

# Marine Science subject report

2021 cohort

February 2022

SBN

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# Contents

|  |           |
|--|-----------|
| <b>Introduction</b> .....                                    | <b>1</b>  |
| Audience and use .....                                       | 1         |
| Report preparation .....                                     | 1         |
| <b>Subject data summary</b> .....                            | <b>2</b>  |
| Subject completion .....                                     | 2         |
| Units 1 and 2 results .....                                  | 2         |
| Units 3 and 4 internal assessment (IA) results .....         | 2         |
| Total marks for IA .....                                     | 2         |
| IA1 marks .....  | 3         |
| IA2 marks .....  | 4         |
| IA3 marks .....  | 5         |
| External assessment (EA) marks .....                         | 6         |
| Final subject results .....                                  | 7         |
| Final marks for IA and EA .....                              | 7         |
| Grade boundaries .....                                       | 7         |
| Distribution of standards .....                              | 7         |
| <b>Internal assessment</b> .....                             | <b>8</b>  |
| Endorsement .....  | 8         |
| Confirmation .....   | 8         |
| Number of samples reviewed and percentage agreement .....    | 9         |
| <b>Internal assessment 1 (IA1)</b> .....                     | <b>10</b> |
| Data test (10%) .....  | 10        |
| Assessment design .....                                      | 10        |
| Assessment decisions .....                                   | 12        |
| <b>Internal assessment 2 (IA2)</b> .....                     | <b>13</b> |
| Student experiment (20%) .....                               | 13        |
| Assessment design .....                                      | 13        |
| Assessment decisions .....                                   | 14        |
| <b>Internal assessment 3 (IA3)</b> .....                     | <b>19</b> |
| Research investigation (20%) .....                           | 19        |
| Assessment design .....                                      | 19        |
| Assessment decisions .....                                   | 20        |
| <b>External assessment</b> .....                             | <b>25</b> |
| Summative external assessment (EA) — Examination (50%) ..... | 25        |
| Assessment design .....                                      | 25        |
| Assessment decisions .....                                   | 25        |

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# Introduction

Despite the challenges brought about by the COVID-19 pandemic, Queensland's education community can look back on 2021 with satisfaction at having implemented the first full assessment cycle in the new Queensland Certificate of Education (QCE) system. That meant delivering three internal assessments and one external assessment in each General subject.

This report analyses that cycle — from endorsing summative internal assessment instruments to confirming internal assessment marks, and designing and marking external assessment. It also gives readers information about:

- applying syllabus objectives in the design and marking of internal and external assessments
- patterns of student achievement.

The report promotes continuous improvement by:

- identifying effective practices in the design and marking of valid, accessible and reliable assessments
- recommending where and how to enhance the design and marking of valid, accessible and reliable assessment instruments
- providing examples of best practice where relevant, possible and appropriate.

## Audience and use

This report should be read by school leaders, subject leaders and teachers to:

- inform teaching and learning and assessment preparation
- assist in assessment design practice
- assist in making assessment decisions
- help prepare students for external assessment.

The report is publicly available to promote transparency and accountability. Students, parents, community members and other education stakeholders can learn about the assessment practices and outcomes for General subjects (including alternative sequences (AS) and Senior External Examination (SEE) subjects, where relevant) and General (Extension) subjects.

## Report preparation

The report includes analyses of data and other information from endorsement, confirmation and external assessment processes. It also includes advice from the chief confirmer, chief endorser and chief marker, developed in consultation with and support from QCAA subject matter experts.



# Subject data summary

## Subject completion

The following data includes students who completed the General subject.

**Note:** All data is correct as at 17 December 2021. Where percentages are provided, these are rounded to two decimal places and, therefore, may not add up to 100%.

Number of schools that offered the subject: 49.

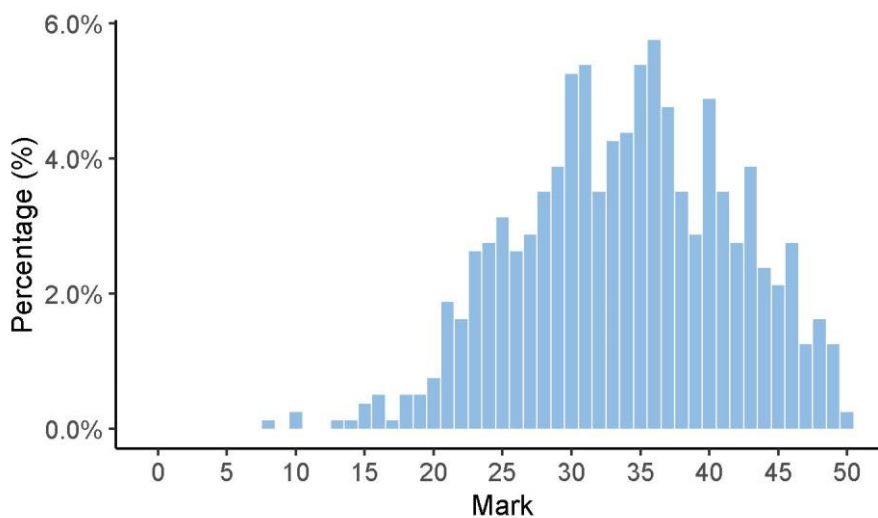
| Completion of units          | Unit 1 | Unit 2 | Units 3 and 4 |
|------------------------------|--------|--------|---------------|
| Number of students completed | 1002   | 968    | 792           |

## Units 1 and 2 results

| Number of students | Satisfactory | Unsatisfactory |
|--------------------|--------------|----------------|
| Unit 1             | 928          | 74             |
| Unit 2             | 787          | 29             |

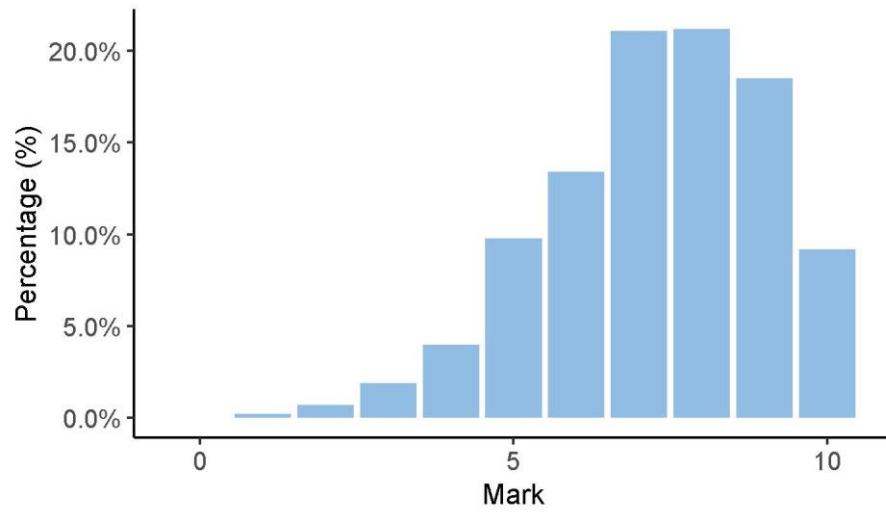
## Units 3 and 4 internal assessment (IA) results

