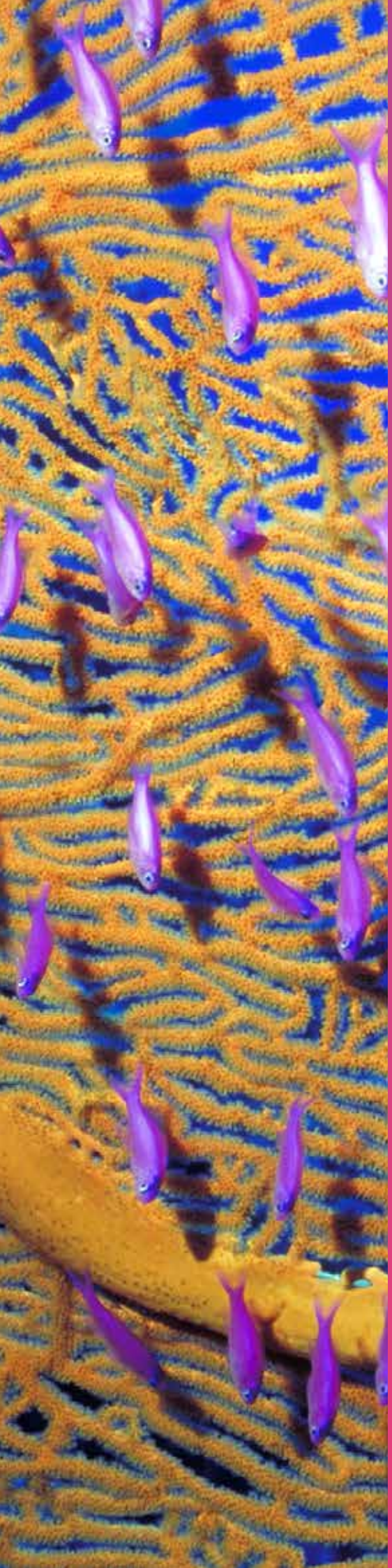

Australian Government

Great Barrier Reef Marine Park Authority

Instructional Manual for Reef Guides

Senior School

Part of the:

'*Be a Marine Biologist for a Day*' Toolkit

Published by the Great Barrier Reef Marine Park Authority

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Preface

The Great Barrier Reef Marine Park Authority has produced this package of resources to assist reef guides working on tourism operations facilitate high quality educational excursions for students and teachers visiting the Great Barrier Reef. These resources will also assist teachers in prepare students for their visit before their excursion and make further connections after.

Visiting the Great Barrier Reef is not just an amazing opportunity for all those involved. Reef activities undertaken by tourism operators, schools and other organisations make an important contribution to promoting understanding of the Great Barrier Reef Marine Park. Our 'Eye on the Reef' monitoring and assessment program enables anyone who visits the Reef to contribute to its long-term protection by collecting valuable information about reef health, marine animals and incidents. These are used to understand the bigger picture and inform how we manage the Reef.

This toolkit uses our Eye on the Reef rapid monitoring survey on Reef visits and builds students' abilities to use this tool from prep to senior school. The educational resources have been written by a Queensland marine science teacher with curriculum-linked content specific to each year level. What makes these resources even better is that they are editable, so that teachers and reef guides can include local context, such as introducing the tourism staff that students will meet and reef site-specific information. This enables students to take their learning from the classroom to the coral.

This toolkit adds to the vast collection of educational materials the Great Barrier Reef Marine Park Authority has produced over many years. It looks forward to the knowledge and understanding this will bring to the tourism industry, as edutourism continues to grow, as well as educators and students.

Dear reef guide,

The purpose of these instructions are to give you an insight into the world of senior school in Queensland, Australia, so you can provide them with an experience that is targeted to their needs. Students in Years 11 and 12 are typically 16-17 years of age.

Whilst excursions are a popular drawcard, most students choose their subjects with the intention of applying to university or obtain a qualification that will help them gain future employment. Either way, school excursions provide unique opportunities for students to become immersed in the curriculum, transforming learning intentions in a unit plan into experiences that are often remembered for years to come. They are a valuable opportunity for you, as a reef guide, to have a large impact on that learning experience and help them succeed in their studies.

However, excursions require a lot of work to organise. Teachers must submit lengthy excursion requests that may or may not be approved depending on school timetables, funding and other hurdles, such as covid. Permissions and payments need to be collected from parents and guardians. Parent helpers, other teachers or learning support workers need to be organised to help on the day. Classes need covering, buses need organising and students need preparing. Therefore, the purpose of the excursion and its outcomes need to be clearly justified.

This aim of these instructions is to help you to prepare for senior school excursion groups by becoming familiar with their experiences at school. In doing so, you will be able to connect the experiences they have at school with the experiences they have on the Reef.

These instructions are divided into five chapters. The first three chapters are based on the Pedagogical Content Knowledge (PCK) model for teachers The first chapter is all about the curriculum. It begins with a broad national focus, to provide context, followed by a detailed look at the two senior marine subjects offered in Queensland schools: (1) marine science, and (2) aquatic practices. It includes a list of all subject matter taught, as well as some sample assessment items, so you know the level of understanding expected of each subject. The second chapter is about how to teach with a selection of teaching pedagogies. Notably, the teaching pedagogy for this *Be a Marine Biologist for a Day* program is an inquiry-based pedagogy, with an overarching inquiry question, '*How can I help the Great Barrier Reef?*' The third chapter is about how students learn. The fourth section is about how to use the pre and post snorkel brief cards. The fifth chapter includes suggestions on how to customise the teacher resources in this program to your tourism operation.

I hope you enjoy delivering this program as much as I enjoyed writing it.

Yours thankfully,

Gail Riches
Commissioned author for *Be a Marine Biologist for a Day*
Owner of Marine Education (www.marineeducation.com.au) and Queensland secondary teacher.

What is in the toolkit?

Instructional manual for reef guides

Suggestions for tourism operators running Reef education programs for:

- primary school
- middle school
- senior school

Part 1 Preparing to find out

Pre-excursion resources for use at school:

- PowerPoint presentations
- student activity books

Part 2 Finding out

On-day resources for use on the Reef excursion:

- Pre-snorkel flip chart
- post-snorkel flip chart
- student activity books
- rapid monitoring survey tools

Part 3 Making connections

Post-excursion resources for use at school:

- PowerPoint presentations
- student activity books
- assessment tasks

Contents

Introduction

Instructional Manual for Reef Guides

Edutourism

Tourism and Events Queensland define edutourism as tourism experiences designed or adapted to meet teaching, learning and experience requirements. They are experiences focused on hands-on learning within a tourism context, with potential for outcomes for local research or community programs. Edutourism can be delivered as stand-alone products within a study tour itinerary or packaged to offer authentic, immersive education programs of approximately one to two weeks. Similar to study tours, edutourism programs may or may not produce a formal study outcome/qualification.

If your tourism operation is looking to establish an edutourism product, refer to the Queensland Study Tours and Edutourism Toolkit. The toolkit has been designed to assist education providers and tourism operators in developing study tours and edutourism programs. It is supported by the Study Tours and Edutourism Opportunities Guide including case studies. The toolkit provides an overview of definitions, key success factors, elements of using a consortium-based approach, requirements for ensuring academic integrity, marketing methods, other considerations and sample itineraries.

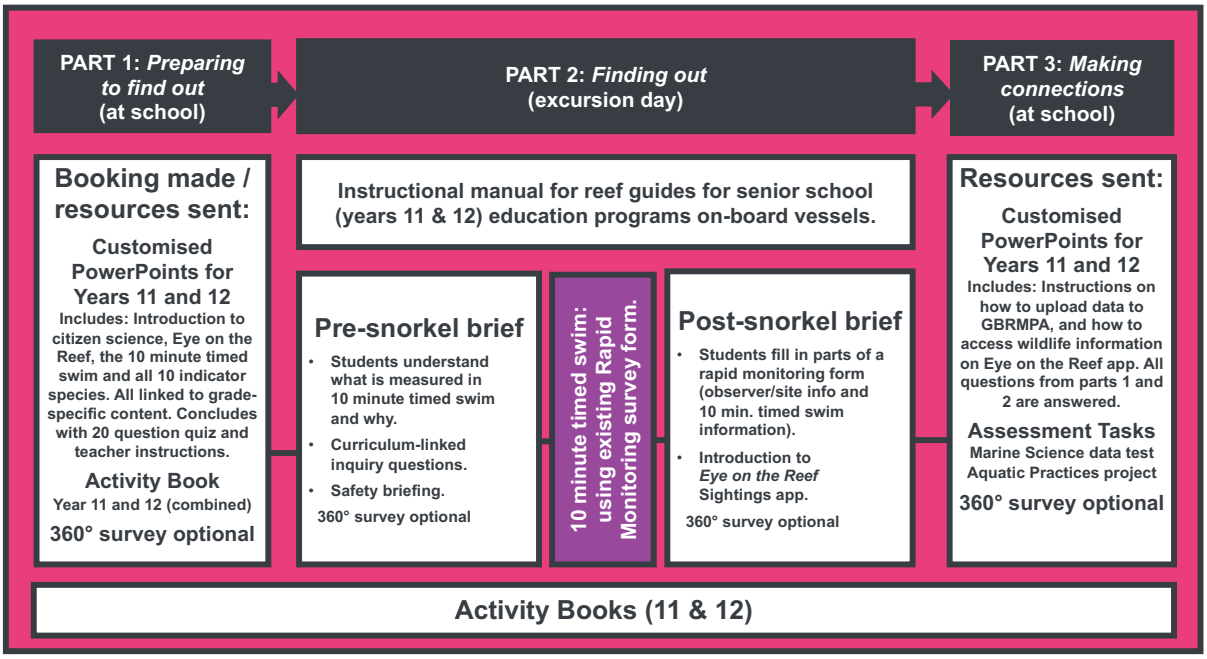
https://teq.queensland.com/industry-resources/how-to-guides/queensland-study-tours-and-edutourism-toolkit

Be a Marine Biologist for a Day has been developed to provide resources with academic integrity and alignment with learning outcomes to present a high quality learning experience for students visiting the Reef.

Be a Marine Biologist for a Day program overview

This manual is part of a training toolkit to support the *Be a Marine Biologist for a Day* learning experience for students visiting the Reef with tourism operators. The toolkit is aimed to develop an understanding of, and appreciation for, the Great Barrier Reef. The main focus of the toolkit is to provide curriculum-linked and grade-appropriate teaching materials for reef guides on board tourism operations delivering education activities to students. The reef guides will lead students using simplified versions of the rapid monitoring survey tools on the Reef. The toolkit also includes pre and post-trip activities and resources that tourism operators can provide to teachers to support the learning objectives of the excursion.

A concept map of the toolkit for senior schools is below (there is also a guide for primary school and middle school excursions).



The toolkit consists of a three-part learning package.

Part 1 *Preparing to Find Out* – pre-excursion resource kit for use at school
Part 2 *Finding Out* – on-day resource kit for use on the Reef
Part 3 *Making Connections* – post-excursion resource kit for use at school

The toolkit is scaled to address three key learning target groups (primary, middle and senior school students) using an inquiry pedagogical model. Each group is further divided into year levels.

Resources are colour coded:

- Orange — Primary school (prep-year 6)
- Blue — Middle school (years 7-10)
- Purple — Senior school (years 11 and 12)
- Red — Additional resources and extension activities (advanced students)

This is the guide for senior students (purple).

The resources for each part are outlined below:

Part 1: Preparing to find out

- Resources that reef guides can share with teachers to be delivered at school, prior to the Reef excursion.
- In-class delivered learning package aimed at preparing students for their Reef excursion. The package develops understanding of the rapid monitoring survey tool as well as general Reef ecosystem and biodiversity knowledge.
- Materials and resources: PowerPoint(s), activity books with corresponding answer books, and teacher instructions (for you to edit/customise).

Part 2: Finding out

- Resources for reef guides to deliver a rapid monitoring survey to schools groups on their Reef excursions.
- Materials and resources: pre-snorkel brief cards/flip book, and post-snorkel brief cards/flip book (developed in PowerPoint so you can edit/customise to your operation, before saving as a PDF and printing double-sided, to make waterproof flip books for use on the Reef). Both flip books include reef guide delivery instructions/cheat sheets to couple the rapid monitoring survey with grade-specific curriculum objectives.
- Modified rapid monitoring survey slates for students to tally their counts of individual species whilst in the water.
- This instructional manual for reef guides to teach target learning groups (primary, middle and seniors levels) and things to consider when delivering educational programs on board vessels.

Part 3: Making connections

- Resources that reef guides can share with teachers to be delivered at school, after the Reef excursion. In-class delivered learning package aimed at reflecting on the Reef excursion and making new connections from the experience that teachers deliver at school.
- Materials and resources: PowerPoint(s) including a 30 question quiz, activity books with corresponding answer books (same as those used for part 1 and 2), and a multi-modal assessment task.

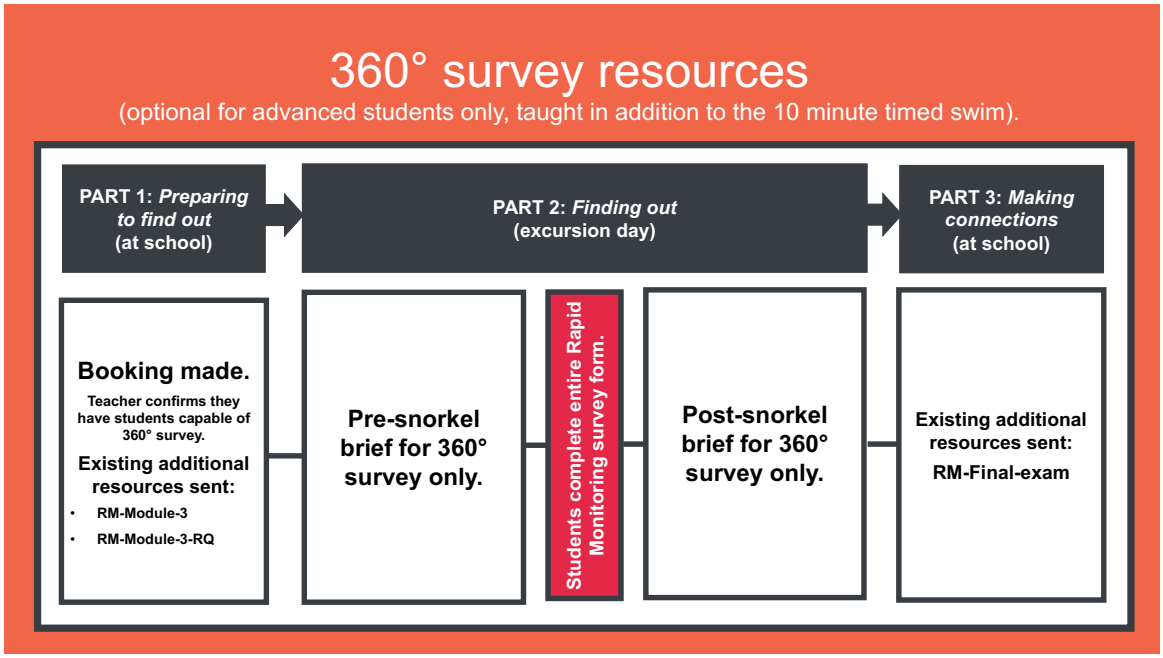
Commonwealth of Australia (GBRMPA). Photographer: M. Knapton.

360° Survey

Due to the young age and inexperience of most participants of the *Be a Marine Biologist for a Day* program, the 360° survey is optional in this program. It enables the school to focus solely on the 10 minute timed swim, to gain an understanding of the indicator species without being overloaded with content.

Senior school students who have the time and are keen and capable to do the 360° survey, can do so. Alternatively, senior students can choose to do the 10 minute timed swim first, and then collect primary data for their assignments for the remainder of their snorkel.

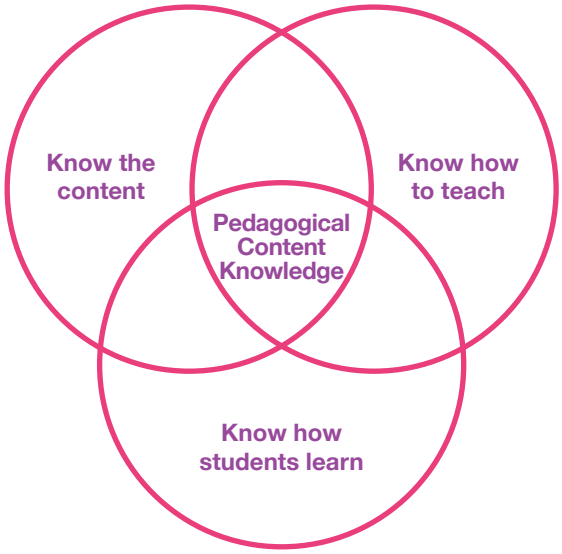
A concept map of the tool kit for the 360° survey is below.



Commonwealth of Australia (GBRMPA). Photographer: K. Anthony.

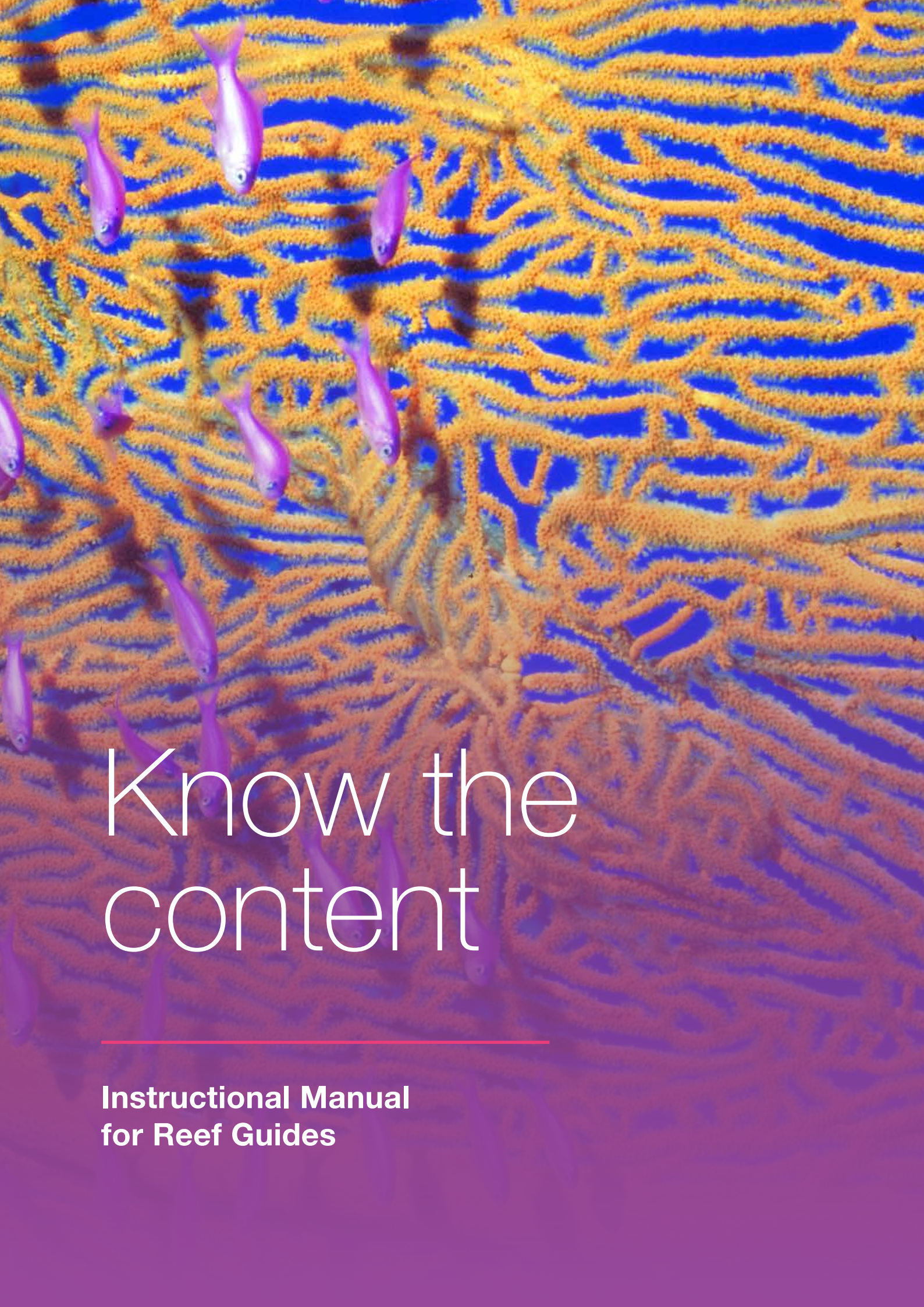
Pedagogical content knowledge

Pedagogical content knowledge is divided into three chapters, inspired by the concept that a good teacher is someone who not only knows the content, but also knows how to teach and how students learn. These chapters are designed to prepare you to deliver high quality education programs to students. They teach you what students are learning at school, how to teach them and how they learn. This knowledge will become your pedagogical content knowledge (PCK), which you will use to teach Part 2 of the *Be a Marine Biologist for a Day* program to senior school students.



PCK was proposed by Lee Shulman in 1985-86 as a *special amalgam* of knowledge possessed by a teacher. PCK has since been widely researched and is regarded as a fruitful tool for understanding teacher knowledge. Just as every profession has a body of knowledge that sets it apart from others and makes people who master such skills considered professionals, so do teachers. PCK is sometimes called 'craft knowledge', or having knowledge of one's craft – being a teacher or educator. PCK is the blending of content (curriculum), pedagogy (how to teach) and learning into an understanding of how particular aspects of subject matter are organised, adapted and represented for instruction. It encompasses theory learned during teacher training and experiences gained from ongoing schooling activities. At the heart of effective teaching is the teacher's PCK.

The next chapters are: (1) know the content (2) know how to teach and (3) know how students learn. In each chapter, your pedagogical content knowledge will continue to build. The pedagogies and theories presented in each of three instruction manuals has been tailored to suit the year levels. Therefore, read all three manuals (for primary, middle and senior school) to grow your knowledge base of how to be a good teacher to students of all ages.



Know the content

Instructional Manual for Reef Guides

Overview of mainstream schooling in Australia

Prep to Year 10

The Australian Curriculum Assessment and Reporting Authority (ACARA) developed the Australian Curriculum for prep to year 10. Learning areas include english, mathematics, science, humanities and social sciences, the arts, technologies, health and physical education and languages. In addition, there are three cross-curriculum priorities and seven general capabilities that teachers should integrate into all learning areas. The cross-curriculum priorities are (1) Aboriginal and Torres Strait Islander histories and cultures (2) Asia and Australia's engagement with Asia and (3) sustainability. The general capabilities are (1) literacy (2) numeracy (3) information and communication technology (4) critical and creative thinking (5) personal and social capability (6) intercultural understanding and (7) ethical understanding.

Year 11 and 12

School in Australia is compulsory until the age of 16. Students who choose to stay at school in years 11 and 12 can either work towards gaining an Australian Tertiary Admissions Rank (ATAR score) for entry into university or undertake a vocational education and training (VET) course whilst at school, such as a school-based certificate, apprenticeship or traineeship.

University prerequisites

University prerequisites are entry requirements that school leavers must meet before they are considered for entry into university. They include ATAR scores and subject prerequisites.

ATAR (Australian Tertiary Admission Rank)

ATAR is the standard pathway to tertiary entry for year 12 school-leavers. ATAR or ATAR-equivalent scores are published by universities to indicate the score a school leaver must achieve to receive an offer. An ATAR is a score between 0 (lowest) and 99.95 (highest) that indicates a student's position relative to all the students in their age group in their state or territory. For example, an ATAR of 80.00 indicates that a student placed in the top 20 per cent of students in their year 12 age group in their state or territory. To be eligible for an ATAR score, a year 12 student must complete (and pass) four to five ATAR subjects. Note: subjects in senior school are either ATAR or non-ATAR. Only Queensland and Western Australia offer marine science as an ATAR subject.

