Marine Science General Senior Syllabus 2019 v1.2

Subject report 2020

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For all Queensland schools

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Introduction

The first summative year for the new Queensland Certificate of Education (QCE) system was unexpectedly challenging. The demands of delivering new assessment requirements and processes were amplified by disruptions to senior schooling arising from the COVID-19 pandemic. This meant the new system was forced to adapt before it had been introduced — the number of summative internal assessments was reduced from three to two in all General subjects. Schools and the QCAA worked together to implement the new assessment processes and the 2020 Year 12 cohort received accurate and reliable subject results.

Queensland's innovative new senior assessment system combines the flexibility and authenticity of school-based assessment, developed and marked by classroom teachers, with the rigour and consistency of external assessment set and marked by QCAA-trained assessment writers and markers. The system does not privilege one form of assessment over another, and both teachers and QCAA assessors share the role of making high-stakes judgments about the achievement of students. Our commitment to rigorous external quality assurance guarantees the reliability of both internal and external assessment outcomes.

Using evidence of student learning to make judgments on student achievement is just one purpose of assessment. In a sophisticated assessment system, it is also used by teachers to inform pedagogy and by students to monitor and reflect on their progress.

This post-cycle report on the summative assessment program is not simply being produced as a matter of record. It is intended that it will play an active role in future assessment cycles by providing observations and findings in a way that is meaningful and helpful to support the teaching and learning process, provide future students with guidance to support their preparations for summative assessment, and promote transparency and accountability in the broader education community. Reflection and research are necessary for the new system to achieve stability and to continue to evolve. The annual subject report is a key medium for making it accessible to schools and others.

Background

Purpose

The annual subject report is an analysis of the previous year's full summative assessment cycle. This includes endorsement of summative internal assessment instruments, confirmation of internal assessment marks and external assessment.

The report provides an overview of the key outcomes of one full teaching, learning and assessment cycle for each subject, including:

- information about the application of the syllabus objectives through the design and marking of internal and external assessments
- information about the patterns of student achievement in each subject for the assessment cycle.

It also provides advice to schools to promote continuous improvement, including:

- identification of effective practices in the design and marking of valid, accessible and reliable assessments
- identification of areas for improvement and recommendations to enhance the design and marking of valid, accessible and reliable assessment instruments
- provision of tangible 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.

The report is to be used by schools and teachers to assist in assessment design practice, in making assessment decisions and in preparing 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 and Senior External Examination subjects, where relevant) and General (Extension) subjects.

Report preparation

The report includes analyses of data and other information from the processes of endorsement, confirmation and external assessment, and 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 enrolments

Number of schools offering the subject: 58.

Completion of units	Unit 1	Unit 2	Units 3 and 4*
Number of students completed	822	857	854

*Units 3 and 4 figure includes students who were not rated.

Units 1 and 2 results

Number of students	Satisfactory	Unsatisfactory	Not rated
Unit 1	772	48	2
Unit 2	801	53	3

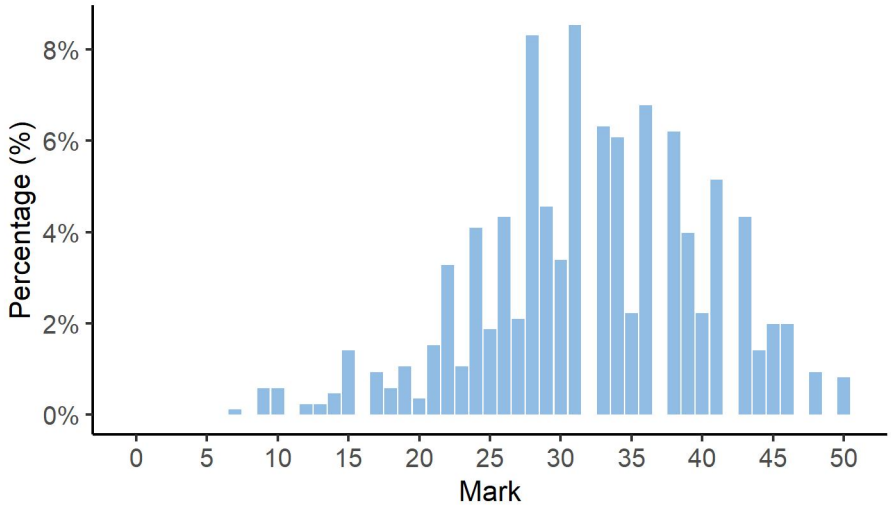
Units 3 and 4 internal assessment results

2020 COVID-19 adjustments

To support Queensland schools, teachers and students to manage learning and assessment during the evolving COVID-19 pandemic in 2020, the QCAA Board approved the removal of one internal assessment for students completing Units 3 and 4 in General and Applied subjects.

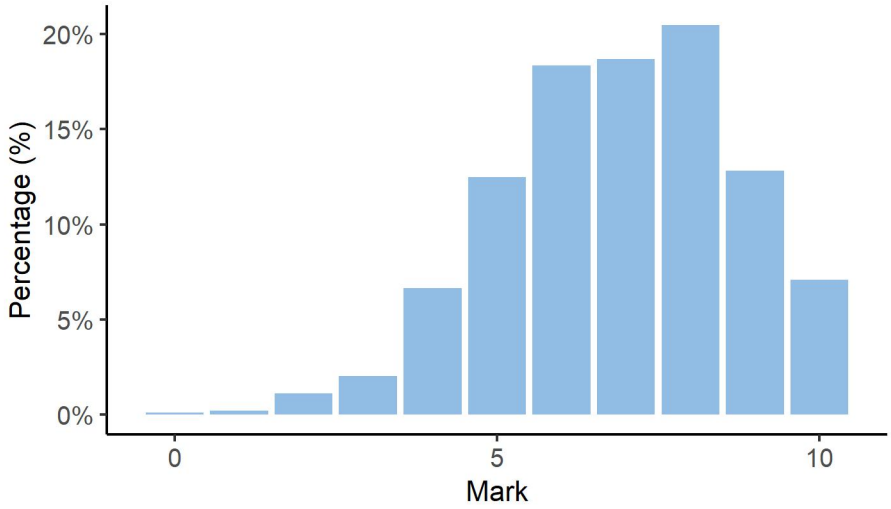
In General subjects, students completed two internal assessments and an external assessment. Schools made decisions based on QCAA advice and their school context. Therefore, across the state some instruments were completed by most schools, some completed by fewer schools and others completed by few or no schools. In the case of the latter, the data and information for these instruments has not been included.