### Total marks for IA

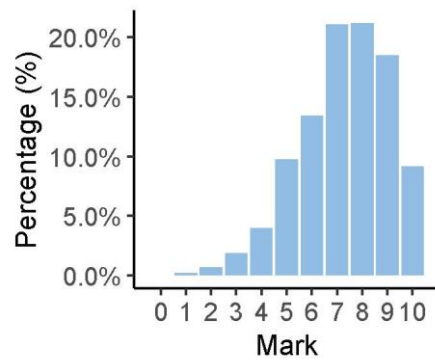


## IA1 marks

### IA1 total

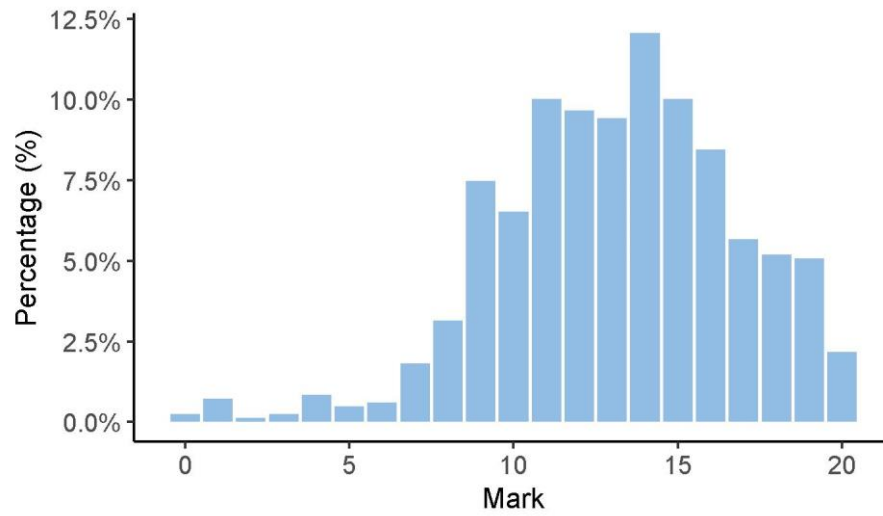


### IA1 Criterion: Data test

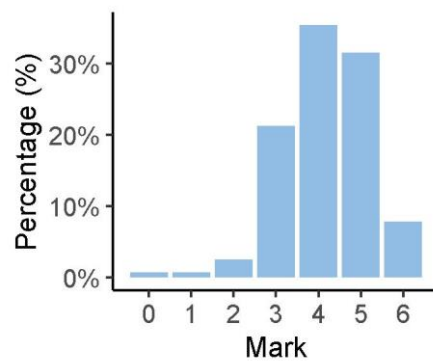


## IA2 marks

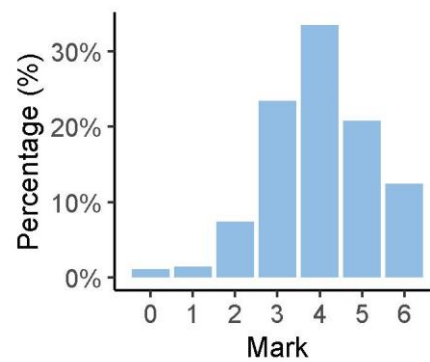
### IA2 total



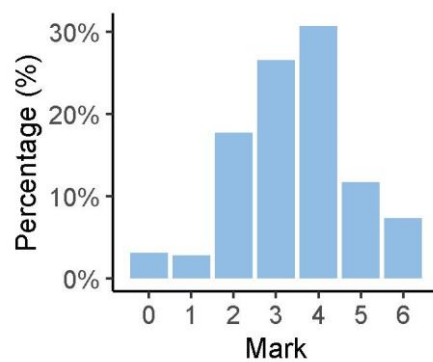
### IA2 Criterion: Research and planning



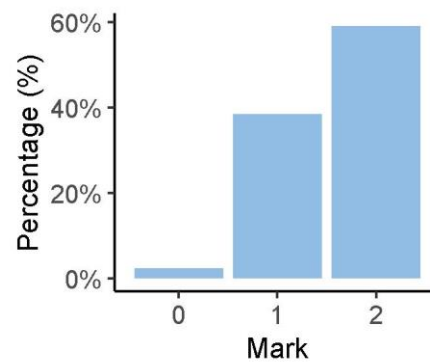
### IA2 Criterion: Analysis of evidence



### IA2 Criterion: Interpretation and evaluation

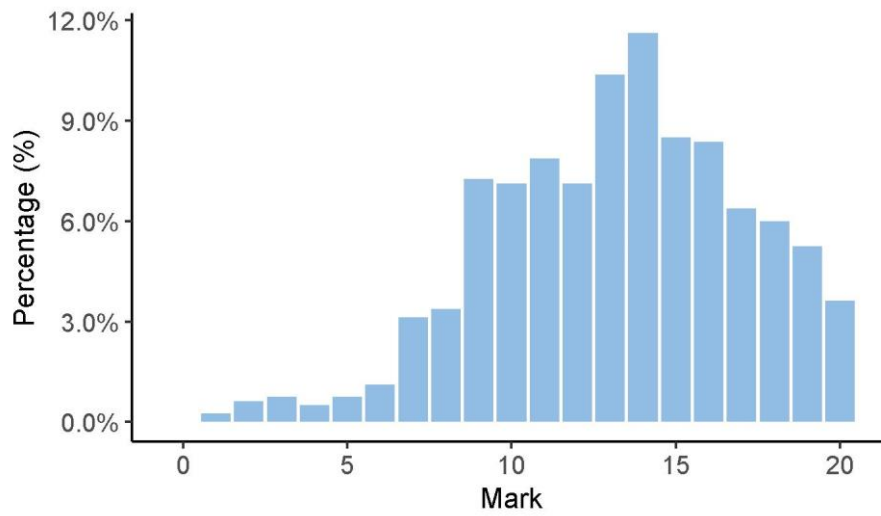


### IA2 Criterion: Communication

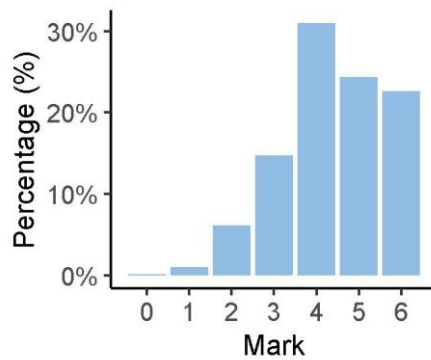


## IA3 marks

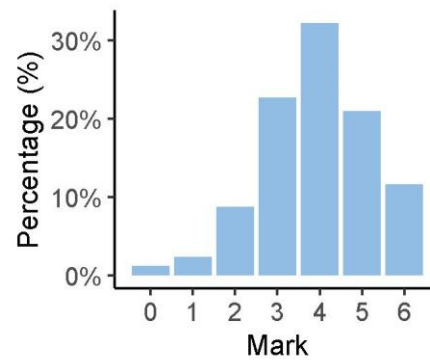
### IA3 total



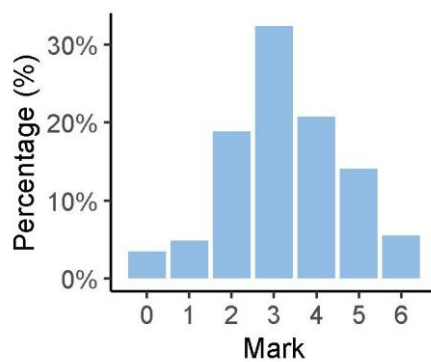
### IA3 Criterion: Research and planning