Subject prerequisites

Subject prerequisites are the ATAR subjects that universities list as prerequisites for entry into a university course. For example, the subject prerequisites for a Bachelor of Science might be a C grade in ATAR English, ATAR maths and one ATAR science. Marine science in Queensland is an ATAR subject. However, many year 10 students choose to study biology, chemistry or physics in years 11 and 12, instead of marine science. This is because most universities do not list marine science as a subject prerequisite. James Cook University was the only university that listed marine science as a subject prerequisite in 2020.

ATAR scores are calculated independently by each state or territory (even though they are all considered equivalent). Only three states teach marine as a subject in school.

Queensland

To be eligible for an ATAR score in Queensland, students must select at least five general (ATAR) subjects, four general (ATAR) subjects and one applied (non-ATAR) subject or four general (ATAR) subjects and one VET qualification at Certificate III or above. Students must also successfully complete an English subject. Marine science is a general (ATAR) subject. Aquatic practices is an applied (non-ATAR) subject.

New South Wales (NSW)

To be eligible for an ATAR score in NSW, students must satisfactorily complete at least 10 units of ATAR courses. Marine studies is a non-ATAR subject in NSW.

Western Australia (WA)

To be eligible for an ATAR score in WA, students need to complete a minimum of four year 12 ATAR courses. Marine and maritime studies is an ATAR course.

Victoria (Vic)

To be eligible for an ATAR score in Victoria, students must qualify for the Victorian Certificate of Education (VCE) and achieve study scores in at least four permissible Unit 3 and 4 VCE studies, including one from the English group. A VCE study score is based on results of school assessments and exams. There are no marine subjects in Victoria, only environmental science.

Australian Capital Territory (ACT)

To be eligible for an ATAR score in the ACT, students need to complete at least 20 standard units in a recognised combination. ACT students have their ATARs calculated from their ACT senior school certificate results. There are no marine subjects in the ACT, only earth and environmental science.

Northern Territory (NT)

To be eligible for an ATAR score in the Northern Territory, students need to successfully complete 90 credits of Stage 2 Tertiary Admissions Subjects. There are no marine subjects in the Northern Territory, only earth and environmental science.

Tasmania (Tas)

To be eligible for an ATAR score in Tasmania, students need to complete two years of post-year 10 study. During these two years, students must achieve a Tasmanian Certificate of Education and achieve a satisfactory achievement or better in at least four courses that are scaled. At least three of these courses must be in their final year (either year 12 or year 13). There are no marine subjects in Tasmania, only environmental science.

South Australia (SA)

To be eligible for an ATAR score in South Australia, students need a university aggregate. SATAC calculates the university aggregate by combining the scaled scores from a student's best 90 credits of study. There are no marine subjects in South Australia, only Earth and Environmental Science.

Vocation education and training (VET) pathways

Vocational education and training (VET) is a learning pathway that provides secondary school students with the opportunity to engage in education and training directly related to work. Successful completion of VET or VETis (VET in schools) provides students with nationally recognised qualifications that deliver the skills and knowledge required for specific industries and occupations. Nationally recognised VET must be delivered by a registered training organisation (RTO), including schools that are RTOs, TAFE and private training providers. VET qualifications such as school-based certificates, apprenticeships and traineeships can be undertaken in years 10, 11 and 12 and may provide credit points towards the year 12 Senior Secondary Certificate of Education (SSCE).

Envirotech Education is a private RTO that offers VET courses in marine conservation.

Year 12 Senior Secondary Certificate of Education (SSCE)

Every state or territory in Australia awards some sort of certificate of completion to graduates at the end of year 12: Queensland Certificate of Education (QCE), NSW Higher School Certificate (HSC), Western Australian Certificate of Education (WACE), Victorian Certificate of Education (VCE), ACT Senior Secondary Certificate (AC SSC), Northern Territory Certificate of Education and Training (NTCET), Tasmanian Certificate of Education (TCE) and South Australian Certificate of Education (SACE).

General requirements for each certificate differ between states and territories. For example, in Queensland, students must achieve the set amount of learning, in the set standard, in a set pattern, while meeting literacy and numeracy requirements. The set amount of learning is 20 credit points, of which at least 12 credit points must come from completed Core Courses of Study (Table 1), and eight credit points from any combination of courses of study. Students must obtain a pass mark to gain the points.

Table 1: Core Courses of Study

Course	QCE credits per course
QCAA General subjects and Applied subjects	up to 4
QCAA General Extension subjects	up to 2
QCAA General Senior External Examination subjects	4
Certificate II qualifications	up to 4
Certificate III and IV qualifications (includes traineeships)	up to 8
School-based apprenticeships	up to 6
Recognised studies categorised as Core	as recognised by QCAA

Senior school in Queensland

The Queensland Curriculum and Assessment Authority

Year 11 and 12

The Queensland Curriculum and Assessment Authority (QCAA) is a statutory body of the Queensland Government. The authority itself does not operate any educational institutions, but creates, amends and certifies syllabuses, issues Queensland Certificates of Education and regulates assessment.

OP to ATAR

Senior schooling in Queensland changed dramatically in 2019. QCAA was responsible for leading this change. QCAA developed all new syllabuses and changed how students are assessed. For example, year 12 students no longer sit a QCS test, nor do they receive an OP score for entry into university. Instead, eligible students receive an ATAR score. QCAA also introduced external exams (for ATAR subjects) for the first time in over 30 years. QCAA marks all external exams. The marine science exam is worth 50 per cent of the total mark for that subject.

General subjects

General subjects are ATAR subjects. They are designed to prepare students for tertiary study. Results of general subjects may contribute to a student's ATAR score. All general subjects have an external exam. General subjects can contribute up to four credits towards the QCE. There are 48 general subjects for schools to choose from, including seven science subjects. However, not all general subjects are offered at schools. Only 58 Queensland schools offered marine science in 2020.

Due to the small cohort of schools that offer marine science, it was nearly cut from the curriculum. In 2015, when decisions were being made on what subjects to make general subjects, marine science was originally proposed to be a single unit of work within the Earth and environmental science syllabus. Many passionate marine science teachers across Queensland expressed the importance of making it a stand-alone syllabus. QCAA listened and agreed. Yet, due to the small cohort of schools that offer marine science, the only resources developed specifically for the syllabus were, and still are, workbooks from MarineEducation.com.au and PowerPoints from WetPaper.com.au.

Applied subjects

Applied subjects are non-ATAR subjects. They are designed to prepare students for further education, training and work. Results of applied subjects only contribute to a student's ATAR score when combined with four general (ATAR) subjects. Applied subjects do not have an external exam (all assessment is internal, which means it is designed by teachers at the school and approved by QCAA). Applied subjects can contribute up to four credits towards the QCE. There are 25 applied subjects for schools to choose from, including three science subjects. However, not all applied subjects are offered at schools. Notably, many schools that offer marine science also offer aquatic practices.

The Great Barrier Reef in the Australian curriculum

Senior students visiting the Reef, may book the excursion as part of a number of different senior subjects.

When deciding how to link the rapid monitoring survey to the senior school curriculum, the marine science and aquatic practices subjects were most compatible and are the focus of this instruction manual.

It is worth noting that we selected marine science as a general subject (ATAR) and aquatic practices as an applied subject. The way the instruction manual breaks down the curriculum for these two subjects can be applied to other senior subjects on the QCAA website.

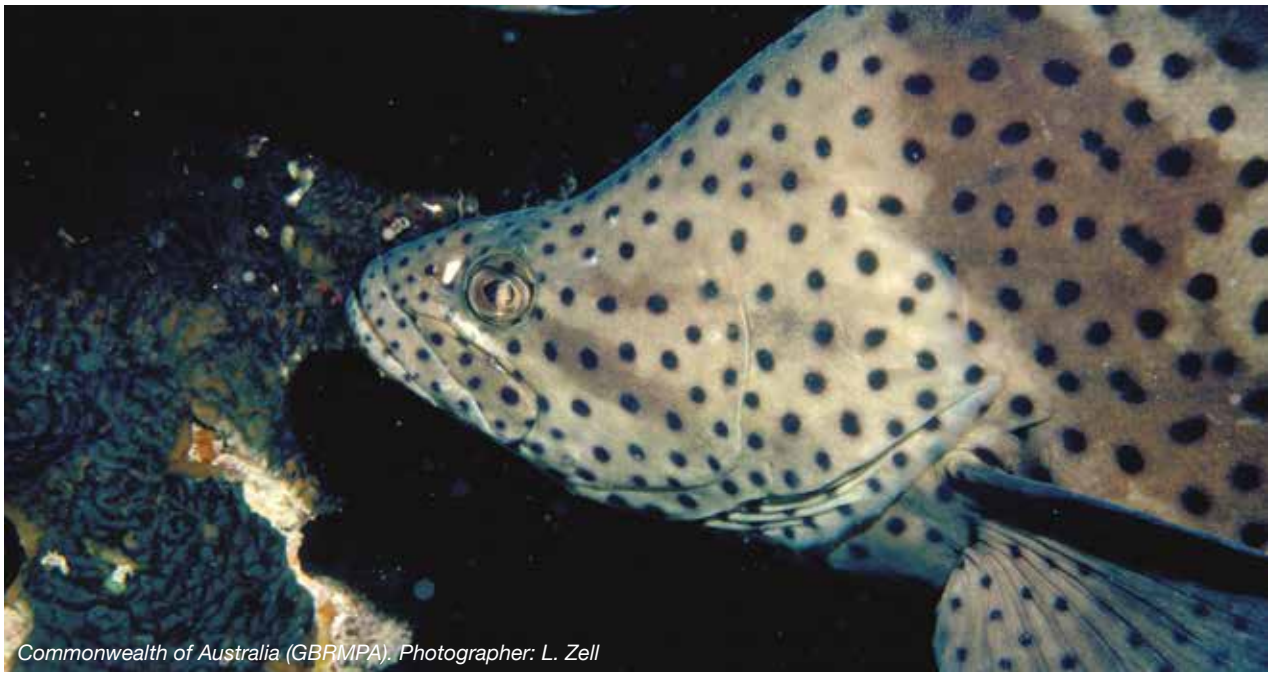
Other general subjects and the units that schools may undertake Reef excursions for include:

- Aboriginal & Torres Strait Islander Studies
  - Unit 1: culture, identity and connections
  - Unit 3: responses and contributions
- Biology
  - Unit 3: biodiversity and the interconnectedness of life
- Chemistry
  - Unit 2: molecular interactions and reactions (water quality)
- Earth & Environmental Science
  - Unit 1: introduction to Earth systems
  - Unit 2: Earth processes — energy transfers and transformations
  - Unit 3: living on Earth — extracting using and managing Earth resources
  - Unit 4: the changing Earth — the cause and impact of Earth hazards.
- Geography
  - Unit 2: planning sustainable places

Other applied subjects and the units that schools may undertake Reef excursions for include:

- Science in Practice
- Sport and Recreation
- Tourism

There are also a number of VET courses that also may include work experience and other topics that are relevant to Reef experiences.



Commonwealth of Australia (GBRMPA). Photographer: L. Zell

QCAA science learning area structure

All learning areas build on the P-10 ACARA Australian Curriculum.

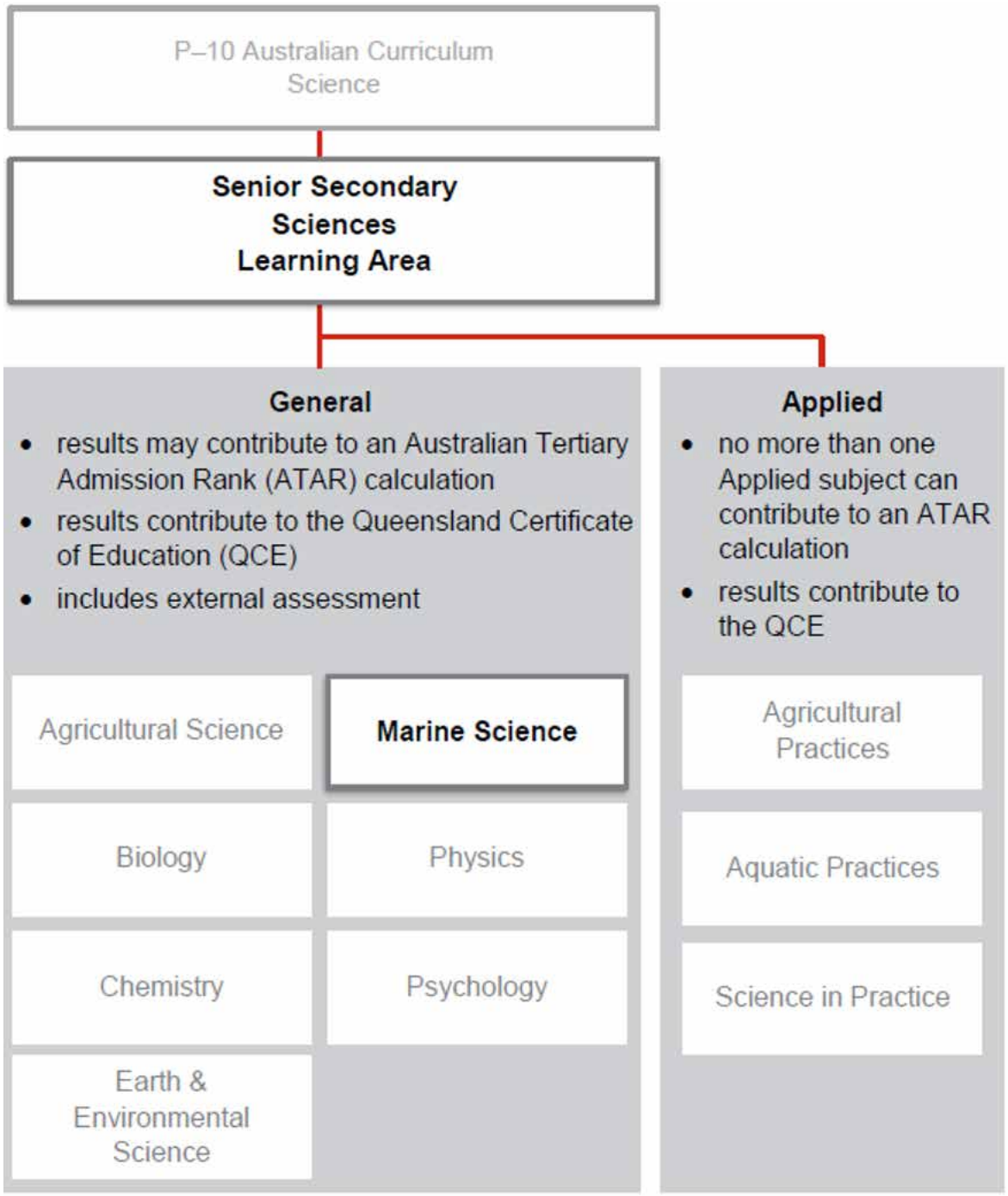
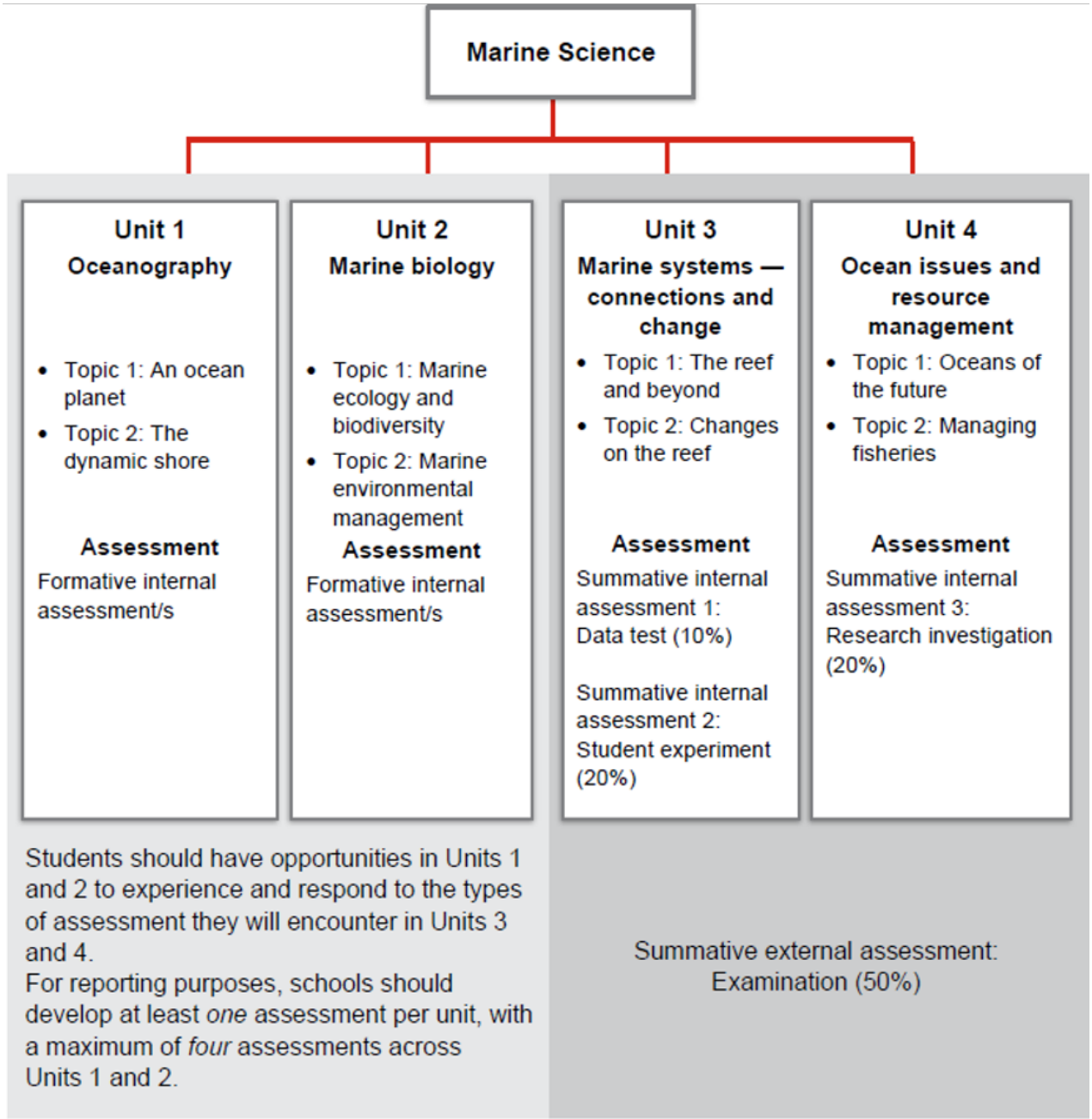


Image: © State of Queensland (QCAA, 2019a; QCAA, 2019b).

Marine science syllabus

In Unit 1, students develop their understanding of oceanography. In Unit 2, they engage with the concept of marine biology. In Unit 3, students study coral reef ecology, changes to the reef and the connectivity between marine systems. This knowledge is linked in Unit 4 with ocean issues and resource management, where students apply knowledge from Unit 3 to consider the future of our oceans and techniques for managing fisheries.

Schools can start teaching Unit 1 in Year 10. Most schools have finished teaching Unit 4 by Term 3 of Year 12, to ensure there is enough time for students to revise for the final exam in Term 4.



Marine science subject matter (content descriptions)
Unit 1 Oceanography

Topic 1: An Ocean Planet

Subject Matter: Oceanography

- Describe bathymetric features of the ocean floor, including the continental margin, ocean-basin floor, deep-sea trenches, mid-ocean ridges, abyssal plain.
- Apply models to understand the geological features of Earth (e.g. sea floor modelling, tectonic plate movements, coastal landforms, stratigraphy).
- Describe the processes of the following cycles: water, carbon and oxygen.

Subject Matter: Ocean currents

- Describe how surface ocean currents are driven by temperature, wind and gravity.
- Describe how water, heat and nutrients are distributed across coastal regions and global ocean basins (e.g. upwelling and downwelling, El Nino and La Nina events, Langmuir circulation, Ekman spiral).
- Describe the physical and chemical properties of water, including structure, hydrogen bonding, polarity, action as a solvent, heat capacity and density.
- Define thermocline, halocline and pycnocline.
- Recognise how thermoclines and nutrients produce the oxygen minimum within the open ocean.
- Explain how thermohaline circulation in the deep ocean is affected by salinity and water density.

Subject Matter: Ocean conservation

- Argue that knowledge of the oceans is limited and requires further investigation.
- Understand that the economic development of a nation and the value placed on marine environment, including the Exclusive Economic Zone (EEZ), affects decisions relating to resource management.

Topic 2: The Dynamic Shore

Subject Matter: Coastlines

- Identify that coastlines are shaped by a number of factors, including tectonic plate movements, shifts in climate patterns and sea level change, weather patterns, and movement of sediments and water (e.g. waves, currents).
- Recognise tidal movement in terms of gravitational pull, current strength and wave action.
- Define sand budget and longshore drift.
- Define reflection, refraction and diffraction.
- Describe the factors of wave action, wind and longshore drift in the management of the movement of water, nutrients, sand, sediment and pollutants (e.g. oil spills, debris).
- Describe the processes of coastal erosion (in terms of accretion and erosion).
- Identify the factors between the atmosphere and the oceans that drive weather patterns and climate (e.g. temperature, wind speed and direction, rainfall, breezes, barometric pressure).
- Recall wave formation processes (e.g. fetch, relationship of wave height and type to water depth and wave celerity).
- Explain how the properties of waves are shaped by weather patterns, natural formations and artificial structures (e.g. interference patterns, fetch, wave sets).

Subject Matter: coastal impacts

- Explain how coastal engineering regulates water or sediment flow, affects currents and impacts the coastline, including marine ecosystems.
- Recognise that longitudinal studies allow scientists to observe changes occurring in marine environments (e.g. satellite imagery, aerial photography, field research).
- Identify how organisms populate areas following changes in habitats (e.g. succession).
- Assess population density data of coastal areas to identify the impact on the health of coastal water.
- Recall types of pollution of coastal zones, including organic waters, thermal, toxic compounds, heavy metals, oil, nutrients and pesticides.

Subject Matter: coastal conservation and monitoring impacts

- Define sustainable management practices.
- Discuss that the education of stakeholders is essential to encouraging sustainable management practices.
- Compare the terms point source and non-point source forms of pollution.
- Describe two direct methods of monitoring water pollution levels using an abiotic test (e.g. nitrate, phosphate, heavy metals) or a biotic test (e.g. faecal coliform).
- Define the term biochemical oxygen demand (BOD).
- Describe how BOD is used to indirectly assess water pollution levels.
- Define the process of eutrophication.
- Identify and describe land management practices that contribute to the health of marine ecosystems, including siltation, algal blooms and agricultural practices.
- Describe and explain an indirect method of measuring pollution levels using a biotic index.
- Recall a bio-indicator with an example.
- Mandatory practical: Conduct water quality tests on a water sample.

Unit 2 Marine Biology

Topic 1: Marine Ecology and Biodiversity

Subject Matter: Biodiversity

- Define the three main types of diversity (i.e. genetic, species and ecosystem).
- Recall the three unique characteristics of marine biodiversity (i.e. wide dispersal at sea, the need for structural complexity, critical nursery habitats).
- Identify the variety of ecosystems (e.g. estuaries, coastal lakes, saltmarshes, mangroves, seagrass, rocky shores, temperate reefs, coral reefs, lagoons, shelf and deep water) that constitute Australia's marine biomes.
- Describe the implications of connectivity to marine ecosystems.
- Identify factors that lead to a loss of diversity (e.g. natural hazard, loss/fragmentation of habitat, pollution, exploitation, introduction of new species, disease).
- Calculate the biodiversity of a marine ecosystem using Simpson's diversity index (SDI).
- Apply data to determine the biodiversity of a marine ecosystem using diversity indices.
- Define ecosystem resilience, disturbance and recovery.

