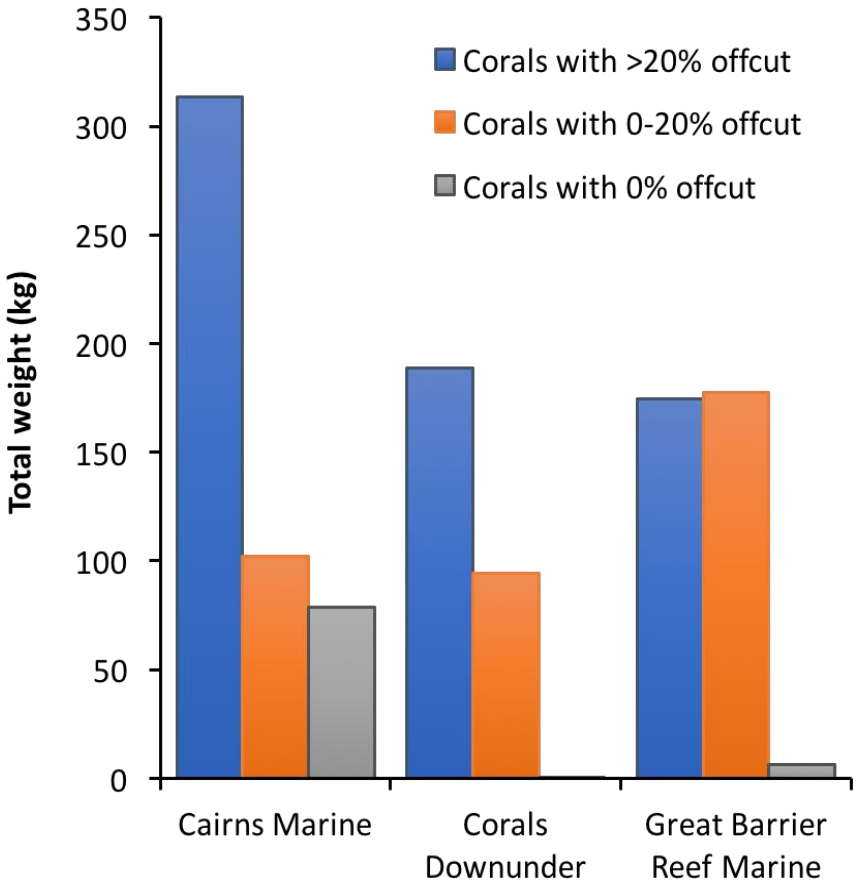

Fig 4 Total weight of corals in taxonomic catergories for which there was consistently high, moderate or negliugible percent offcut, across the three different businesses. For specific taxa in each category see Figure 3.

Taxonomic weighting based on log book data

Given the overarching importance of the taxonomic composition of unloads on the overall percent offcut, we assessed whether the proportional representation of taxa in the current study is broadly reflective of the relative take of different taxa across the entire QCF based on 2016/17 logbook data provided by Fisheries Queensland. To make valid comparisons between the current study and catch reporting data some pooling of taxonomic categories was required (Table 4). Based on the number of corals (or coral pieces) sampled in this study relative to the 2016/17 logbook data, both *Acanthastrea* and *Scolymia* are significantly under-represented in the current sample. Meanwhile, *Euphyllia parancora* and *Cynarina* are over-represented in the current sampling. Given that both *Scolymia* and *Acanthastrea* are generally subject to high (>20%) percent offcut, undersampling of these taxa would have reduced the estimated overall percent offcut. However, the proportional sampling of the other 18 major taxonomic categories in the current sample was similar to that recorded across the entire QCF, based on the 2016/17 logbook data, albeit based on number of corals rather than weight. However, even if we had sampled 4-5 times more *Acanthastrea* corals each weighing 200g and cut 25% substrate form each coral, the overall percent offcut would only have increased to 27.8%.

