

Marine Science subject report

2023 cohort

February 2024





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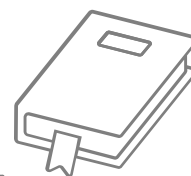
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Introduction



Throughout 2023, schools and the Queensland Curriculum and Assessment Authority (QCAA) continued to improve outcomes for students in the Queensland Certificate of Education (QCE) system. These efforts were consolidated by the cumulative experience in teaching, learning and assessment of the current General and General (Extension) senior syllabuses, and school engagement in QCAA endorsement and confirmation processes and external assessment marking. The current evaluation of the QCE system will further enhance understanding of the summative assessment cycle and will inform future QCAA subject reports.

The annual subject reports seek to identify strengths and opportunities for improvement of internal and external assessment processes for all Queensland schools. The 2023 subject report is the culmination of the partnership between schools and the QCAA. It addresses school-based assessment design and judgments, and student responses to external assessment for this subject. In acknowledging effective practices and areas for refinement, it offers schools timely and evidence-based guidance to further develop student learning and assessment experiences for 2024.

The report also includes information about:

- how schools have applied syllabus objectives in the design and marking of internal assessments
- how syllabus objectives have been applied in the marking of 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 that demonstrate best practice.

Schools are encouraged to reflect on the effective practices identified for each assessment, consider the recommendations to strengthen assessment design and explore the authentic student work samples provided.

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 internal and external assessment.

The report is publicly available to promote transparency and accountability. Students, parents, community members and other education stakeholders can use it to learn about the assessment practices and outcomes for senior 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.

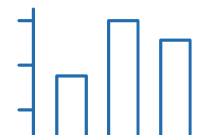
Subject highlights

53

schools offered
Marine Science

**80.65%**
of students
completed
4 units**97.53%**
of students
received a C
or higher

Subject data summary



Subject completion

The following data includes students who completed the General subject.

Note: All data is correct as at January 2024. Where percentages are provided, these are rounded to two decimal places and, therefore, may not add up to 100%.

Number of schools that offered Marine Science: 53.

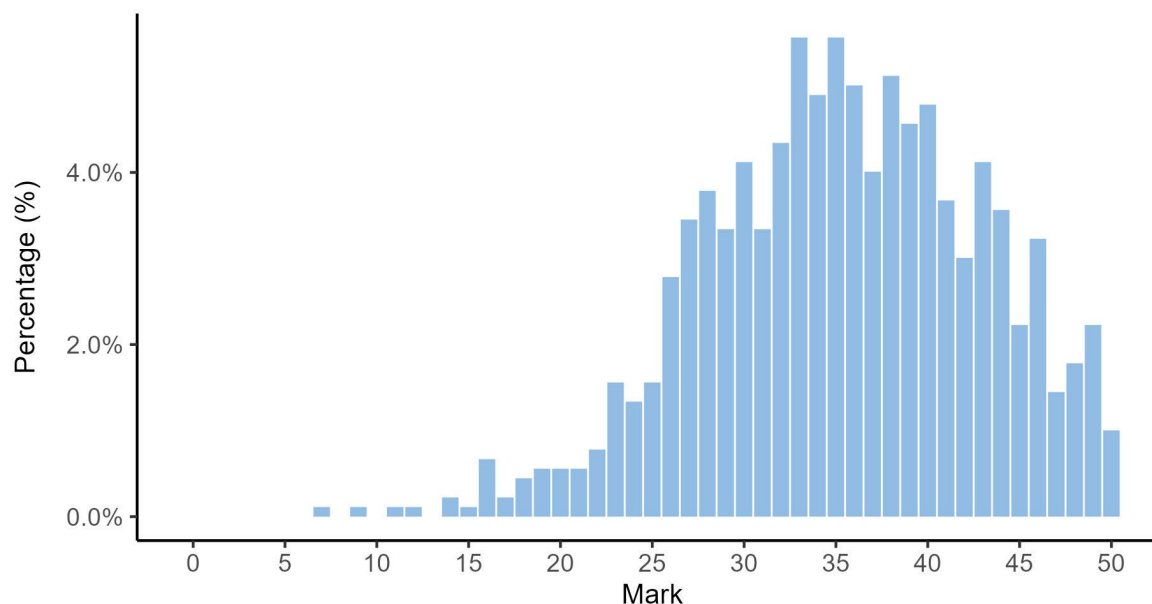
Completion of units	Unit 1	Unit 2	Units 3 and 4
Number of students completed	1,106	1,048	892

Units 1 and 2 results

Number of students	Satisfactory	Unsatisfactory
Unit 1	1,003	103
Unit 2	969	79

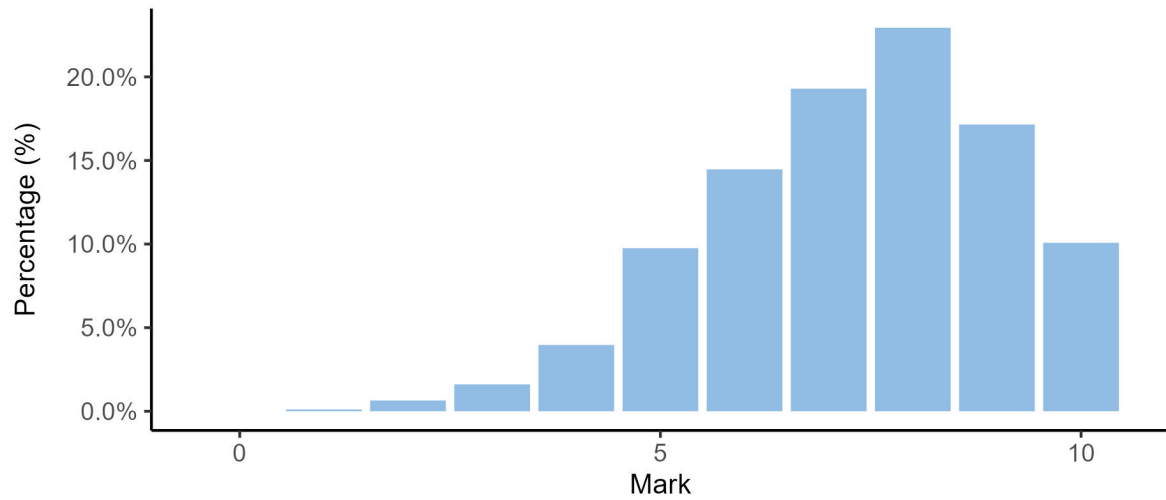
Units 3 and 4 internal assessment (IA) results