Total results for internal assessment

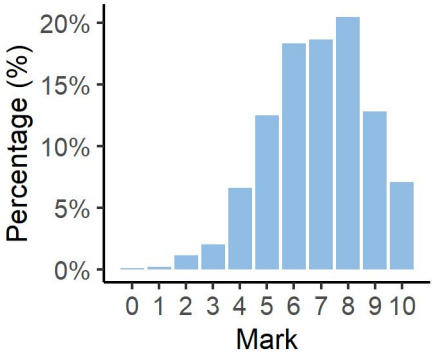


IA1 results

IA1 total

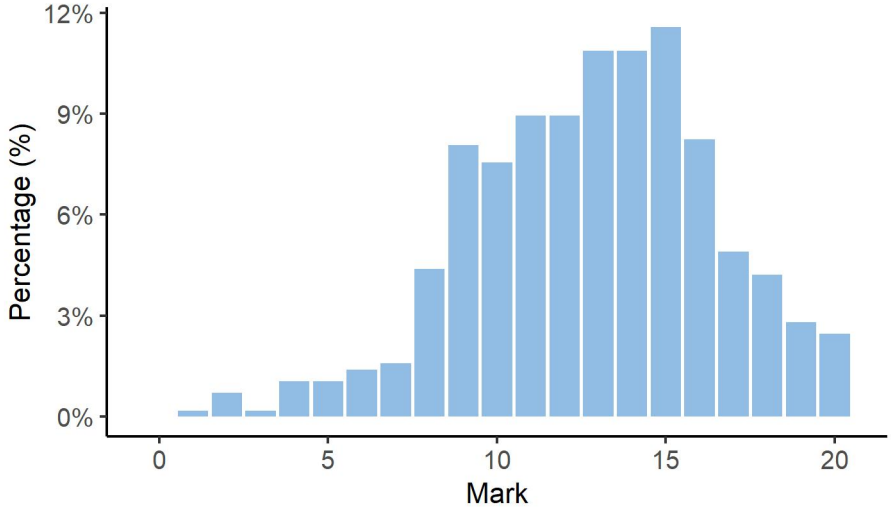


IA1 Criterion 1

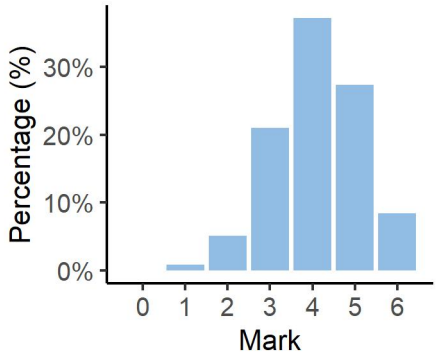


IA2 results

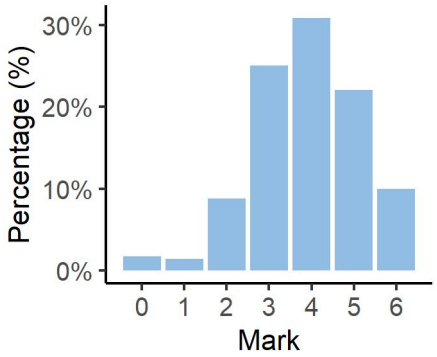
IA2 total



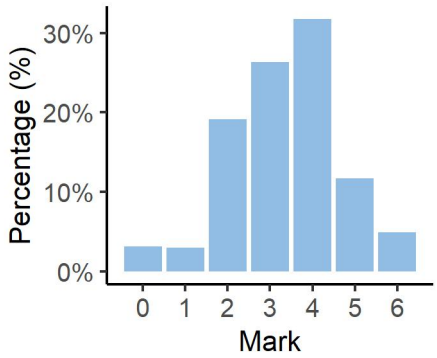
IA2 Criterion 1



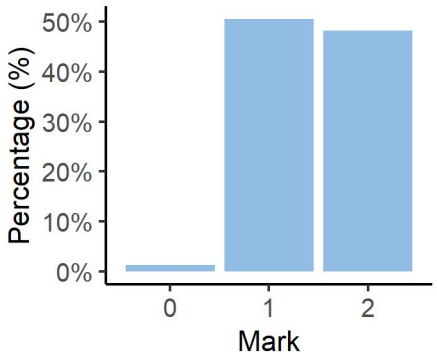
IA2 Criterion 2



IA2 Criterion 3

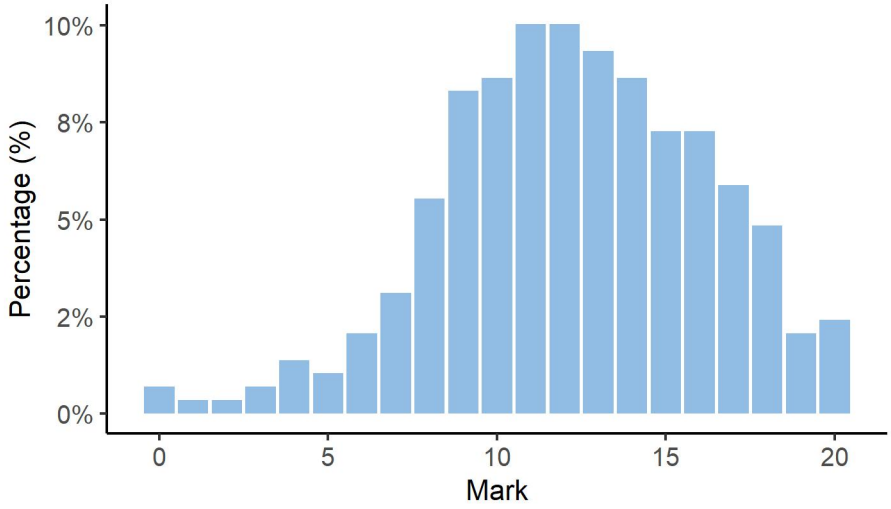


IA2 Criterion 4

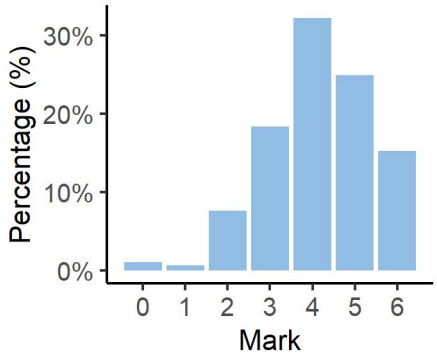


IA3 results

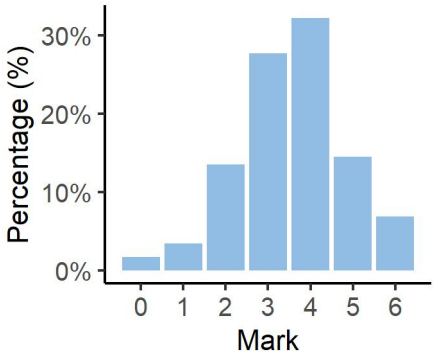
IA3 total



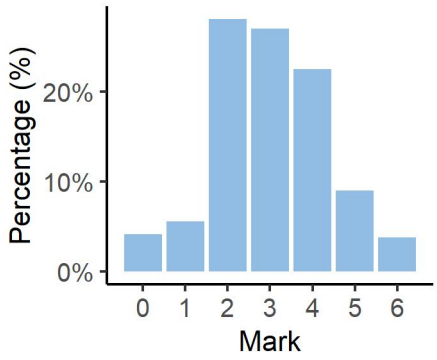
IA3 Criterion 1



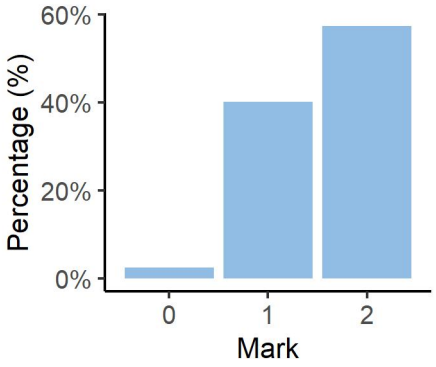
IA3 Criterion 2



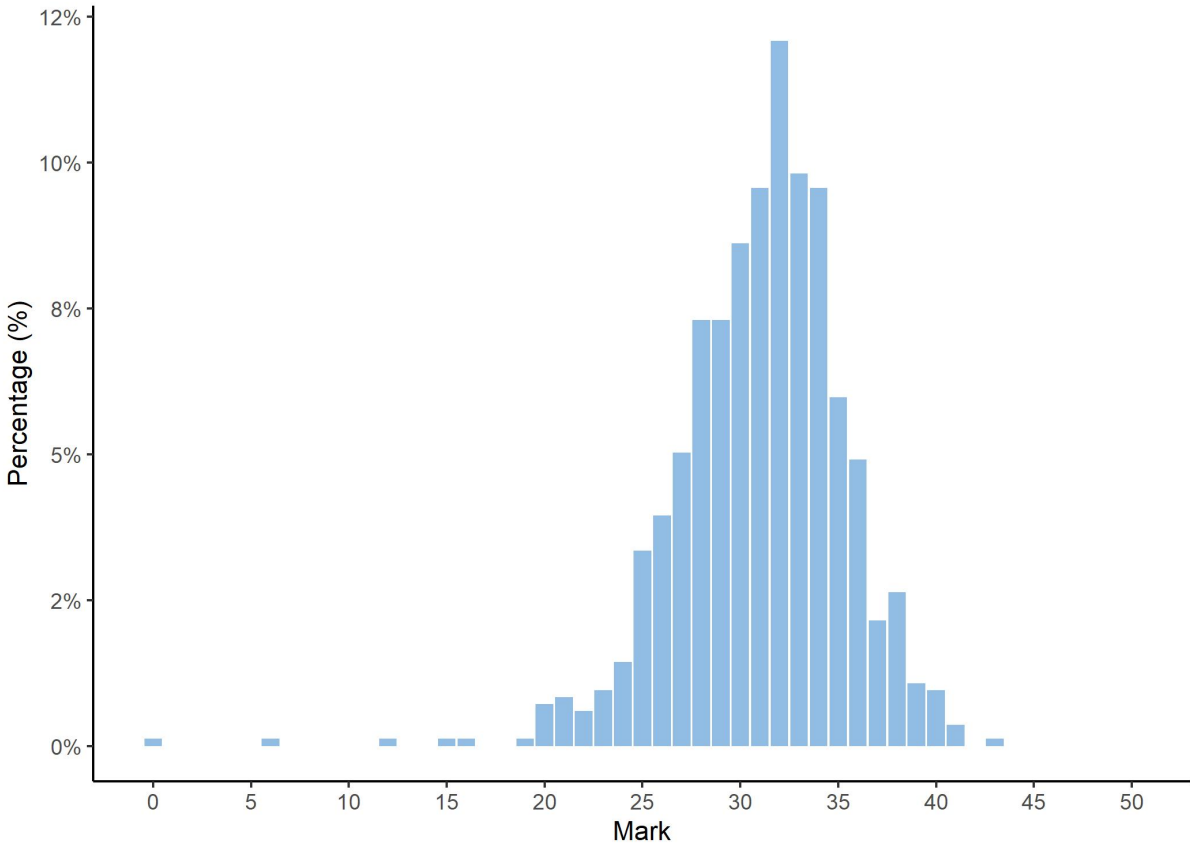
IA3 Criterion 3



IA3 Criterion 4



External assessment results



Final standards allocation

The number of students awarded each standard across the state are as follows.

Standard	A	B	C	D	E
Number of students	84	332	388	31	0

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	100–78	77–64	63–44	43–14	13–0

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 sections 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 subject matter and to the assessment objective. Refer to the quality assurance tools for detailed information about the assessment practices for each assessment instrument.

Total number of items endorsed in Application 1

Number of items submitted each event	IA1	IA2	IA3
Total number of instruments	50	50	50
Percentage endorsed in Application 1	32	92	90

Confirmation

Confirmation is the quality assurance process based on the attribute of reliability. Teachers make judgments about the evidence in students' responses using the instrument-specific marking guide (ISMG) to indicate the alignment of students' work with performance-level descriptors and determine a mark for each criterion. These are provisional criterion marks. The QCAA makes the final decision about student results through the confirmation processes. Data presented in the assessment decisions section identifies the level of agreement between provisional and final results.