Subject Matter: Biotic components of marine environments

- Identify biotic components of marine ecosystems (i.e. trophic levels, food chains, food webs, interactions and population dynamics).
- Categorise biotic interactions based on the following terms: symbiosis (i.e. parasitism, mutualism, commensalism and amensalism), competition (i.e. intraspecific and interspecific), and predation.
- Classify organisms in trophic levels in a food web based on the following terms: producers, primary consumers, secondary consumers, tertiary consumers, decomposers.
- Describe how matter cycles through food webs, including the process of bioaccumulation.
- Recall the terms population size, density, abundance, distribution (i.e. clumped, uniform, random), carrying capacity, niche, K-strategists and r-strategists, keystone species.
- Assess population data to measure population size, density, abundance, distribution, carrying capacity.

Subject Matter: Abiotic components of the marine ecosystem

- Understand that marine ecosystems are influenced and limited by abiotic factors in ways that may be different from terrestrial ecosystems due to the different physical and chemical properties of water compared to air.
- Distinguish abiotic components of marine ecosystems: light availability, depth, stratification, temperature, currents (water and wind), tides, sediment type and nutrient availability.
- Understand the importance of limiting factors and tolerance limits in population distributions.
- Assess data to identify an organism's tolerance limit.
- Apply the concept of zonation using the following terms: intertidal, pelagic (neritic, oceanic), benthic and abyss.
- Mandatory practical (student experiment): Conduct an investigation to determine factors of population dynamics (e.g. density or distribution) and assess abiotic components of a local ecosystem case study. Emphasis should be placed on assessing the processes and limitations of the chosen technique (e.g. quadrat, transect). When students identify and describe marine species, they should use field guides and identification keys.

Subject Matter: Adaptation

- Categorise different groups of animals using structural characteristics.
- Identify and classify adaptations as anatomical (structural), physiological (functional) or behavioural.
- Describe the role of adaptation in enhancing an organism's survival in a specific marine environment.

Topic 2: Marine Environmental Management

Subject Matter: Marine conservation

- Recall the arguments for preserving species and habitats (i.e. ecological, economic, social, aesthetic, ethical).
- Describe the direct and indirect values of marine ecosystems of Australia.
- Describe the role of stakeholders in the use and management of marine ecosystems.
- Discuss the specific value systems that identified stakeholders use (i.e. ecocentric, technocentric and anthropogenic).
- Recognise the issues affecting a selected marine ecosystem.
- Apply the terms ecosystem resilience, disturbance and recovery as indicators of 'health' of marine environments to a chosen case study.

Subject Matter: Resources and sustainable use

- Recall the precautionary principle of the marine environmental planning and management process as well as a requirement that any network of marine protected areas be comprehensive, adequate and representative.
- Understand that criteria are used to inform decisions regarding the design of protected marine areas.
- Compare the strategies and techniques used for marine environmental planning and management with reference to a specific case study.
- Evaluate the marine environmental planning and management process using primary or secondary data of a specific case study (this may be linked to fieldwork).

EVERY Subject Matter dot point from Units 3 and 4 is a potential external exam question.

Unit 3 Marine Systems – Connections and Change

Topic 1: The Reef and Beyond

Subject Matter: Coral reef distribution

- Identify the distribution of coral reefs globally and in Australia.
- Identify abiotic factors that have affected the geographic distribution of corals over geological time including dissolved oxygen, light availability, salinity, temperature, substrate, aragonite and low levels of nitrates and phosphates.
- Recall that corals first appeared within the geological record over 250 million years ago but not in Australian waters until approximately 500,000 years ago.
- Recognise that the Great Barrier Reef of today has been shaped by changes in sea levels that began over 20,000 years before present (BP) and only stabilised 6500 years BP.
- Recall the different types of reef structure (e.g. fringing, platform, ribbon, atolls, coral cays).
- Recognise the zonation within a reef cross-section (e.g. reef slope, reef crest/rim, lagoon/back reef).

Subject Matter: Coral reef development

- Recall the following groups of coral: Alcyonacea ‘soft corals’ and the two morphological groups within Scleractinia ‘hard corals’ — reef-forming/hermatypic and non-reef forming/ahermatypic.
- Classify a specific coral to genus level only, using a relevant identification key.
- Identify the anatomy of a typical reef-forming hard coral including skeleton, corallite, coelenteron, coral polyp, tentacles, nematocysts, mouth and zooxanthellae.
- Recall that the limestone skeleton of a coral is built when calcium ions [Ca2+] combine with carbonate ions [CO32-].
- Describe the process of coral feeding (including night-feeding patterns and the function of nematocysts).
- Identify and describe the symbiotic relationships in a coral colony (including polyp interconnections and zooxanthellae).
- Recall the life cycle stages of a typical reef-forming hard coral (sexual: gametes, zygotes, planulae, polyp/asexual budding; asexual: fragmentation, polyp detachment).
- Explain the process of larval dispersal, site selection, settlement and recruitment.
- Explain that growth of reefs is dependent on accretion processes being greater than destructive processes.
- Assess data of abiotic factors (e.g. dissolved oxygen, salinity, substrate) that affect the distribution of coral reefs.

Subject Matter: Reef habitats and connectivity

- Recognise that corals are habitat formers or ecosystem engineers.
- Explain that habitat complexity (rugosity), established by corals, influences diversity of other species.
- Explain connectivity between ecosystems and the role this plays in species replenishment.
- Understand that fish life cycles are integrated within a variety of habitats including reef and estuarine systems.
- Describe how fish, particularly herbivore populations, benefit coral reefs.
- Identify ecological tipping points and how this applies to coral reefs.
- Describe hysteresis and how this applies to the concept of reef resilience.
- Assess the diversity of a reef system using a measure that could include (but not limited to) line intercept transects, quadrats and fish counts using underwater video survey techniques, benthic surveys, invertebrate counts and rugosity measurements.
- Analyse reef diversity data, using an index, to determine rank abundance.
- Interpret, with reference to regional trends, how coral cover has changed on a reef over time.
- Recognise that some of the factors that reduce coral cover (e.g. crown-of-thorns) are directly linked to water quality.
- Understand that the processes in this sub-topic interact to have an overall net effect (i.e. they do not occur in isolation).
- Mandatory Practical: Examine the concept of connectivity within or between habitats by investigating the impact of water quality on reef health.

Topic 2: Changes on the Reef

Subject Matter: Anthropogenic change

- Analyse results from models to determine potential reef futures under various scenarios.
- Recall the global anthropogenic factors affecting the distribution of coral (i.e. coral mining, pollution: organic and non-organic, fishing practices, dredging, climate change, ocean acidification and shipping).
- Describe the specific pressures affecting coral reefs (i.e. surface run-off, salinity fluctuations, climate change, cyclic crown-of-thorns outbreaks, overfishing, spills and improper ballast).
- Recognise that during the Holocene no evidence of coral bleaching or ocean acidification can be found within coral cores dating back 6000 years.
- Explain the concept of coral bleaching in terms of Shelford's law of tolerance.
- Interpret thermal threshold data for reefs in the northern, central and southern sections of the Great Barrier Reef in relation to the likelihood of a bleaching event.
- Use a specific case study to evaluate the ecological effects on other organisms (e.g. fish) after a bleaching event has occurred.
- Describe the conditions necessary for recovery from bleaching events.
- Compare the responses to bleaching events between two regions, while recognising that coral cover increases on resilient reefs once pressures are reduced or removed.
- Interpret data, including qualitative graphical data of coral cores, that demonstrates that coral cores can act as a proxy for the climate record (i.e. they provide information on the changes in weather patterns and events affecting the composition of coral communities).

Subject Matter: Ocean equilibria

- Explain the reason for differences between ocean pH and freshwater – presence of carbonate buffering system.
- Explain that the carbonate system is linked to geological processes and operates on geological timescales.
- Recognise that increases in atmospheric carbon dioxide influences both global temperature and ocean pH.
- Describe sources of carbon dioxide in the atmosphere and how this influences ocean chemistry.

- Describe the effect of ocean acidification on sea water in terms of increasing the concentration of hydrogen ions and decreasing the concentration of carbonate ions.
- Explain how the carbonate compensation depth (CCD) varies due to depth, location and oceanographic processes such as upwelling and coastal influences.
- Understand that the ocean's capacity to absorb carbon dioxide is changing and is linked to temperature (uptake) and changes in primary productivity (storage, e.g. biological pump).

Subject Matter: Implications for marine systems

- Recognise that the type of carbonate ions and concentration of ions have an implication for the development of shell-forming and skeletal-forming organisms including hard corals (Scleractinia), coralline algae, molluscs, plankton and crustaceans.
- Interpret trends in data in relation to the carbonate system and changes in pH.
- Distinguish between laboratory-scale and field-based experiments and what they demonstrate about ocean acidification.
- Describe the potential consequences of ocean acidification for coral reef ecosystems.
- Explain how resilience may partially offset ocean acidification responses in the short term.
- Mandatory Practical: Investigate the effects an altered ocean pH has on marine carbonate structures.

Unit 4 Ocean Issues and Resource Management

Topic 1: Oceans of the Future

Subject Matter: Management and conservation

- Recall and use the arguments for preserving species and habitats (i.e. ecological, economic, aesthetic, ethical) through identifying their associated direct and indirect values in a given case study.
- Recall and explain the criteria (i.e. site selection, networking and connectivity, replication, spacing, size and coverage) used to design protected marine areas.
- Identify management strategies used to support marine ecosystem health (e.g. managing threats, zoning, permits, plans, longitudinal monitoring).
- Evaluate the success of a named protected marine area.
- Compare the roles of government and non-government organisations in the management and restoration of ecosystems and their relative abilities to respond (e.g. speed, diplomatic constraints, political influence, enforceability).

Subject Matter: Future scenarios

- Evaluate future scenarios for a named marine system through the analysis of different atmospheric condition datasets.
- Compare historical geological data (e.g. of coral cores) with changes in land use practices and global carbon dioxide and temperature levels.
- Recognise that ocean acidification has indirect consequences on the ocean and its uses.
- Identify the factors between the atmosphere and the oceans that drive weather patterns and climate (e.g. temperature, wind speed and direction, rainfall, breezes and barometric pressure).
- Understand that average global temperature increases impact on marine environments by altering thermal regimes and changing physical and chemical parameters of the ocean (e.g. aragonite saturation levels and rising sea levels).

Topic 2: Managing Fisheries

Subject Matter: Fisheries and population dynamics

- Understand that the term fishery has a variety of meanings and that there are three main types (i.e. artisanal, recreational and commercial).
- Understand the significance of wild caught fish as the major source of protein globally.
- Understand that the world's fisheries are in decline.
- Explain how distribution of fish populations are determined by temperature, primary productivity and nutrient dispersal, and these are influenced by currents, upwelling and seasonal factors.
- Assess rugosity data and link this to fish diversity.
- Assess the impact of bioaccumulation through the food web into edible seafood.
- Explain how the alteration of thermal regimes caused by climate change is affecting the distribution of fish populations.
- Compare a case study of a fish population in decline with a case study of a fish population that is in recovery in relation to fisheries management practices.
- Interpret fish population data using the Lincoln Index (capture-recapture method) and identify the reliability of this data to inform fisheries management decision making on quota and total allowable catch.
- Identify the factors (e.g. sampling techniques, fish behaviour, temporal and spatial movement, life history) that determine the reliability of fisheries population data and consider the limitations of these factors.
- Recognise an international agreement that is used to manage migratory pelagic species.
- Appraise the use of maximum sustainable yields and maximum economic yields.
- Recognise that fisheries management has shifted from single species maximum sustainable yield towards ecosystem-based fisheries management.
- Understand the value of marine protected areas, including estuarine and open-water environments, to fisheries sustainability.
- Mandatory Practical: Apply the Lincoln Index in a modelled capture-recapture scenario.

Subject Matter: Australia's fisheries management

- Identify the Australian Fishing Zone (AFZ).
- Infer that the status of Australian fisheries is due to science-based management, the rule of law and good governance.
- Identify an example of a major Australian edible seafood export product and an import product.
- Examine the factors that lead to a higher proportion of the seafood consumed in Australia being imported.
- Recall that Australian fisheries have an economic value.
- Explain monitoring and control of total allowable catch and fixed quotas.
- Describe dynamic spatial zoning fish management (including e-monitoring) as a fish management technique in terms of ecosystem-based management in relation to a case study.
- Describe the use of the precautionary principle as applied to ecosystem management.

Subject Matter: Aquaculture

- Recognise why the current state of aquaculture in the world cannot address food security.
- Analyse Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) fisheries reports to determine changes in fisheries practices over the past 10 years, including economic contribution of aquaculture relative to wild catch for the top five aquaculture species in Australia by volume and value.
- Identify attributes (e.g. resilience, fast growth rate, low-feed conversion ratio) of an aquaculture species detailing its life cycle, adaptations, requirements and marketability that would make a species desirable to farm.
- Predict the maximum carrying capacity of an aquaculture system based on the size of the ponds or tanks, the requirements of a species, and farming technique.
- Contrast the different aquaculture systems (e.g. open, closed or recirculating, intensive and extensive).
- Understand issues with output pollution, biosecurity and waste removal, and production of feed for aquaculture.

Marine science assessment

(This is the same for ALL general (ATAR) science subjects including biology).

Formative vs Summative

Formative assessments provide feedback to both students and teachers about each student's progress, whereas summative assessments count towards a student's final mark. Assessment in Units 1 and 2 is formative, developed by the school. Assessment in Units 3 and 4 is summative. Three assessments are developed by the school but QCAA endorses each assessment and confirms the results. The fourth summative external assessment (EA) is a final exam developed and marked by QCAA (Table 2).

Table 2: Assessment for Unit 1 and 2 (formative) 3 and 4 (summative)

Assessment	Unit 1	Unit 2	Unit 3	Unit 4
Formative assessments	•	•		
Summative internal assessment 1			•	
Summative internal assessment 2			•	
Summative internal assessment 3				•
Summative external assessment			•	•

Internal Assessment 1 (IA1)
Data Test (10%)

Students respond to items using qualitative data and/or quantitative data derived from the mandatory or suggested practicals, activities or case studies from the unit being studied. There is a practice data test in the *Be a Marine Biologist for a Day* program.

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. Most excursions to the Reef will be to collect data for this assessment item. Many schools only allow one excursion per subject per year.

Internal Assessment 3 (IA3)
Research Investigation (20%)

This assessment requires students to **evaluate a claim** by developing a research question, researching, analysing and interpreting **secondary** evidence from scientific texts.

External Assessment (EA)
Examination (50%)

Exam questions are developed by QCAA from randomly selected dot points in subject matter in Units 3 and 4.

Internal Assessment 2 (IA2)
Student Experiment (20%)

The student experiment can be conducted in the lab or in the field. The school decides. In order to complete the assessment task, students must:

- identify an experiment to modify*
- develop a research question to be investigated
- research relevant background scientific information to inform the modification of the research question and methodology
- conduct a risk assessment and account for risks in the methodology
- conduct the experiment
- collect sufficient and relevant qualitative data and/or quantitative data to address the research question
- process and present the data appropriately
- analyse the evidence to identify uncertainty and limitations
- interpret the evidence to draw conclusion/s to the research question
- evaluate the reliability and validity of the experimental process
- suggest possible improvements and extensions to the experiment
- communicate findings in an appropriate scientific genre (e.g. report, presentation poster, journal article, conference presentation).

*Teachers will first conduct the experiment, in class or on an excursion. Students then must modify that experiment for their IA2. Modifications can be minor (e.g. increasing the number of repeats) or major (e.g. changing a dependent variable, changing the experimental design).
Year 11 students typically modify Mandatory Practical 2 for their (formative) IA2.
Year 12 students typically modify Mandatory Practical 3 for their (summative) IA2 (Table 3).

Table 3: Mandatory and Suggested Practicals for Marine Science

Unit	Mandatory practicals	Suggested practicals
1	• Conduct water quality tests on a water sample.	• Conduct a convection experiment. • Investigate thermoclines (using ice and water, and hot and cold coloured water); salinity (using student-made straw hydrometers); stratification (using salt and fresh water). • Conduct a wave tank experiment. • Conduct a beach profile/dune transect and use sand sifts to decide on sphericity (roundness of sand grains).
2	• Conduct an investigation to determine factors of population dynamics (e.g. density or distribution) and assess abiotic components of a local ecosystem case study. Emphasis should be placed on assessing the processes and limitations of the chosen technique (e.g. quadrat, transect). When students identify and describe marine species, they should use field guides and identification keys.	• Estimate populations, e.g. survey count, quadrats, species density, percentage coverage, indirect or direct observation, catch and release. • Use field guides to identify to a genus level. • Use a range of field equipment to measure abiotic factors related to marine environments. • Conduct in-field mapping of food webs via gut analysis to determine food sources. • Identify physical structures of a specific marine organism (this could be virtual, practical or as a demonstration).
3	• Examine the concept of connectivity within or between a habitat by investigating the impact of water quality on reef health. • Investigate the effects an altered ocean pH has on marine carbonate structures.	• Identify coral genus (photo, online or field). • Classify plankton using field work techniques such as collection/trawls. • Investigate zooxanthellae (with flotsam jellyfish or aquarium coral) using a microscope. • Examine coral diversity using a transect technique (using online or field data). • Investigate how CO_2 lowers the pH of a solution. • Investigate how changes in temperature and salinity affect the solubility of CO_2 in aqueous saline solutions. • Investigate the effect of CO_2 on planktonic organisms.
4	• Apply the Lincoln index in a modelled capture–recapture scenario.	• Assess the life history of a fish by reviewing otoliths using a microscope. • Analyse a water or sand sample to identify the presence of microplastics. • Investigate factors that affect the growth rate of an aquaculture species.

The research question

Students choose a dependent variable (DV) to measure, and an independent variable (IV) to change.

Examples include:

'Is there a significant difference in [DV] between [this] and [that]? for example, '*Is there a significant difference in live coral cover between location A (protected) and location B (unprotected)*?'.

'Is there a linear relationship between [IV] and [DV]? for example, '*Is there a linear relationship between macroalgae and herbivore abundance?'.*

Students collect primary data on their excursion to answer their research question.

Students then return to school to analyse their data and present it on a graph. Most students will be expected to know how to calculate a P value or r value to statistically answer their research question. All students will be expected to identify any trends, patterns or relationships in their results, critically evaluate their experimental design, identify any limitations to their sampling technique, evaluate the reliability and validity of their results, identify any anomalies, and include margins of error to their analyses. Most students will be familiar with how to calculate mean and standard deviation (s). Some will know how to calculate and graph standard error of the mean (SEM) and Confidence Intervals (CI) using Microsoft Excel.

Rapid monitoring survey and IA2s

There are many ways that a rapid monitoring survey form can be used by students wanting to collect primary data. All rapid monitoring survey forms and courses are available to schools to help plan for their IA2's. Students can use the survey form to formulate their research question. Students who already have a research question can use the survey form to further improve their IA2. For example, a survey form can be used to record *Measured Variables* (MV) so their influence can be considered in the outcome of the study. Measured variables could include abiotic factors such as visibility and water temperature, or biotic factors such as other benthos percentages and coral impacts. Students who record MVs and discuss their influence in the outcome of the study are more likely to obtain a better mark. Therefore, the rapid monitoring survey form can be useful in many ways.

Similarly, if students discover mid-excursion that their original plan is not working, they could use the rapid monitoring survey methodology instead. It is not uncommon for students to modify their research question or methodology mid-excursion. Notably, some students (and teachers) will not be aware that a timed swim counts as a quadrat, or that quadrats can be circular, as opposed to square. Reef guides should be open to ideas about how the rapid monitoring survey form can be used to meet the needs of the students and teachers.

Examples of student assessment can be found in Appendix A.

Aquatic practices subject matter (content elaborations)
Environmental

E1: Environmental Conditions

E1.1 Understanding weather and tides is essential for activities in and on the water

- Interpretation of weather and tide data (e.g. Bureau of Meteorology website).
- Calculation of tide heights and charting datum points.
- Prediction of tide heights and weather conditions.

E1.2 Oceanography and riparian processes shape aquatic environments

- Coastal processes (e.g. longshore drift, chemical and physical erosion, reef formation).
- Wave formation and types of waves.
- Ocean currents (localised, national and international).
- River processes.

E2: Ecosystems

E2.1 Aquatic ecosystems include biotic and abiotic components

- Biotic components (organisms, communities and populations).
- Abiotic components (e.g. temperature, light, pH, dissolved oxygen, salinity).
- Relationships between biotic and abiotic components.
- Interdependent relationships between organisms.
- Different aquatic ecosystems (e.g. coastal, estuarine and riparian).

E2.2 Aquatic habitats are the places where organisms live

- Ecosystems and habitats.
- Habitats of local aquatic organisms.

E2.3 Particular organisms are suited to aquatic ecosystems and habitats

- Classification of aquatic organisms.
- Aquatic organisms have behavioural, structural and functional adaptations suited to their habitat.
- Identification of common local aquatic organisms.

E2.4 The condition of aquatic ecosystems varies as a result of the biotic and abiotic components

- Condition of biotic and abiotic components (e.g. testing for pollutants and taking measurements).
- Factors that impact on ecosystem condition.
- Impacts of component condition on their relationship/s (e.g. algal bloom).

E3 Conservation and Sustainability

E3.1 Marine and freshwater pests and threats, including pollution, impact on aquatic environments

- Marine pests and associated threats, including crown of thorns starfish, toxic algae, European carp and salvinia.
- Ways aquatic industries impact on their environment (e.g. overfishing, agricultural runoff and human erosion activities).
- Sources of aquatic pollution and associated threats, including ballast water, oil pollution, and fouling organisms.
- Quarantine breaches.

E3.2 Actions conserve, sustain and bioremediate aquatic environment

- Definitions of conservation, sustainability and bioremediation.
- Legislation rules and regulations exist to conserve and sustain aquatic environments (e.g. Marine Park Zones and government departmental authorities' fishing rules and regulations).
- Aboriginal communities and Torres Strait Islander communities have knowledges and practices that support ecosystem condition (e.g. ceremonial purposes, sustainable living).

E4: Citizen Science (Elective)

E4.1 The scientific method involves asking questions about the natural world and collecting data systematically to address the question

- Dependent and independent variables.
- Importance of controlling variables in scientific investigations.

E4.2 Citizen science programs engage volunteers and the public in scientific research programs

- Participation in a citizen science project (e.g. CoralWatch, Reef Guardians, Eye on the Reef, Seagrass-Watch, Healthy Waterways).
- Public benefits of citizen science programs (e.g. heightened).
- Public awareness of environmental issues and tourism.

E4.3 Citizen science allows scientists to gather data over time, across large geographic areas to answer significant research questions

- Areas of ongoing research (e.g. impact of global warming on coral reefs, migration/mating habits of whales and sharks).

Recreational

R1: Entering the Aquatic Environment

R1.1 People engage with the aquatic environment in different ways

- Range of aquatic activities (e.g. boating, fishing, snorkelling, sailboarding, canoeing, surfing, aquariums and fishkeeping).
- Specialised equipment and materials.
- Factors determining available activities (e.g. weather, water visibility, swell, tides).

R1.2 Scientific principles explain how objects behave in the water

- Application of Archimedes' principle, Boyle's Law and the principles of buoyancy.

R2: Aquatic Activities (Elective)

R2.1 Navigation knowledge and skills are essential for activities on the water

- Equipment requirements for boats, including navigation lights.
- Characteristics and interpretation of charts.
- Bearing and position.
- Steering of a compass course.
- Planning a passage and plotting a course.

R2.2 Specialised skills are required to safely participate in aquatic activities

- Skills required to operate water craft (e.g. following collision regulations, IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities) buoys and buoyage).
- Skills required to safely snorkel (e.g. equalising, finning techniques, clearing mask and snorkel techniques).