Total marks for IA

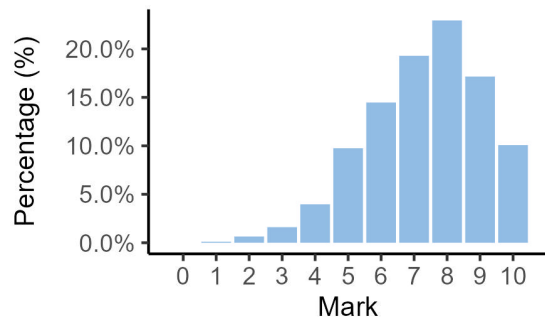


IA1 marks

IA1 total

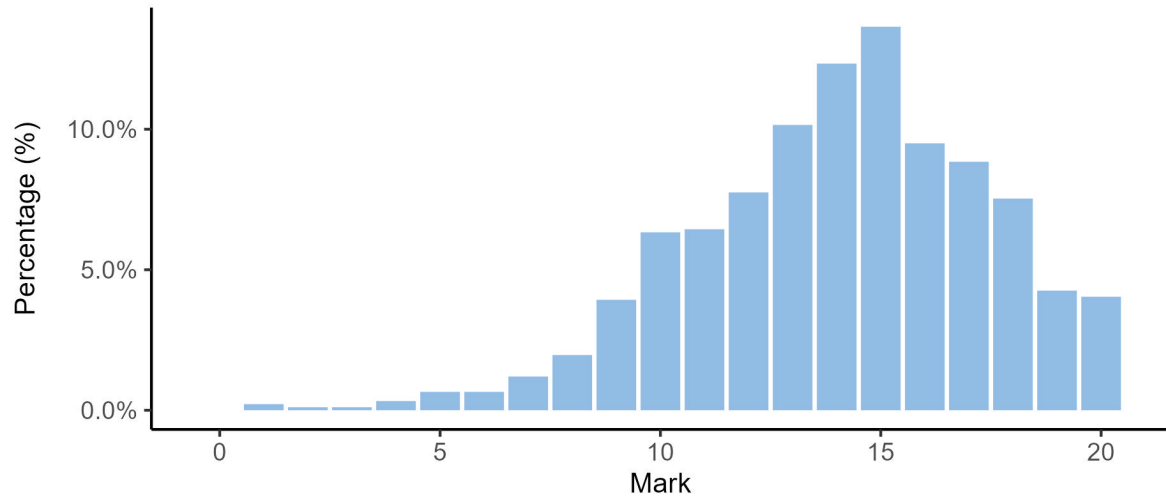


IA1 Criterion: Data test

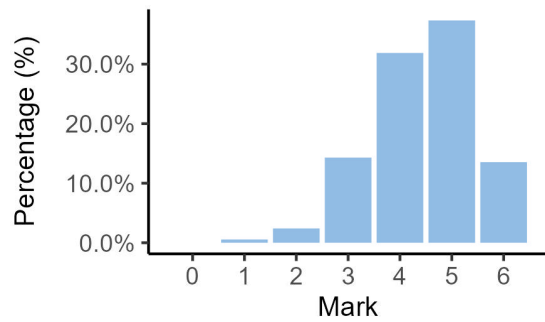


IA2 marks

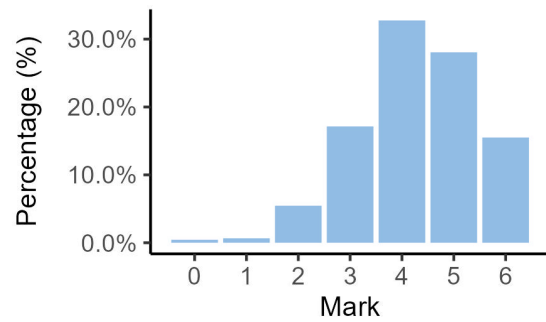
IA2 total



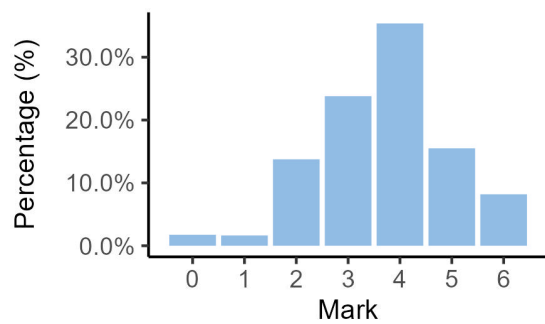
IA2 Criterion: Research and planning



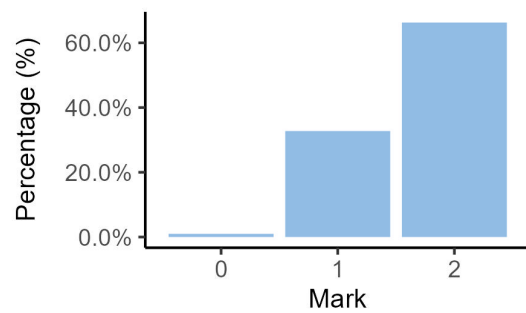
IA2 Criterion: Analysis of evidence



IA2 Criterion: Interpretation and evaluation

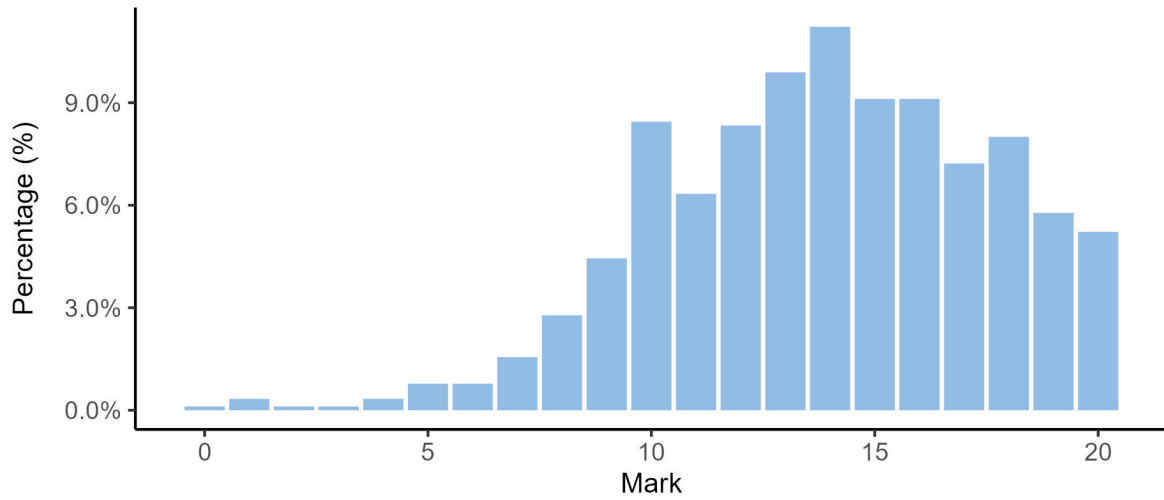


IA2 Criterion: Communication

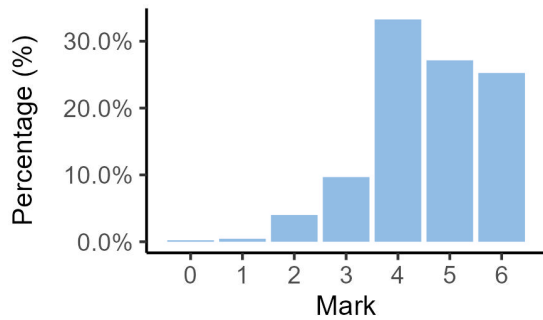


IA3 marks

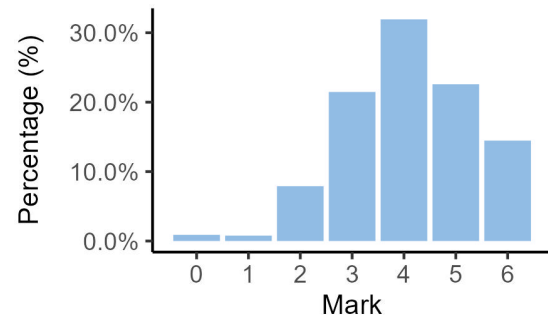
IA3 total



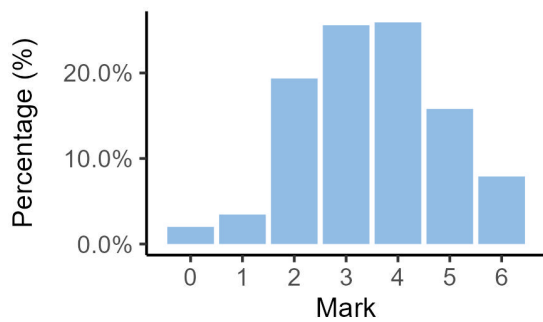