Number of samples reviewed at initial, supplementary and extraordinary review

IA	Number of schools	Number of samples requested	Supplementary samples requested	Extraordinary review	School review	Percentage agreement with provisional
1	58	298	0	0	0	100
2	34	178	43	0	1	97.72
3	24	116	18	0	1	98.01

Internal assessment 1 (IA1)

Data test (10%)

The IA1 data test requires students to apply a range of cognitions to multiple provided items. Students respond to items using qualitative and/or quantitative data derived from practicals, activities or case studies on the reef and beyond, or changes on the reef from Unit 3. 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.

The data test focuses on the application of a range of cognitions in response to quantitative and/or qualitative 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 practices

Validity priority	Number of times priority was identified in decisions*
Alignment	20
Authentication	0
Authenticity	14
Item construction	11
Scope and scale	12

*Total number of submissions: 50. Each priority might contain up to four assessment practices.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that featured:

- a variety of datasets that were clearly derived from Unit 3 subject matter, e.g. mandatory or suggested practicals
- items that demonstrated clear alignment with the objectives being assessed by using the cognitive verbs listed in the mark allocation table in the syllabus, e.g. objective 2 items used the following verbs: calculate, determine, identify, recognise and use
- authentic datasets and questions that were clearly based on teaching and learning activities that students had experienced in Unit 3, e.g. biodiversity of hard corals (based on morphology) from video transect data
- items that showed clear alignment between the cognition in the question, the objective being assessed and the expected student response
- items that used only one cognition

- an updated marking scheme that clearly matched each mark (including partial marks) to a valued feature of the expected response, e.g. 1 mark for correct substitution into the formula and 1 mark for the correct value
- only relevant data that students would need to respond to the given items
- questions that were scaffolded to assess objectives independently, e.g. using separate items to a) calculate the herbivory rate (objective 2), and b) draw a conclusion about the relationship between algal cover and rugosity (objective 4)
- question cues that used terminology directly from the mark allocation table (Syllabus section 4.5.1) to ensure alignment with the objective being assessed
- datasets that were unambiguous and able to be interpreted with objectivity
- question cues that were succinct and clearly prompted the requirements of the student response.

Practices to strengthen

It is recommended that assessment instruments:

- include unseen datasets that are appropriately different from QCAA sample assessments
- include a sequence of items that is appropriately different from QCAA sample assessments
- include at least two and no more than four datasets
- include an appropriate amount of data within each dataset, allowing students to understand the dataset and respond to the item within 60 minutes
- include a balance of items across the apply, analyse and interpret objectives as per the syllabus instrument mark allocation table
- include only items that require students to use the given datasets
- use datasets that include diagrams, such as graphs, rather than asking students to sketch or draw these in their responses
- avoid assessing objective 1 — describe and explain; valid data test items only assess objectives 2, 3 and 4
- avoid items where the answers are given in other items within the instrument
- avoid unnecessary repetition of cognitions, subject matter or calculations
- include only item types appropriate to a data test, i.e. avoid multiple-choice items
- ensure each item cues for a particular objective or is closely aligned with the cognitions identified within the mark allocation table (Syllabus section 4.5.1).

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 practices

Accessibility priority	Number of times priority was identified in decisions*
Transparency	12
Language	13
Layout	9
Bias avoidance	8

*Total number of submissions: 50. Each priority might contain up to four assessment practices.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that featured:

- clear links between the items and the data required to answer the question, e.g. see figure 1 in dataset 1
- clear communication of task elements
- consistent layout and language with clearly legible datasets, including legends, labelled axes, correct units and figure labels
- minimal distractors, e.g. brief and succinct instructions that avoided unnecessary detail or complexity
- clear, appropriate headings
- items that were constructed to avoid factors such as gender, social and/or cultural background
- a response space that matched the length of the expected response, e.g. one line for a single word response
- a succinct commentary accompanying each dataset that avoided unnecessary details or complexity.

Practices to strengthen

It is recommended that assessment instruments:

- use language consistently between datasets and items, e.g. avoid referring to the same measurement using different terms — *average* colour score versus *mean* colour score
- avoid jargon and acronyms in the datasets
- are checked for typographical, spelling and grammatical errors within items and datasets
- are formatted using the page break tool in the Endorsement application to ensure that datasets, figure labels and items are not separated across pages. The print preview function should be used to ensure the layout of the task is appropriate
- clearly indicate which dataset is to be used for each question
- 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 final results

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional
1	Data test	100	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
- schools applied their marking schemes consistently across cohorts
- marking schemes were revised by schools during marking to incorporate acceptable but unexpected student responses
- marking schemes included a range of acceptable responses
- marking schemes used accepted abbreviations, e.g. FT error for 'follow through error'.

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 in this IA, it is recommended that:

- schools check that mark totals and percentages have been determined correctly
- schools use the percentage cut-offs from the ISMG to determine the final mark out of 10
- schools update the original marking scheme (that was submitted at endorsement) to indicate how unexpected responses are marked
- schools implement internal quality assurance processes (e.g. cross marking) to ensure intra-marker and inter-marker reliability
- schools update marking schemes rather than rigidly apply their original marking scheme.

Additional advice

- Confirmers could clearly follow school decision-making processes when student responses were clearly annotated with marks in accordance with a detailed marking scheme.
- Schools should ensure that all pages are correctly scanned in PDF files before uploading for confirmation, especially for double-sided student responses.
- Schools should seek feedback on draft assessment tasks from across their community of practice (i.e. within the school and, where possible, between schools) to ensure accuracy of subject matter content.

- Schools should seek support to address subject-specific content knowledge issues and to access subject-specific datasets through associations such as Marine Teachers Association of Queensland (MTAQ), Great Barrier Reef Marine Park Authority (GBRMPA) and Science Teachers Association of Queensland (STAQ).

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 reef and beyond, or changes on the reef from Unit 3. Students may use a practical performed in class as the basis for their methodology. They 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 practices

Validity priority	Number of times priority was identified in decisions*
Alignment	10
Authentication	2
Authenticity	0
Item construction	0
Scope and scale	0

*Total number of submissions: 50. Each priority might contain up to four assessment practices.

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
- authentication strategies that included guidance for drafting, scaffolding and teacher feedback
- clear alignment of cognitions and language with the syllabus and the assessment objectives
- checkpoints to monitor student progress through the task, e.g. select modifications, complete risk assessment, collect and analyse data, submit draft, submit final response
- an indication of how students can work collaboratively and how the school will manage authentication of student work in these situations, e.g. the teacher will compare the responses of students who have worked together in groups
- clear scaffolding that modelled processes and directed students to address all components of the task without leading students to a pre-determined response
- a clear statement that feedback can only be provided on one draft
- practicals that were based on authentic contexts relevant to local contexts and/or issues

- task requirements that used language from the syllabus
- authentication strategies that aligned with checkpoints listed, e.g. one drafting opportunity.