Commercial

C1: Employment

C1.1 Core skills for work are valued by employers

- Work roles and workplace rights and expectations and incorporation of established guidelines in industry policies and procedures relevant to activities in aquatic contexts.
- Recognition, appreciation and responsiveness to differing values, beliefs, perspectives and behaviours.
- Anticipation or identification of problems in aquatic contexts, decisions about courses of action to solve problems and reflection on the outcomes of decisions.
- Strategies for working effectively with technology applied in activities in aquatic contexts to connect to other people and contexts for aquatic work-related purposes.
- Identification of how digital technology and digitally-based systems can extend, enhance or make possible specific aspects of an aquatic role or task, and create new opportunities.

C1.2 There are different career opportunities and pathways in aquatic industry and businesses

- Roles in aquatic industry and businesses (e.g. marine engineer, eco-tour guide, boat-builder, dive instructor, commercial fisher, aquaculturist).
- Pathways into aquatic employment (e.g. apprenticeships and traineeships).
- Knowledge, skills and qualifications relevant to positions, roles and/or pathways (e.g. Coxswain's licence, deckhand certificate).

C1.3 Employers expect employees to build and update their knowledge and skills

- Industry guidelines and standards change over time (e.g. licencing requirements).
- Marine and aquatic industry associations (e.g. Boating Industries Alliance Australia, Maritime Safety Queensland).
- Training and education providers and courses (e.g. local providers for boat and jet-ski licences).
- Recording and updating training and other learning (e.g. certificates, registrations and licences).

C2: Aquaculture, aquaponics and aquariums (elective)

C2.1 Different methods are suited to particular stock/plants, locations, climates, types of water and purposes

- Different methods (e.g. cage/pond farming, open/closed systems).
- Organisms suited to purpose (e.g. redclaw for aquaculture, perch for aquaponics).
- Equipment, resources and materials needed (e.g. netting for mariculture).
- Sources for quality organisms, feed and other resources.

C2.2 Water quality is essential for animal/plant production

- Water quality parameters (e.g. pH, dissolved oxygen, nitrates).
- Testing and adjusting water quality (e.g. temperature).

C2.3 Quantity and quality of nutrition is essential for organism production

- Types of feed/nutrition.
- Constituents of feed/nutrition (e.g. protein, carbohydrate and fats).
- Dietary needs of different stock/plants.
- Feed/nutrition contamination and its effects on organisms and systems.
- Feed/nutrition preparation and storage.

C2.4 Healthy organisms are essential for animal/plant production

- Recognition and recording of changes in organisms (e.g. growth rates, appearance, signs of illness, changes in population).
- Causes of ill health and disease (e.g. biofouling, parasites, deficiency diseases).
- Strategies to prevent and treat disease (e.g. cleaning tanks, altering pH, administering supplements).

C3: Boat building and marine engineering (elective)

C3.1 Different vessel designs are suited to different situations

- Major hull types (displacement and planning).
- Different hull shapes for different purposes (e.g. punt for sheltered estuary waters, deep-v hulls for open water).
- Materials for vessel construction are dependent on purpose (e.g. rubber, alloy, wood, fibreglass, steel).

C3.2 Boats are designed and constructed using a variety of materials and techniques

- Vessel or model construction to scale plans.
- Application of tools and materials to fabricate vessel or model.
- Design testing and modification.

C3.3 There are different propulsion systems and types of marine engine installations for vessels

- Uses of different marine installations (e.g. inboard, outboard, stern-drive and jet).
- Principles of mechanical and non-mechanical boat propulsion (e.g. powered and non-powered craft, such as traditional sailing vessels).
- Factors influencing selection and use of particular propulsion systems.

C3.4 Marine engines are internal combustion engines

- Operation of different forms of internal combustion engine (e.g. two-stroke, four-stroke, diesel, turbine and steam).
- Operating principles of engine support systems (e.g. fuel, ignition, cooling, lubrication and charging systems).
- Safe practices for fuelling engines and maintaining and storing batteries.

Cultural

Cu1: Cultural Understanding

Cu1.1 People source a range of resources from waterways

- Aquatic organisms are used for a variety of purposes in different cultures (e.g. food, fertiliser, compost and mulch, and bioremediation).
- Aquatic resources (e.g. food preparation technologies and techniques in different cultures, shell art, driftwood carving).

Cu1.2 Indigenous peoples have spiritual, social, economic and cultural links with waterways and places

- Indigenous peoples', including Aboriginal peoples', and Torres Strait Islander peoples', relationships with, connections to, and understanding of country and place.
- Protocols for working with Aboriginal and Torres Strait Islander communities and Indigenous knowledge.

Cu1.3 There are different social and cultural attitudes to industries and activities associated with, and impacting on, aquatic environments

- Social and political responses to impacts of industries and activities on aquatic environments (e.g. attitudes towards whaling, accidents such as the Exxon Valdez oil spill and Fukushima nuclear accident, organisations such as Greenpeace).
- Unlawful activities in aquatic environments (e.g. illegal fishing and trawling, piracy).

Cu2: Historical Understandings (Elective)

Cu2.1 Aquatic industries and activities were, and continue to be economically, socially and culturally significant

- Aquatic industries and activities (e.g. trading goods, immigration, fishing and trawling).
- Waterways of importance to aquatic industries and activities, including those: in the school's local area (e.g. fishing and trade routes in Cape York and the Torres Strait Islands); in Australia (e.g. Brisbane River); internationally (e.g. Suez Canal, Panama Canal, Great Lakes).
- Representations of Aboriginal peoples' and Torres Strait Islander peoples' spiritual and cultural relationships with, connections to, and understanding of waterways (e.g. fish traps and shell middens).
- Economic, social and cultural impacts of maritime industries and activities (e.g. whaling stations, pearl divers).

Cu2.2 The history of aquatic places, events and activities continues to be of interest and importance

- Shipwrecks (e.g. the Australian Hospital Ship Centaur, HMAS Sydney).
- Museums (e.g. the Queensland Maritime Museum).
- Trade routes, vessel and cargos from the past.
- Immigration routes and vessels from the past.
- Aquatic industries and activities from the past (e.g. whaling in Australia and New Zealand).

Cu2.3 Aquatic technologies and culture are interdependent

- Designs of water craft from different cultures.
- Development of aquatic technologies over time (e.g. boat building, navigation and propulsion technologies, fishing techniques).
- Scientific and cultural impacts of major ocean voyages (e.g. Columbus, Cook, Darwin).

Safety and Management Practices

SM1: Legislation, rules and regulations for aquatic environments

SM1.1 Commonwealth and state legislation, rules and regulations control activities in aquatic environments

- Legislation, rules and regulations relevant to aquatic activities (e.g. native title, marine parks, licences and permits for provision of products and services).
- Resources to support understanding and implementation of legislation, rules and regulations (e.g. Queensland Fisheries and Boating Handbook, materials from Wet Paper Publications — Marine Studies curriculum material for Australian Secondary Schools).
- Implementing legislation, rules and regulations (e.g. operating a vessel according to International Association of Lighthouse Authorities (IALA) buoyage system).

SM1.2 Commonwealth and state legislation, rules and regulations are administered by government departments and authorities

- Functions of relevant authorities (e.g. Department of Agriculture, Fisheries and Forestry's recreational fishing rules and regulations for Queensland).
- Information and advice from relevant officers in government departments and authorities (e.g. Queensland Transport's boating licences).

SM1.3 Observation of workplace health and safety practices is essential when participating in aquatic activities

- Understand and implement duty of care.
- Difference between risks and hazards.
- Conduct risk assessments.
- Manage risks and hazards.
- Implement risk management plans (e.g. take preventative action).

SM2: Equipment maintenance and operations

SM2.1 The natural environment impacts on reliable and safe operation of equipment

- Components of the aquatic environment that impact on equipment (e.g. Salts, water, air, sunlight and living things).
- Selection of processes and products to protect equipment against the natural environment.
- Implementation of processes and using products to protect equipment against effects of the natural environment (e.g. cleaning and storing equipment).

SM2.2 Regular maintenance is essential for reliable and safe operation of equipment

- Use of operation manuals for service instructions and information (e.g. Following maintenance schedules, everyday servicing and maintenance of equipment).
- Identification of faults and taking appropriate action.

SM2.3 It is essential to follow equipment operating instructions at all times

- Operation manuals.
- Online support materials.
- Training and courses.

SM3: First aid and safety

SM3.1 The aquatic environment poses particular threats

- Identification of aquatic threats, injuries and emergencies, e.g. hypothermia, hyperthermia, marine stings, drowning

SM3.2 First aid skills are applied in response to illness, injuries and emergencies

- Responses to illness, injuries and emergencies (e.g. hyperthermia, allergic reactions, unconsciousness, bleeding, burns and scalds, fractures, cardiopulmonary resuscitation (CPR), pressure immobilisation technique).

SM3.3 Aquatic environment requires specialised safety skills.

- Application of specialised aquatic safety skills (e.g. survival techniques including HELP/HUDDLE, swimming, treading water, rescue tow).

SM4: Management practices

SM4.1 Working with others is essential when working in aquatic environments

- Instructions from teachers and trainers.
- Strategies for working and collaborating effectively in teams.
- Effective communication strategies.

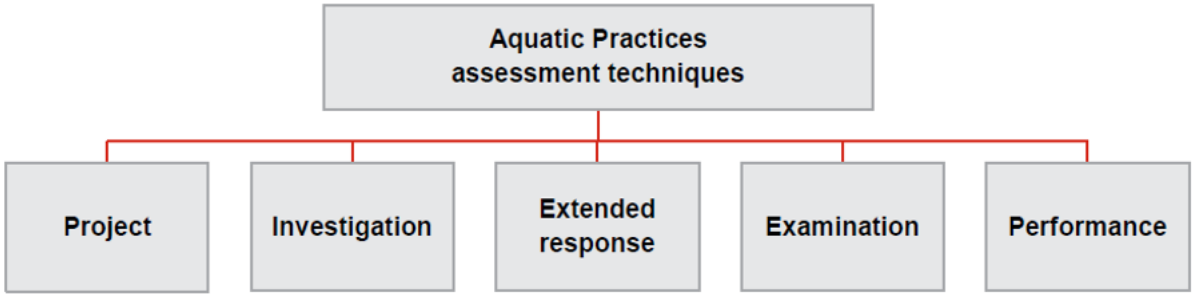
SM4.2 Completion of aquatic activities requires a range of management skills

- Goal-setting to complete aquatic activities.
- Plan and organise aquatic activities.
- Management of time and resources to complete aquatic activities.
- Demonstration of initiative.

Aquatic practices assessment

Assessment techniques

All assessment is internal and developed by the school (endorsed by QCAA). There is no external exam. Units 1 and 2 are formative. Units 3 and 4 are summative. Units 1 and 2 often repeat the assessment techniques for Units 3 and 4. Schools have, on average, 6 to 8 assessments in total. Schools choose which assessment techniques to use. Choices include a project, investigation, extended response, internal examination and/or a performance (below). When marking assessments, teachers use Table 4 provided by QCAA. Schools are allowed to change the words that are *not* highlighted, to suit the requirements of the task.



Project

A project consists of at least two different assessable components from the following:

- written (e.g. a set of data)
- spoken (e.g. an explanation of a procedure)
- multimodal (e.g. a presentation of a set of data and its purpose and meaning)
- performance (e.g. demonstration)
- product (e.g. model of a boat)

Examples include: rod building and testing, planning a tour itinerary, boat hull design and evaluation, lure design and building, or an aquaculture project.

There is a project assessment task template for the *Be a Marine Biologist for a Day* program

Investigation

In aquatic practices, investigations involve research and follow an inquiry approach.

Examples include: investigation of water quality, research into historically significant shipwrecks, investigation of Aboriginal and/or Torres Strait Islander fishing techniques.

Extended response

This technique assesses the interpretation, analysis/examination and/or evaluation of ideas and information in provided stimulus materials. Stimulus material could include: scientific texts (e.g. journal/ research article) media texts (e.g. letter to the editor, documentary), data and statistics (e.g. tide chart, weather data), maps and charts (e.g. map indicating reefs and other features). An extended response occurs over a set period of time. Students may use class time and their own time to develop a response.

Examination (short response)

Short response tests typically consist of a number of items that may include students responding to some or all of the following activities: drawing, labelling or interpreting equipment, graphs, tables or diagrams; calculating using algorithms; responding to seen or unseen stimulus materials; interpreting ideas and information. Questions, scenarios and problems are typically unseen.

Performance

Performance assessments involve student application of identified skill/s. Examples include:

- seafood preparation (filleting techniques)
- snorkelling
- nautical knot tying
- participating in aquatic activities in recreational contexts (e.g. boating camp)
- organising and managing events
- demonstration of health and safety mechanisms and procedures (e.g. first aid, lifesaving)

Rapid monitoring survey and aquatic practices assessments

There are many ways that a rapid monitoring survey form can be used by students studying aquatic practices. How exactly will depend on the school and the assessment technique. Every assessment for aquatic practices is developed by the school. Therefore, each school will have their own version for each assessment. For example, an exam paper from one school will be different to an exam paper at another school. It will be up to the reef guide to find out the details of their assessments, so you can apply your knowledge of the rapid monitoring survey to match the requirements of their assessments.

Examples of assessment can be found in Appendix B.

Commonwealth of Australia (GBRMPA). Photographer: C. Jones.

Know how to teach

Instructional Manual for Reef Guides

Teacher qualifications and experience

The following information gives you an understanding of the qualifications and experience teachers and other school staff may have. This will help you understand why you may have different experiences with different teachers. Teacher are humans too, but they may come from very different levels of experience, knowledge and comfort on excursions.

Australia

To teach in Australia, you must hold a degree with a minimum of four years' tertiary study. That must include university-based assessment on site, and at least 45 days' supervised teaching practice in primary or secondary schools. Qualifications may include:

- a four year Bachelor of Education degreer
- a three year Bachelor's degree (in anything) plus a Post Graduate Certificate in Education (PGCE) in primary or secondary, such as a Masters or Graduate Diploma of Education.

Teacher registration

All teachers in Australia must hold teaching registration with the board of education of the state or territory they intend to teach in. For Queensland, the board of education is the Queensland College of Teachers (QCT).

Queensland College of Teachers

To be eligible for registration, teachers must have appropriate qualifications, meet the English language proficiency requirements (if applicable) and meet the 'suitability to teach' criteria. After registration has been granted, teachers are eligible to seek employment in any Queensland school. *Note:* all teachers must start on a preliminary registration before moving to full registration (even experienced teachers arriving to Queensland).

Marine experience not compulsory

A teacher can be asked by their school to teach any subject, regardless of qualifications. Therefore, a marine science or aquatic practices teacher may have never taught the subject before, nor had any experience teaching in marine environments.

Teacher aides

Teacher aides are not qualified nor employed to teach, but interact with students under the direct or indirect supervision of a qualified teacher. To work as a teacher aide in Australia, a qualification in education is desirable. Examples include a Certificate III or IV in Education Support. Again, a teacher aide may not be experienced teaching in marine environments.

Professional development

Professional development is an annual requirement for teachers with QCT's full registration regardless of whether they are teaching full-time or part-time, or undertaking supply or contract teaching. Teachers must complete 20 hours of professional development for any year they teach 20 days or more. Popular professional development's for marine teachers include the Eye on the Reef program, and the AUSI snorkelling course offered at the annual Marine Teachers Association Qld (MTAQ) conference.

Senior school teaching pedagogies

What is a pedagogy?

Pedagogy is often described as the act of teaching. The pedagogy adopted by teachers shapes their actions, judgements and other teaching strategies by taking into consideration theories of learning, understandings of students and their needs, and the backgrounds and interests of individual students. The field relies heavily on educational psychology, which encompasses scientific theories of learning, and to some extent on the philosophy of education, which considers the aims and value of education from a psychological perspective.

Five pedagogical approaches for modern-day classrooms include constructivist, collaborative, integrative, reflective and inquiry-based learning. A **constructivist** approach is based on the central notion that learners construct their own understanding of the world around them based on experience as they live and grow. A **collaborative** approach involves groups of learners working together to solve a problem, complete a task or create a project. An **integrative** approach provides learners with a learning environment that helps them make learning connections across curricula. A **reflective** approach means looking at what the teacher and learners do in the classroom, thinking about why they do it, and analysing how it works. This is a process of self-evaluation and self-observation. An **inquiry-based** approach requires more than simply answering questions or getting the right answer. It espouses investigation, exploration, search, quest, research, pursuit and study. The inquiry-based approach usually starts with a stimulation, followed by a demonstration, experiment, field study and project work. The pedagogy adopted for the '*Be a Marine Biologist for a Day*' program for senior schools is inquiry-based.

Pedagogical approaches can also be placed on a spectrum from **teacher-centred** to **learner-centred**. An example of a teacher-centred pedagogical approach would be direct instruction, such as from a formal authority, expert or personal model. The teacher is at the centre of the learning process and typically relies on methods such as whole-class lectures, rote memorisation, and chorus answers (call-and-response). This approach is often criticised, especially if students complete only lower-order thinking tasks and are afraid of the teacher. In contrast, an example of a student-centred pedagogical approach would be inquiry-based learning or cooperative learning where the teacher is a facilitator, personal model or delegator. This approach has many associated terms (for example constructivist, participatory, active learning), but it generally draws on learning theories suggesting learners should play an active role in the learning process. Students therefore use prior knowledge and new experiences to create knowledge. The teacher facilitates this process, but also creates and structures the conditions for learning.

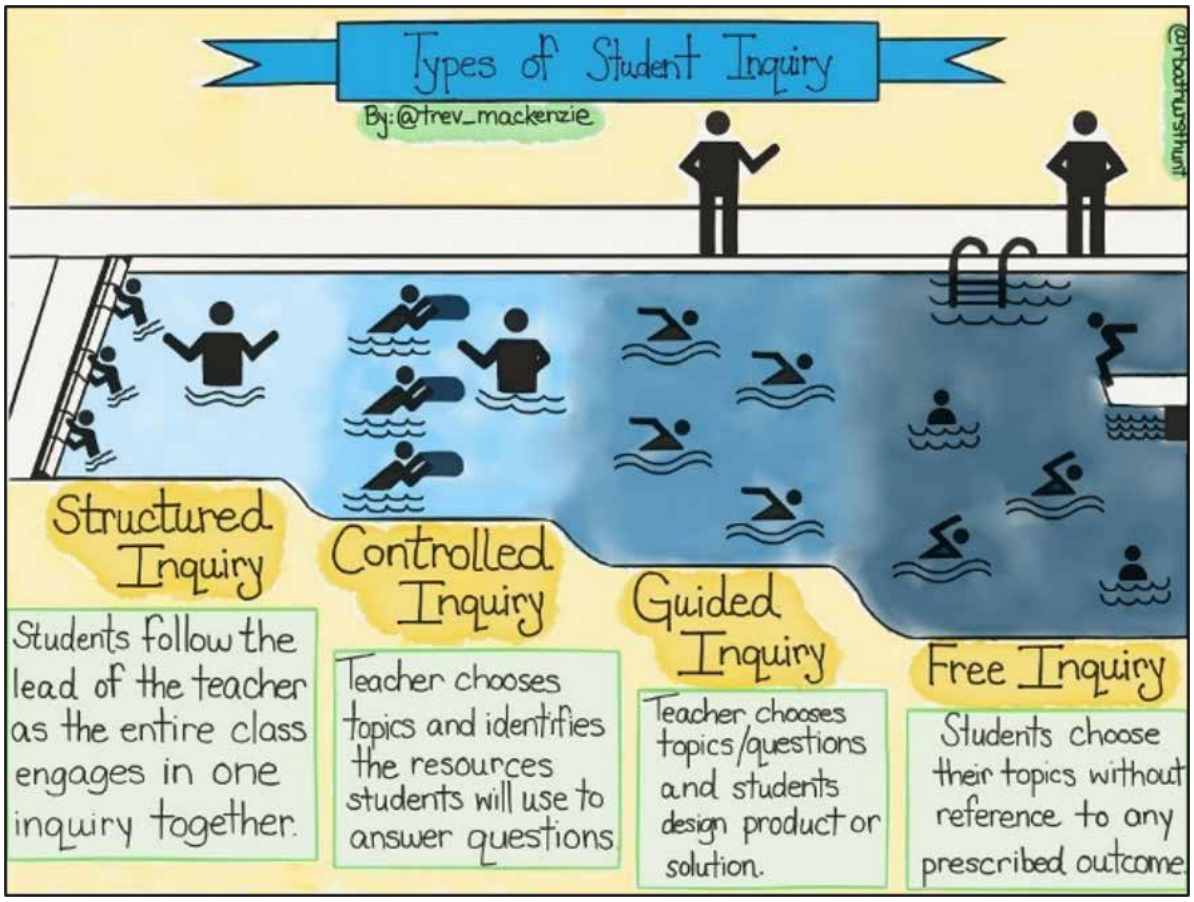
Both teacher-centred and learner-centred pedagogies can be effective, but teachers must consider the local context, including the number of students in the class, the physical environment, the availability of teaching and learning materials and prior learning. It is suggested that teachers should be flexible and carefully adapt their pedagogical approaches based on the learning environment.

Inquiry-based learning

Inquiry-based learning is an approach to learning that emphasises the student's role in the learning process. Rather than the teacher telling students what they need to know, students are encouraged to explore the material, ask questions and share ideas. How much assisted help the teacher provides during the inquiry process can vary.

Types of student inquiry include structured, controlled, guided and free. Structured inquiry is when students follow the lead of the teacher as the entire class engages in one inquiry together. Controlled inquiry is when the teacher chooses types and identifies the resources students will use to answer questions. Guided inquiry is when the teacher chooses topics/questions and students design a product or solution. Free inquiry is when students choose their topics without reference to any prescribed outcome.

The *Be a Marine Biologist for a Day* program can be tailored to be any one of these types of student inquiry, depending on the needs of the school.



Senior school behaviour management

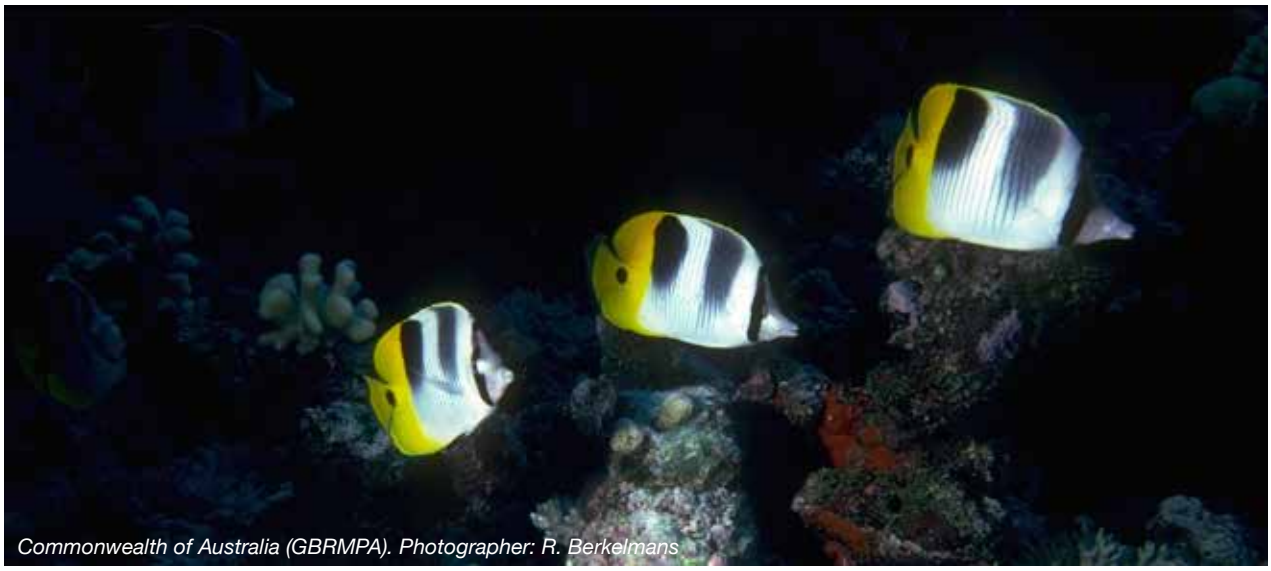
Most senior school students exhibit exemplary behaviour whilst on excursions. Senior students are usually 16 years or above. They are not little children anymore. Most of them hold jobs and are very well behaved. All are expected to be role models for students in younger grades. Teachers often remind them of this responsibility as a behaviour management strategy. Senior students have been on many excursions before and know what is expected of them.