IA3 Criterion: Research and planning



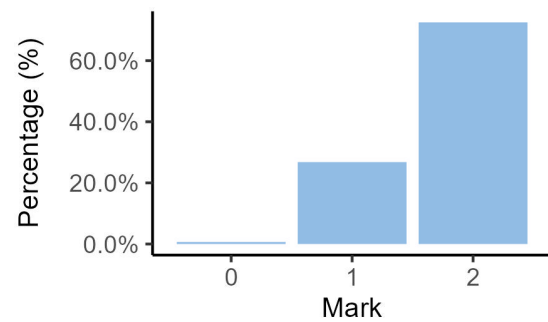
IA3 Criterion: Analysis and interpretation



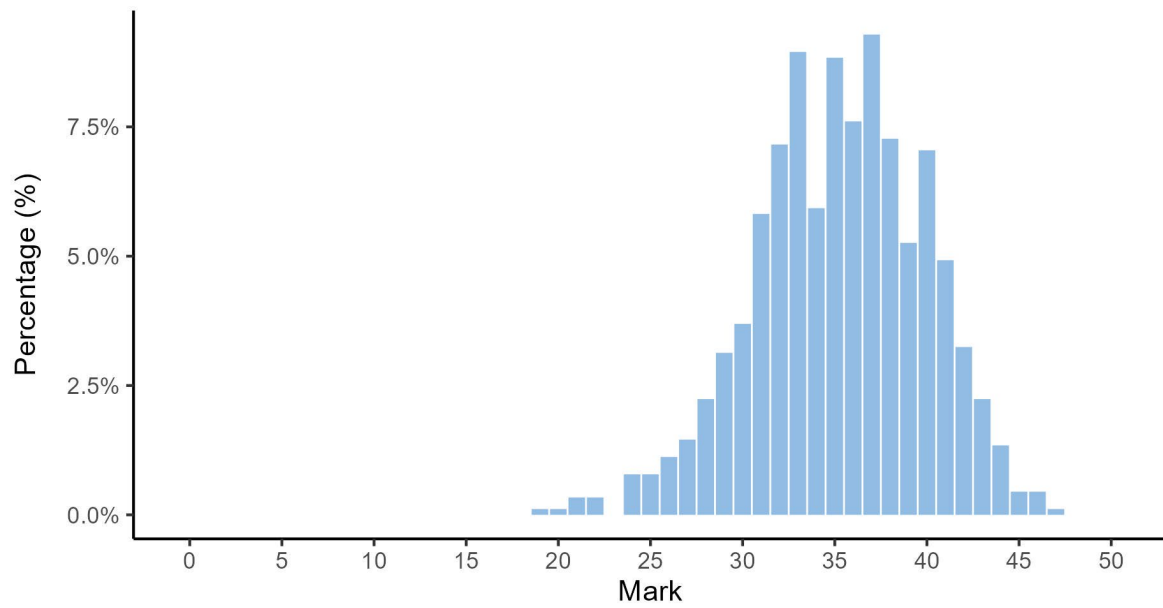
IA3 Criterion: Conclusion and evaluation



IA3 Criterion: Communication

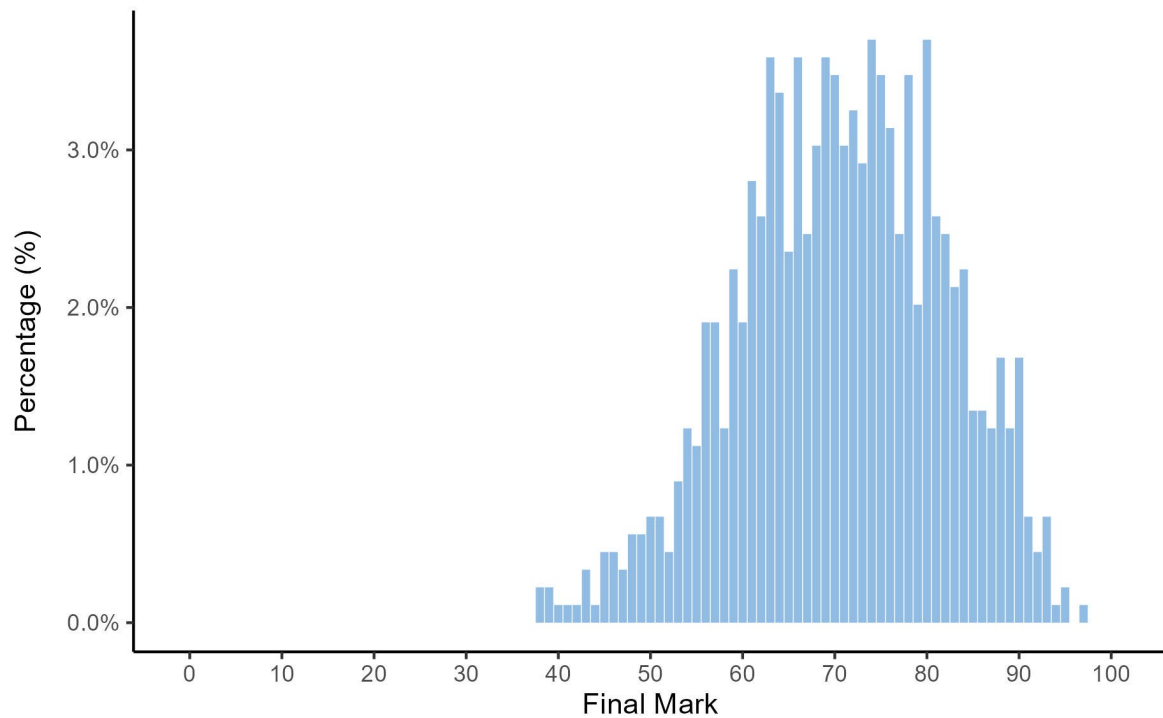


External assessment (EA) marks



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	100–83	82–68	67–48	47–19	18–0

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	135	413	322	22	0

Internal assessment



The following information and advice relate 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 *QCE and QCIA policy and procedures handbook v5.0*, Section 9.6.

