# Marine Science 2019 v1.2

IA2 mid-level annotated sample response

July 2018

## Student experiment (20%)

This sample has been compiled by the QCAA to assist and support teachers to match evidence in student responses to the characteristics described in the instrument-specific marking guide (ISMG).

### Assessment objectives

This assessment instrument is used to determine student achievement in the following objectives:

2. apply understanding of the reef and beyond or changes on the reef to modify experimental methodologies and process primary data
3. analyse experimental evidence about the reef and beyond or changes on the reef
4. interpret experimental evidence about the reef and beyond or changes on the reef
5. investigate phenomena associated with the reef and beyond or changes on the reef through an experiment
6. evaluate experimental processes and conclusions about the reef and beyond or changes on the reef
7. communicate understandings and experimental findings, arguments and conclusions about the reef and beyond or changes on the reef.

**Note:** Objective 1 is not assessed in this instrument.

# Instrument-specific marking guide (ISMG)

## Criterion: Research and planning

### Assessment objectives

2. apply understanding of the reef and beyond or changes on the reef to modify experimental methodologies and process primary data
5. investigate phenomena associated with the reef and beyond or changes on the reef through an experiment

| The student work has the following characteristics: | Marks |
|---|---|
| • informed application of understanding of the reef and beyond or changes on the reef to modify experimental methodologies demonstrated by<br>- a considered rationale for the experiment<br>- justified modifications to the methodology<br>• effective and efficient investigation of phenomena associated with the reef and beyond or changes on the reef demonstrated by<br>- a specific and relevant research question<br>- a methodology that enables the collection of sufficient, relevant data<br>- considered management of risks and ethical or environmental issues. | 5–6 |
| • adequate application of understanding of the reef and beyond or changes on the reef to modify experimental methodologies demonstrated by<br>- a reasonable rationale for the experiment<br>- feasible modifications to the methodology<br>• effective investigation of phenomena associated with the reef and beyond or changes on the reef demonstrated by<br>- a relevant research question<br>- a methodology that enables the collection of relevant data<br>- management of risks and ethical or environmental issues. | 3–4 |
| • rudimentary application of understanding of the reef and beyond or changes on the reef to modify experimental methodologies demonstrated by<br>- a vague or irrelevant rationale for the experiment<br>- inappropriate modifications to the methodology<br>• ineffective investigation of phenomena associated with the reef and beyond or changes on the reef demonstrated by<br>- an inappropriate research question<br>- a methodology that causes the collection of insufficient and irrelevant data<br>- inadequate management of risks and ethical or environmental issues. | 1–2 |
| • does not satisfy any of the descriptors above. | 0 |

## Criterion: Analysis of evidence

### Assessment objectives

2. apply understanding of the reef and beyond or changes on the reef to modify experimental methodologies and process primary data
3. analyse experimental evidence about the reef and beyond or changes on the reef
5. investigate phenomena associated with the reef and beyond or changes on the reef through an experiment

| The student work has the following characteristics: | Marks |
|---|---|
| • appropriate application of algorithms, visual and graphical representations of data about the reef and beyond or changes on the reef demonstrated by correct and relevant processing of data<br>• systematic and effective analysis of experimental evidence about the reef and beyond or changes on the reef demonstrated by<br>- thorough identification of relevant trends, patterns or relationships<br>- thorough and appropriate identification of the uncertainty and limitations of evidence<br>• effective and efficient investigation of phenomena associated with the reef and beyond or changes on the reef demonstrated by the collection of sufficient and relevant raw data. | 5–6 |
| • adequate application of algorithms, visual and graphical representations of data about the reef and beyond or changes on the reef demonstrated by basic processing of data<br>• effective analysis of experimental evidence about the reef and beyond or changes on the reef demonstrated by<br>- identification of obvious trends, patterns or relationships<br>- basic identification of uncertainty and limitations of evidence<br>• effective investigation of phenomena associated with the reef and beyond or changes on the reef demonstrated by the collection of relevant raw data. | 3–4 |
| • rudimentary application of algorithms, visual and graphical representations of data about the reef and beyond or changes on the reef demonstrated by incorrect or irrelevant processing of data<br>• ineffective analysis of experimental evidence about the reef and beyond or changes on the reef demonstrated by<br>- identification of incorrect or irrelevant trends, patterns or relationships<br>- incorrect or insufficient identification of uncertainty and limitations of evidence<br>• ineffective investigation of phenomena associated with the reef and beyond or changes on the reef demonstrated by the collection of insufficient and irrelevant raw data. | 1–2 |
| • does not satisfy any of the descriptors above. | 0 |