Practices to strengthen

It is recommended that assessment instruments:

- include only experiments clearly related to Unit 3 subject matter (i.e. General syllabus — the reef and beyond, or changes on the reef) for students to modify
- include all the task specifications in the task description
- include appropriate information in the scaffolding section, e.g. timeline, checkpoints, prompts about the requirements for the response
- include appropriate drafting and authentication strategies, e.g. collecting progressive samples of student work, interviews with students, using plagiarism-detection software
- ensure that practicals align with subject matter identified within task specifications
- select authentication strategies that consider group work situations.

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 practices

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

*Total number of submissions: 50. Each priority might contain up to four assessment practices.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that featured:

- clear instructions that aligned to the specifications within the syllabus, the assessment objectives and the ISMG
- clear communication of task elements, using succinct language and featuring accurate spelling, grammar and textual features
- communication that avoided jargon, and specialist and colloquial language
- clear, appropriate headings
- checkpoints that provided an indication of the time available to students (e.g. Week 4) rather than specific dates.

Practices to strengthen

It is recommended that assessment instruments:

- include scaffolding that clearly directs students to address all aspects of the task, including the rationale
- avoid repetition of elements of the task in different sections.

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 final results

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional
1	Research and planning	96.49	3.51	0
2	Analysis of evidence	98.60	1.40	0
3	Interpretation and evaluation	96.32	3.68	0
4	Communication	99.47	0.18	0.35

Effective practices

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

- in the Analysis of evidence criterion
  - the following analysis techniques were used to demonstrate *thorough* identification of trends, patterns or relationships
    - measures of central tendency, e.g. mean
    - measures of dispersion, e.g. standard deviation
    - measures of correlation, e.g. Pearson's correlation coefficient, *r*
    - context-specific measures, e.g. percentage cover, diversity indexes
  - the following analysis techniques were used to demonstrate *thorough and appropriate* identification of uncertainty and limitations of evidence
    - indicators of uncertainty, e.g. standard error, confidence intervals
    - statistical tests, e.g. Student's t-test.

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 sample may provide evidence of more than one criteria. The characteristics highlighted may not be the only time the characteristics have occurred throughout the response.

Research and planning (5–6 marks)
A considered rationale for the experiment

The rationale contains evidence of a logical, scientifically informed basis for the experiment.

In the case of corals, the consumption of H^+ and CO_3^{-2} ions involved in ocean acidification and the creation of HCO_3^- lessens the concentration of CO_3^{-2} ions, impeding calcification. This is a serious repercussion as the calcium carbonate ($CaCO_3$) skeletons of corals "are the backbone of tropical coral reef ecosystems" (Australian Institute of Marine Science, 2019). Furthermore, the "skeletons of stony corals are the main building blocks of the reef structure and provide food, shelter and substrate for a myriad of other organisms" (Mollica, et al., 2018). This ecological significance highlights the need to protect corals from the effects of ocean acidification. However, effective strategies cannot be implemented unless the issue and its potential consequences are understood, which is difficult considering that future conditions can only be modelled in laboratory experiments.

Therefore, the dependent variable will be coral mass because of the susceptibility of coral to reductions in seawater pH, which will be the independent variable. Hence, the research question is: **"How does coral fragment mass vary in pH 6, pH 8 and pH 10 when in seawater with a salinity of 35 parts per thousand after eight days?".**

Research and planning (5–6 marks)
A specific and relevant research question

The response explicitly states the relationship in question and allows effective investigation of the topic.

Modifications to Methodology

Instead of oyster shells, coral fragments were used. This was to investigate the impact of ocean acidification on an organism that is a keystone species and is abundant in coral reef ecosystems. Three pH levels, 6, 8 and 10, were tested so as to represent acidic, control and alkaline conditions that are close to the current and projected ocean pH. The number of replicants was increased from one to five to increase the accuracy of the data and enable the mean and standard error to be calculated. The fragments were submerged for seven days rather than four, dried overnight in an incubator set to 45°C, and weighed on the eighth day. This was to allow time for the coral mass to undergo measurable change. Additionally, the glass beakers covered with plastic wrap were substituted for lidded containers to better diminish the potential for atmospheric carbon dioxide to react with the seawater and alter its pH.

Analysis of evidence (5–6 marks)
Thorough identification of relevant trends, patterns or relationships

The identified trends, patterns and relationships are not superficial and allow a justified conclusion to the research question to be drawn.

Analysis and Interpretation:

The data shown indicates an increase in coral cover for offshore reefs with a mean percentage cover of 75.39% in comparison to the mean percentage cover of 30.47%. The large difference of 44.92% between inshore and offshore reefs suggests that offshore reefs contain a greater coral population that inshore reefs. This data suggests that effects from populated areas decreases the life of coral within close proximity. The steady trend of increasing coral cover as distance from land further indicates possibility for this trend to be applied to more distant reefs. The standard deviation of both reefs is high with values of 13.16 and 10.61 which indicated a high spread of data. The high standard errors of 7.54 and 5.30 indicates that there are irregularities in the data. Inshore reefs show a slightly higher standard deviation and standard error than offshore, indicating a greater spread of data. The result of the T Test conducted shows a value of 0.004 which indicates the data is statistically significant.

Analysis of evidence (5–6 marks)
Thorough and appropriate identification of the uncertainty and limitations of evidence

The response suitably recognises and states the uncertainty and limitations of the data in a way that is not superficial or partial. The response examines the uncertainty to determine if the evidence that will be used to draw a conclusion to the research question is reliable and valid.

Practices to strengthen

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

- in the Research and planning criterion
  - a *specific* research question should be explicit enough to be answered within the required response length
  - *justified* modifications to the methodology should ensure that the experiment collects sufficient data to draw valid conclusions, e.g. in some water-based field studies, the methodology prohibited students from collecting sufficient data
- in the Interpretation and evaluation criterion, the uncertainty and limitations identified in the analysis of the evidence should be used to
  - *justify* the discussion of the reliability and validity of the experimental process
  - *logically derive* the suggested improvements and extensions to the experiment.