Percentage of instruments endorsed in Application 1

Number of instruments submitted	IA1	IA2	IA3
Total number of instruments	54	54	54
Percentage endorsed in Application 1	37%	77%	87%

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 instrument-specific marking guide (ISMG), and are used to make decisions about the cohort's results.

Refer to *QCE and QCIA policy and procedures handbook v5.0*, Section 9.7.

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

IA	Number of schools	Number of samples requested	Number of additional samples requested	Percentage agreement with provisional marks
1	53	285	0	98.11%
2	53	359	41	64.15%
3	53	355	14	79.25%

Internal assessment 1 (IA1)



Data test (10%)

This assessment focuses on the application of a range of cognitions to multiple provided items.

Student responses must be completed individually, under supervised conditions, and in a set timeframe.

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	25
Authentication	0
Authenticity	6
Item construction	2
Scope and scale	5

*Each priority might contain up to four assessment practices.

Total number of submissions: 54.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- featured contextually relevant datasets that were clearly derived from topics relevant to Unit 3 subject matter, e.g. datasets that show beneficial relationships between herbivorous fish populations and reduced algal cover of corals
- provided opportunities for students to respond to each assessment objective using a variety of skills and cognitions, e.g. calculate quantities and identify features when assessing Objective 2
- ensured that the marks allocated for each question aligned with the scale of the expected response, e.g. the marking guide avoided awarding part marks; multi-step calculations only awarded marks for appropriate steps.

Practices to strengthen

It is recommended that assessment instruments:

- ensure marks are based on the nature of response required for the objective assessed, e.g. Objective 4 responses draw conclusions based on the analysis of data

- assess specific cognitions using a range of skills, e.g. when assessing Objective 2, include calculate and determine cues to avoid repetition of questions requiring students to identify a value from a graph
- provide opportunity for students to produce unique responses by ensuring datasets are sufficiently different from QCAA samples.

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	2
Language	10
Layout	10
Transparency	11

*Each priority might contain up to four assessment practices.

Total number of submissions: 54.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- used datasets that could be clearly read by students, e.g. graphs that included scales and data plots that were clear and legible when printed
- ensured datasets were clearly identified and were referred to within the question using appropriate cues, e.g. 'use evidence from Figure 3'.

Practices to strengthen

It is recommended that assessment instruments:

- use cues that clearly indicate the requirements of the expected student response, e.g. 'Justify your response'
- include only necessary information within datasets, e.g. remove extraneous information that is not required to generate an appropriate response or demonstrate the cognitions being assessed
- apply formatting features consistently, e.g. labelling of figures/tables or relative positioning of context, dataset and questions.

Additional advice

- Quality assurance processes should be carried out prior to submitting assessments for endorsement to ensure that they adhere to syllabus requirements (*QCE and QCIA policy and procedures handbook v5.0*, Section 9.6.1). These processes should also ensure that the uploaded marking scheme aligns with the assessment instrument submitted for endorsement.
- Datasets should be sufficiently different from year to year to allow for unique student responses (see *Guidelines for reviewing and developing assessment instruments: Advice to*

schools — *Sciences* under Resources in the Syllabuses application (app) on the QCAA Portal).

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	98.11%	1.89%	0%	0%

Effective practices

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

- annotations on student responses (e.g. ticks and crosses) were used to indicate where evidence matched the marking scheme (*QCE & QCIA policy and procedures handbook v5.0*, Section 9.7.1)
- provisional marks were accurately calculated by correctly converting the awarded marks to a percentage using the total possible marks, and then applying the percentage cut-offs in the ISMG (see the *Making judgments* webinar under Resources in the Syllabuses app).

Samples of effective practices

The following excerpt demonstrates the use of annotations on a student response to indicate where evidence matches the marking scheme in an Objective 2 item that required determination of an unknown scientific quantity. The response includes the substitution of values into the formula (1 mark) and correct calculation of the SDI value (1 mark).

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.



The following excerpt demonstrates the use of annotations on a student response to indicate where evidence matches the marking scheme in an Objective 3 item that required analysis to

determine the percentage coral cover and density of *Acanthaster*. The response uses evidence (1 mark) to identify the relationship between these two variables (1 mark).

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

As *Acanthaster* Density increases percentage coral cover decreases, this can be seen on the graph where at $0.5n/100m^2$ Percentage cover was 80% and at $2n/100m^2$ percentage cover was 20%.

The following excerpt demonstrates the use of annotations on a student response to indicate where evidence matches the marking scheme in an Objective 4 item that required a conclusion be drawn regarding the impact of coral bleaching on fish communities (1 mark). This conclusion was based on the interpretation of coral bleaching data and fish surveys (1 mark).

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

According to the data, bleaching does not negatively affect fish communities in Moreton Bay. This is because although there ~~was~~ was bleaching, the areas with the highest bleaching % also had the highest SDI values. Eg. 27.5% bleaching at Shag rock, calculated SDI of 0.8 whereas ~~and~~ ^{only} 5% bleaching at mid island, SDI of 0.26. This means that bleaching does not negatively affect fish communities in Moreton Bay.

Practices to strengthen

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

- marking schemes outline the allocation of marks to valued features of the expected student response. To support consistent judgments, marking schemes should also provide a suggested response
- the use of partial credit (i.e. part marks) is avoided for incomplete cognitions
- marking schemes are updated prior to confirmation review to ensure errors are corrected and alternative student responses are accounted for.

Additional advice

- Internal quality assurance processes (e.g. cross marking) should be implemented to ensure intra- and inter-marker reliability (*QCE and QCIA policy and procedures handbook v5.0*, Section 9.7.1).

- The language used in the assessment instrument (e.g. labelling of figures/tables) should align with language used in the marking scheme.
- Student responses to comparable assessments need to be clearly annotated and the related marking scheme supplied at confirmation. Comparable assessments should be developed in the Endorsement app to ensure the correct examination and its matching marking scheme are available for confirmation (*QCE and QCIA policy and procedures handbook v5.0, Section 7.4*).

Internal assessment 2 (IA2)



Student experiment (20%)

This assessment requires students to research a question or hypothesis through collection, analysis and synthesis of primary data. A student experiment uses investigative practices to assess a range of cognitions in a particular context. Investigative practices include locating and using information beyond students' own knowledge and the data they have been given.

Research conventions must be adhered to. This assessment occurs over an extended and defined period of time. Students may use class time and their own time to develop a response.

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	7
Authentication	2
Authenticity	0
Item construction	6
Scope and scale	0

*Each priority might contain up to four assessment practices.