## Criterion: Interpretation and evaluation

### Assessment objectives

4. interpret experimental evidence about the reef and beyond or changes on the reef
6. evaluate experimental processes and conclusions about the reef and beyond or changes on the reef

| The student work has the following characteristics: | Marks |
|---|---|
| • insightful interpretation of experimental evidence about the reef and beyond or changes on the reef demonstrated by justified conclusion/s linked to the research question<br>• critical evaluation of experimental processes about the reef and beyond or changes on the reef demonstrated by<br>- justified discussion of the reliability and validity of the experimental process<br>- suggested improvements and extensions to the experiment that are logically derived from the analysis of evidence. | 5–6 |
| • adequate interpretation of experimental evidence about the reef and beyond or changes on the reef demonstrated by reasonable conclusion/s relevant to the research question<br>• basic evaluation of experimental processes about the reef and beyond or changes on the reef demonstrated by<br>- reasonable description of the reliability and validity of the experimental process<br>- suggested improvements and extensions to the experiment that are related to the analysis of evidence. | 3–4 |
| • invalid interpretation of experimental evidence about the reef and beyond or changes on the reef demonstrated by inappropriate or irrelevant conclusion/s<br>• superficial evaluation of experimental processes about the reef and beyond or changes on the reef demonstrated by<br>- cursory or simplistic statements about the reliability and validity of the experimental process<br>- ineffective or irrelevant suggestions. | 1–2 |
| • does not satisfy any of the descriptors above. | 0 |

## Criterion: Communication

### Assessment objective

7. communicate understandings and experimental findings, arguments and conclusions about the reef and beyond or changes on the reef

| The student work has the following characteristics: | Marks |
|---|---|
| • effective communication of understandings and experimental findings, arguments and conclusions about the reef and beyond or changes on the reef demonstrated by<br>- fluent and concise use of scientific language and representations<br>- appropriate use of genre conventions<br>- acknowledgment of sources of information through appropriate use of referencing conventions. | 2 |
| • adequate communication of understandings and experimental findings, arguments and conclusions about the reef and beyond or changes on the reef demonstrated by<br>- competent use of scientific language and representations<br>- use of basic genre conventions<br>- use of basic referencing conventions. | 1 |
| • does not satisfy any of the descriptors above. | 0 |

# Task

| **Context** |
|---|
| You have completed the following practicals in class:<br>• Examine coral diversity using a transect technique (using online or field data) (suggested practical).<br>• Investigate the effects an altered ocean pH has on marine carbonate structures (mandatory practical). |
| **Task** |
| Modify (i.e. refine, extend or redirect) an experiment in order to address your own related hypothesis or question.<br>You may use a practical performed in class, a related simulation or another practical related to Unit 3 (as negotiated with your teacher) as the basis for your methodology and research question. |

# Sample response

| Criterion | Marks allocated | Result |
|---|---|---|
| **Research and planning**<br>Assessment objectives 2, 5 | 6 | 4 |
| **Analysis of evidence**<br>Assessment objectives 2, 3, 5 | 6 | 4 |
| **Interpretation and evaluation**<br>Assessment objectives 4, 6 | 6 | 4 |
| **Communication**<br>Assessment objective 7 | 2 | 2 |
| **Total** | **20** | **14** |

The annotations show the match to the instrument-specific marking guide (ISMG) performance-level descriptors.