As a general observation, marine science students are typically better behaved than aquatic practices students. Marine science is a general subject. An assessment result in marine science could decide if a student is offered a place at university or not. Aquatic practices is an applied subject, with students often pick for '*a bit of fun*'. Most problems occur simply because students are so excited to be there.

For senior students, most poor behaviour is either impulsive, or driven by emotion, with little rational thought. They do something silly because they think it will be funny, or they're trying to impress their friends. Or they may get in a fight because they're unable to control their emotions, such as anger or jealousy. There is a scientific explanation for this phenomenon. The brain is not fully developed until a person reaches the age of approximately 25. In teenagers, the pre-frontal cortex (the front part of the brain) that is responsible for smart decision-making and moderating social behaviour is still developing. The amygdala, on the other hand, is fully developed. The amygdala is responsible for emotions and impulsive behaviours. It often highjacks the decision-making functions of a teenager's brain resulting in them making poor choices.

It is unlikely a fight will break out on an excursion. However, the students will be super excited and could do something impulsive or stupid to try and be funny or entertaining, particularly around their friends. Most marine science and aquatic practices students will be very competent in the water. You can expect their snorkeling ability to be very good. However, that does not always mean they are safe. They may swim off too far or be under water for too long, so that surface watch, or passing boats, have trouble spotting them. Be aware of attention-seeking behaviours, such as picking up sea cucumbers, poking sea anemones, showing off to their peers and being silly in general.

Many problems are preventable by providing students with the information they need to make informed choices. The snorkel brief will be your first line of defense to prevent problems. Therefore, do not get tricked into thinking it's okay to shorten a snorkel brief because students look like they already know what to do. Make sure everyone can hear you clearly, be very specific about what you need them to know, and ask questions to check understanding. Their response will not only give you an indication of their understanding, but also their level of attention and maturity. If told not to do something in advance, there is a good chance they will respect your wishes.



Commonwealth of Australia (GBRMPA). Photographer: R. Berkelmans

Know how students learn

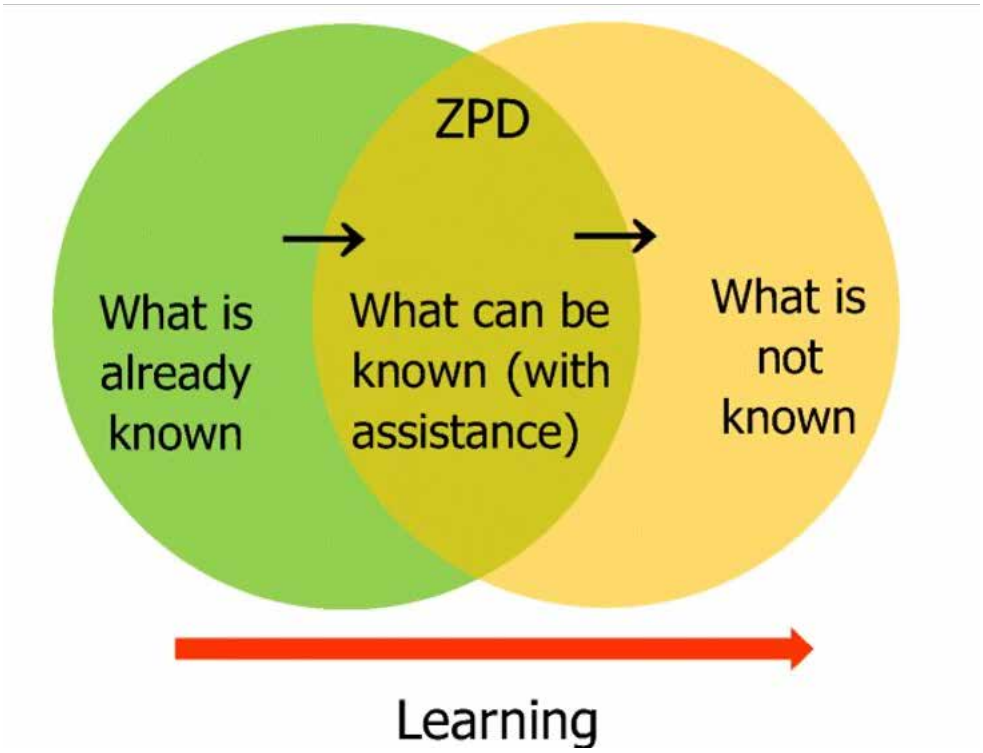
Instructional Manual for Reef Guides

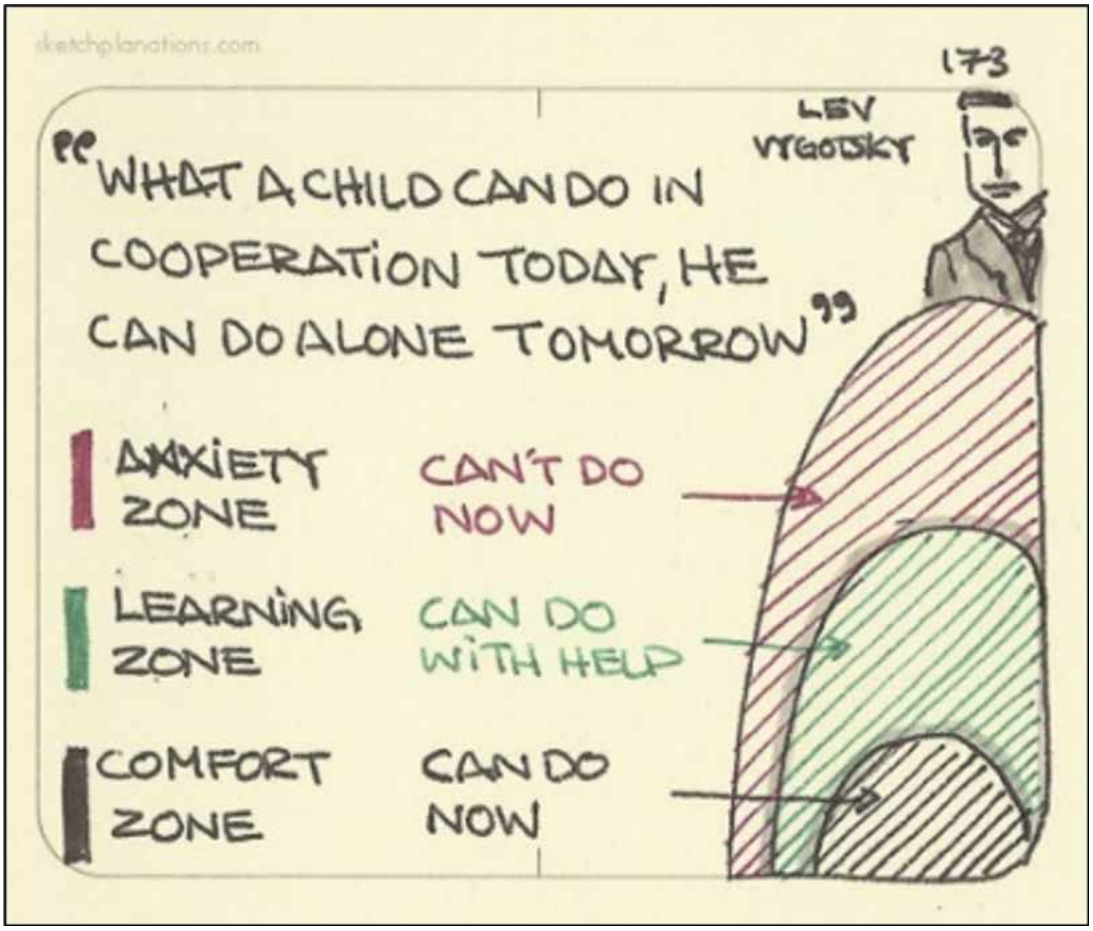
Vygotsky's Zone of Proximal Development and scaffolding

The Zone of Proximal Development (ZPD) has been described as the difference between what a learner can do without help and what he or she can achieve with guidance and encouragement from a skilled partner. Thus, the term 'proximal' refers to those skills that the learner is 'close' to mastering. The term '*zone*' is the area of learning that occurs when a person is assisted by a teacher or peer with a higher skill set. The person learning the skill set cannot complete it without the assistance of the teacher or peer. The teacher then helps the student attain the skill, until the teacher is no longer needed.

Vygotsky believed that children would not advance very far if they were left to discover everything on their own. It's crucial for a child's development that they're able to interact with more knowledgeable others, without whom they would not be able to expand on what they know. Vygotsky noted cultural experiences where children are greatly helped by knowledge and tools handed down from previous generations. He also noted that good teachers shouldn't present material that is too difficult and 'pull the students along'. Vygotsky argued that, rather than examining what a student knows to determine intelligence, it is better to examine their ability to solve problems independently and with an adult's help.

Scaffolding is a process through which a teacher or a more competent peer helps a student in their ZPD as necessary and tapers off this aid as it becomes unnecessary—much as workers remove a scaffold from a building after they complete construction. For scaffolding to be effective, one must start at the child's level of knowledge and build from there.

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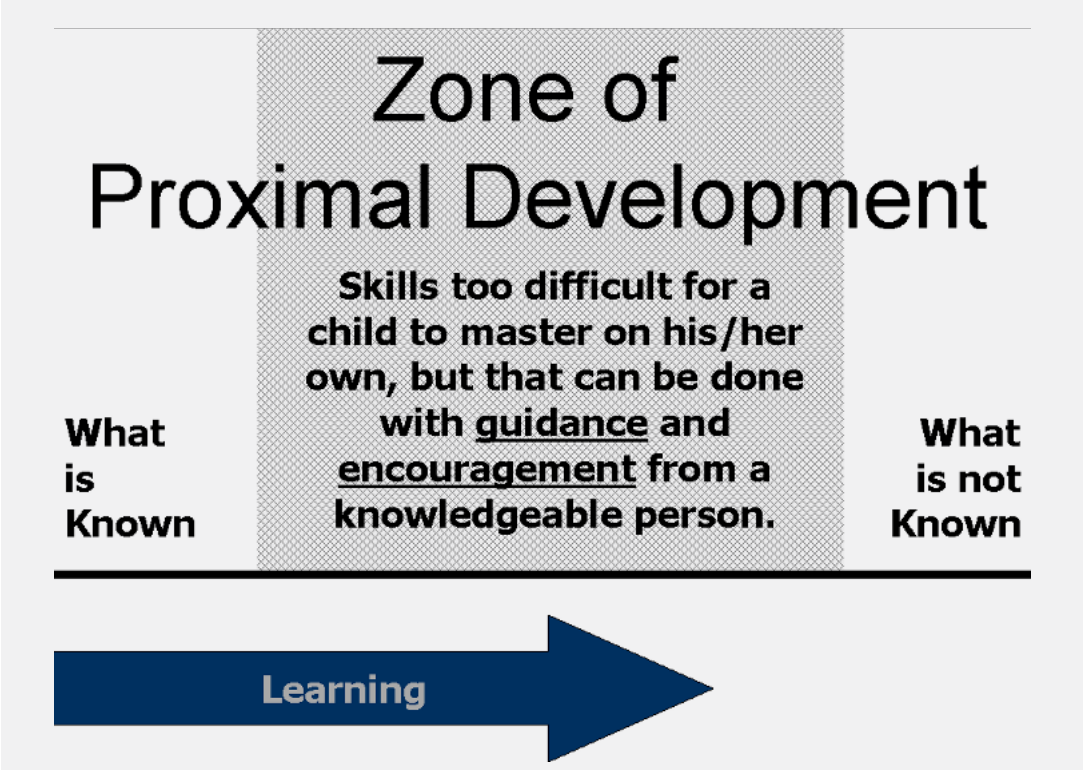
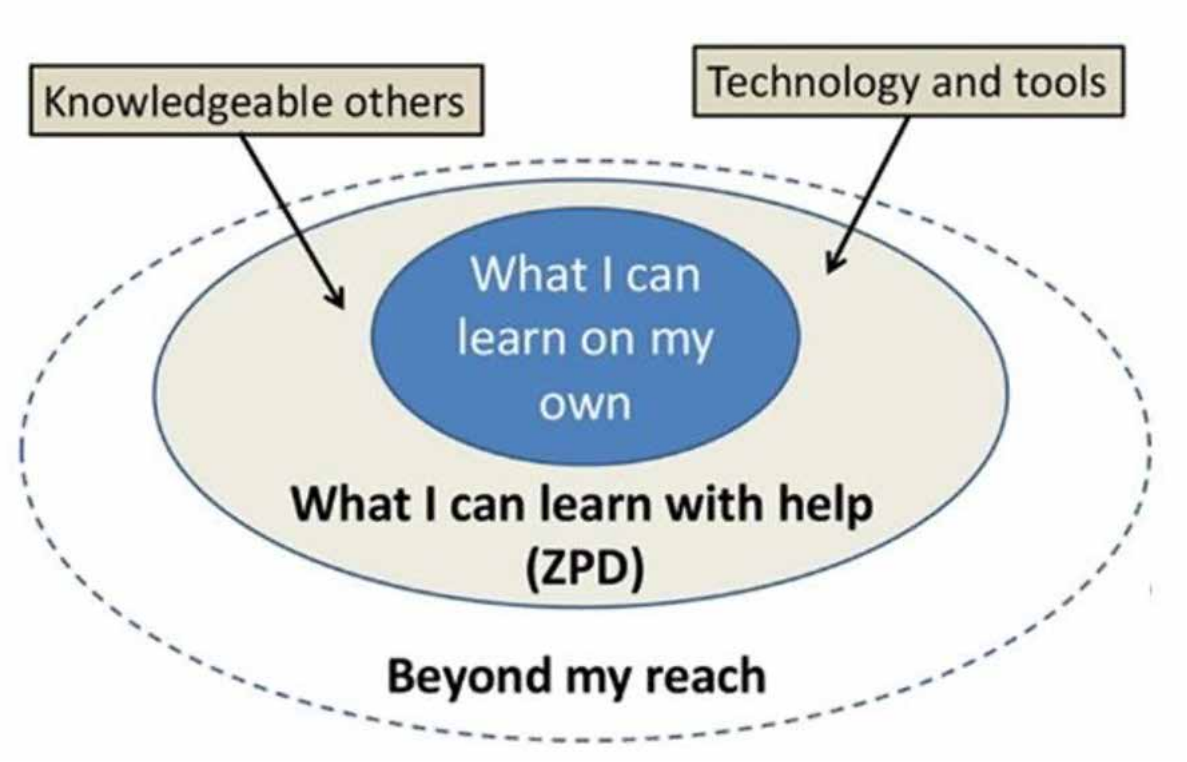
LEV VYGOTSKY
"WHAT A CHILD CAN DO IN COOPERATION TODAY, HE CAN DO ALONE TOMORROW"
ANXIETY ZONE
CAN'T DO NOW
LEARNING ZONE
CAN DO WITH HELP
COMFORT ZONE
CAN DO NOW


Zone of Proximal Development
Skills too difficult for a child to master on his/her own, but that can be done with guidance and encouragement from a knowledgeable person.
What is Known
What is not Known
Learning

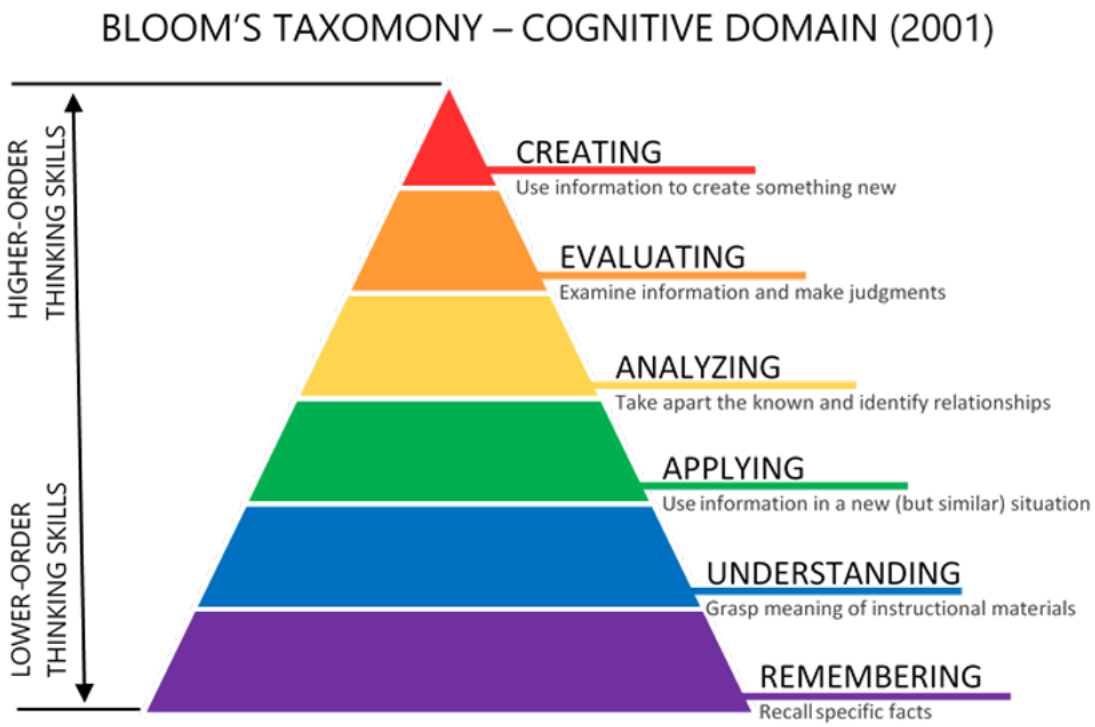


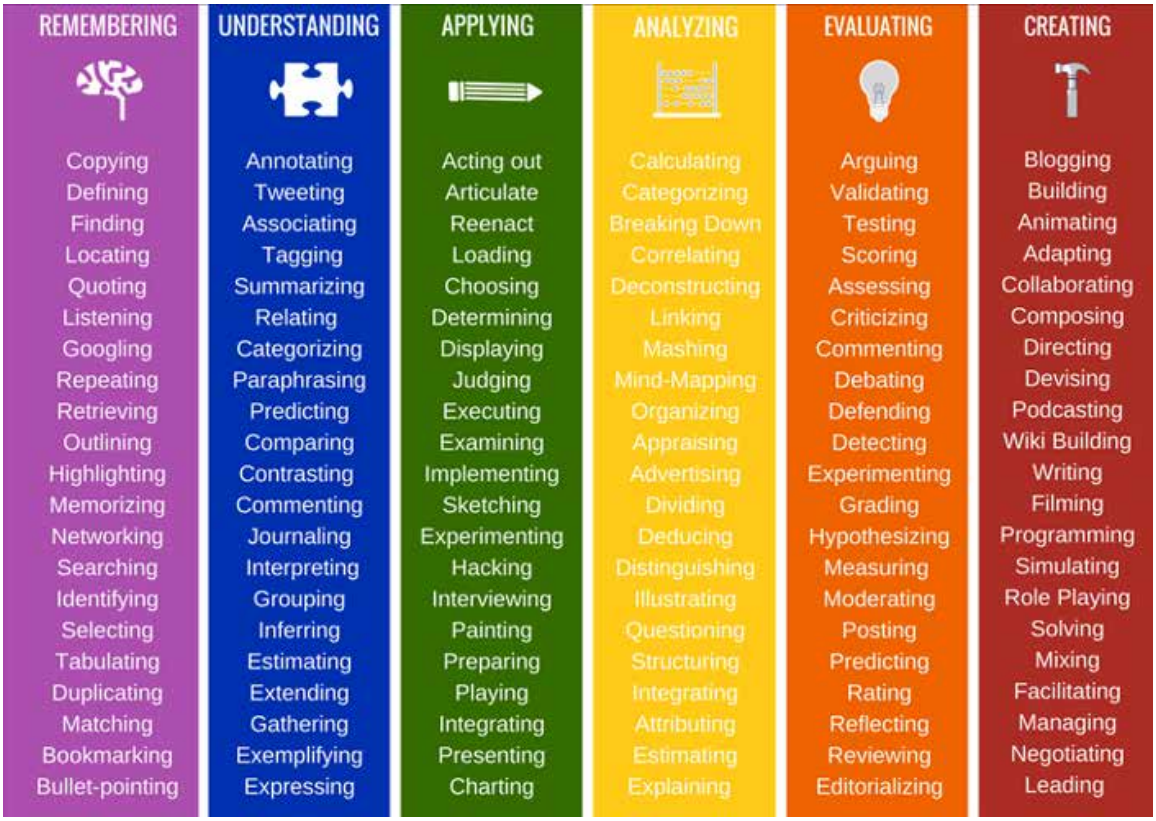
Notably, scaffolding in education does have some boundaries. One of the largest hurdles to overcome is managing multiple students. While scaffolding is meant to be a relatively independent process for students, the initial phase of providing individual guidance can easily be overlooked when managing large classrooms. This hurdle of scaffolding and ZPD is important to acknowledge so that teachers can find solutions to the problems or alter their teaching methods. Note: senior biology classes are typically more popular and have larger class sizes than marine classes. Large schools also tend to have larger classes.

As a reef guide, it is important to question each student, to identify their zone of proximal development. Once you have established what they know with confidence, you can customise their experience so it's not too hard or too easy. It needs to be just challenging enough so they can grow confident in their ability to do a rapid monitoring survey in the future. For example, the 360° survey might be a little too much to take on. But the 10 minute timed survey is just challenging enough for them to feel like they achieved something. High achieving students, on the other hand, might be trusted with a 360° survey and even a Reef health impact survey. Any sense of achievement feels good. Anything that feels good, they will want to do again.

Bloom's taxonomy

Bloom's taxonomy follows a hierarchy, which, supports the idea that learning is built on prior knowledge and skills already learnt. The pyramid demonstrates how each learning outcome must be achieved before moving onto the next level.





Bloom's six levels begin with the most basic understanding and then increase in complexity. Each level also reflects the type of activities that the student will perform or practice at that level of understanding.

Lower-order thinking skills (LOTS) are represented by the lower three levels in Bloom's taxonomy: remembering, understanding, and applying. LOTS does not require much thinking 'outside the box'. You learn it, then you remember it. Hence the name, lower order thinking skills.

Higher-order thinking skills (HOTS) are represented by the top three levels in Bloom's taxonomy: analyzing, evaluating, and creating. HOTS refer to skills that go beyond memorizing information or regurgitating stories. HOTS requires thinking 'outside the box'. Using information that you already know and remember, you can analyse, evaluate or create something new.

In order to reach the higher level of thinking skills, the lower-order of thinking skills must be achieved first.