Total number of submissions: 54.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- provided scaffolding that supported students to develop a unique research question
- used primary data generated by students as part of their fieldwork.

Practices to strengthen

It is recommended that assessment instruments:

- ensure all task specifications are included and align with the syllabus requirements of the assessment instrument (Syllabus section 4.5.2)
- clearly identify the task elements to be completed individually and task elements to be completed as a group (e.g. using asterisks in the task specifications) and include appropriate authentication strategies that reflect this decision.

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	0

*Each priority might contain up to four assessment practices.

Total number of submissions: 54.

Effective practices.

Accessibility priorities were effectively demonstrated in assessment instruments that:

- provided clear and consistent communication of the genre to be used, i.e. written (e.g. scientific report) or multimodal (e.g. scientific poster presentation)
- avoided unnecessary jargon when providing scaffolding
- included checkpoints to monitor student progress throughout the task.

Practices to strengthen

There were no significant issues identified for improvement.

Additional advice

- Quality assurance processes should be carried out prior to submitting assessments for endorsement to ensure that they demonstrate 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	79.25%	20.75%	0%	0%
2	Analysis of evidence	81.13%	13.21%	0%	5.66%

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
3	Interpretation and evaluation	83.02%	11.32%	5.66%	0%
4	Communication	98.11%	0%	1.89%	0%

Effective practices

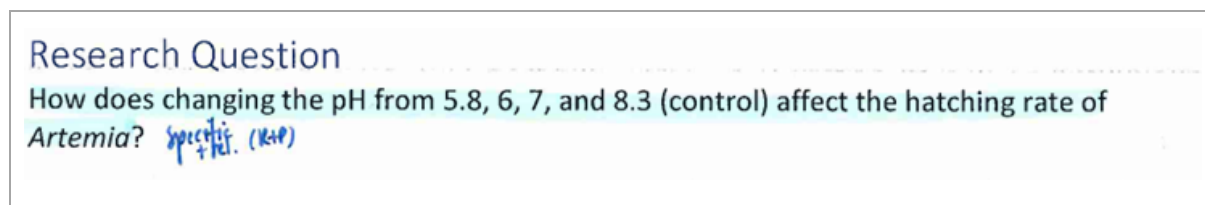
Accuracy and consistency of the application of the ISMG for this IA was most effective when:

- for the Interpretation and evaluation criterion
 - conclusions directly responded to the research question and were *justified* using supporting trends, patterns and relationships identified in the analysis of evidence
 - critical evaluation of the reliability and validity of the experimental process involved *justified* discussion of the uncertainty and limitations identified in the analysis of evidence
 - *logically derived* improvements and extensions were based on the analysis uncertainties and limitations, and explained how specific aspects of the experimental process could be further refined, redirected or extended to improve the validity of the experiment or reliability of evidence.

Samples of effective practices

The following excerpt demonstrates a specific and relevant research question. This shows a question relevant to Unit 3 subject matter that clearly indicates the relationship between specified variables.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.



The following excerpt demonstrates processing of data that is correct and relevant to the research question. This shows an appropriate graphical representation of correlational data using a scatter graph created from raw data and a measure of correlation (regression).

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

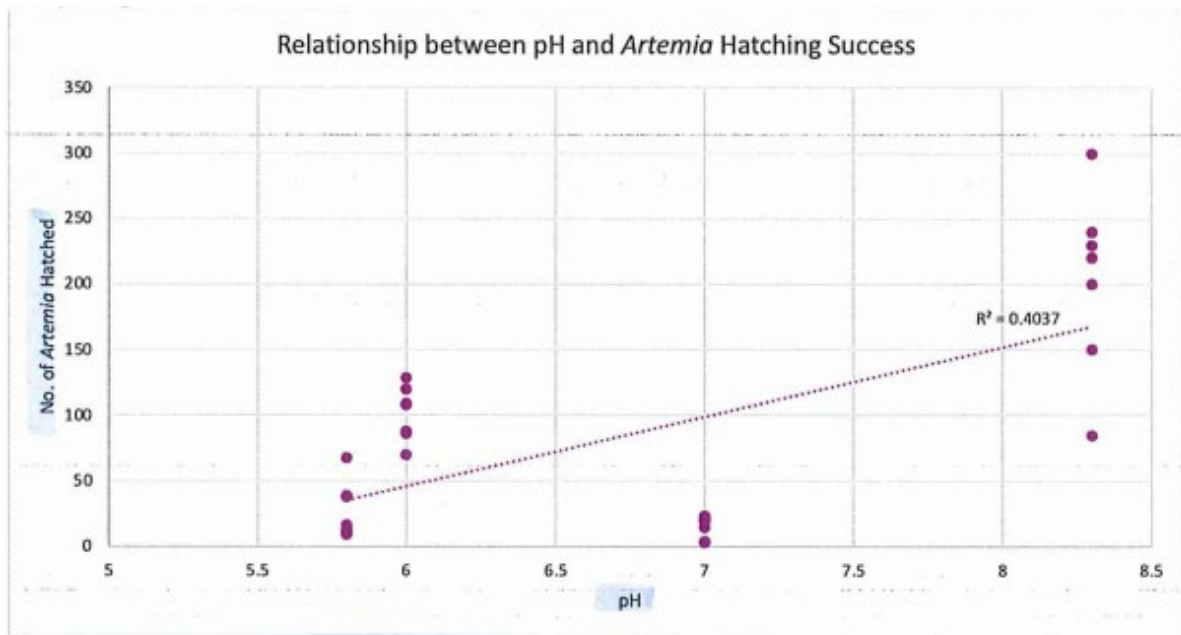


Figure 7: Relationship between pH and Artemia hatching success.

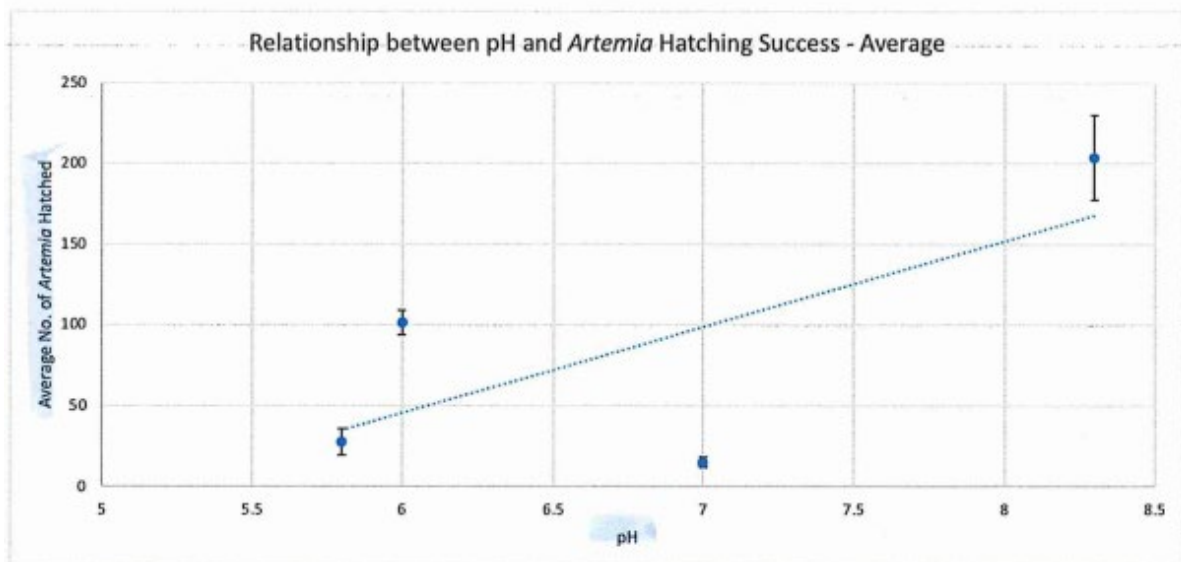


Figure 8: Relationship between pH and Artemia hatching success, depicted by average values. Error bars depict standard error.