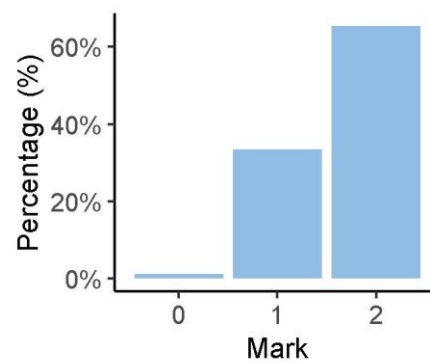
### IA3 Criterion: Analysis and interpretation



### IA3 Criterion: Conclusion and evaluation

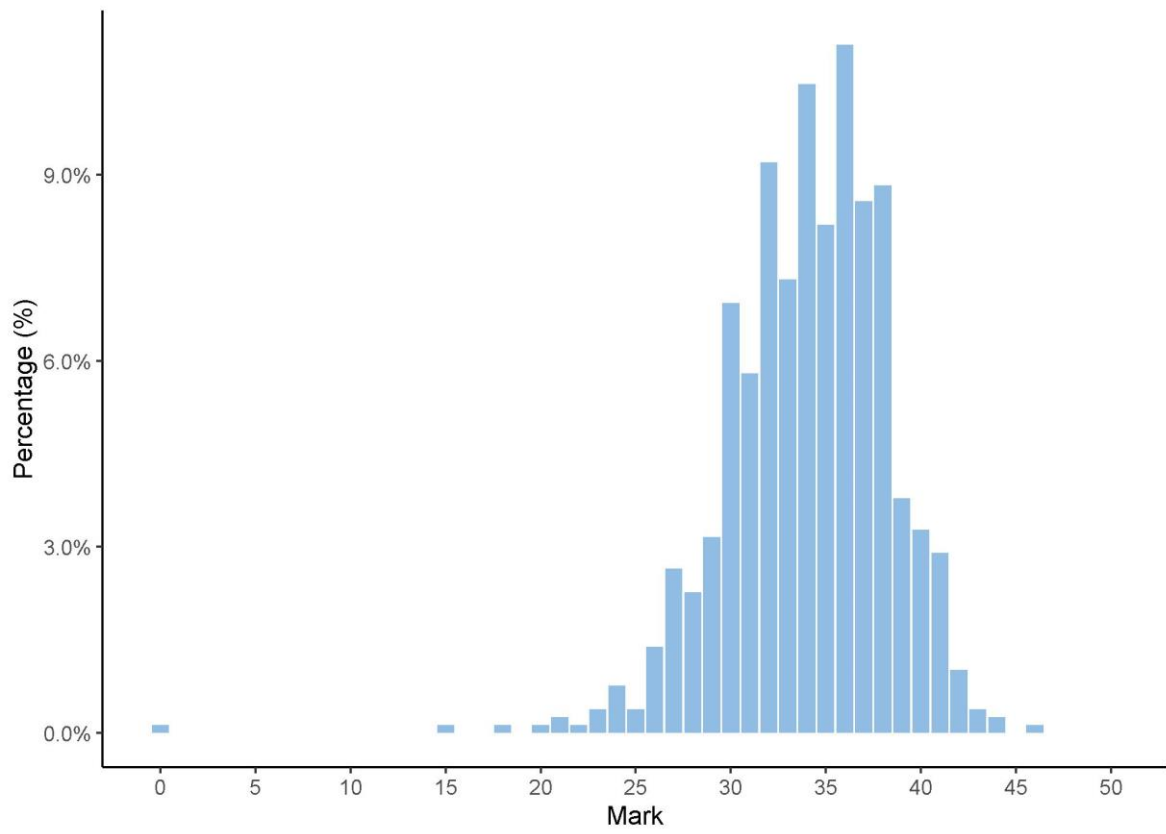


### IA3 Criterion: Communication



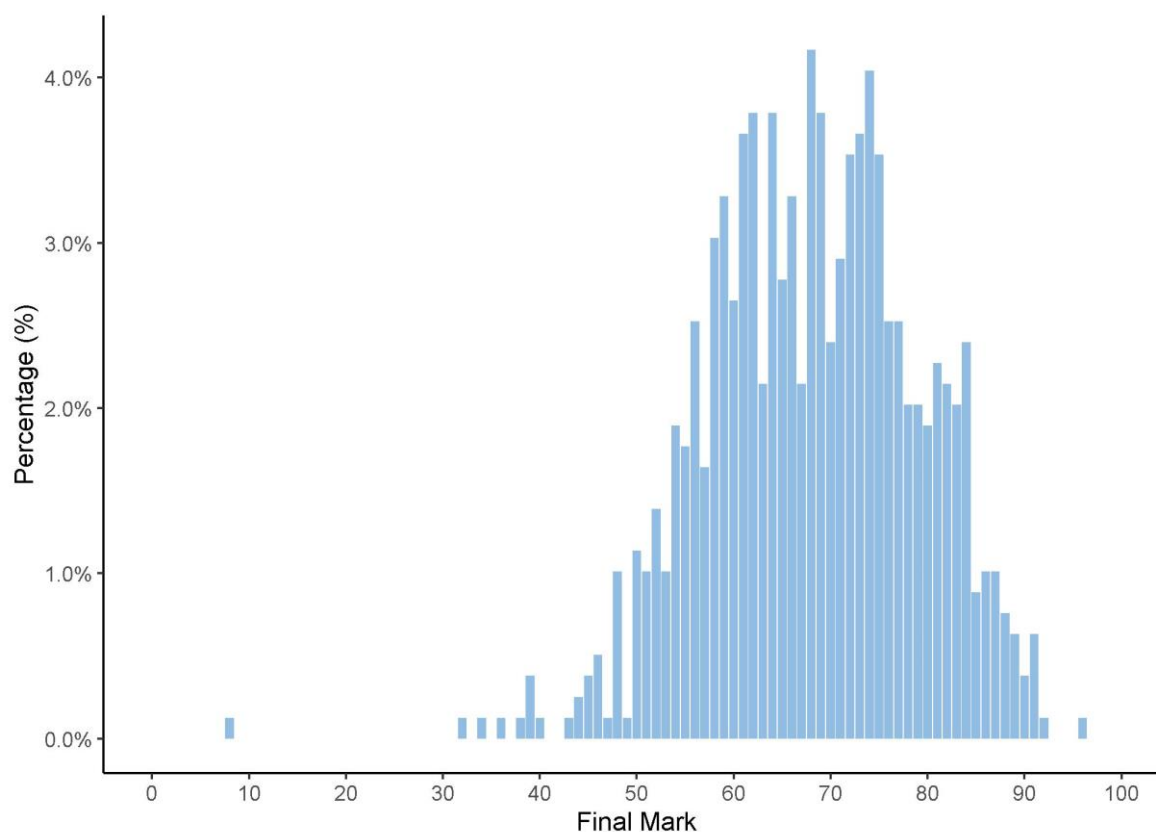


## External assessment (EA) marks



# Final subject results

## Final marks for IA and EA



## Grade boundaries

The grade boundaries are determined using a process to compare results on a numeric scale to the reporting standards.

| Standard       | A      | B     | C     | D     | E    |
|----------------|--------|-------|-------|-------|------|
| Marks achieved | 100–81 | 80–66 | 65–46 | 45–17 | 16–0 |

## Distribution of standards

The number of students who achieved each standard across the state is as follows.

| Standard           | A   | B   | C   | D  | E |
|--------------------|-----|-----|-----|----|---|
| Number of students | 114 | 352 | 311 | 14 | 1 |



# Internal assessment

The following information and advice pertain to the assessment design and assessment decisions for each IA in Units 3 and 4. These instruments have undergone quality assurance processes informed by the attributes of quality assessment (validity, accessibility and reliability).