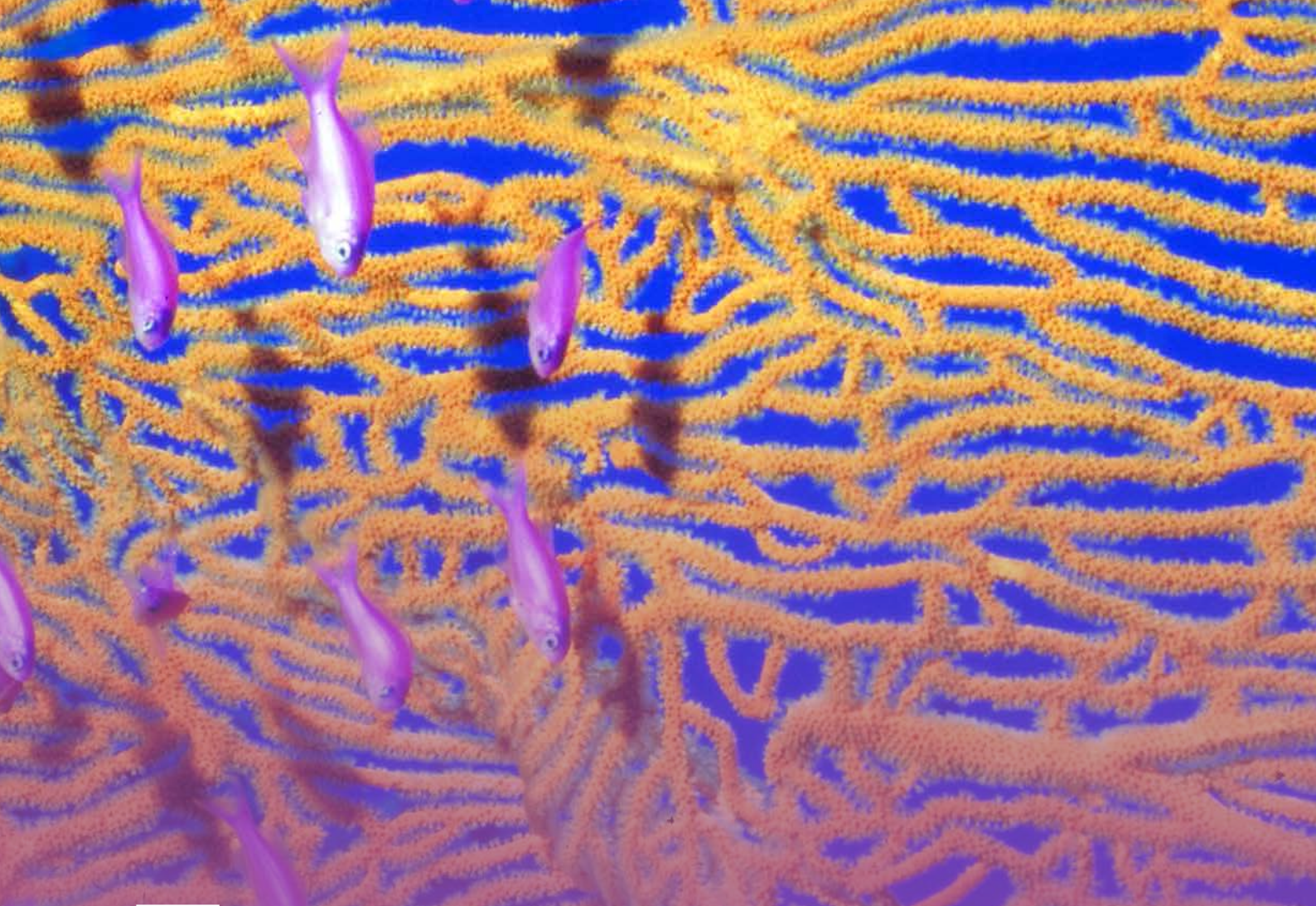
A lot of emphasis is put on cognitive verbs in senior subjects, such as those in Bloom's taxonomy. Teachers use them frequently in class. Every internal assessment item sent to QCAA for confirmation (checking) must feature cognitive verbs in all task instructions. QCAA also use them for the start of every external exam question. Students must learn them, so they know what to do to answer the question correctly. Likewise, exam questions that use LOTS cognitive verbs are worth fewer marks than exam questions that use HOTS cognitive verbs. Any assessment item that a student brings to an excursion will feature a cognitive verb. Understanding the meaning of the cognitive verb will help you understand what the student must do to complete the task. Cognitive verbs also feature on criteria sheets or rubrics used to grade student work. A glossary of cognitive verbs from QCAA can be found in every senior syllabus. The one for marine science is on the following page.

Note: there are more theories to how students learn in the primary and middle school guides.

Commonwealth of Australia (GBRMPA). Photographer: D. Wachenfeld.

Cognitive verbs

Cognitive Verb	Description
Apply	Use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation.
Argue	Give reasons for or against something; challenge or debate an issue or idea; persuade, prove or try to prove by giving reasons.
Assess	Measure, determine, evaluate, estimate or make a judgement about the value, quality, outcomes, results, size, significance, nature or extent of something.
Calculate	Determine or find (e.g. a number, answer) by using mathematical processes; obtain a numerical answer showing the relevant stages in the working; ascertain/ determine from given facts, figures or information.
Categorise	Place in, or assign to, a particular class or group; arrange or order by classes or categories; classify, sort out, sort, separate.
Classify	Arrange, distribute or order in classes or categories according to shared qualities or characteristics.
Compare	Display recognition of similarities and differences and recognise the significance of these similarities and differences.
Define	Give the meaning of a word, phrase, concept or physical quantity; state meaning and identify or describe qualities.
Describe	Give an account (written or spoken) of a situation, event, pattern or process, or of the characteristics or features of something.
Discuss	Examine by argument; sift the considerations for and against; debate; talk or write about a topic, including a range of arguments, factors or hypotheses; consider, taking into account different issues and ideas, points for and/or against, and supporting opinions or conclusions with evidence.
Distinguish	Recognise as distinct or different; note points of difference between; discriminate; discern; make clear a difference/s between two or more concepts or terms.
Evaluate	Make an appraisal by weighing up or assessing strengths, implications and limitations; make judgements about ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria.
Explain	Make an idea or situation plain or clear by describing it in more detail or revealing relevant facts; give an account; provide additional information.
Identify	Distinguish; locate, recognise and name; establish or indicate who or what someone or something is; provide an answer from a number of possibilities; recognise and state a distinguishing factor or feature.
Recall	Remember; present remembered ideas, facts or experiences; bring something back into thought, attention or into one's mind.
Recognise	Identify or recall particular features of information from knowledge; identify that an item, characteristic or quality exists; perceive as existing or true; be aware of or acknowledge.
Understand	Perceive what is meant by something; grasp; be familiar with (e.g. an idea); construct meaning from messages, including oral, written and graphic communication.



Eye on the Reef Training

Instructional Manual for Reef Guides

Eye on the Reef training

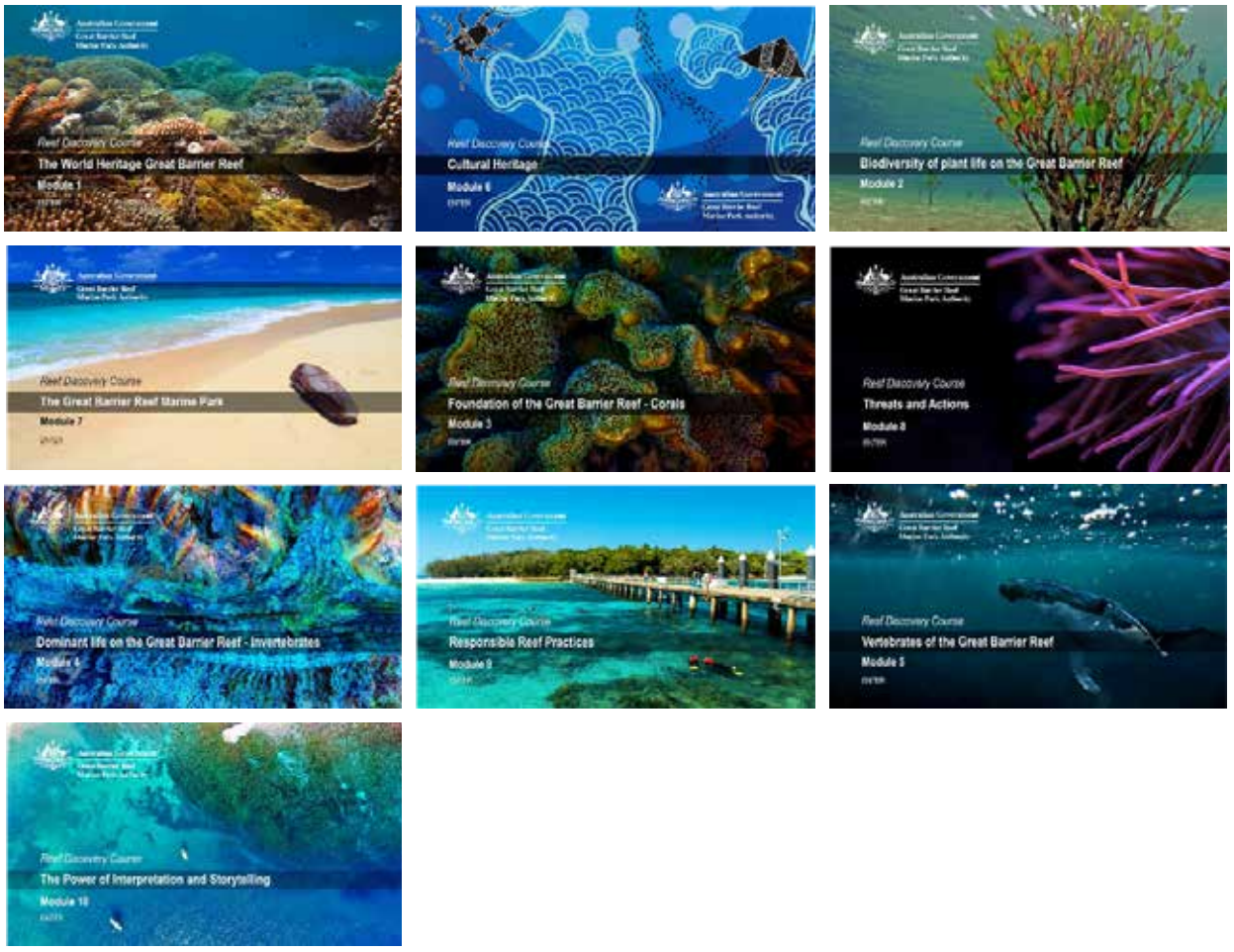
Being a good reef guide is not just about knowing what students need to learn. It is also about you having good knowledge and skills as well. There are a number of online training programs as well as workshops and in-water training opportunities for tourism staff and teachers to complete. Copies of the online training modules are available as interactive PDF and can be used to support teacher professional development opportunities as well as training for tourism staff.

Reef Discovery Course

The Reef Discovery Course is a convenient online education package that aims to improve knowledge and understanding of the Great Barrier Reef World Heritage Area, its cultural connections, biological diversity, management and protection, and how best to interpret this information to visitors.

The comprehensive training is a free online course covering the A-Z of all things Great Barrier Reef and how best to share that knowledge with visitors. Designed as a primer by the Great Barrier Reef Marine Park Authority, the course aims to inspire people to learn more about the Reef, how valuable it is and how to deliver accurate information about it in an interesting and memorable way.

To gain access to the Reef Discovery Course, please complete the Eye on the Reef online registration at www.gbrmpa.gov.au or email eyeonthereef@gbrmpa.gov.au

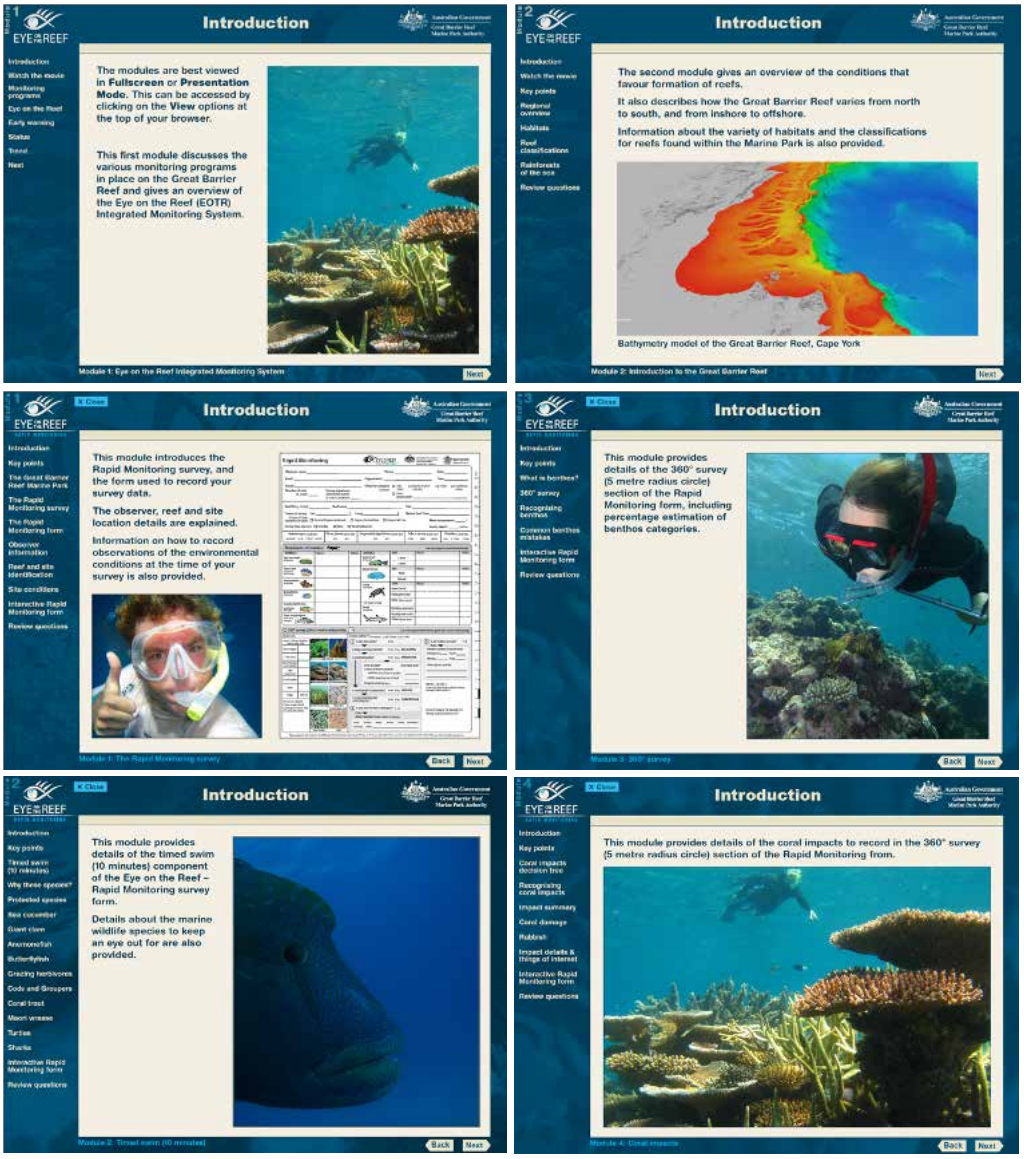


Rapid monitoring training

The rapid monitoring survey online training program has six training modules, which include knowledge reviews and short assessment quizzes.

Each module takes up to 30 minutes to complete. Once participants review all modules and quizzes, they are ready to start undertaking surveys and will be added to the rapid monitoring survey team. In order to submit rapid monitoring data, you need to complete the online training and register to be part of the rapid monitoring survey team.

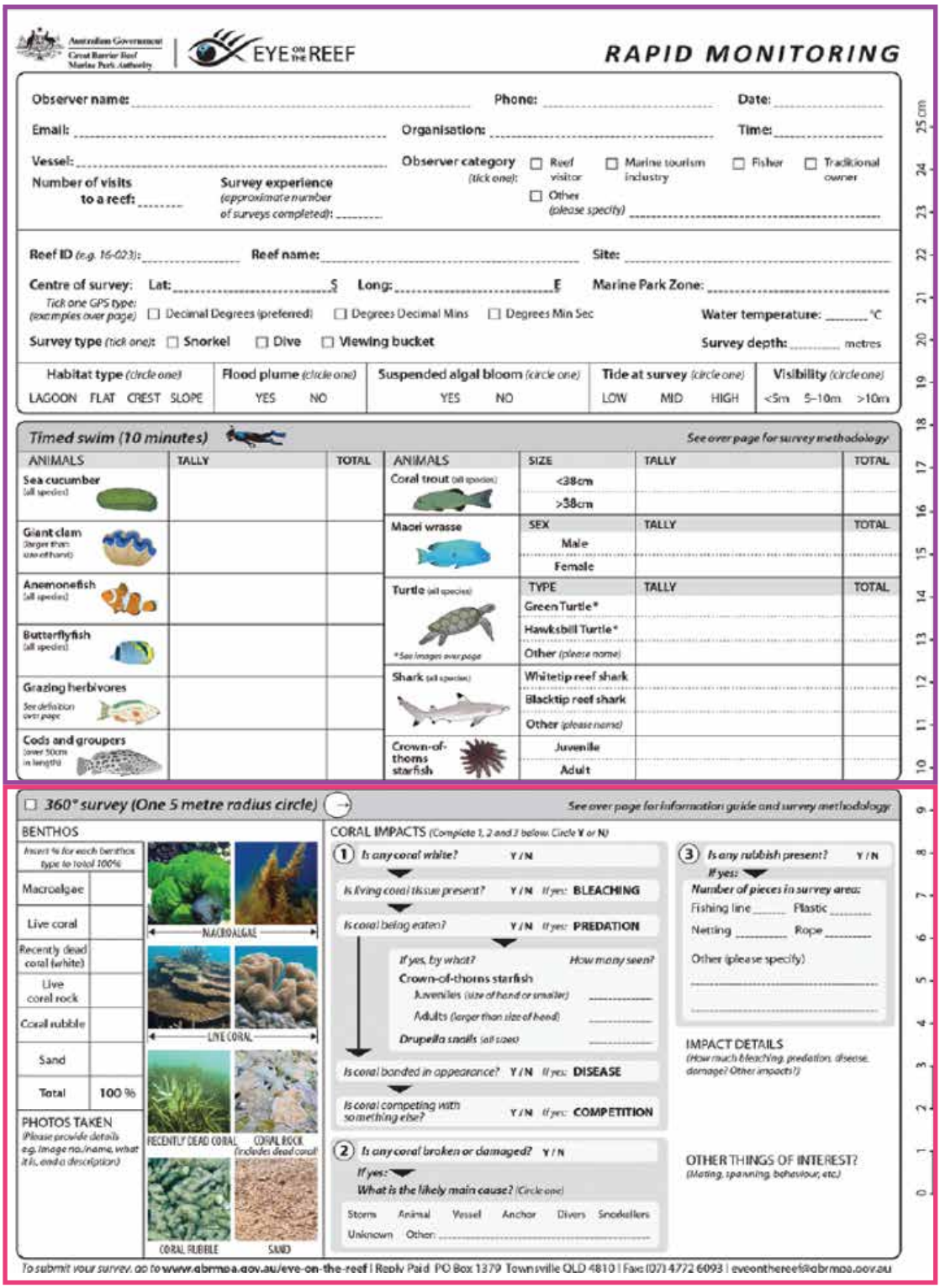
To be part of the rapid monitoring survey team, please complete the Eye on the Reef online registration at www.gbrmpa.gov.au or email eyeonthereef@gbrmpa.gov.au



Modified rapid monitoring survey for senior schools

The senior school resources in this toolkit mainly focus on developing students' skills in counting all the species seen in the timed swim section of the rapid monitoring survey and starting to build skills to conduct the 360° survey. Resources help students learn about all the species and why we observe and count them and provide learning that is curriculum-linked for their year level.

Skills such as methodology, animal identification, counting and tallying are critical for senior school students participating in these activities. Further details on this are outlined in the chapter customising resources for your tourism operation.



EYE ON THE REEF

RAPID MONITORING

Observer name: ..... Phone: ..... Date: .....

Email: ..... Organisation: ..... Time: .....

Vessel: ..... Observer category (tick one): ☐ Reef visitor ☐ Marine tourism industry ☐ Fisher ☐ Traditional owner ☐ Other (please specify) .....

Number of visits to a reef: ..... Survey experience (approximate number of surveys completed): .....

Reef ID (e.g. 16-023): ..... Reef name: ..... Site: .....

Centre of survey: Lat: ..... S Long: ..... E Marine Park Zone: .....

Tick one GPS type: (examples over page) ☐ Decimal Degrees (preferred) ☐ Degrees Decimal Mins ☐ Degrees Min Sec Water temperature: ..... °C

Survey type (tick one): ☐ Snorkel ☐ Dive ☐ Viewing bucket Survey depth: ..... metres

Habitat type (circle one)	Flood plume (circle one)	Suspended algal bloom (circle one)	Tide at survey (circle one)	Visibility (circle one)
LAGOON FLAT CREST SLOPE	YES NO	YES NO	LOW MID HIGH	<5m 5–10m >10m

Timed swim (10 minutes) See over page for survey methodology

ANIMALS	TALLY	TOTAL
Sea cucumber (all species)		
Giant clam (larger than size of hand)		
Anemonefish (all species)		
Butterflyfish (all species)		
Grazing herbivores (See definition over page)		
Cods and groupers (over 50cm in length)		

ANIMALS	SIZE	TALLY	TOTAL
Coral trout (all species)	<38cm		
	>38cm		
Maori wrasse	SEX	TALLY	TOTAL
	Male		
	Female		
Turtle (all species) *See images over page	TYPE	TALLY	TOTAL
	Green Turtle*		
	Hawksbill Turtle*		
	Other (please name)		
Shark (all species)	Whitetip reef shark		
	Blacktip reef shark		
	Other (please name)		
Crown-of-thorns starfish	Juvenile		
	Adult		

☐ 360° survey (One 5 metre radius circle) → See over page for information guide and survey methodology

BENTHOS

Insert % for each benthos type to total 100%

Macroalgae	
Live coral	
Recently dead coral (white)	
Live coral rock	
Coral rubble	
Sand	
Total	100 %

PHOTOS TAKEN (Please provide details e.g. image no./name, what it is, and a description)

MACROALGAE LIVE CORAL RECENTLY DEAD CORAL CORAL ROCK (includes dead coral) CORAL RUBBLE SAND

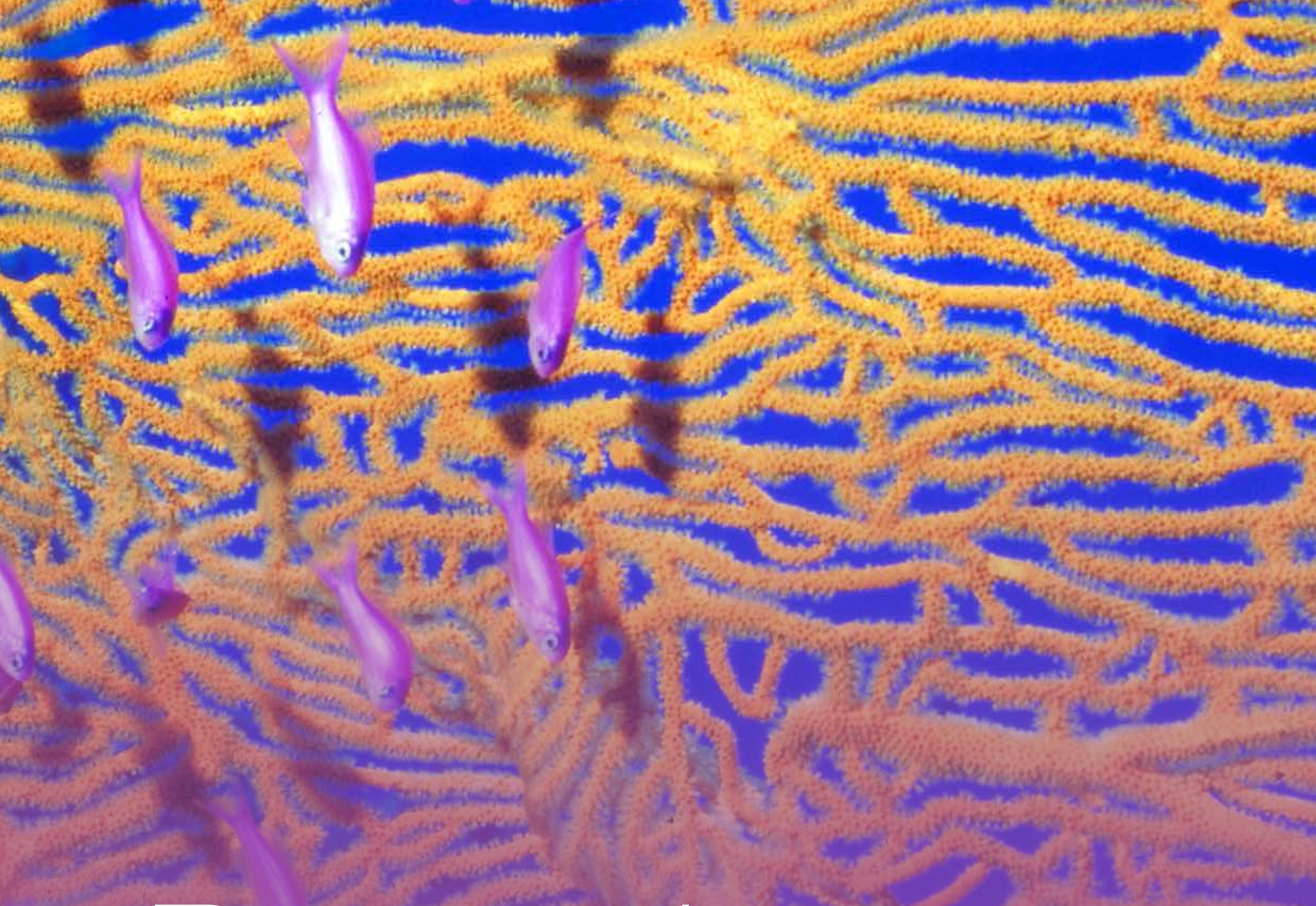
CORAL IMPACTS (Complete 1, 2 and 3 below. Circle Y or N)

1. Is any coral white? Y / N
   - Is living coral tissue present? Y / N If yes: BLEACHING
   - Is coral being eaten? Y / N If yes: PREDATION
     - If yes, by what? How many seen?
     - Crown-of-thorns starfish
       - Juveniles (size of hand or smaller) .....
       - Adults (larger than size of head) .....
     - Drupella snails (all sizes) .....
   - Is coral banded in appearance? Y / N If yes: DISEASE
   - Is coral competing with something else? Y / N If yes: COMPETITION
2. Is any coral broken or damaged? Y / N
   - If yes: What is the likely main cause? (Circle one)
     - Storm Animal Vessel Anchor Divers Snorkellers
     - Unknown Other: .....
3. Is any rubbish present? Y / N
   - If yes: Number of pieces in survey area:
     - Fishing line ..... Plastic .....
     - Netting ..... Rope .....
     - Other (please specify) .....