**Key:** Research and planning | Analysis of evidence | Interpretation and evaluation | Communication

**Note:** Colour shadings show the characteristics evident in the response for each criterion.

| | |
|---|---|
| **Communication [2]**<br><br>**acknowledgment of sources of information through appropriate use of referencing conventions**<br><br>The use of in-text referencing fits the purpose of a scientific report.<br><br>**Research and planning [5–6]**<br><br>**a considered rationale for the experiment**<br><br>The rationale contains evidence of a logical, scientifically informed basis for the experiment. | Coral reefs are an important marine habitat type for many fish and invertebrate species (Connell 1978). The Great Barrier Reef is one of the greatest areas in biodiversity in the world. Additionally, the Great Barrier Reef has several environmental and economic benefits (Moberg & Folke 1999). Reef structures help to protect shorelines from erosion and storm surges, and it is estimated that coral reefs are worth over $350,000 per hectare per year (Costanza et al. 2014). The majority of this economic benefit comes from recreational and commercial fishing and tourism.<br><br>The Great Barrier Reef Catchment has a substantial amount of sugar cane farming which often uses fertilisers containing dissolved inorganic nitrogen (DIN). Excess fertiliser or topsoil containing fertiliser, can be washed into the Great Barrier Reef lagoons making it readily available for plant life (Webster et al., 2012). The increase in dissolved inorganic nitrogen can affect water quality and the algal community of the reefs. In the water, the excess nitrogen can also cause blooms of phytoplankton (Lapointe et al., 2005). The increased amount of phytoplankton can decrease water clarity and limit photosynthesis of the coral's zooxanthellae. Prolonged periods of decreased photosynthesis in the zooxanthellae can ultimately result in coral death (Roth 2014).<br><br>Coral reef systems do need to contain some algae because it is an important food source for many fish and invertebrates. Additionally, some algal species contain calcium carbonate and as the algae die or are consumed; the calcium carbonate helps to fuse pieces of coral together into a larger reef structure (Castro & Huber 2010). However, if there is too much algae on a reef it can be an indicator of high nutrient (nitrogen and phosphorous) levels in the water (Birrell, McCook & Willis 2005). Additionally, algae compete for space with coral, and especially new coral settling on a reef. Therefore, as benthic algae can quickly colonise dead coral surfaces, it may limit the ability of the reef to keep growing (Diaz- |

Pulido & McCook 2002). Consequently, a good indicator of health in a coral reef system could be assessing the amount of living coral and the amount of algae.

As the coral dies, there is more space on the reef for algae to colonize and grow. Therefore, the reefs where coral is dying may show a shift from a coral community to an algal community (Birrell, McCook & Willis 2005). Additionally, if the water has high levels of nitrogen and phosphorous in the water this will act as a fertilizer for the algae on the reef. This results in an increase in algal biomass on the reef (Lapointe et al. 2005). Finally, the increased algal cover on the reef makes it difficult for the reef to recover, even if the water quality improves. The algae take up space on the reef and that limits the ability of the coral larvae to settle on the reef and regrow new reef (McCook 2001). Therefore, it is unlikely that these areas will recover quickly from any disturbances.

As many of the impacts on coral reefs come from humans, it would be expected that coral reefs closer to large population centres would show greater impacts. This lead to the question of examining coral reef health in reefs near and far from the coast of mainland Australia.

**Research and planning [3–4]**

**a relevant research question**

The research question is connected to the rationale and allows the effective investigation of Topic 1: The reef and beyond (Coral reef distribution) in the *Marine Science 2019* syllabus. However, the response does not specifically identify the independent variable or the dependent variable.

## Research question

Does the amount of living coral on a reef increase with distance from the coast?