Additional advice

- Respect for animals must underpin all decisions and actions involving the care and use of animals. Experiments that require the endpoint as the death of any animal (e.g. lethal dose LD50) are unacceptable. For more information, refer to Section 1.2.4 of the syllabus.
- Schools should use the ISMG from the syllabus without making any changes to wording or formatting.
- Methodologies should be based on experiments that consider only one dependent variable (e.g. mandatory or suggested practicals from the syllabus) rather than complicated experiments that consider more than one dependent variable or involve complex systems in which external variables are difficult to control. Quality student experiments were conducted in traditional field studies, laboratory conditions investigating variables (e.g. calcification, oxygen and salinity) and using virtual and online coral reef data.
- As part of the teaching and learning process, teachers should demonstrate the relevant data processing techniques that can be used to identify trends/patterns/relationships (e.g. diversity indexes) and uncertainty/limitations of data in practicals (e.g. confidence intervals) before students use these practicals as a basis their experiments.
- Teachers should use the strategies identified in the *QCE and QCIA policy and procedures handbook* to
  - manage response length to ensure that student responses meet the conditions of the syllabus
  - promote academic integrity to ensure that student responses clearly demonstrate their students' own achievement.

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 about oceans of the future and managing fisheries from Unit 4. 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 practices

Validity priority	Number of times priority was identified in decisions*
Alignment	8
Authentication	0
Authenticity	0
Item construction	3
Scope and scale	1

*Total number of submissions: 50. Each priority might contain up to four assessment practices.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that featured:

- simple and direct claims that were clearly aligned to Unit 4 subject matter, e.g. aquaculture is the answer to the issue of overfishing
- claims that could generate multiple research questions e.g. Australia exports too much seafood
- claims that could be narrowed down into specific and relevant research questions, e.g. climate change is the biggest threat to marine ecosystem health
- claims that have sufficient data available for students to research, e.g. bycatch reduction devices (BRDs) have decreased capture of non-target species
- sufficient claims for the size of the cohort, allowing students to develop unique responses to the task
- authentication strategies that included guidance for drafting, scaffolding and teacher feedback
- checkpoints to monitor student progress through the task
- scaffolding that directed students to address all components of the task
- claims based on authentic, locally relevant and topical issues

- checkpoints that aligned with authentication strategies and syllabus requirements, e.g. a single clearly-identified drafting point, articulated strategies to authenticate individual's work when some elements of the task were undertaken in groups
- claims that were clearly aligned to specific scientific concepts that students could use as the basis of their investigation
- claims that allowed for investigation through several different scientific concepts.

Practices to strengthen

It is recommended that assessment instruments:

- include all the task specifications in the task description
- contain claims that are clearly derived from Unit 4 subject matter, i.e. oceans of the future or managing fisheries
- use claims that are assertions without evidence. Science as a Human Endeavour (SHE) statements from the syllabus can be used as a starting place to develop claims; however, these statements are not necessarily suitable to be directly used as claims
- include appropriate drafting and authentication strategies, e.g. collecting progressive samples of student work, interviews with students, using plagiarism-detection software
- include appropriate information in the scaffolding section, e.g. it does not lead students towards a predetermined response by specifying the scientific concepts students are to investigate
- 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.

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 practices

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

*Total number of submissions: 50. Each priority might contain up to four assessment practices.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that featured:

- claims written using clear, succinct language and featuring accurate spelling, grammar and textual features
- clear instructions that align to the specifications within the syllabus, the assessment objectives and the ISMG
- clear, appropriate headings

- checkpoints that provide an indication of the time available to students (e.g. Week 4) rather than specific dates
- formatting applied consistently.

Practices to strengthen

It is recommended that assessment instruments:

- avoid repetition of elements of the task in different sections, e.g. restating the checkpoints in the scaffolding section
- are checked for typographical, spelling and grammatical errors.

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 final results

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional
1	Research and planning	96.54	3.46	0
2	Analysis and interpretation	98.27	1.73	0
3	Conclusion and evaluation	99.30	0.35	0.35
4	Communication	97.92	0.35	1.73

Effective practices

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

- in the Conclusion and evaluation criterion, discussion of the reliability and validity of the experimental process was *justified* by referring to the limitations of evidence identified in the analysis.

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 in this IA, it is recommended that:

- in the Research and planning criterion
  - a *considered* rationale should clearly connect the research question to Unit 4 subject matter
  - a *specific* research question should be explicit enough to be answered within the required response length

- in the Communication criterion, when there is evidence of more of the characteristics of the upper performance level than the lower level, then the higher mark (i.e. 2) should be awarded.

Additional advice

- Schools should use the ISMG from the syllabus without making any changes to wording or formatting.
- It is not necessary for schools to remove teacher feedback from student responses before uploading them for confirmation, particularly if the feedback is expressed in the language of the ISMG.
- Teachers should develop resources and teaching/learning strategies that reflect the specific requirements of a research investigation (e.g. a rationale that develops the research question from a claim, extrapolation of findings of the research to the claim) rather than using approaches from previous syllabuses (e.g. extended response task) or other contexts (e.g. literature review).
- Teachers should use the strategies identified in the *QCE and QCIA policy and procedures handbook* to
  - manage response length to ensure that student responses meet the conditions of the syllabus
  - promote academic integrity to ensure that student responses clearly demonstrate their students' own achievement.

External assessment

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

Assessment design

Assessment specifications and conditions

Description

This examination included two papers. Each paper consisted of a number of different types of possible items:

- multiple choice
- short response items requiring single-word, sentence or paragraph responses
- calculating using algorithms
- interpreting graphs, tables or diagrams
- responding to unseen data and/or stimulus
- extended response (300–350 words or equivalent).

Conditions

Paper 1

- Time: 90 minutes plus 10 minutes perusal.
- Other: QCAA-approved graphics calculator permitted.

Paper 2

- Time: 90 minutes plus 10 minutes perusal.
- Other: QCAA-approved graphics calculator permitted.

The assessment instrument consisted of two papers. Questions were derived from the context of Unit 3 and 4. This assessment was used to determine student achievement in the following assessment objectives:

1. describe and explain the reef and beyond, changes on the reef, oceans of the future and managing fisheries
2. apply understanding of the reef and beyond, changes on the reef, oceans of the future and managing fisheries
3. analyse evidence about the reef and beyond, changes on the reef, oceans of the future and managing fisheries to identify trends, patterns, relationships, limitations or uncertainty
4. interpret evidence about the reef and beyond, changes on the reef, oceans of the future and managing fisheries to draw conclusions based on analysis.