The following excerpt demonstrates processing of data that is correct and relevant to the research question. This includes a summary raw data table showing treatments, replicates, a measure of central tendency (mean) and an indicator of uncertainty (SE). Correct and relevant representation of categorical data is shown using a bar graph with custom error bars and a t-test.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Processed data:

Table 3: Mean, standard deviation, standard error

Locations	Mean	SD	SE
Tydemann Reef	22.50	18.45	5.83
Wilson Reef	42.00	13.17	4.17
Southeast Edge, Osprey Reef	100.00	0.00	0.00
Northeast Osprey Reef	100.00	0.00	0.00

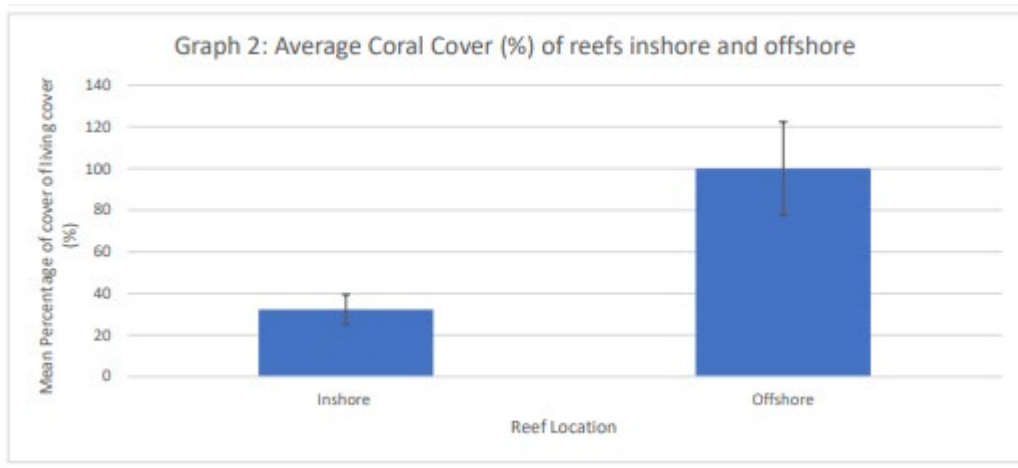


Table 4: Mean

Locations	Mean	P-Value: 0.01195 Alpha-Level: 0.05
Inshore reefs	32.25	
Outer shore reefs	100	

The following excerpt demonstrates improvements and extensions to the methodology that are logically derived from the analysis of evidence.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Improvements

- Increasing the number of grid squares in the quadrat to determine a more accurate percentage cover, along with using larger and clearer photos to gain a precise percentage reading may improve accuracy of the results, and increase the reliability of the data
- To improve the reliability of the data, locations with different proximity to shore, for example, Magpie or Noddy reefs and, Potter or Gilbey reefs - could be used to test the robustness of the experiment's conclusions
- To enable more data points the number of photos selected could be increased from 40 to 80
- Percentage coral cover calculated from each photo could be done three times by three different researchers with the resulting average used as the percentage cover used for that photo - improving the accuracy of measurements
- Using a printed copy of a grid quadrat would ensure that the lines are straight and the squares equal in size, minimising human error
- To accurately determine the percentage cover, AI could be used to distinguish between living and dead coral in a photo, thereby eliminating differences in human perception, as well as researcher bias

Extensions

- Analysing certain types of coral as well as conducting the experiment in varying weather to determine if this changes the total percentage of coral cover
- Techniques which analyse coral health, colour, temperature and water quality
- Comparative testing of other coral from different regions from multiple studies on the same investigation to find whether the results are consistent across geographical locations, thus identifying similarities and differences in coral reef health across locations.
- Conducting experiments during different seasons to account for seasonal variations in water quality and coral health, and investigate whether there is a statistically significant difference across seasons which could then lead to further research to determine relevant seasonal causal factors, potentially improving reef management strategies worldwide.

Practices to strengthen

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

- for the Research and planning criterion
 - a *considered* rationale clearly connects the research question to Unit 3 subject matter, identifies the relevance of the independent and dependent variables, and provides a scientifically informed basis for the experiment
 - a *specific* research question explicitly states the relationship between an independent and dependent variable, and relevant parameters (e.g. time of reaction or number of days) are included where appropriate
 - each modification to the original methodology is *justified* by explaining how the refinement, redirection or extension improves the reliability or validity of the experiment
 - *considered* management of risks, ethical and environmental issues is specific to the research question and demonstrates careful and deliberate thought.
- for the Analysis of evidence criterion
 - *correct* processing of data includes
 - *relevant* measures of central tendency (e.g. mean), measures of dispersion (e.g. standard deviation) and indicators of uncertainty (e.g. standard error) along with

measures of correlation (e.g. Pearson correlation coefficient, r) or a comparison of means (e.g. t-test)

- graphical representations *relevant* for the processed data (i.e. bar graphs used for comparisons, line graphs used for trends and scatterplots created from raw data) are used to identify relationships
- *thorough* identification of trends, patterns and relationships is directly related to answering the research question and allows for the development of a justified conclusion
- *thorough* and *appropriate* identification of the uncertainty and limitations is clearly linked to the research question and is supported by data and/or reasoning.

Additional advice

- Appendixes should only include supplementary material that is not directly used as evidence when marking the response (*QCE and QCIA policy and procedures handbook v5.0*, Section 8.2.6), e.g. if
 - raw data is included in an appendix, there must be evidence of collection of sufficient and relevant raw data in other areas of the response, e.g. methodology, sample calculations and data summary table or presentation
 - the risk assessment is included in an appendix, there must be evidence of considered management of both risks and ethical/environmental issues in the response.
- Schools should review advice about how to determine provisional marks using the best-fit model (refer to *Using ISMGs For General Science syllabuses* under Resources in the Syllabuses app on the QCAA Portal).