Due to the difficulty in identifying coral and algae to species level some assumptions were made in conducting the experiment to address the research question. It was assumed that the coral counted (due to the branching morphology observed) was in the Acropora genus and that the algae observed was a form of turf algae.

## Original experiment

The original experiment (from the class fieldwork booklet) was a benthic distribution study at Heron Island.

1. Collect all equipment (tape measure, plastic 1m x 1m quadrat, field guide, recording device)
2. Adhere to safety and ethical guidelines as outlined by your classroom teacher. These include personal safety (appropriate shoes, hat, sunscreen, water), looking out for others (reminding each other to drink water, reapply sunscreen, going to the teacher if a group member is unwell) and the environment (observe but don't touch). There are venomous animals on the reef flat. Some are cryptic and difficult to see. If you are bitten or stung let your teacher know immediately.
3. Travel to the leeward side of the island at low tide.
4. Go to your allocated site (chosen randomly (using Google maps and a random number generator) prior to conducting the experiment.)
5. Decide on clear guidelines for counting an animal in a quadrat before you begin.
6. In groups place your tape measure along the reef flat for 10m. This will form your transect line.
7. Place your plastic quadrat at 2m.
8. Using your field guide identify all macro invertebrates present. Record each species and their total abundance.
9. Repeat steps 5 – 7 at 2m intervals.

**Research and planning [5–6]**

**a methodology that enables the collection of sufficient, relevant data**

The methodology shows careful and deliberate thought. It enables collection of adequate data so an informed conclusion to the research question can be drawn.

**Research and planning [3–4]**

**feasible modifications to the methodology**

The modifications can be achieved. However, the response does not justify how the modifications will refine, extend or redirect the original experiment.

**management of risks and ethical or environmental issues**

Ethical issues have been managed. However, the response does not show careful or deliberate identification and planning.

**Analysis of evidence [3–4]**

**basic processing of data**

The response shows the fundamental steps involved in manipulating the raw data mathematically to produce the evidence.

10. Gather equipment and return to camp.
11. Discuss your results as a group.
12. Enter results into an excel spread sheet and analyse.

### Modifications to the methodology

Two locations from the online reef database (www.globalreefrecord.org) were selected. To collect data 10 random 1m x 1m photographic quadrats were chosen along the transect at each location. which increased the sample size which allowed for data analysis to occur.

To improve the method a

- 100-point grid was placed over each photographic quadrat. The substrate directly below each intercept was identified to give percentage cover of each substrate type. For simplicity, each intercept counted as the whole 1%, regardless of what was in the adjoining squares.
- Each image of living colour was also interpreted using a coral health chart (www.coralwatch.org/web/guest/coral-health-chart) and assigned a coral colour score.

### Safety and ethical considerations

- This was a virtual experiment so it was safe.

### Processed data

For the analysis of this experiment the following data processing occurred:

- the mean was chosen as the most appropriate measure of central tendency
- standard deviation was calculated as a measure of spread.

**Table 1:** Sample calculations

| ***Calculation*** | ***Example*** |
|---|---|
| Mean percentage living coral | *Mean was calculated in excel by using the AVERAGE function*<br>$\mu$ (near shore) = $\frac{10+20+24+28+30+15+18+32+27+29}{10}$<br>$\mu$ = 23.3 % |
| Frequency (coral scores) | *Frequency was calculated in excel by using the COUNT function*<br>*f = n(near shore, coral score 3)*<br>*f = 4* |
| Standard deviation for a sample population | *Standard deviation (s) was calculated in excel by using the STDEV function.*<br>*s (near shore, live coral)= 7.3* |

**Analysis of evidence [5–6]**

**collection of sufficient and relevant raw data**

The raw data is adequate for forming a conclusion and has direct bearing upon the research question.

**Communication [2]**

**appropriate use of genre conventions**

Raw data is recorded with the associated uncertainties and expressed consistently to the correct number of significant figures.

The response uses units and symbols correctly.