Paper 1 Section 1 was 15 multiple choice questions (15 marks).

Paper 1 Section 2 was 10 short response questions (45 marks).

Paper 2 Section 1 was 8 short response questions (55 marks).

Assessment decisions

Overall, students responded well to the following assessment aspects:

- describing and explaining, and apply understanding
- Unit 3 Topic 1 (subtopics: Coral reef development; Reefs, habitats and connectivity)
- Unit 4 Topic 1 (subtopic: Management and conservation)
- Unit 4 Topic 2 (subtopics: Australia's fisheries management; Aquaculture).

Effective practices

The following samples were selected to illustrate highly effective student responses in some of the assessment objectives of the syllabus.

Multiple choice item response

Assessment objective: Objective 1 — Describe and explain

QUESTION 1

Which of the following reef structures is commonly associated with continental islands?

(A) atoll

(B) coral cay

(C) fringing reef

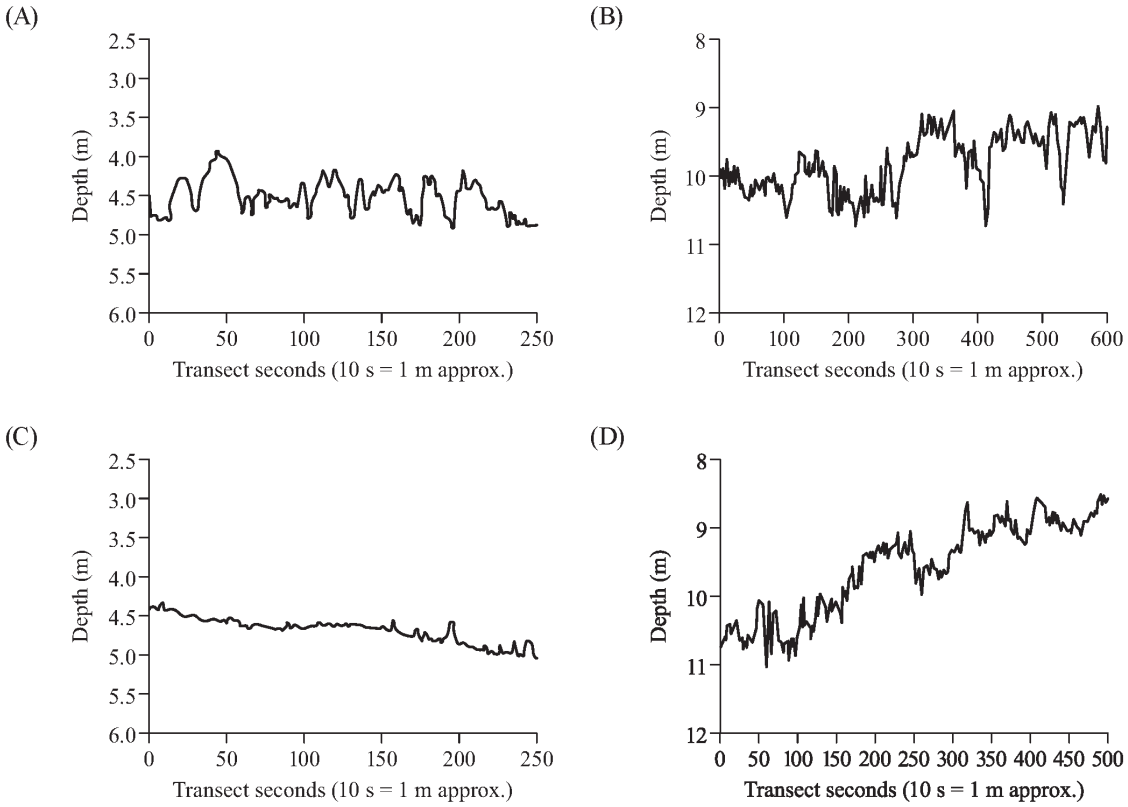
(D) platform reef

Option	Validity statements
A	This option is plausible because atolls are reef structures, but they are associated with volcanoes.
B	This option is plausible because coral cays are reef structures, but they are built on older reefs not continental islands.
C	Key
D	This option is plausible because platform reefs are reef structures, but they are not associated with continental islands.

Assessment objective: Objective 4 — Interpret evidence

QUESTION 12

The rugosity transects for four sites on the same reef, measured with an electronic depth sensor, are shown. Which site would have the greatest diversity of fish?



Adapted from: Dustan, P, Doherty, O, Pardede, S 2013, Figure 3 and 4 in 'Digital reef rugosity estimates coral reef habitat complexity', *PLoS ONE*, vol. 8, issue 2, https://doi.org/10.1371/journal.pone.0057386

Option	Validity statements
A	This option is plausible because it shows a rugosity transect; however, Site A shows less rugosity and a smaller change in depth than B and D.
B	This option is plausible because it shows a rugosity transect; however, Site B shows high rugosity but a smaller change in depth.
C	This option is plausible because it shows a rugosity transect; however, Site C shows low rugosity.
D	Key

Short response

Assessment objective: Objective 1 — Describe and explain

Item: Paper 1 Question 20 a)

Student sample of an effective response

Effective student responses:

- identified that as pH decreases, both calcite and aragonite saturations decrease
- linked the decrease in pH to increased dissolution of carbonate reef builders
- identified that as pH decreases, aragonite organisms, such as corals and some macroalgae, will be affected more than calcite organisms
- indicated that the reef ecosystem would have a higher proportion of calcite organisms
- indicated that the consequence of ocean acidification is a reduction in complexity and diversity of the coral reef ecosystem.

Describe and explain (5 marks)	a) Describe the consequences of ocean acidification and predict the impact on the complexity and diversity of the coral reef ecosystem. *[5 marks]* Ocean acidification reduces ocean pH (8.18 - 7.49), aragonite saturation (3.4 - 0) and calcite saturation (5.3 - 1.3). This has an impact on coral reef ecosystems as corals utilise aragonite to form their $CaCO_3$ skeletons, however once the saturation state of aragonite falls below 4.4, they start to dissolve or get weak. This has an impact on the rugosity, the decrease of which reduces the number of available niches, thus increasing competition & and predation, decreasing the diversity & complexity of the reef ecosystem. This also has an effect on See page 11 20. a) the shells of ~~eal~~ crustaceans & microalgaes such as coccolithophores & diatoms.