Internal assessment 3 (IA3)



Research investigation (20%)

This assessment requires students to evaluate a claim. They will do this by researching, analysing and interpreting secondary evidence from scientific texts to form the basis for a justified conclusion about the claim. A research investigation uses research practices to assess a range of cognitions in a particular context. Research practices include locating and using information beyond students' own knowledge and the data they have been given.

Research conventions must be adhered to. This assessment occurs over an extended and defined period of time. Students may use class time and their own time to develop a response.

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	3
Authentication	1
Authenticity	0
Item construction	1
Scope and scale	0

*Each priority might contain up to four assessment practices.

Total number of submissions: 54.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- clearly identified that all elements of this task were to be completed individually and included appropriate authentication strategies
- provided opportunity for students to respond to claims that were clearly derived from Unit 4 subject matter, e.g. 'MPAs are an effective management strategy to ensure marine biodiversity.'

Practices to strengthen

It is recommended that assessment instruments:

- include all task specifications and align with the syllabus requirements of the assessment instrument (Syllabus section 5.5.1).

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 priority	Number of times priority was identified in decisions*
Bias avoidance	0
Language	1
Layout	0
Transparency	2

*Each priority might contain up to four assessment practices.

Total number of submissions: 54.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- clearly identified the claims students could choose from to produce their response
- included stimulus within the task if it was referred to as part of the task instructions.

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	90.57%	7.55%	1.89%	0%
2	Analysis and interpretation	90.57%	7.55%	1.89%	0%
3	Conclusion and evaluation	88.68%	11.32%	0%	0%
4	Communication	100%	0%	0%	0%

Effective practices

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

- for the Research and planning criterion
 - a *considered* rationale clearly linked the development of the research question to the claim and showed an informed application of understanding of relevant Unit 4 scientific concepts
 - the research question was based on *specific* measurable variables *relevant* to syllabus subject matter and aligned to the claim. For instance, an investigation on the effects of commercial fisheries specified the species analysed and the methods used to measure these effects, e.g. catch per fishing effort, bycatch reduction
- for the Analysis and interpretation criterion
 - effective analysis of datasets included *thorough* identification of trends, patterns or relationships between the variables identified in the research question
 - identification of limitations that affected the reliability and validity of the evidence was *thorough* and *appropriate*, and distinct from the discussion of the quality of evidence
 - *sufficient* evidence for all variables stated in the research question was identified, to allow for effective analysis and the development of *justified* scientific arguments.

Samples of effective practices

The following excerpt demonstrates a *considered* rationale that clearly illustrates the development of a *specific* and *relevant* research question from the claim. The research question is relevant to Unit 4 concepts and specifies the variables and how they are measured.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Claim:

Bioaccumulation is a threat to global food security.

Research Question: What is the likelihood that significant amounts of microplastics will be found in salmon, based on bioaccumulation found within their prey?

Rationale:

There are two key concepts within the claim that must be defined to develop a specific research question.

'Bioaccumulation' refers to the accumulation (build-up) of substances within an organism, such as chemicals, plastics or heavy metals. It occurs when the substances are entering the organism at a faster rate than which they can be used or excreted (*Bioaccumulation*, 2020). Bioaccumulation leads to biomagnification; the process of built-up substances being passed on to the next trophic level within a food web and increasing concentration (Adriaens et al., 2007). Bioaccumulation in marine organisms has become more common due to direct and indirect forms of ocean pollution. To narrow the spectrum of data, the common pollutant of marine life, microplastics, will be focused on specifically (*Marine Plastic Pollution*, n.d.).

Microplastics are plastics that have broken down into small, often microscopic, pieces within the ocean that plague the diets of fish. Microplastics give the algae they consume a surface to grown on, then enter into the stomachs of the fish once consumed. Insect larvae and other organisms consumed by fish are also susceptible to microplastic accumulation (Kögel et al., 2023).

An example of biomagnification is when humans consume fish that have accumulated microplastics within their bodies. While its estimated humans only consume about 1000 microplastics from fish each year, microplastics accumulate within the body. This can cause cancer, chronic inflammation and other effects (Lee et al., 2023). As microplastics in marine life accumulate, it is possible that fish may become a food unsafe for humans to consume.

Salmon is one of the most consumed fish globally and is a source of protein and nutrients, consumed by more than 3 billion people (*Sustainable Seafood | Industries | WWF, n.d.*). Salmon are primarily piscivorous predators and feed on other fish, therefore microplastics can enter the stomachs of salmon when fish they prey upon have consumed them. Wild salmon prey on a variety of fish species including herring, lanternfish, anchovies and sprat (Sissener, 2018). In fisheries, their diets consist mainly of fishmeal, which is generally made up of oily fish like mackerel, anchovies, herring and sardine (Barlow, 2003).

Salmon becoming inconsumable would create a threat to global food security. Global food security, the second key term, refers to the global human population's ability to access safe and nutritious foods (*Global Food Security | Journal | ScienceDirect.com by Elsevier, n.d.*). Increase in accumulation of microplastics in salmon would make it an unsafe food and limit access to it.

This report aims to investigate the likelihood that salmon will contain microplastics due to accumulation within their prey, determining if it is currently a safe food for consumption by humans and the future implications if bioaccumulation of microplastics were to increase.

The following excerpt demonstrates a critical evaluation of the research processes and claims. The student response shows an insightful description of the quality of evidence, including recency, methodology and sample size. The validity and reliability of the evidence is also considered.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Evaluation:

In order to determine if the evidence is sound enough to answer the research question, the reliability and validity of the data must be considered. All studies are recent and were published within the last 5 years. Table 1 & 2 and figure 2 were published in 2018, and figure 1 in 2021. This increases the validity as amounts of microplastic found in fish are representative to recent levels of ocean pollution. All data sets are relevant to the research question as they all investigate microplastics in multiple species of salmon prey in multiple environments. Sampling bias is also avoided as random sampling was used to collect the samples, increasing validity of the data.

The quality of some data was greatly affected by small sample sizes. All samples in table 1 were under 100 fish, most under 20. All samples in table 2 had under 20 fish. These small samples decrease validity and reliability as they are less representative of the actual population. If the experiments were to be repeated with a new sample, it is highly likely the results would greatly differ. The data referenced as salmon prey in figure 1 all had sample sizes of over 100.

The reliability was also impacted by uncontrolled variables. Figure 1 references fish commonly used in fishmeal as a predictor of accumulation of microplastics in farmed salmon. The data only shows the microplastics within the fish, regardless of length or weight. The extraction of microplastics before making fishmeal was not considered and could greatly decrease the amount of microplastics that end up in fishmeal. The reliability of being able to draw conclusions of how much microplastic is found within fishmeal simply based on what's found in the fish is decreased.

The following excerpt demonstrates a critical evaluation of the research processes and claims. This excerpt suggests improvements and extensions to the investigation that are considered and relevant to both limitations of the evidence and the claim.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Suggested Improvements

- Ensure all investigative data is collected under similar conditions using similar methodologies to draw accurate and reliable conclusions.
- Enhance conclusions drawn by gathering additional sources regarding the 2011 MHW's effect on annual catch and CPUE of Shark Bay blue swimmer crabs. This increases the investigation's reliability as conclusions are verified by a wider variety of credible findings.