**Analysis of evidence**

**Table 2:** Percentage cover of living coral and algae at near shore and off shore locations. Percentages are based on 100-point intercept grids overlaying 1m x 1m photo quadrats.

| Reef location | Sample | Percentage cover living coral (%) | Percentage cover algae (%) | Coral colour score (live coral only) |
|---|---|---|---|---|
| Near shore (10 km) | 1 | 10 | 80 | 2 |
| | 2 | 20 | 75 | 3 |
| | 3 | 24 | 70 | 3 |
| | 4 | 28 | 68 | 4 |
| | 5 | 30 | 70 | 4 |
| | 6 | 15 | 80 | 3 |
| | 7 | 18 | 65 | 2 |
| | 8 | 32 | 60 | 4 |
| | 9 | 27 | 50 | 4 |
| | 10 | 29 | 68 | 3 |
| | Mean | 23.3 | 68.6 | 3.2 |
| | SD | 7.3 | 9.1 | |
| Off shore (50 km) | 1 | 50 | 45 | 4 |
| | 2 | 75 | 20 | 4 |
| | 3 | 67 | 25 | 5 |
| | 4 | 60 | 34 | 5 |
| | 5 | 70 | 22 | 5 |
| | 6 | 72 | 25 | 4 |
| | 7 | 60 | 37 | 6 |
| | 8 | 66 | 22 | 6 |
| | 9 | 58 | 40 | 3 |
| | 10 | 69 | 31 | 5 |
| | Mean | 64.7 | 30.1 | 4.7 |
| | SD | 7.6 | 8.6 | |

**[3–4]**

**identification of obvious trends, patterns or relationships**

The response identifies an easily recognised pattern that has some relevance to the research question.

**basic identification of uncertainty and limitations of evidence**

The response shows fundamental consideration of the impact of measurement uncertainty. However, standard deviation is not an appropriate measure of uncertainty.

**Communication [2]**

**fluent and concise use of scientific language and representations**

The response represents data in an appropriate format to ensure that the trends, patterns and relationships can be accurately interpreted.

**Analysis of evidence [3–4]**

**identification of obvious trends, patterns or relationships**

The response identifies an easily recognised pattern that has some relevance to the research question.

**Communication [2]**

**fluent and concise use of scientific language and representations**

The response represents data in an appropriate format to ensure that the trends, patterns and relationships can be accurately interpreted.

**Analysis of evidence**

The data shows the mean percentage cover of the near shore reef was lower than the offshore reef. The standard deviation has been used a measure of the uncertainty associated with these averages (±SD). The standard deviation suggests that the data is variable.

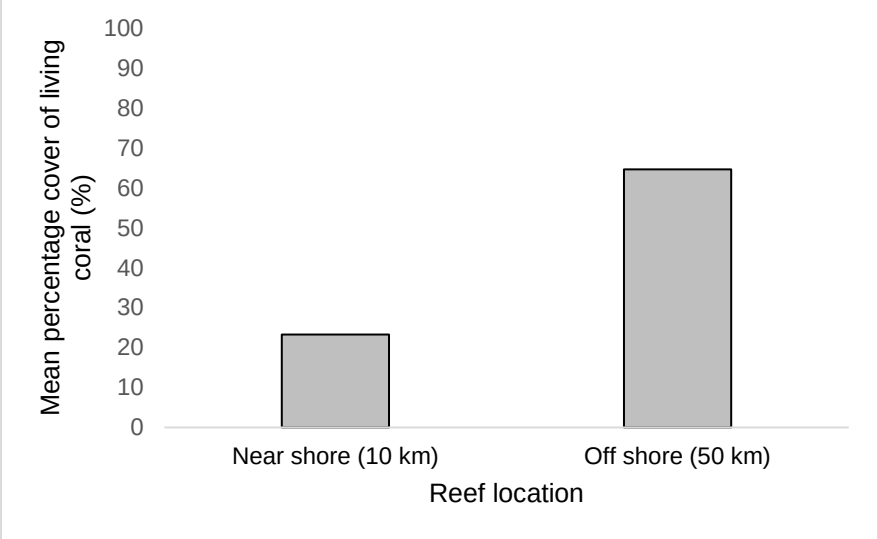


**Figure 1:** Mean percentage of living coral (at near shore and off shore coral reef locations.

The off shore location shows an increase in the sample mean (percentage living coral cover) compared to the near shore location. This suggests that there is a greater amount of living coral further from shore.