## Endorsement

Endorsement is the quality assurance process based on the attributes of validity and accessibility. These attributes are categorised further as priorities for assessment, and each priority can be further broken down into assessment practices.

Data presented in the Assessment design section identifies the reasons why IA instruments were not endorsed at Application 1, by the priority for assessments. An IA may have been identified more than once for a priority for assessment, e.g. it may have demonstrated a misalignment to both the subject matter and the assessment objective/s.

Refer to the quality assurance tools for detailed information about the assessment practices for each assessment instrument.

### Percentage of instruments endorsed in Application 1

| Number of instruments submitted      | IA1 | IA2 | IA3 |
|--------------------------------------|-----|-----|-----|
| Total number of instruments          | 49  | 49  | 49  |
| Percentage endorsed in Application 1 | 51% | 94% | 84% |

## Confirmation

Confirmation is the quality assurance process based on the attribute of reliability. The QCAA uses provisional criterion marks determined by teachers to identify the samples of student responses that schools are required to submit for confirmation.

Confirmation samples are representative of the school's decisions about the quality of student work in relation to the ISMG and are used to make decisions about the cohort's results. If further information is required about the school's application of the ISMG to finalise a confirmation decision, the QCAA requests additional samples.

Schools may request a review where an individual student's confirmed result is different from the school's provisional mark in one or more criteria and the school considers this result to be an anomaly or exception.

The following table includes the percentage agreement between the provisional marks and confirmed marks by assessment instrument. The Assessment decisions section of this report for each assessment instrument identifies the agreement trends between provisional and confirmed marks by criterion.

**Number of samples reviewed and percentage agreement**

| <b>IA</b> | <b>Number of schools</b> | <b>Number of samples requested</b> | <b>Number of additional samples requested</b> | <b>Percentage agreement with provisional marks</b> |
|-----------|--------------------------|------------------------------------|---|--|
| <b>1</b>  | 49                       | 254                                | 0   | 100%   |
| <b>2</b>  | 49                       | 263                                | 118   | 51.02%   |
| <b>3</b>  | 49                       | 264                                | 42  | 73.47%   |



## Internal assessment 1 (IA1)

### Data test (10%)

The IA1 data test focuses on the application of a range of cognitions in response to quantitative and/or qualitative data. Students respond to items using qualitative and/or quantitative data derived from Unit 3 practicals, activities or case studies on The reef and beyond or Changes on the reef. The task requires students to identify unknown scientific quantities or features; identify trends, patterns, relationships, limitations or uncertainty in datasets; and draw conclusions based on the analysis of data.

In Marine Science, datasets used are either generated from mandatory practicals or obtained from valid and contextually relevant scientific sources.

### Assessment design

#### Validity

Validity in assessment design considers the extent to which an assessment item accurately measures what it is intended to measure and that the evidence of student learning collected from an assessment can be legitimately used for the purpose specified in the syllabus.

#### Reasons for non-endorsement by priority of assessment

| Validity priority | Number of times priority was identified in decisions* |
|-------------------|---|
| Alignment         | 17  |
| Authentication    | 0   |
| Authenticity      | 1   |
| Item construction | 3   |
| Scope and scale   | 2   |

\*Each priority might contain up to four assessment practices.

Total number of submissions: 49.

#### Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- included a range of datasets that were clearly derived from Unit 3 subject matter, e.g. mandatory or suggested practicals
- used cues that clearly aligned with the objective being assessed as listed in *the Mark allocations* table in the syllabus, e.g. objective 3 items used 'identify the relationship', 'identify uncertainty'
- included only relevant information needed for students to respond to the given items.

## Practices to strengthen

It is recommended that assessment instruments:

- do not include items that assess objective 1 'describe and explain scientific concepts, theories, models and systems and their limitations'
- contain datasets that are of suitable scope and scale, e.g. are clearly based on data adapted from the mandatory or suggested practicals
- include a marking scheme that clearly and consistently matches each mark to an important feature in the expected response, e.g. one mark for working and one mark for calculating the correct value.

## Accessibility

Accessibility in assessment design ensures that no student or group of students is disadvantaged in their capacity to access an assessment.

### Reasons for non-endorsement by priority of assessment

| Accessibility priority | Number of times priority was identified in decisions* |
|------------------------|---|
| Bias avoidance         | 1   |
| Language               | 4   |
| Layout                 | 2   |
| Transparency           | 10  |

\*Each priority might contain up to four assessment practices.

Total number of submissions: 49.

## Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- avoided unnecessary detail or complexity, i.e. provided brief and concise instructions
- used a cue that made reference to the relevant dataset, e.g. 'Refer to Figure 1'
- provided an appropriate response space, e.g. one line for a single word response
- used formatting features to make task elements clear, e.g. used legends, figure labels.

## Practices to strengthen

It is recommended that assessment instruments:

- avoid using acronyms
- use correct spelling, punctuation and grammar
- use formatting features, layout conventions, and language consistently throughout the assessment instrument.

## Assessment decisions

### Reliability

Reliability is a judgment about the measurements of assessment. It refers to the extent to which the results of assessments are consistent, replicable and free from error.

#### Agreement trends between provisional and confirmed marks

| Criterion number | Criterion name | Percentage agreement with provisional | Percentage less than provisional | Percentage greater than provisional | Percentage both less and greater than provisional |
|------------------|----------------|---------------------------------------|----------------------------------|-------------------------------------|---|
| 1                | Data test      | 100%                                  | 0%                               | 0%                                  | 0%  |

### Effective practices

Accuracy and consistency of the application of the ISMG for this IA was most effective when:

- school-developed marking schemes clearly matched each mark to a valued feature of the expected response
- marking schemes included a range of acceptable responses
- marking schemes were updated during the marking process to incorporate acceptable but unexpected student responses
- schools correctly calculated mark totals and percentages and used the percentage cut-offs from the ISMG to determine the final mark out of 10.

#### Samples of effective practices

There are no student response excerpts because either the student/s did not provide permission or there were third-party copyright issues in the response/s.

### Practices to strengthen

To further ensure accuracy and consistency of the application of the ISMG for this IA, it is recommended that:

- marking schemes are created to directly align with the endorsed assessment instrument and clearly award marks for the valued features of the expected student response.



## Internal assessment 2 (IA2)

### Student experiment (20%)

The IA2 student experiment requires students to modify (i.e. refine, extend or redirect) an experiment to address their own hypothesis or question related to the Unit 3 topics The reef and beyond or Changes on the reef. Students may use a practical performed in class as the basis for their methodology. Students develop a research question, collect and process primary data, analyse and interpret evidence, and evaluate the reliability and validity of their experimental process.

In Marine Science, the student experiment is carried out using laboratory and/or fieldwork methods.

### Assessment design

#### Validity

Validity in assessment design considers the extent to which an assessment item accurately measures what it is intended to measure and that the evidence of student learning collected from an assessment can be legitimately used for the purpose specified in the syllabus.