IMPACT DETAILS (How much bleaching, predation, disease, damage? Other impacts?)

OTHER THINGS OF INTEREST? (Mating, spawning, behaviour, etc.)

To submit your survey, go to www.gbrmpa.gov.au/eye-on-the-reef | Reply Paid PO Box 1379 Townsville QLD 4810 | Fax (07) 4772 6093 | eyeonthereef@gbrmpa.gov.au



Pre and post snorkel brief cards

Instructional Manual for Reef Guides

At first, the pre-snorkel brief cards may look a little confusing and you may think they are in the wrong order, but they are not. They are like this on purpose. The pre-snorkel and post-snorkel cue cards are designed to be used as flip books. The students will be seated in front of you. You will hold the cards up high for everyone to see. The content is repeated on the back of the *previous card* so that you don't need to keep turning them towards you to see what they are. That way, not only can you keep the cards facing the students, but there are questions that you can ask the students. You can feel assured that they are directly related to what the students are learning at school for that particular year level. Remember, this program uses an inquiry-based approach to learning, so your delivery of the content should involve a lot of questioning (as opposed to telling them the information). The inquiry questions will help you with this. The students should already know the answers to the questions if they completed Part 1 at school. If not, they may need you to introduce each species first.

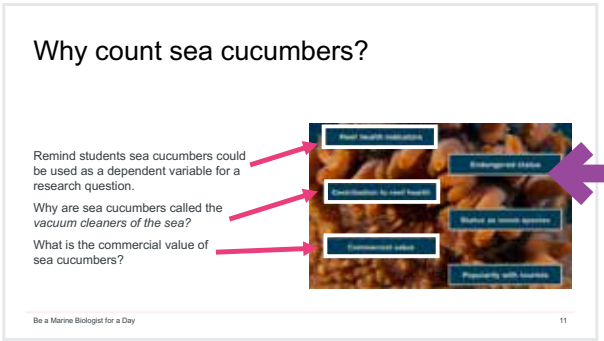
Save the PPT to PDF. Print double-sided on waterproof paper (Officeworks can do this for you) to the size of your liking (A4 is recommended). Alternatively, print double-sided and laminate the pages instead. Punch holes along the top edge of each page. Use a large ring to bind the pages together. The pages must be able to flip easily without damage.

The age groups are colour-coded. Primary school (P-6) is in orange. Middle school (7-10) is in blue. Senior school (11-12) is in purple. The pre-snorkel and post-snorkel brief cards for the advanced 360° survey are in red.

What the REEF GUIDE is reading from

What the Students are looking at

What the REEF GUIDE is reading from



What the Students are looking at

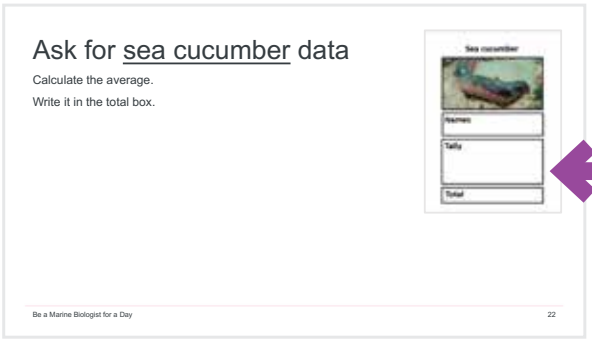
Pre-snorkel presentation

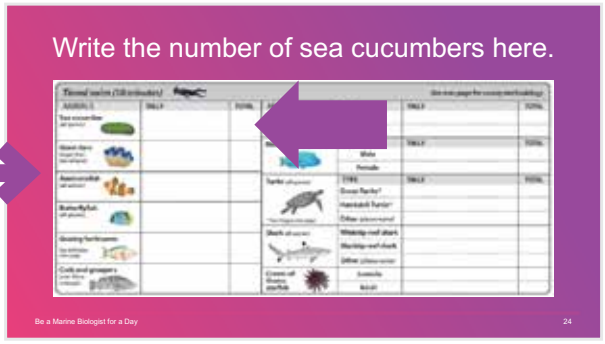
The pre-snorkel presentation is shorter than the middle school's version because it is likely the seniors will also be doing the entire rapid monitoring survey (including the 360° survey). Therefore, we don't want to make the pre-snorkel briefs too long. There is some degree of assumed knowledge about the indicator species already — from prior learning at school, and part 1 of *Be a Marine Biologist for a Day.* The main purpose for the presentation is to ensure they know exactly what to count (they will count all 10 species per buddy pair) and why they are being counted, from a management perspective and an assignment perspective. The 10 min timed swim and 360° survey pre-snorkel brief cards are not places together because the students are also likely to be collecting their own primary data and/or coral watch data and may decide to only do the 10min timed swim. Also having a separate set of cue cards for the 360° survey means they can be used for keen middle school students as well.

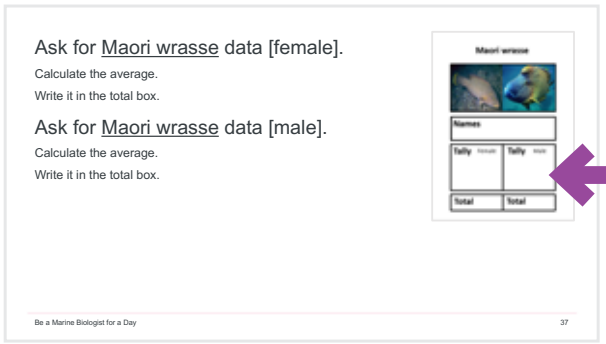
Seniors are the only age group counting ALL 10 indicator organisms per buddy pair in the 10 minute survey. So they were asked questions from the rapid monitoring course in Part 1 at school, before the excursion. If they completed Part 1 at school they should be very well prepared. If they did not complete Part 1 at school before the excursion, they may need additional guidance and preparation. The pre-snorkel cue cards are designed for both scenarios.

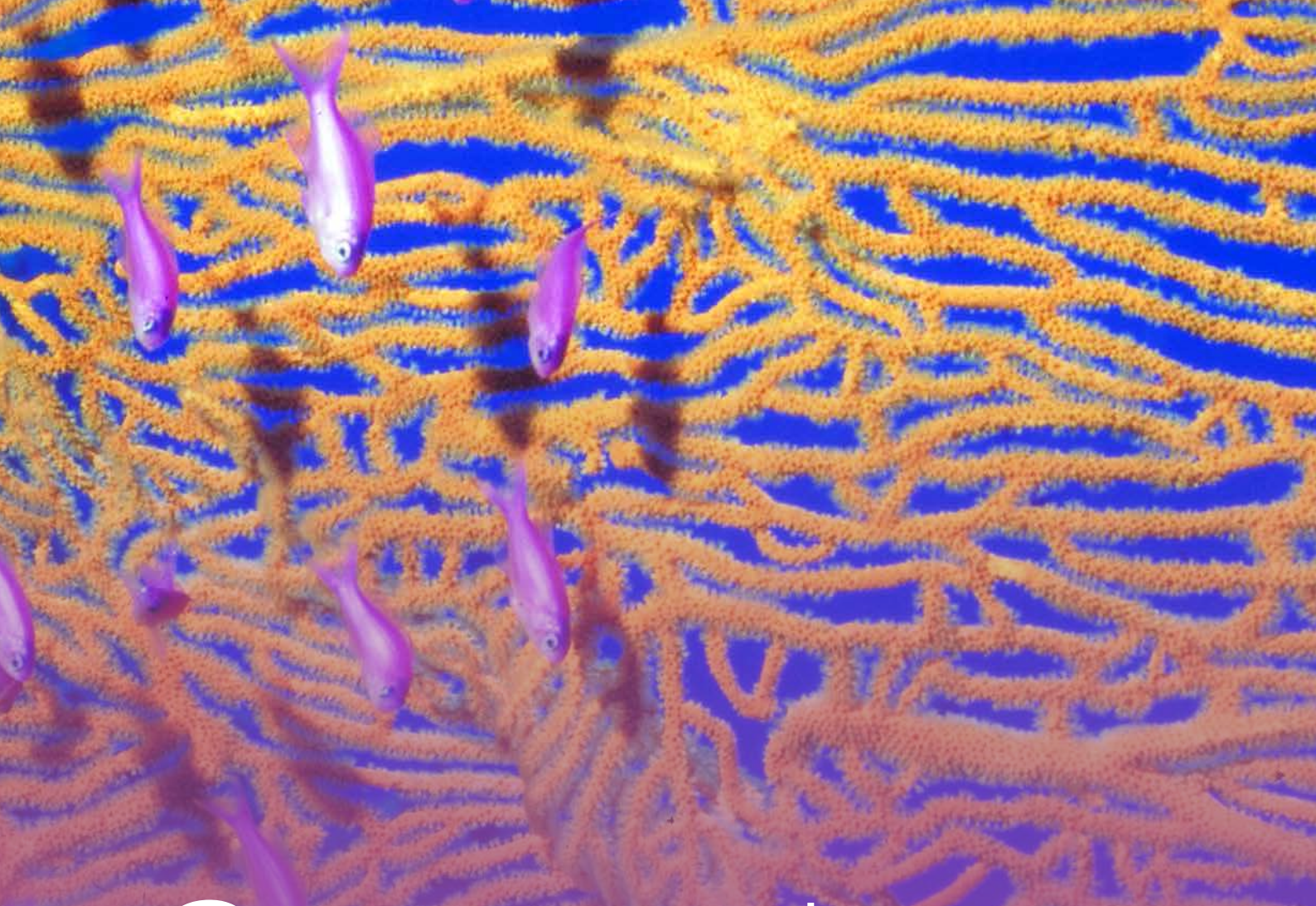
Post-snorkel presentation

The post-snorkel presentation is all about collecting the data from each buddy pair and transferring it to their own survey forms (in their activity books) and calculating the averages. The averages go in the TOTAL box. Encourage students to calculate the averages themselves.







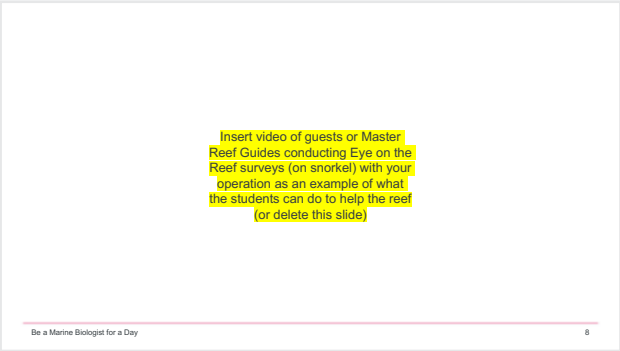


Customsing resources to your operation

Instructional Manual for Reef Guides

Part 1: Preparing to find out

May of the slides in part 1 of the toolkit can be customised to your operation, particularly at the start and end of the PowerPoint slides. There will either be prompts highlighted in yellow, or prompts in the notes section of each slide. Check both (and delete when finished). Notably, there are a lot of repeated slides between year levels. You may be able to copy/paste an edited slide from one year level to another year level, to save time. If you'd prefer to leave the examples as they are, that is okay too. However, make sure you go through each slide to delete any unwanted prompts/highlights/notes before preparing to send out to schools.

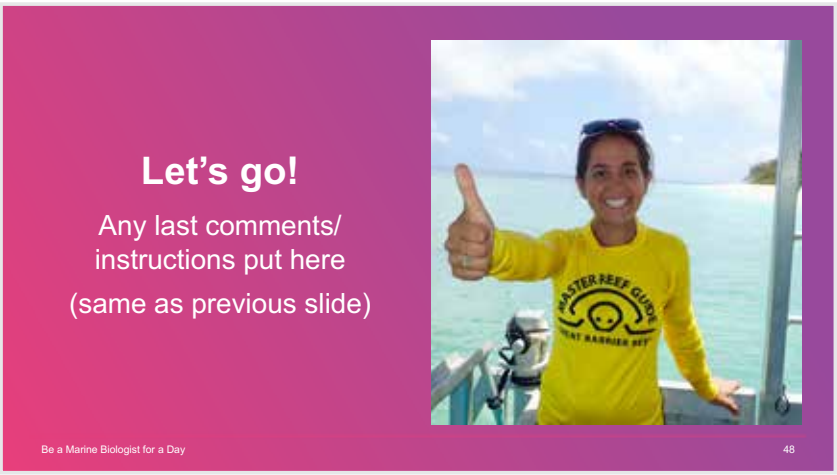


Part 2: Finding out

Pre-snorkel brief cards

Change any pictures to customise the cards to your operation and the animals that reside there.

Add any last comments/instructions on the last slide of the pre-snorkel brief.



Post-snorkel brief cards

You will need to customise quite a lot in the post-snorkel brief cards before printing, such as what the students will be writing on their rapid monitoring forms (for example, the name of the vessel, reef, site). If you visit several sites, write them all in. You can simply tell the students which one to copy down. That is much easier than trying to spell a word to a group of students. If you'd prefer to leave the examples as they are, that is okay too.

Part 3: Making connections

No changes are required to the PowerPoints for Part 3. *Note*: the quiz is in Part 1 (not Part 3).

Activity books

The students will all have copies of the first and second part of the rapid monitoring survey form in their activity books (NOT the 360° survey part). It is recommended you keep a class set of activity books as spares for school groups that forget to bring them. This is highly unlikely, but it is better to be safe than sorry. Alternatively, have some spare rapid monitoring forms they can take home with them. Organise to have plenty of pencils and erasers as well. You don't need to make any changes to the activity books, unless you have changed some of the questions in the PowerPoints. The questions in Parts 1 and 3 are the same as the questions in the activity books.

Keep in mind most schools only print in black and white, so colour pictures are likely to be printed in black and white.

Senior activity books have an additional two pages on COTS that other grade levels don't have. This is because seniors are the only age group completing the entire 10 min rapid monitoring survey of all indicator species by themselves (in buddy pairs).

Assessment tasks

There are two assessment tasks. One is a practice data test IA1 for marine science (or any general science subject). The other is a project for aquatic practices students that contains three components: a multi-modal component (e.g. video), a written component (the activity book) and a performance component (demonstration of snorkelling). You shouldn't have to make any changes to either of those assessment tasks.

Sharing the experience

Asking teachers to share students' work after the excursion will give you a chance to see how students apply what they have learnt. It is always good to follow up to see the impact you have had on these students. They will remember Reef excursions for the rest of their lives, especially if it is the only time they ever go. You will be amazed at how much of an impact you can have on particular students.

You can even ask schools to share photos of their trip on social media or send you some photos (with permission). This makes for good marketing for your tourism operations as well as the school. If you are given any photos or take some of your own, ensure you have permission to publish. Most schools get parents to complete a permission form at the start of the school year that allows their children to be photographed. But do not assume this is always the case. You can ask the schools to share their photos on their social media and tag your company page, so you can re-share the post.

You could even ask for some student testimonials to share on your company's website about the experience. It is also nice to follow up and check what teachers think of the experience. Many teachers will return year after year with the next cohort of students.

Other educational resources

There are many more educational resources available on the Great Barrier Reef Marine Park Authority's website and YouTube channels that are available for use on your vessels or to share with teachers.

Final tips and things to consider

Eye on the Reef tourism weekly survey

Conducting Eye on the Reef tourism weekly monitoring surveys will give you the knowledge and credibility to deliver rapid monitoring surveys with students and other paying guests under the *Be a Marine Biologist for a Day* program. The tourism weekly survey form records reef health indicators, environmental measurements and the presence of protected and iconic species. All of these factors directly relate to specific known concerns about the resilience of the Reef. By taking part in this monitoring program, tourism operators gain detailed knowledge that can help them improve the local management of their site, update reef interpretation tours and tailor products for their visitors.

Eye on the Reef app and sighting network

There are many ways to get involved and everyone's contribution is welcomed — whether you're a regular day-tripper, tourist on their first visit, fisher, Marine Park ranger, marine tourism staff or marine scientist. One of the easiest ways anyone can get involved is by downloading our free Eye on the Reef app to record reef health, animal sightings and incidents. There are also other monitoring programs for people who visit the Reef more regularly, have more time or marine biology knowledge, or are willing to undergo training.

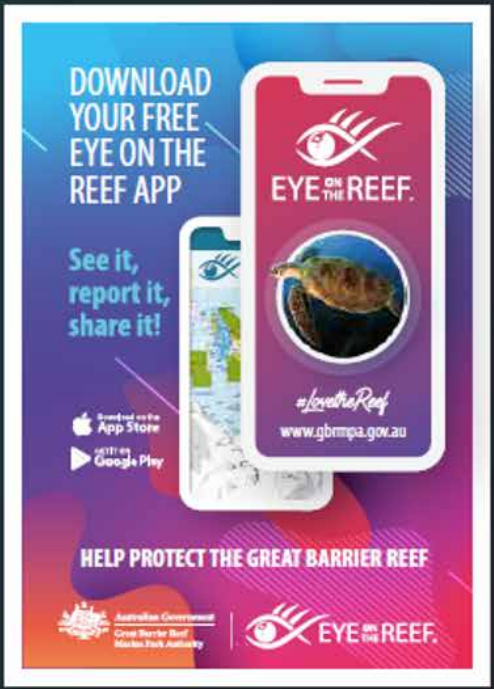
Master reef guide

All reef guides and staff working on tourism operations along the Great Barrier Reef are critically important to educating Reef visitors. Delivering education experiences to students and improving your knowledge through tourism weekly and the Reef Discovery Course will help you to becoming a great reef guide and educator.

Master reef guides take this to the next level and strive to be world-leading coral reef guides and interpreters, sharing the wonders of the Great Barrier Reef World Heritage Area through engaging stories and memorable experiences. These reef ambassadors can provide up-to-date information on the Reef, share stories of the magical World Heritage Area, and explain what people can do to make a difference.

The Master Reef Guide program is delivered by the Great Barrier Reef Marine Park Authority, Association of Marine Park Tourism Operators and Tourism and Events Queensland. Master reef guide intakes happen in response to industry demand but you can start working towards becoming a master reef guide so you are ready when the opportunity arises.

COMMUNITY TOOLS



Download the free App

SIGHTINGS NETWORK

Check out who's seen the coolest critters.
Visit: www.gbrmpa.gov.au/sightings-network

WHO IS IT FOR?
Everyone that visits the Reef – daily, weekly, yearly or once in a lifetime

WHAT DOES IT DO?

- Enables all Reef users to report rare sightings and unusual events in real time via a free smartphone app and interactive website
- Contributes to an up-to-date website map of wildlife distribution, which helps to build knowledge about species diversity, abundance, habitat and range
- Provides access to complete Marine Park zoning from your phone
- Allows you to share your wildlife experiences with friends
- Includes key contacts to report incidents

Download the survey form at
www.gbrmpa.gov.au

RAPID MONITORING

Want to be a marine biologist for a day?
Do a Rapid Monitoring survey and make your observations count.

WHO IS IT FOR?
Anyone who wants to learn about coral reef biology and then contribute to our knowledge of the Great Barrier Reef

WHAT DOES IT DO?

- Guides you through a standardised assessment of reef health
- Enables the reporting of impacts such as coral bleaching and the presence of crown-of-thorns starfish, anywhere on the Reef
- Increases your awareness of species that play an important role in reef function and evoke wonder from visitors
- Provides a way for the community to give something back to the Reef
- Integrates with other Eye on the Reef surveys

PROFESSIONAL TOOLS

TOURISM WEEKLY MONITORING

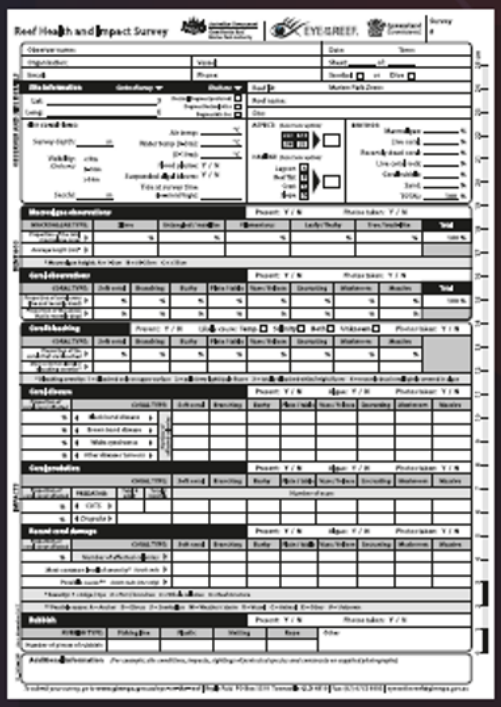
Tourism staff know their sites better than anyone – this knowledge can help build an overall picture of Reef health.

WHO IS IT FOR?
Dedicated tourism staff

WHAT DOES IT DO?

- Provides long-term trend data about particular Reef sites and early warnings of impacts
- Provides the tools and training to monitor regular sites weekly and build knowledge of the Reef
- Creates and connects a team of trained monitoring professionals, simultaneously providing information for numerous Reef sites
- Provides tourism operators with a biological calendar for their sites, enabling staff to tailor in-water activities and presentations
- Integrates with other Eye on the Reef surveys

For more information, email
eyeonthereef@gbrmpa.gov.au



REEF HEALTH AND IMPACT SURVEY

A scientific surveying tool that provides robust information on the health of a particular Reef

WHO IS IT FOR?
Those with prior marine biology qualifications or experience, or a motivation to learn

WHAT DOES IT DO?