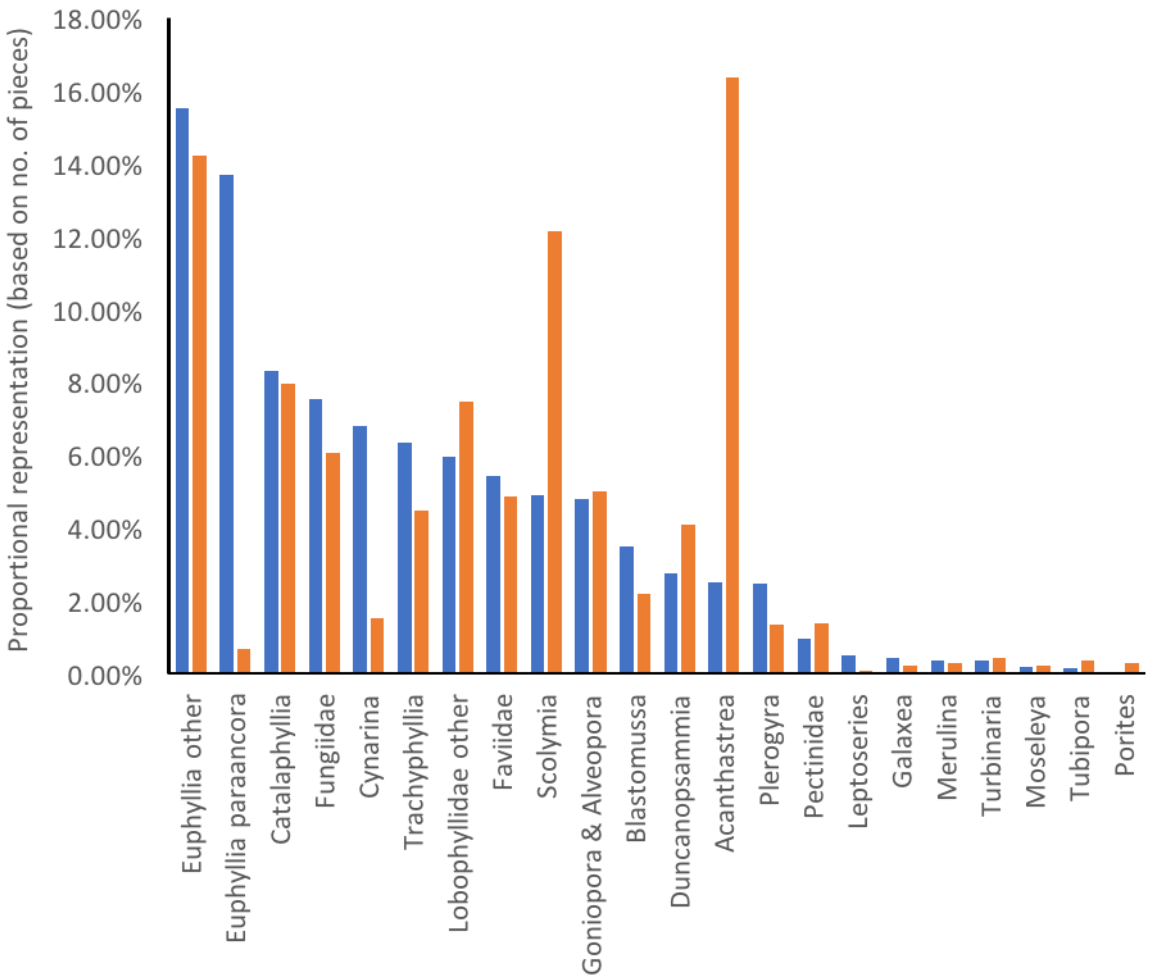

Fig 5 Proportional representation of species groups in current sampling (first column – blue) versus 2016/17 log book data provided by Queensland Fisheries (second column – orange).

Table 4 Taxonomic representation in the samples considered for this study versus relative to the relative composition of catches recorded for 2016/17.

Species groups	n	Percent of sample	Percent of overall harvest (2016/17)	Total weight (g)	Overall offcut (%)
Euphyllia other	1153	15.53%	14.22%	223933	40.46%
Euphyllia paraancora	1015	13.68%	0.68%	38421	0.00%
Catalaphyllia	616	8.30%	7.96%	133995	34.37%
Fungiidae	559	7.53%	6.05%	28304	0.05%
Cynarina	504	6.79%	1.52%	47099	39.61%
Trachyphyllia	470	6.33%	4.49%	12700	0.00%
Lobophyllidae other	442	5.96%	7.46%	115676	23.47%
Faviidae	403	5.43%	4.85%	92681	29.96%
Scolymia	365	4.92%	12.14%	37094	27.77%
Goniopora & Alveopora	355	4.78%	5.03%	76342	33.63%
Blastomussa	259	3.49%	2.20%	74325	31.28%
Duncanopsammia	204	2.75%	4.08%	38239	19.76%
Acanthastrea	187	2.52%	16.38%	48685	21.31%
Plerogyra	185	2.49%	1.37%	39993	54.96%
Pectinidae	72	0.97%	1.40%	13712	29.39%
Leptoseries	37	0.50%	0.10%	3838	19.44%
Galaxea	33	0.44%	0.22%	6095	17.02%
Merulina	28	0.38%	0.29%	2350	9.46%
Turbinaria	28	0.38%	0.44%	2852	4.99%
Moseleya	13	0.18%	0.21%	4103	12.55%
Tubipora	12	0.16%	0.38%	1761	6.62%
Porites	2	0.03%	0.29%	393	11.88%