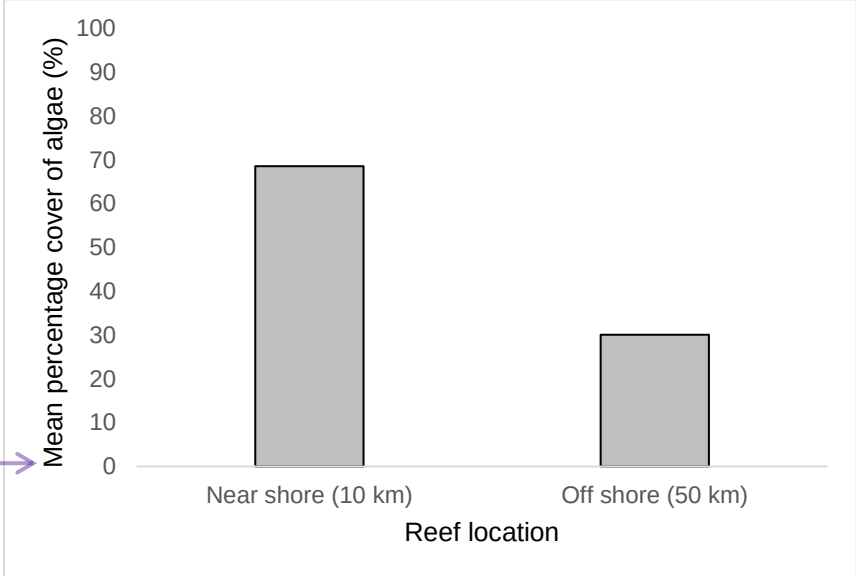


**Figure 2:** Mean percentage of algae at near shore and off shore coral reef locations.

**[3–4]**

**identification of obvious trends, patterns or relationships**

The response identifies an easily recognised pattern that has some relevance to the research question.

**Communication [2]**

**fluent and concise use of scientific language and representations**

The response represents data in an appropriate format to ensure that the trends, patterns and relationships can be accurately interpreted.

**Analysis of evidence [3–4]**

**identification of obvious trends, patterns or relationships**

The response identifies an easily recognised pattern that has some relevance to the research question.

**basic identification of uncertainty and limitations of evidence**

The response shows fundamental consideration of the impact of error on the experimental results.

**Interpretation and evaluation [3–4]**

**reasonable description of the reliability and validity of the experimental process**

Evaluation of the experimental process suggests that the process lacks reliability and validity. However, the response does not use evidence to justify these statements.

The off shore location shows a decrease in the sample mean (percentage algal cover) compared to the near shore location. These results suggest that there is a greater amount of algae in near shore environments.