This sample has been included to demonstrate a response that clearly matches the features of the expected response.

Assessment objective: Objective 1 — Describe and explain

Item: Paper 1 Question 20 b)

Student sample of an effective response

Effective student responses:

- explained that resilience
  - varies between organisms and/or reefs
  - impacts the reef's ability to resist the impact of ocean acidification
  - decreases over time.

Describe and explain (3 marks)	b) Explain how resilience may partially offset ocean acidification responses in the short term. *[3 marks]* Resilience will possibly offset ocean acidification responses in the short term by creating a buffer. By ~~creating~~ farming corals that have greater resilience to the effects of ocean acidification, corals will be less impacted by the decreasing pH of the ocean. However, corals lack the ability to adapt or acclimatize, so the continued decrease in pH shows that this is not a viable & long term solution to the impacts of ocean acidification & climate change.

This sample has been included to demonstrate a response that clearly matches the features of the expected response.

Assessment objective: Objective 1 — Describe and explain

Item: Paper 1 Question 22

Student sample of an effective response

Effective student responses:

- identified that upwelling brings nutrient-rich water to the surface
- indicated that nutrient-rich water promotes algae and plankton growth
- indicated that fish gather in upwelling due to increased food supply, affecting the distribution of fish populations.

Describe and explain (3 marks)	**QUESTION 22 (3 marks)** Explain how upwelling influences the distribution of fish populations. Upwelling is when currents bring cold and nutrient-rich water from lower layers of the ocean to the surface. The increase in nutrients causes increased primary productivity and phytoplankton blooms which are a food source for fish. Therefore, where upwelling occurs more fish will be there ~~affecting~~ influencing the distribution of the populations.

This sample has been included to demonstrate a response that clearly matches the features of the expected response.

Assessment objective: Objective 2 — Apply understanding

Item: Paper 2 Question 1 c)

Student sample of an effective response

Effective student responses:

- identified two advantages. The majority of students were awarded marks for identifying that laboratory experiments
  - allow variables to be controlled to isolate cause and effect
  - are repeatable.

Apply understanding (2 marks)	c) Identify two advantages that these laboratory-scale experiments have over field-based experiments when investigating the effects of ocean acidification on sea urchins. *[2 marks]* Laboratory-scale experiments provide more accurate insight into the effects of changing pH on a singular species. Laboratory-scale experiments are highly controlled & results are not impacted by additional natural influences. The one factor is able to be studied, so a reliable conclusion is drawn.

This sample has been included to demonstrate a response that clearly matches the features of the expected response.

Assessment objective: Objective 4 — Interpret evidence

Item: Paper 2 Question 1 b)

Student sample of an effective response

Effective student responses:

- identified that decrease in pH has a negative impact on fertilisation
- identified that decrease in pH has a negative impact on the development and morphology of larvae
- identified that decrease in pH due to CO_2 has more impact than a decrease in pH due to hydrogen ions from HCl
- concluded that the negative impact on morphology is due to a decrease in $[CO_3^{2-}]$ available rather than dissolution
- concluded that increased atmospheric CO_2 leads to acidification of seawater by decreasing pH
- concluded that increased atmospheric CO_2 decreases population size by interfering with reproduction and larval stages of the life cycle.

Interpret evidence (6 marks)	b) Draw a conclusion about the impact of atmospheric CO_2 on the development of sea urchins. *[6 marks]* As atmospheric CO_2 continues to rise, the % of fertilised sea urchin eggs decreases. CO_2 levels directly impact the pH of water, & as they continue to rise, the ocean's buffer system is unable to keep up with the excess CO_2 molecules, therefore the pH decreases. The larval stage of sea urchins contains its first $CaCO_3$ deposition. Acidic water removes CO_3^{2-} ions from the column as it readily bonds with H^+ ions, so the fitness of the urchins decreases & the likelihood of larvae survival is low. Acidic water also dissolves $CaCO_3$, which will have a significant impact on urchin development.

This sample has been included to demonstrate a response that clearly matches the features of the expected response.

Assessment objective: Objective 4 — Interpret evidence

Item: Paper 2 Question 2 c)

Student sample of an effective response

Effective student responses:

- identified that aquaculture production dropped significantly because stocks were reduced to
  - try to eradicate the disease
  - reduce the risk of white spot escaping into the wild population.

Interpret evidence (2 marks)	c) In terms of biosecurity, infer two reasons why an outbreak of white spot disease in 2017 had a greater impact on the production of aquaculture-farmed prawns than on wild-caught prawns. *[2 marks]* An outbreak of whitespot disease in 2017 had a greater impact on aquaculture-farmed prawns as they ~~are~~ are stocked more dense therefore disease spreads quicker through farms than in the wild affecting biosecurity. Another reason could be that the marketability of aquaculture decreased for fear of the disease impacting production.

This sample has been included to demonstrate a response that clearly matches the features of the expected response.

Assessment objective: Objective 4 — Interpret evidence

Item: Paper 2 Question 8

Student sample of an effective response

Effective student responses:

- stated 2008 as the answer
- linked increased discharge to increase in P and N nutrient levels
- explained that increased nutrient levels led to phytoplankton blooms
- linked increased blooms to increased survival of crown-of-thorns starfish (COTS) larvae
- concluded that COTS numbers would increase, leading to a higher probability of an outbreak.

Interpret evidence (5 marks)	Deduce which year posed the greatest threat of a crown-of-thorns starfish (COTS) outbreak. Explain your reasoning. 2008 posed the greatest threat of a crown-of-thorns ~~stoot~~ starfish (COTS) outbreak. This is because the TN(t) and TP(t) were at their highest in the year. High levels of nutrients and phosphorus cause algal blooms to form which are a main food source for juvenile COTS. As there was more food available more COTS would spawn and create an ~~trigger~~ outbreak. As well as this the total suspended solids (TSS) was high meaning as it settled it would ~~sp~~ smother coral reefs stressing them and causing them to die allowing more space for algae to grow, again increasing the threat of an COTS outbreak.

This sample has been included to demonstrate a response that clearly matches the features of the expected response.

Practices to strengthen

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

- the cognitive verb and the number of marks for each item as a guide to determining the expected response
- that responses should align to the stimulus provided in the items using the cognitive verb 'draw conclusions'
- cueing students to respond with correct terminology, especially when responding to items related to subject matter from Unit 3 Topic 2.