#### Reasons for non-endorsement by priority of assessment

| Validity priority | Number of times priority was identified in decisions* |
|-------------------|---|
| Alignment         | 1   |
| Authentication    | 1   |
| Authenticity      | 0   |
| Item construction | 0   |
| Scope and scale   | 0   |

\*Each priority might contain up to four assessment practices.

Total number of submissions: 49.

#### Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- featured mandatory or suggested practicals from Unit 3 for students to use as the basis for their methodology and research question
- used authentic and locally relevant contexts and/or issues as the basis of the practicals
- used checkpoints that manage modifications to mandatory practicals to ensure compliance with 'Safety and ethics' considerations (Syllabus section 1.2.4)
- included a clear statement that feedback can only be provided on one draft.



## Practices to strengthen

It is recommended that assessment instruments:

- include only experiments that are clearly aligned with Unit 3 subject matter
- include all the required task specifications within the task description
- identify authentication strategies that consider group work situations, e.g. the teacher will compare the responses of students who have worked together.

## Accessibility

Accessibility in assessment design ensures that no student or group of students is disadvantaged in their capacity to access an assessment.

### Reasons for non-endorsement by priority of assessment

| Accessibility priority | Number of times priority was identified in decisions* |
|------------------------|---|
| Bias avoidance         | 0   |
| Language               | 0   |
| Layout                 | 0   |
| Transparency           | 0   |

\*Each priority might contain up to four assessment practices.

Total number of submissions: 49.

## Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- provided clear instructions that aligned to the specifications within the syllabus, assessment objectives and ISMG
- communicated task elements clearly and concisely
- utilised correct spelling, punctuation and grammar
- featured check points to monitor student progress throughout the task, e.g. specific weeks to select modifications, complete risk assessment, collect and analyse data, submit draft, submit final response.

## Practices to strengthen

There were no significant issues identified for improvement.

## Assessment decisions

### Reliability

Reliability is a judgment about the measurements of assessment. It refers to the extent to which the results of assessments are consistent, replicable and free from error.

### Agreement trends between provisional and confirmed marks

| Criterion number | Criterion name                | Percentage agreement with provisional | Percentage less than provisional | Percentage greater than provisional | Percentage both less and greater than provisional |
|------------------|-------------------------------|---------------------------------------|----------------------------------|-------------------------------------|---|
| 1                | Research and planning         | 65.31%                                | 34.69%                           | 0%                                  | 0%  |
| 2                | Analysis of evidence          | 69.39%                                | 28.57%                           | 0%                                  | 2.04%   |
| 3                | Interpretation and evaluation | 69.39%                                | 26.53%                           | 4.08%                               | 0%  |
| 4                | Communication                 | 97.96%                                | 0%                               | 2.04%                               | 0%  |

### Effective practices

Accuracy and consistency of the application of the ISMG for this IA was most effective when:

- in the Research and planning criterion
  - the rationale clearly established a logical link between dependent and independent variables
  - a *specific* research question focussed on only one factor such as identifying a trend or finding a difference
  - *justified* modifications ensured that *sufficient, relevant* raw data was collected
  - in *considered* management of risk and ethical/environmental issues, each issue was clearly and separately stated, including for virtual experiments, e.g. how the placement of an underwater camera may impact the environment
- in the Analysis of evidence criterion
  - evidence of *correct and relevant* processing of data was provided in the form of correct sample calculations
  - *thorough* identification of relevant trends, patterns or relationships was demonstrated through the calculation of
    - means
    - standard deviations
    - correlation coefficients ( $R^2$ )
    - percentage cover
    - diversity indices
  - *thorough and appropriate* identification of uncertainties and limitations in data was demonstrated through the calculation of
    - standard error
    - t-tests.

## Samples of effective practices

The following are excerpts from responses that illustrate the characteristics for the criteria at the performance level indicated. The excerpt may provide evidence of more than one criterion. The characteristics identified may not be the only time the characteristics have occurred throughout a response.

These student response excerpts have been included:

- to demonstrate a considered rationale for the experiment (Excerpt 1)
- to demonstrate justified modifications to methodology (Excerpt 2).

|   |   |
|---|---|
| <p><b>Research and planning (5–6 marks)</b></p> <ul style="list-style-type: none"> <li>• a considered rationale for the experiment</li> <li>• justified modifications to the methodology</li> </ul> | <p><b>Excerpt 1</b></p> <p><b>1.0 Rationale</b></p> <p>Corals reefs are large underwater structures located in warm, shallow, and tropical waters. These ecosystems are composed of a mosaic of habitats varying in scale, composition, and ecology and as such are considered “rainforests of the sea” due to biodiversity only comparable to tropical rainforests (Noaa.gov, 2021). The foundation of these ecosystems are corals, a colonial marine invertebrate which produces a bony skeleton from calcium and carbonate obtained from the sea (Ross, 2018).</p> <p>Corals are considered to be both habitat formers and ecosystem engineers (Richmond, 2019) as they create, modify, and maintain habitats. Their hard substrate supports a myriad of marine species by providing suitable shelter and protection from predators and reducing adverse effects of species interactions. The structure itself also influences immediate water movement, creates sediments, and cycles nutrients. (Richmond, 2019). Fish are the most obvious habitat responders to coral and the relationships between them and coral are complex and often vary between species (Reid, 2020). For example, specialist species are much more selective in their habitat compared to generalist species.</p> <p>The structural complexity, or rugosity, of a reef can be a major influencer of its ecology. Rugosity can be measured across numerous scales, but each individual coral species contributes to the overall complexity of a reef system. Numerous studies have been conducted to investigate the implications of this feature on fish communities. W.A Nugraha et al (2020) explored the correlation between coral cover and rugosity of fish density in East Java Waters. They found that with an increase in rugosity of 1.1 to 1.4, fish density increased from 0.06 to 0.24 individuals/m<sup>3</sup>, suggesting a strong correlation between the reef profile topographic complexity and fish density (see Appendix 2). Conversely, a weak negative relationship was found between coral cover and the abundance of fish. It was then questioned if these relationships are unique to the East Java Waters or are mirrored across other reef ecosystems. This prompts the following research question.</p> <p><b>2.0 Research Question</b></p> <p>How does coral reef rugosity influence the diversity and abundance of reef fish on Lady Elliot Island reef flat?</p> |
|---|---|

**Excerpt 2****Modifications to Methodology**

Differing temperatures (34 °C, 24 °C, 10 °C) of the 1 molar acid replaced the varying pH level solutions in the experimental method. Instead of Gaviscon tablets, cuttlebone as a realistic form of a marine carbonate structure was utilised. This was conducted to understand the effects that the increase in temperature and therefore acidification of the ocean has on the rate of dissolution of carbonate structures. This modification addresses the research question.

1cm<sup>3</sup> blocks of the cuttlebone were cut, producing an equal surface area, and eliminating variation, which could skew the results. To accurately record the percentage of the amount of cuttlebone dissolved, it was weighed before and after it was placed in the solution, whereas only estimations of percentage change were documented for the original method. A slightly larger sample size (4 cubes per temperature instead of 3) of carbonate structures were utilised for the modified experiment to help demonstrate sufficient and a higher accuracy of data.

A one molar acid was utilised to best represent the acidity of the ocean before such levels of carbon was evident in the waters (cool/room temperature sample), and how it then increased as the temperature increased (room/warm temperature). This relates it to the chemical functioning of the reef and the research question.