Good

Suggested Extensions

- Expand on current conclusions by sourcing scientific research outlining MHW effects on blue swimmer crab fisheries globally instead of Shark Bay alone. This would increase reliability of conclusions drawn and enable the claim's findings to be extrapolated in a more reliable, valid manner.
- Increase the investigation's scope by highlighting whether MHWs reduce annual catch and CPUE of other crustaceans (e.g. brown tiger prawns) in Shark Bay. This would enable clear conclusions to be drawn as to what extent the Crustacea subphylum is affected by MHWs and whether some species are more resistant to MHW conditions than others.

Good

Practices to strengthen

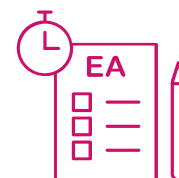
To further ensure accuracy and consistency of the application of the ISMG for this IA, it is recommended that:

- for the Conclusion and evaluation criterion
 - an *insightful* description of quality of evidence includes consideration of the reliability and validity of identified evidence and the effect this consideration has on the ability to draw a justified conclusion to the research question
 - both improvements and extensions to the investigation are proposed and suggestions are considered in relation to the identified limitations of evidence and are *relevant* to the claim
 - *justified* conclusions relevant to the research question are supported by the *credible* scientific findings developed through interpretation of evidence, which can then be *extrapolated* upon when responding to the claim.

Additional advice

- Students should be supported through the investigation in order to satisfactorily complete the task (refer to the *IA3 effective processes and practices* resources available in the Syllabuses app on the QCAA Portal).
- School-based assessment policies and procedures for managing response length must be applied clearly and consistently when making judgments about student responses to assessment (*QCE and QCIA policy and procedures handbook v5.0*, Section 8.2.6).
- Schools should review advice about how to determine provisional marks using the best-fit model (see the *Making judgments* webinar and *Using ISMGs for General Science syllabuses* under Resources in the Syllabuses app). Further information about making judgments using an ISMG is also available in the Assessment Literacy app (*Module 3 — Making reliable judgments*).

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.

Examination (50%)

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 two papers:

- Paper 1, Section 1 consisted of multiple choice questions (20 marks)
- Paper 1, Section 2 consisted of short response questions (26 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 and Managing fisheries.

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

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 question responses

There were 20 multiple choice questions 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	7.02	1.13	1.47	90.37
2	3.51	11.1	12.68	72.59
3	68.4	14.72	10.19	6.68
4	47.68	4.98	45.07	2.15
5	9.51	19.25	64.89	6.23
6	44.85	23.78	15.18	15.97
7	63.76	22.54	12.68	1.02
8	5.21	94.68	0.11	0
9	6.34	38.96	16.08	38.62

Question	A	B	C	D
10	11.1	80.86	6.12	1.7
11	76.33	8.27	7.25	7.81
12	57.19	18.46	14.38	9.85
13	7.59	56.51	11.44	24.46
14	15.74	3.62	77.58	2.94
15	15.4	8.38	65.46	10.42
16	20.27	51.42	14.84	13.36
17	11.33	6.23	78.26	4.08
18	16.87	7.7	4.64	70.55
19	0.68	4.53	93.77	0.91
20	56.4	26.84	3.06	13.59

Effective practices

Overall, students responded well when they:

- identified stages of the life cycle of coral
- identified and described factors that affected coral reef distribution
- explained the application of the precautionary principle to different situations
- identified unknown scientific quantities or features from a graph.

Samples of effective practices

Short response

The following excerpt is from Question 26b) in Paper 1. It required students to explain a management technique that should be implemented to prevent overexploitation of a resource.

Effective student responses:

- identified a management technique
- explained the management technique.

This excerpt has been included to demonstrate a clear explanation of the management technique.

Considering the limited data available, a precautionary total allowable commercial catch (TACC) would reduce and prevent overexploitation. A TACC reduces the mass (although sometimes the number) of fish that can be removed within a year. With the addition of fixed quotas, fisheries resources can be shared among stakeholders in a sustainable way. TACC prevents unsustainable yield, supporting reproduction in fisheries.

The following excerpt is from Question 4b) in Paper 2. It required students to explain how one biotic and one abiotic factor affect the site selection process.

Effective student responses:

- identified an abiotic factor
- identified a biotic factor
- explained how each factor affects site selection.

This excerpt has been included:

- to demonstrate clear explanations of the roles the identified biotic and abiotic factors have on site selection by coral planula.

A biotic factor is the presences of crustose coralline algae, the algae provides chemical cues to the planula to indicate that it can settle. An abiotic factor is the current, ocean currents distribute gametes and planulas affecting site selection as they move them between and across reefs.

The following excerpt is from Question 5 in Paper 2. It required students to explain the role of connectivity in species replenishment, using a relevant fish species as an example.

Effective student responses:

- identified an example of a relevant fish species
- explained that the identified species moves between habitats during its life cycle
- explained the importance of connectivity in species replenishment.

This excerpt has been included:

- to demonstrate a clear explanation of the importance of connectivity in species replenishment and identification of a species that moves between habitats during its lifecycle.

Connectivity is vital to species replenishment. The mangrove jack fish is one such example. As juveniles, the mangrove jack lives in mangrove ecosystems before migrating to the coral reefs as mature adults. The connectivity between the mangrove and coral reef ecosystems is vital to their survival as this fish species requires the mangroves to provide food and shelter. This is important for species replenishment, as because if something were to happen to the adult mangrove jacks on the reef, the juveniles already within the mangroves provide the species with a chance to reproduce and replenish their numbers.

The following excerpt is from Question 6b) in Paper 2. It required students to draw a conclusion about the state of global fisheries and justify their conclusion.

Effective student responses:

- concluded that global fisheries are in decline
- identified two pieces of supporting evidence to justify the conclusion.

This excerpt has been included to demonstrate a justified conclusion using trends in data.

- overtime, global fisheries have declined
- the amount of over- and fully-fished stocks have greatly increased (from 10% - 35% and 50% - 60% respectively) between 1975-2015.
- the amount of underfished fish stocks has decreased from 40% - 5% over the same time.

Practices to strengthen

When preparing students for external assessment, it is recommended that teachers consider:

- how students need to respond to the *explain* cognitive verb to demonstrate understanding of concepts, e.g. explanation of a management technique, explanation of low food conversion ratio and the importance of connectivity to species replenishment
- teaching and learning opportunities that allow development of quality responses to fully describe or explain concepts, especially in relation to multi-step processes, e.g. the effect of decreased pH of ocean water on skeletal or shell-forming organisms, and the dissolution of carbon dioxide into ocean waters
- ensuring students' understanding of key concepts is precise and not conflated, e.g. identifying pH as a factor that affects the distribution of coral reefs or describing food web relationships when explaining connectivity
- breaking down responses to interpret evidence cognitions. This includes
 - developing the significance aspect of compare questions
 - using relevant evidence from data to justify conclusions or predictions.