Implications

This study provides strong scientific support for the 25% overall percent offcut across all coral in the Specialty Coral category, as advocated by industry prior to the conduct of this study. The actual overall offcut recorded during this study was 25.40. The average percent offcut recorded across all corals considered in this study was only 17.23%, due to the large number of corals (3,560 out of 7,422) that were not trimmed. However, this value poorly reflects the overall weight of material that was trimmed across all corals because it is mostly smaller corals that are not trimmed, while a significant portion (>20%) of substrate and dead skeleton is trimmed from many of the larger corals (e.g., Faviidae).

Despite significant time and logistic constraints on this project, we sampled a total of 7,422 corals, representing 4.84% of the total recorded catch (153,123 pieces) for 2016/17. The proportional representation of taxa sampled in this study was broadly reflective of the taxonomic composition of catches across the entire industry, though select taxa (*Acanthasterea* and *Scolymia*) were under-represented. We show however, that even if there was better representation of *Acanthastrea* in the current sampling, this would not have greatly altered the overall percent offcut.

The percent offcut from corals may vary regionally depending on the nature of the substrate and variation in the growth morphology of corals in different regions. This was apparent based on differences in the percent offcut from *Catalaphyllia* in the northern versus southern GBR. However, this study did not detect any systematic increase in the percent offcut from north to south, such that weighting the results according to the proportional catch from different ports would not have greatly influenced the results.

Recommendations

This study was unequivocally intended to rigorously quantify the percentage weight of substrate that is trimmed from stony corals in the Specialty Coral quota category, such that the actual weight of trimmed corals is reflected in the Specialty Coral quota while the total (pre-cut) weight of all corals collected is accounted for in the TAC. While it was suggested that the percent offcut would vary regionally, a single value of the percent offcut was required to be applied across the entire QCF. It was anticipated that resulting estimate of the overall percentage weight that is trimmed from Specialty Corals may have been very different (higher or lower) than the 25% that was proposed by industry, though this would not necessarily change the management decisions by Fisheries Queensland. As it turns out, this study supports the 25% percent reallocation of Specialty Coral quota to Other Coral, to reflect the overall percent offcut of substrate and dead coral skeleton, which is ultimately discarded. It is recommended therefore, that the 25% reallocation be maintained at least until additional data is obtained that warrants further increases in this reallocation.

While not included in this report, the entire sampling regime undertaken for this project provides potentially important insights into the nature of the fishery. Importantly, we now have detailed information on not only the taxonomic composition for the catch (which can be ascertained from logbook data anyway), but also the size (specifically, weight) distribution of corals that are being collected. This represents important baseline data against which to assess changes in the nature of the fishery (e.g., to assess whether there are targeting smaller corals over time) by repeating this sampling after 3-7 years. It is recommended that the sampling be repeated within this timeframe.

Extension and Adoption

The purpose of this project is to provide technical validation of an important element of the harvesting process that can be used to guide management of the fishery. The fishery manager is a co-investigator so guides the implementation of the methods and has unfettered access to project results. Industry will be advised of the outcomes of this study through the industry body, Pro-vision Reef Inc., a representative of which is also a co-investigator. Other indirect beneficiaries include the Great Barrier Reef Marine Park Authority, Queensland Boating and Fisheries Patrol, Queensland Parks and Wildlife Service, and the Sustainable Fisheries section and CITES Scientific Authority at the Australian Government Department of the Environment and Energy. This work will also have applicability to any entities, which permit the harvesting of corals.

The QCF is acutely aware of the conduct of this study, and was advised of the imminent completion of the project at the Pro-vision Reef Annual General Meeting in May 2017 and is awaiting circulation of the draft report. Given the importance of the project outputs to government approval processes that affect the future viability of the QCF, the GBRMPA, the CITES Scientific Authority and the Sustainable Fisheries sections of the Commonwealth Department of the Environment and Energy will also be directly advised of the outcomes of this study.