With these modifications refining and redirecting the original experiment, the data should produce a higher reliability and validity, as well as enabling the collection of sufficient and relevant data.

**Independent Variable:** temperature of water baths

**Dependent Variable:** amount of cuttlebone dissolved

**Controlled Variables:** cuttlebone size, acid type per solution (1 molar), technique, specific temperature per bath

**Monitored Variables:** time, water temperature, cuttlebone size

This excerpt has been included:

- to demonstrate justified discussion of the reliability and validity of the experimental process
- to demonstrate a response which provides an independent and methodical consideration of both reliability and validity.

**Interpretation and evaluation (5–6 marks)**

- justified discussion of the reliability and validity of the experimental process

**SOURCES OF ERROR***Reliability:*

| Random  | Systematic   |
|---|--|
| <ul style="list-style-type: none"> <li>The coral was sourced from an aquarium store and had previously been dried out, potentially making the coral skeleton weaker depending on how it was dried out.</li> <li>The previous location of the coral is unknown, introducing bias and reducing reliability because conditions may have affected the coral skeletons strength.</li> <li>Before being collected, the coral was in sunlight – effecting the amount of coral bleaching, weakening the coral skeleton – introducing inaccuracies.</li> </ul> | <ul style="list-style-type: none"> <li>The temperature of the incubator fluctuated throughout the experimental process – impacting the rate of dissolution and decreasing reliability (Calbreath &amp; Baxter, n.d.).</li> <li>The pH and concentration were not being monitored, likely causing the rate of dissolution to vary, altering end results.</li> <li>The weight reading on the electronic balance fluctuated and could have been effected by human error. Therefore, producing less accurate readings and impacting calculations. Also, difference balances were used for each reading.</li> <li>Not all sample jars were filled to the top, allowing oxygen to potentially affect the dissolution.</li> </ul> |

*Validity:*

- The standard deviation for 0.05M, 0.1M and 0.5M showed consistent validity, however, for 0.2M, the standard deviation is further from the mean, which is less valid.
- The standard error, shown in the error bars in graph 2, is very small. Therefore, the error is very limited and the data is more accurate.
- No outliers were visually observed in the data, consequently, improving validity. However, this was not confirmed mathematically, decreasing reliability.

**Practices to strengthen**

To further ensure accuracy and consistency of the application of the ISMG for this IA, it is recommended that:

- in the Research and planning criterion, a considered rationale clearly and directly relates the experiment to Unit 3 subject matter (i.e. The reef and beyond, or Changes on the reef)
- in the Interpretation and evaluation criteria, suggestions include both improvements and extensions to the experiment, and that these are clearly derived from the analysis of data.

**Additional advice**

- Practicals used for teaching, learning and assessment must provide opportunities for effective modelling to demonstrate management of ethical and environmental concerns (as outlined in Syllabus section 1.4.2) as part of risk management processes.



## Internal assessment 3 (IA3)

### Research investigation (20%)

The IA3 research investigation requires students to gather secondary evidence related to a research question in order to evaluate a claim based on the Unit 4 topics Oceans of the future and Managing fisheries. Students develop a research question, collect and analyse secondary data, interpret evidence to form a justified conclusion, discuss the quality of the evidence and extrapolate the findings of the research to the claim.

### Assessment design

#### Validity

Validity in assessment design considers the extent to which an assessment item accurately measures what it is intended to measure and that the evidence of student learning collected from an assessment can be legitimately used for the purpose specified in the syllabus.

#### Reasons for non-endorsement by priority of assessment

| Validity priority | Number of times priority was identified in decisions* |
|-------------------|---|
| Alignment         | 6   |
| Authentication    | 0   |
| Authenticity      | 0   |
| Item construction | 1   |
| Scope and scale   | 0   |

\*Each priority might contain up to four assessment practices.

Total number of submissions: 49.

#### Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- used claims that were clearly aligned to Unit 4 subject matter, e.g. 'Ongoing declines in production of the world's fisheries may have serious ecological and socioeconomic consequences'
- expressed checkpoints in a way that provides schools flexibility within a defined timeline, e.g. 'Week 5'
- utilised claims that could be narrowed down into specific and relevant research questions, e.g. 'Current management policies have no effect on the ability to manage overfishing.'

## Practices to strengthen

It is recommended that assessment instruments:

- utilise claims that are clearly derived from Unit 4 subject matter, i.e. Oceans of the future or Managing fisheries, e.g. 'Zoning plans are integral to fishing management'
- ensure that task specifications are consistent throughout the instrument, e.g. if a written response is specified in the task conditions, ensure later task specifications do not indicate a multimodal presentation as an acceptable response type
- include all task specifications in the task description.

## Accessibility

Accessibility in assessment design ensures that no student or group of students is disadvantaged in their capacity to access an assessment.

### Reasons for non-endorsement by priority of assessment

| Accessibility priority | Number of times priority was identified in decisions* |
|------------------------|---|
| Bias avoidance         | 0   |
| Language               | 1   |
| Layout                 | 0   |
| Transparency           | 1   |

\*Each priority might contain up to four assessment practices.

Total number of submissions: 49.

## Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- featured claims written using clear, succinct language and featuring accurate spelling, punctuation and grammar
- included clear instructions that aligned with the specifications within the syllabus, the assessment objectives and the ISMG.

## Practices to strengthen

It is recommended that assessment instruments:

- utilise correct spelling, punctuation and grammar.

## Assessment decisions

### Reliability

Reliability is a judgment about the measurements of assessment. It refers to the extent to which the results of assessments are consistent, replicable and free from error.

### Agreement trends between provisional and confirmed marks

| Criterion number | Criterion name              | Percentage agreement with provisional | Percentage less than provisional | Percentage greater than provisional | Percentage both less and greater than provisional |
|------------------|-----------------------------|---------------------------------------|----------------------------------|-------------------------------------|---|
| 1                | Research and planning       | 81.63%                                | 14.29%                           | 4.08%                               | 0%  |
| 2                | Analysis and interpretation | 89.8%                                 | 8.16%                            | 2.04%                               | 0%  |
| 3                | Conclusion and evaluation   | 85.71%                                | 12.24%                           | 2.04%                               | 0%  |
| 4                | Communication               | 95.92%                                | 4.08%                            | 0%                                  | 0%  |

### Effective practices

Accuracy and consistency of the application of the ISMG for this IA was most effective when:

- in the Analysis and interpretation criterion, the identification of uncertainty and limitations of evidence was distinct from the evaluation of the research process
- in the Conclusion and evaluation criterion
  - suggested improvements and extensions address identified limitations of evidence.
  - suggestions include both improvements and extensions, and apply the findings of the evaluation back to the claim.

### Samples of effective practices

The following is an excerpt from a response that illustrates the characteristics for the criterion at the performance level indicated. The excerpt may provide evidence of more than one criterion. The characteristics identified may not be the only time the characteristics have occurred throughout a response.

This student response excerpt has been included:

- to demonstrate, a *considered* rationale identifying *clear* development of the research question from the claim.



**Research and planning  
(5–6 marks)**

- a considered rationale identifying clear development of the research question from the claim

**Rationale**

The research question was derived from the claim 'The Great Barrier Reef is Bleaching,' and the key points identified in the claim were, the Great Barrier Reef and Bleaching.