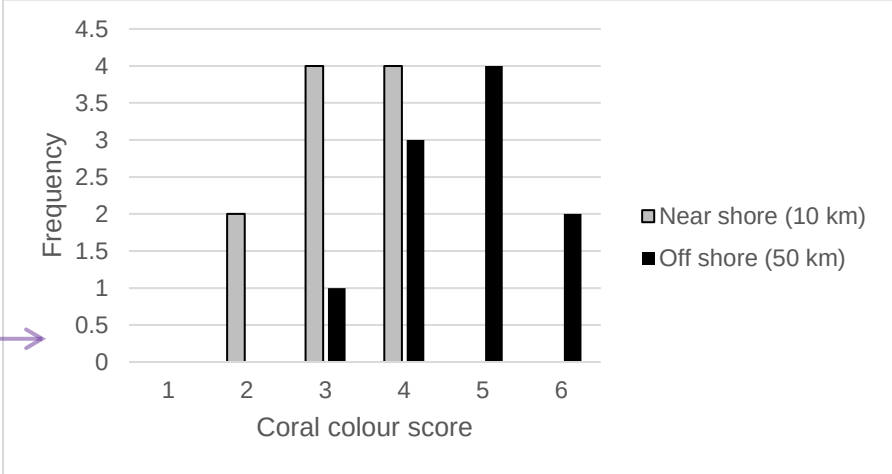


**Figure 3:** Frequency of coral colour score of near shore and off shore reef locations.

The frequency of coral scores for the off-shore reef is higher than the near shore reefs.

**Evaluation**

**Limitations of the evidence**

This study examined the influence of reef location on living coral and algal amount. Confounding variables were controlled where possible. The uncertainty in the data can be explained by a lack of reliability and validity in the experimental process.

The standard deviation calculated in this experiment appears to be low. This indicated that the experimental methodology was adhered to. One possible explanation some of the variability of the data is the coral itself and the experimenter was biased in assigning values to live coral.

No outliers (valid extreme values) were visually observed in the data.

**Sources of error**

***Affecting reliability***

- Confounding variables could not be minimised in this experiment and therefore it cannot be known how they contributed to the reliability.
- Whilst there was random selection within the quadrats, convenience sampling was chosen for the selection of two sites.
- The image resolution of the photograph, used to measure the percentage cover, is poor and the grid lines placed on the photograph were imprecise.

***Affecting validity***

- The benthic percentage cover was determined indirectly. The visibility of the photograph limits the experimenter in interpreting the data.

**Suggested improvements and extensions**

**Interpretation and evaluation [3–4]**

**suggested improvements and extensions to the experiment that are related to the analysis of evidence**

The suggested improvements would improve the validity and reliability of the experiment. However, the response does not use evidence to inform the modifications.

**Interpretation and evaluation [5–6]**

**justified conclusion/s linked to the research question**

The response uses sound reasons and evidence to support a conclusion that directly responds to the research question.

**Communication [2]**

**fluent and concise use of scientific language and representations**

The response is easily understood, avoids unnecessary repetition and meets the required length.

**acknowledgment of sources of information through appropriate use of referencing conventions**

The use of a referencing system fits the purpose of a scientific report.

### Suggested improvements

In this experiment, the reliability and validity of the data and experimental process could be improved by

- minimising the confounding variables by doing more research into different experimental techniques
- using more random sampling
- improving the image resolution of the photograph
- sampling the benthic area directly using a total count
- improving the visibility of the photograph
- doing the experiment again.

### Suggested extensions

- Extend the experiment to consider before and after bleaching events, different types of coral, different reef locations, and different reef distances.

### Conclusion

In conclusion, the evidence suggests that the amount (percentage cover) of living coral on a reef increases with distance (10km and 50km) from the coast. The results of this study also suggest that there may be an impact of proximity to land on coral reef survivorship. The literature suggests that the increase in algae in near shore reefs is likely caused by nitrogen and phosphorous input from the cane farming in the Great Barrier Reef Catchment. Since the reef is unlikely to recover quickly from any nutrient-based disturbance, it is important to manage nutrient input into the Great Barrier Reef Catchment to prevent any potential disturbances.

**Word count:** 1564

### Reference List

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Costanza, R, de Groot, R, Sutton, P, van der Ploeg, S, Anderson, SJ, Kubiszewski, I, Farber, S, Turner, RK, 2014. Changes in the global value of ecosystem services. Global Environmental Change. 26, 152-158.

Moberg, F and Folke, C, 1999. Ecological goods and services of coral reef ecosystems. Ecological Economics 29, 215 – 233.