Climate change has gradually increased the atmospheric temperature and in turn led to increasing sea surface temperatures (SST) (Dahlman & Lindsey, 2020). SST globally has increased around one degree Celsius since 1900. This rapid increase in SST will have devastating affects on coral all around the world including the Great Barrier Reef (GBR) (Dahlman & Lindsey, 2020). The increasing SST will affect corals because the symbiotic algae (zooxanthellae) which live in the tissue of the coral will be under stress as the SST exceeds their thermal tolerance (Berkelmans & J.H van oppen, 2006). The SST in the coral sea where the GBR is located has not yet reached the thermal threshold of the zooxanthellae consistently which is why the coral bleaching has only happened in events. These coral bleaching events (CBE) have happened during the El-Nino phase of the El-Nino Southern Oscillation because it rapidly warms the water of the basin between the east coast of Australia and South America (L'Heureux, 2014) which has caused the CBEs. Queensland was experienced an El-Nino phase in years 1998, 2006 and 2016 which are corresponding years of coral bleaching events.

The increasing SST is also having its effect on ENSO itself. The ENSO phases are dictated by fluctuations in water temperature along the east coast of Australia and South America (L'Heureux, 2014). However the increasing SST is affecting both EL-Nino and La-Nina phases making them more intense and increasing their frequency (Yang, et al., 2021). El-Nino phases being linked to coral bleaching events the frequency and intensity of both is likely to increase leading to the creation of the research question 'To what extent does increasing sea surface temperatures influence El-Nino phases of El-Nino Southern Oscillation affecting the frequency of Great Barrier Reef bleaching events?'

**Research Question**

To what extent does increasing sea surface temperatures influence El-Nino Phases of El-Nino Southern Oscillation affecting the frequency of future Great Barrier Reef bleaching events?

The following are excerpts from a response that illustrate the characteristics for the criteria at the performance level indicated. The sample may provide evidence of more than one criterion. The characteristics highlighted may not be the only time the characteristics have occurred throughout the response.

These student response excerpts have been included:

- to demonstrate multiple relevant limitations of evidence and the impact of each on the quality of data collected (Excerpt 1)
- to demonstrate improvements to the investigation are considered and linked to the analysis of information (Excerpt 1)
- to demonstrate extensions to the investigation are relevant to the claim (Excerpt 2).

|  |   |
|--|---|
| <p><b>Analysis and interpretation (5–6 marks)</b></p> <ul style="list-style-type: none"> <li>thorough and appropriate identification of limitations of evidence</li> </ul>                                     | <p><b>Excerpt 1</b></p> <p><b>4.1 Limitations of the Evidence and improvements</b></p> <ul style="list-style-type: none"> <li>The strength and reliability of the data collected should be taken in account as with time, has come greater technology, therefore earlier years may have data that is an estimation which effects the reliability of the data. This is a limitation that cannot be improved.</li> <li>It should be noted that the CCSBT state reviews of SBT data in 2006 indicated that southern bluefin tuna catches may have been substantially under-reported over the previous 10-20 years and the data presented here do not yet include estimates for this unreported catch (CCSBT 2021). Therefore, this affects the reliability of the data. This is a limitation that cannot be improved.</li> <li>Figure 3 only accounts for the gross estimation of SBT in 1980 and does not consider the previous years when SBT fishing was at its peak. This can exaggerate the effect of the CCSBT in 1994 by looking at a larger percentage rise for populations that are no way near what they would have been before the 1960s slaughter of SBT. This can be improved by looking for sources that do account for the 1960 SBT populations also, to get the full spectrum of the commissions effect.</li> <li>Figure 3 also consider only Japan and Australia. Whilst they were the main countries responsible for SBT fishing, countries such as New Zealand, Korea, South Africa, Taiwan, and Indonesia did account for 7.8% of the fishing effort of SBT (CCSBT 2020). Therefore, data collected by those countries on populations was missed and concludes that figure 3 is only a model of the actual SBT population worldwide. Further research into the population decrease in these missing countries is needed to see the full extent of the CCSBT's effect.</li> </ul> |
| <p><b>Conclusion and evaluation (5–6 marks)</b></p> <ul style="list-style-type: none"> <li>suggested improvements and extensions to the investigation that are considered and relevant to the claim</li> </ul> | <p><b>Excerpt 2</b></p> <p><b>4.2 Suggested extension</b></p> <ul style="list-style-type: none"> <li>It would be beneficial to extend this investigation by looking at other fishing techniques as they have an impact on population numbers. Whilst longline fishing has the greatest effect as seen by the CCSBT data, it does not account for all SBT that have been caught. Therefore, other methods such as bottom trawling and purse seine should be explored. This will allow a greater sample of evidence to prove with more confidence that the commission is influencing the fishing of SBT as well as address further information towards the claim.</li> <li>This experiment can be extended by looking at other species caught using longline fishing, or other fishing techniques. As the demand for seafood rises, people look to other fish species, and this could affect their numbers also.</li> </ul>   |

### Practices to strengthen

To further ensure accuracy and consistency of the application of the ISMG for this IA, it is recommended that:

- in the Research and planning criterion
  - a *considered* rationale introduces and explains key ideas of the research question, which is clearly derived from the claim

- *relevant* research questions are closely aligned to Unit 4 (as opposed to Unit 3) subject matter
- a *specific* research question is able to be answered to within the syllabus conditions (e.g. investigating one organism or one location) and is able to be extrapolated to the claim.

### **Additional advice**

- If students use a claim that is different to the claims that are provided in the endorsed assessment instrument, they should ensure that new claim is linked closely to Unit 4 subject matter so that they can produce a considered rationale and a relevant research question.



# External assessment

External assessment (EA) is developed and marked by the QCAA. The external assessment for a subject is common to all schools and administered under the same conditions, at the same time, on the same day.

## Summative external assessment (EA) — Examination (50%)

### Assessment design

The assessment instrument was designed using the specifications, conditions and assessment objectives described in the summative external assessment section of the syllabus. The examination consisted of one paper:

- Paper 1, Section 1 consisted of multiple choice questions (20 marks)
- Paper 1, Section 2 consisted of short response questions (40 marks)
- Paper 2, Section 1 consisted of short response questions (48 marks).

The examination assessed subject matter from Units 3 and 4. Questions were derived from the contexts of:

- The reef and beyond
- Changes on the reef
- Oceans of the future
- Managing fisheries.

The assessment required students to respond to multiple choice and short response items.

### Assessment decisions

Assessment decisions are made by markers by matching student responses to the external assessment marking guide (EAMG). The external assessment papers and the EAMG are published in the year after they are administered.

### Multiple choice item responses

There were 20 multiple choice items in Paper 1.

#### Percentage of student responses to each option

##### Note:

- The correct answer is **bold** and in a **blue** shaded table cell.
- Some students may not have responded to every question.

| Question | A            | B            | C            | D            |
|----------|--------------|--------------|--------------|--------------|
| 1        | <b>12.97</b> | 52.89        | 28.75        | 4.75         |
| 2        | <b>81</b>    | 8.6          | 6.16         | 3.72         |
| 3        | 0.51         | <b>84.72</b> | 3.47         | 10.65        |
| 4        | 33.25        | <b>57.25</b> | 2.57         | 6.29         |
| 5        | <b>31.45</b> | 9.76         | 1.8          | 56.48        |
| 6        | 4.11         | <b>83.31</b> | 3.72         | 8.22         |
| 7        | 4.24         | 10.01        | 31.45        | <b>53.66</b> |
| 8        | 5.13         | 10.01        | <b>61.87</b> | 22.46        |
| 9        | 13.61        | <b>51.35</b> | 10.01        | 24.39        |
| 10       | 9.76         | <b>66.24</b> | 5.26         | 17.97        |
| 11       | 2.57         | 33.12        | 50.96        | <b>12.84</b> |
| 12       | 6.16         | 5.78         | <b>57</b>    | 30.55        |
| 13       | 8.86         | 30.04        | 6.03         | <b>54.56</b> |
| 14       | 47.63        | 14.51        | <b>36.71</b> | 0.64         |
| 15       | <b>54.3</b>  | 10.4         | 29.78        | 5.01         |
| 16       | 7.19         | 1.93         | 26.96        | <b>63.41</b> |
| 17       | 2.44         | 11.94        | <b>69.83</b> | 15.28        |
| 18       | 3.08         | 4.75         | <b>89.86</b> | 1.8          |
| 19       | <b>38.38</b> | 21.31        | 27.86        | 11.81        |
| 20       | 9.37         | <b>40.82</b> | 28.11        | 21.18        |

## Effective practices

Overall, students responded well to:

- items that required concepts to be described, e.g. describing how herbivorous fish benefit coral reefs
- items that required application of understanding, e.g. using the Lincoln index to calculate fish population
- items that required unknown information to be identified from datasets, e.g. identifying the ecological tipping point associated with changes in carbonate chemistry.

The following excerpts have been selected to illustrate effective student responses in one or more of the syllabus assessment objectives. The characteristics identified may not be the only time the characteristics have occurred throughout a response.

## Samples of effective practices

### Short response

Assessment objective: 1

Paper 1

Question 25b

This question required students to describe the process of night feeding in corals.

Effective student responses:

- identified that tentacles are extended during feeding
- identified the role of tentacles in prey capture
- identified the role of nematocysts in prey paralysis.

This student response excerpt has been included:

- to demonstrate a response that clearly matches the features of the expected response — tentacles are extended, nematocysts sting and immobilise prey, tentacles transport prey to the mouth.

|                                       |  |
|---------------------------------------|--|
| <b>Describe and explain (3 marks)</b> | <p>During the night, corals are required to feed themselves as the zooxanthellae do not photosynthesise due to there being no sunlight. Rather, coral polyp's <del>are</del> extend their tentacles towards their prey, once within range, they sting the prey with their nematocysts, stunning &amp; immobilising them. They then drag their prey back to them with their tentacles where they then feed it to their mouth as it enters the digestive sack, where it is digested.</p> |
|---------------------------------------|--|

Assessment objective: 2

Paper 2

Question 4a

This question required students to use data to determine the fish family most affected by a cyclone.

Effective student responses:

- determined Labridae as the fish family most affected
- provided evidence from the data provided to support this determination.

This student response excerpt has been included:

- to demonstrate a response that clearly matches the features of the expected response— Labridae is identified, and evidence is provided to support that determination
- to show how students can use bullet points to organise their response.

Apply understanding  
(2 marks)

▷ Labridae is the family most ~~affected~~ affected.  
 ▷ This is because though being the second most highest population, they experienced to most drastic decrease with the whole population being wiped out.

Assessment objective: 3

Paper 2

Question 5a

This question required students to identify the relationship between global temperature, the concentration of atmospheric CO<sub>2</sub>, and the pH of Australian waters.

Effective student responses:

- identified that increases in atmospheric CO<sub>2</sub> correspond to increases in surface air temperature
- determined sea surface temperature increases at the same rate as surface air temperature
- identified that ocean pH decreases as water temperature, air temperature and atmospheric CO<sub>2</sub> increases.

This student response excerpt has been included:

- to demonstrate a response that clearly matches the features of the expected response
- because it identifies
  - an increase in global air temperature corresponds to an increase in sea surface temperature
  - CO<sub>2</sub> increases coincide with increases in global temperature (and therefore sea surface temperature)
  - the pH of Australian water decreases, while atmospheric CO<sub>2</sub> and global temperature increase.

Analyse evidence  
(3 marks)

As <sup>air</sup> global temperature increases from <sup>an anomaly of -0.5°C in</sup> 1910 to 1.0°C in 2010, the sea surface temperature also increases from -0.3°C to 0.5°C. As the overall global temperature increases, atmospheric carbon dioxide also increases, while the pH of Australian waters decreases.

Assessment objective: 4

Paper 2

Question 4b

This question required students to draw conclusions about how changes in habitat complexity influenced the diversity of fish species found at the reef.

Effective student responses:

- identified an inference from the data
- identified supporting evidence for that inference
- identified two more inferences with supporting evidence.

This student response excerpt has been included to:

- demonstrate a full-mark response that clearly identifies multiple inferences, each with supporting evidence.

Interpret evidence  
(4 marks)

After The cyclone caused a major change in rugosity, in which rugosity declined. Rugosity is a measure of habitat complexity meaning when rugosity declined, habitat complexity declined. A decrease in rugosity decreases available niches leaving less habitats to live and hide as well as less resources (e.g. food) to survive. Chaetodontidae and Labridae were ~~not~~ completely wiped out after the cyclone. Pomacentridae decreased in number of individuals by just over half. Acanthuridae had no effect by the cyclone and Scaridae benefited from the cyclone as there were a few herbivores present after the cyclone. As the number of herbivores increased, this indicates an increase in algae cover over the reef and only half of omnivores declined as the algae still provided some food. There were a few planktivores left in Pomacentridae indicating some abundance of plankton. Overall, species diversity declined on the reef due to a decline in rugosity and food availability.



Assessment objective: 4

Paper 2

Question 7

This question required students to compare the potential changes in coral cover and resilience in two regions of the Great Barrier reef in response to an increase in temperature.

Effective student responses:

- identified a similarity
- identified a difference
- identified the significance for coral cover
- identified the significance for coral resilience.

This student response excerpt has been included to:

- demonstrate a response that clearly identified a similarity, a difference, and the significance of this change to coral cover.

|   |  |
|---|--|
| <b>Interpret evidence<br/>(4 marks)</b> | <p>If the MMM increased to <math>29.2^{\circ}\text{C}</math>, both regions would experience stresses regarding coral and potentially the migration of species due to intolerable conditions. However, the bleaching threshold temperature of the Southern region is <math>29^{\circ}\text{C}</math>, meaning the corals would experience a mass bleaching event as <math>29.2^{\circ}\text{C}</math> exceeds <sup>decreasing coral cover immensely.</sup> this. Whereas, the Far Northern region the bleaching threshold is <math>30^{\circ}\text{C}</math>, meaning the reef is more likely to have a higher resilience to recover and it's coral cover won't be impacted too highly. The Southern regions resilience may not be able to recover as the threshold was exceeded.</p> |
|---|--|

### Practices to strengthen

It is recommended that when preparing students for external assessment, teachers consider:

- revising cognitive verbs and expected responses. For example, a question that requires students to 'compare' requires the recognition of a similarity, a difference and the significance of the similarity and/or difference. Similarly, the stem 'draw conclusions' requires students to make a judgement based on evidence or reasoning
- providing opportunities for students to practice explaining concepts, theories, models and systems under examination conditions
- encouraging students to use the number of marks as a cue for the number of key points to provide in a response
- the multiple choice items where students answered incorrectly to ensure subject matter is sufficiently covered.