- Provides a snapshot of reef health at any time, on any reef
- Includes a breakdown of habitat and quantifiable impact assessment measures, using a protocol developed by recognised experts
- Adds to a large data set covering over 700 reefs across the Great Barrier Reef
- Aligns with the Australian Institute of Marine Science's Long-term Monitoring Program
- Requires a high degree of training and experience, making it a top-shelf surveying tool to aim for

For more information, email
eyeonthereef@gbrmpa.gov.au

Reference List

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Senior Pathways: Table of core courses of study
https://www.institute4learning.com/resources/articles/multiple-intelligences/

Page 15 and 61

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QCAA (2019b). Aquatic Practices 2019 v1.0 Applied Senior Syllabus. Queensland Curriculum and Assessment Authority. Accessed 03/04/2021 from: https://www.qcaa.qld.edu.au/downloads/senior-qce/syllabuses/snr_aquatic_19_app_syll.pdf

Marine Science Subject Report
QCAA (2021). Marine Science General Senior Syllabus 2019 v1.2 Subject report 2020. Queensland Curriculum and Assessment Authority. Accessed 03/04/2021 from: https://www.qcaa.qld.edu.au/downloads/senior- qce/sciences/snr_marine_science_20_subj_rpt.pdf

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Teacher qualification and experience
https://www.qcaa.qld.edu.au/downloads/senior-qce/syllabuses/snr_aquatic_19_app_syll.pdf (page 28)

Criteria sheet for aquatic practices
https://www.qcaa.qld.edu.au/downloads/senior-qce/sciences/snr_aquatic_19_app_highlighted_standards.pdf

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Image for inquiry-based learning
https://www.pinterest.com.au/pin/408068416222036479/

CHECK COPYWRIGHT

Page 56 and 57

Image for Zygotsky's Zone of Proximal Development
https://www.researchgate.net/figure/Vygotskys-zone-of-proximal-development-ZPD_fig5_334613532

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Image for Zygotsky's Zone of Proximal Development by Sketchplanations Accessed 27/04/2021 from:
https://sketchplanations.com/zone-of-proximal-development

Image for Zygotsky's Zone of Proximal Development by Simply Psychology Accessed 27/4/2021 from:
https://www.simplypsychology.org/Zone-of-Proximal-Development.html

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Image for Bloom's taxonomy
https://educationaltechnology.net/blooms-taxonomy/

Appendix A

Marine Science assessment examples

EXAMPLE
IA1 (Data Test)

Example

Dataset 3

Scientists investigated the biodiversity of hard coral on Moffatt Reef in Hypothetical Bay. Their investigation lasted several months. The scientists recorded the number of individual coral colonies in multiple underwater video transects. Table 1 summarises their results.
In writing your response, you may use the abbreviations given in the table for the species' names.

Table 1: Mean number of coral recorded on Moffatt Reef in Hypothetical Bay

Species of coral	Mean number of individual coral colonies		p-value
	Site A	Site B	
Fungia fungites (FF)	14	0	< 0.001
Stylophora pistillata (SP)	25	11	< 0.05
Acropora hyacinthus (AH)	19	21	< 0.001
Acropora tenuis (AT)	32	3	< 0.001

Item 6 (analyse evidence) **2 marks**

Contrast the difference in the mean number of individual coral colonies in Site A and Site B for *Fungia fungites* and *Acropora hyacinthus*.

_____

Item 7 (interpret evidence) **2 marks**

Draw a conclusion about what the different p-values in Table 1 show. Give reasons for your conclusion.

_____

_____

Dataset 3

Item 8 (apply understanding) **3 marks**

Calculate the species diversity for Site B (to two decimal places) using the following formula:

$$SDI = 1 - \left(\frac{\sum n(n-1)}{N(N-1)}\right)$$

where:

N = total number of organisms of all species

n = number of organisms of one species

Show your working.

$SDI_{Site\ B}$ = (2 d.p.)

Item 9 (interpret evidence) **2 marks**

In a follow-up experiment, two individual coral colonies were observed in Site B of Moffatt Reef in Hypothetical Bay.

Infer the probability that these two individual coral colonies were from the same species. Give a reason for your response.

EXAMPLE
IA2 (Student Experiment)

A Grade Example

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

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

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

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

coral, and especially new coral settling on a reef. Therefore, as benthic algae can quickly colonise dead coral surfaces, it may limit the ability of the reef to keep growing (Diaz-Pulido & McCook 2002). Consequently, a good indicator of health in a coral reef system could be assessing the amount of living coral and the amount of algae.

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

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

Research and planning [3–4]

a relevant research question

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

Research question

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

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

Original experiment

The original experiment (from the class fieldwork booklet based on Methods for ecological monitoring of coral reefs) was a benthic distribution study at Heron Island. It used a 10m transect from shore (at low tide) with 1m x 1m quadrats every 2m. Site selection was based on the leeward side of the island. Transect positions were chosen randomly (using Google maps and a random number generator) prior to conducting the experiment.

Modifications to the methodology

Convenience sampling was used to select two locations from the online reef database (www.globalreefrecord.org). One location was a reef near the coast (less than 10km), and the other location was far from the coast (more than 50km). This was to ensure the research question could be addressed. To ensure that sufficient, relevant data was collected the original experiment was changed to increase the number of samples and measurements, as the original experiment had a small sample size.

Research and planning [5–6]

a methodology that enables the collection of sufficient, relevant data

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

justified modifications to the methodology

The response gives sound reasons for how the modifications to the methodology will refine, extend or redirect the original experiment.

Consequently 10 random 1m x 1m photographic quadrats were chosen along the transect at each location. The random selection of quadrats was used to minimise sample bias. The increase in sample size allowed the calculation of a mean, standard error and confidence intervals. Allowing the data to be extrapolated to a population.

As an indirect method was used to establish coral health the experiment was modified to improve the reliability and validity of the data. This was addressed through using a

- 100-point grid over each photographic quadrat. The substrate directly below each intercept was identified to give percentage cover of each substrate type. For simplicity, each intercept counted as the whole 1%, regardless of what was in the adjoining squares. This allowed for more precise data to be collected.
- Each image of living colour was also interpreted using a coral health chart (www.coralwatch.org/web/guest/coral-health-chart) and assigned a coral colour score. This allowed for quantifiable qualitative data to be collected to ascertain if the coral could be included in the sample.

Identified variables included:

- **Independent variable (IV):** location of the reef (distance from shore in km)
- **Dependent variable (DV):** substrate type (living coral or dead coral/algae)
- **Controlled variables (CV):** quadrat size, survey, technique, date, image resolution
- **Monitored variables (MV):** weather, time and tide cycle, previous storm activity, visibility

considered management of risks and ethical or environmental issues

The response shows careful and deliberate identification and planning to handle risks and ethical or environmental issues in the experiment.

Safety and ethical considerations

Conducting this experiment virtually means that possible safety and ethical considerations (e.g. use of snorkelling equipment, damage to the reef) were avoided.

Processed data

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

- the mean was chosen as the most appropriate measure of central tendency
- standard deviation was calculated as a measure of spread and used to calculate standard error
- standard error was chosen as a measure of uncertainty and
- a confidence interval was chosen as a measure of reliability.

Analysis of evidence [5–6]

correct and relevant processing of data

Raw data is manipulated accurately to provide evidence that is applicable to the research question.

Table 1: Sample calculations

Calculation	Example
Mean percentage living coral	Mean was calculated in excel by using the AVERAGE function μ (near shore) = $\frac{10+20+24+28+30+15+18+32+27+29}{10}$ $\mu = 23.3\ \%$
Frequency (coral scores)	Frequency was calculated in excel by using the COUNT function f = n(near shore, coral score 3) f = 4
Standard deviation for a sample population	Standard deviation (s) was calculated in excel by using the STDEV function. s (near shore, live coral)= 7.3
Standard error	Standard error was calculated in excel by dividing the standard deviation by the square root of the sample size. $SE_{\bar{X}} = \frac{s}{\sqrt{n}}$ $SE_{\bar{X}} = \frac{7.3}{\sqrt{10}}$ $SE_{\bar{X}} = 2.3$ where $SE_{\bar{X}}$ is the standard error of the mean s is the sample standard deviation and n is the size (number of scores) in a sample.
Confidence interval	*A confidence interval of 95% was calculated in excel using the CONFIDENCE.T function* $CI\ (95\%) = (0.05, s, n)\ \ CI\ (95\%) = (0.05, 7.3, 10)$ $CI\ (95\%) = 5.2$ where CI is the confidence interval s is the sample standard deviation and n is the size (number of scores) in a sample.

[5–6]

collection of sufficient and relevant raw data

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

Communication [2]

appropriate use of genre conventions

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

The response uses units and symbols correctly.

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

Reef location	Sample	Percentage cover living coral (%)	Percentage cover algae (%)	Coral colour score (live coral only)
Near shore (10 km)	1	10	80	2
	2	20	75	3
	3	24	70	3
	4	28	68	4
	5	30	70	4
	6	15	80	3
	7	18	65	2
	8	32	60	4
	9	27	50	4
	10	29	68	3
	Mean	23.3	68.6	3.2
	s	7.3	9.1	
	Standard error	2.3	2.9	
	Confidence interval	5.2	6.5	
Off shore (50 km)	1	50	45	4
	2	75	20	4
	3	67	25	5
	4	60	34	5
	5	70	22	5
	6	72	25	4
	7	60	37	6
	8	66	22	6
	9	58	40	3
	10	69	31	5
	Mean	64.7	30.1	4.7
	s	7.6	8.6	
	Standard error	2.4	2.7	
	Confidence interval	5.4	6.2	

The data shows the mean percentage cover of the near shore reef was within the range of 21.0 – 25.6% whilst the offshore was 62.3 – 67.1%. The standard error has been used a measure of the uncertainty associated with these averages (±SE). The standard error suggests that there is some imprecision in the data collection process. However the similarity of the SE indicates that there was similarity in the methodology used.

Communication [2]

fluent and concise use of scientific language and representations

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

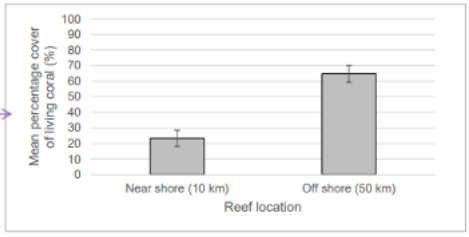


Figure 1: Mean percentage of living coral (confidence intervals presented as error bars) at near shore and off shore coral reef locations.

Analysis of evidence [5–6]

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.

The off shore location shows a 41.4% increase in the sample mean (percentage living coral cover) compared to the near shore location. This suggests that there is a greater amount of living coral further from shore.

Analysis: The data indicates, with 95% confidence that the sample mean (percentage cover of living coral) falls within 18.1 – 28.5% for the near shore reef and 59.3 – 70.1% for the offshore reef. As there is no overlap in the error bars (confidence intervals) this indicates that there is a statistical difference between the two means. Therefore, it can be suggested with confidence that distance has a significant positive effect on the amount of live coral present.

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.

Communication [2]

fluent and concise use of scientific language and representations

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

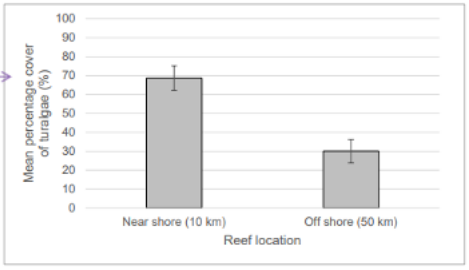


Figure 2: Mean percentage of algae (error bars represented as confidence intervals) at near shore and off shore coral reef locations.

Analysis of evidence [5–6]

thorough identification of relevant trends, patterns or relationships

The response identifies trends, patterns or relationships that are applicable to the research question.

The off shore location shows a 38.5% decrease in the sample mean (percentage algal cover) compared to the near shore location. These results suggest that there is a greater amount of algae in near shore environments.

thorough and appropriate identification of the uncertainty and limitations of evidence

The response suitably identifies 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.

Analysis: The data indicates, with 95% confidence that the sample mean (percentage cover of algae) falls within 62.1 – 75.1% for the near shore reef and 22.9 – 36.3% for the offshore reef. As there is no overlap in the error bars (confidence intervals) this indicates that there is a statistical difference between the two means. Therefore, it can be suggested with confidence that distance has a significant negative effect on the amount of algae present.

Communication [2]

fluent and concise use of scientific language and representations

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

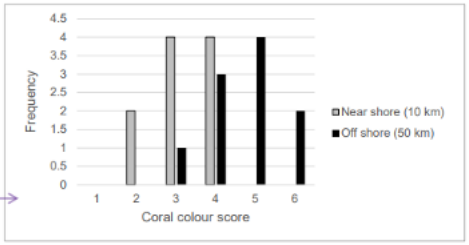


Figure 3: Frequency of coral colour score of near shore and off shore reef locations.

Analysis of evidence [5–6]

thorough identification of relevant trends, patterns or relationships

The response identifies trends, patterns or relationships that are applicable to the research question.

The frequency of coral scores for the off-shore reef is more positively skewed than the near shore reefs. The mode is higher for the off-shore reef at a coral colour score of 5 compared to 3 for the near shore reef.

Analysis: As this data is based on qualitative measurements a mathematically analysis was not chosen for this data. However, the higher coral score (based on the mode) indicates that the amount of living coral present in the off-shore reef is healthier than the near shore. Further research (see extensions) could be considered based on this data.

Evaluation

Limitations of the evidence

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

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.

The standard error calculated in this experiment appears to be low, suggesting the data obtained is reliable. However, the low sample size of this experiment is a major factor in determining the range of the confidence intervals (refer to Table 1 and Figure 1). The confidence intervals are larger in the algae cover data compared to the living coral cover data. This indicates that there is more confidence in the mean of the living coral data. One possible explanation for this is that the experimenter was biased in assigning values to live coral. If this is the case then the evidence has limited ability to be used to extrapolate the findings of the experiment to the population of corals (Acropora spp.) on the two reefs examined.

No outliers (valid extreme values) were visually observed in the data. However, this was not confirmed mathematically, consequently the mean reported may have altered the results of the data analysis.

Interpretation and evaluation [5–6]

justified discussion of the reliability and validity of the experimental process

The response uses sound reasoning and evidence from the identification of uncertainties and limitations to support the consideration of the reliability and validity of the experimental process.

Sources of error

Effecting reliability

- Confounding variables could not be minimised in this experiment and therefore it cannot be known which additional abiotic and biotic factors affected the percentage cover of living coral.
- Whilst there was random selection within the quadrats, convenience sampling was chosen for the selection of two sites. This could explain some of the remaining imprecision in the data (i.e. consider standard error, Table 1).
- The image resolution of the photograph, used to measure the percentage cover, is poor and the grid lines placed on the photograph were imprecise. The precision of this camera (XL Catlin Seaview SVII) was not identified on the website. However it is assumed that this contributes to the coral percentage data being imprecise.

Effecting validity

- The benthic percentage cover is determined indirectly. The standard deviation of the data suggests that this technique could contribute to the variability in the data.
- The visibility of the photograph limits the experimenter in interpreting the data. This introduced bias therefore could contribute to the data being inaccurate.

Interpretation and evaluation [5–6]

suggested improvements and extensions to the experiment that are logically derived from the analysis of evidence

The response uses clear, sound reasoning to arrive at improvements and extensions that would improve the reliability and validity of the experimental process by reducing the impact of the identified random and systematic errors.

Suggested improvements and extensions

Suggested improvements

Reducing the random error in the experimental process would improve its reliability. In this experiment, the reliability of the data could be improved by increasing the number of repeat readings of each sample, increasing the number of samples and running the experiment (trial) more than once to decrease standard error.

To address the imprecision in the data a random selection technique for site location and a positive calibration of the human experimenter should be chosen to decrease the sample bias. This could improve both the reliability and the validity of the experimental process and would allow the results to be generalised to the Acropora spp. coral population.

The accuracy of the data could be improved by using a grid on the camera lens when initially taking the photograph. This would ensure that the virtual quadrat was placed as per an *in situ* experiment, rather than the experimenter adding the quadrat afterwards (increasing sample bias) thus increasing the validity of the experiment.

Suggested extensions

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

Conclusion

justified conclusion/s linked to the research question

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

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

Communication [2]

fluent and concise use of scientific language and representations

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

Word count: 1847

EXAMPLE
IA3 (Research Investigation)

A Grade Example

Context

Investigate one of the following claims:

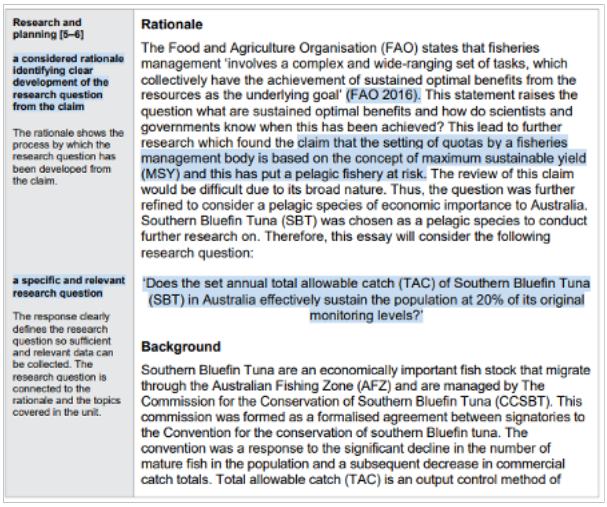
- Regional increases in primary ocean productivity may be offset by large, global predicted losses in productivity.
- The global ocean conveyor belt can be 'shut down'.
- Aquaculture productivity is essential for achieving food security.
- As a model, maximum sustainable yield (MSY) should be used to inform fish stock management.

You may identify an alternative claim in consultation with your teacher. This claim must be related to Unit 4 subject matter.

Task

Gather secondary evidence related to a research question in order to evaluate the claim. Develop your research question based on a number of possible claims provided by your teacher.

Obtain evidence by researching scientifically credible sources, such as scientific journals, books by well-credentialed scientists, and websites of governments, universities, independent research bodies or science and technology manufacturers. You must adhere to research conventions.



Research and planning [5–6]

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

The rationale shows the process by which the research question has been developed from the claim.

a specific and relevant research question

The response clearly defines the research question so sufficient and relevant data can be collected. The research question is connected to the rationale and the topics covered in the unit.

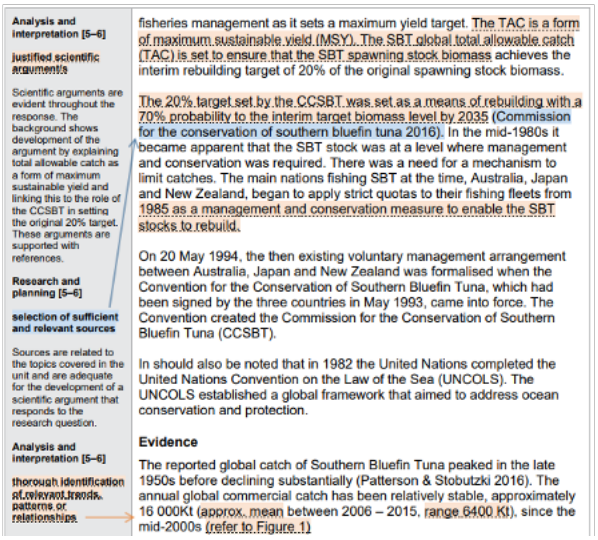
Rationale

The Food and Agriculture Organisation (FAO) states that fisheries management 'involves a complex and wide-ranging set of tasks, which collectively have the achievement of sustained optimal benefits from the resources as the underlying goal' (FAO 2016). This statement raises the question what are sustained optimal benefits and how do scientists and governments know when this has been achieved? This lead to further research which found the claim that the setting of quotas by a fisheries management body is based on the concept of maximum sustainable yield (MSY) and this has put a pelagic fishery at risk. The review of this claim would be difficult due to its broad nature. Thus, the question was further refined to consider a pelagic species of economic importance to Australia. Southern Bluefin Tuna (SBT) was chosen as a pelagic species to conduct further research on. Therefore, this essay will consider the following research question:

'Does the set annual total allowable catch (TAC) of Southern Bluefin Tuna (SBT) in Australia effectively sustain the population at 20% of its original monitoring levels?'

Background

Southern Bluefin Tuna are an economically important fish stock that migrate through the Australian Fishing Zone (AFZ) and are managed by The Commission for the Conservation of Southern Bluefin Tuna (CCSBT). This commission was formed as a formalised agreement between signatories to the Convention for the conservation of southern Bluefin tuna. The convention was a response to the significant decline in the number of mature fish in the population and a subsequent decrease in commercial catch totals. Total allowable catch (TAC) is an output control method of



Analysis and interpretation [5–6]

justified scientific argument/s

Scientific arguments are evident throughout the response. The background shows development of the argument by explaining total allowable catch as a form of maximum sustainable yield and linking this to the role of the CCSBT in setting the original 20% target. These arguments are supported with references.

Research and planning [5–6]

selection of sufficient and relevant sources

Sources are related to the topics covered in the unit and are adequate for the development of a scientific argument that responds to the research question.

Analysis and interpretation [5–6]

thorough identification of relevant trends, patterns or relationships

fisheries management as it sets a maximum yield target. The TAC is a form of maximum sustainable yield (MSY). The SBT global total allowable catch (TAC) is set to ensure that the SBT spawning stock biomass achieves the interim rebuilding target of 20% of the original spawning stock biomass.

The 20% target set by the CCSBT was set as a means of rebuilding with a 70% probability to the interim target biomass level by 2035 (Commission for the conservation of southern bluefin tuna 2016). In the mid-1980s it became apparent that the SBT stock was at a level where management and conservation was required. There was a need for a mechanism to limit catches. The main nations fishing SBT at the time, Australia, Japan and New Zealand, began to apply strict quotas to their fishing fleets from 1985 as a management and conservation measure to enable the SBT stocks to rebuild.

On 20 May 1994, the then existing voluntary management arrangement between Australia, Japan and New Zealand was formalised when the Convention for the Conservation of Southern Bluefin Tuna, which had been signed by the three countries in May 1993, came into force. The Convention created the Commission for the Conservation of Southern Bluefin Tuna (CCSBT).

In should also be noted that in 1982 the United Nations completed the United Nations Convention on the Law of the Sea (UNCOLS). The UNCOLS established a global framework that aimed to address ocean conservation and protection.

Evidence

The reported global catch of Southern Bluefin Tuna peaked in the late 1950s before declining substantially (Patterson & Stobutzki 2016). The annual global commercial catch has been relatively stable, approximately 16 000Kt (approx. mean between 2006 – 2015, range 6400 Kt), since the mid-2000s (refer to Figure 1)

The identified relationships are adequate for the purpose of responding to the research question and can support a valid conclusion. They have direct bearing upon and are applicable to the formation of the scientific argument.

identification of sufficient and relevant evidence

The evidence in the response draws upon the available qualitative and quantitative data to respond to the research question. It links directly to the research question.

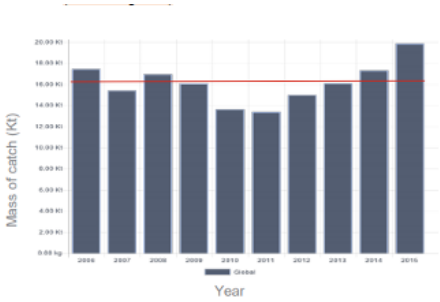


Figure 1: Global commercial catch (Kt) of Southern Bluefin Tuna from 2006 - 2015

(Source: Patterson & Stobutzki 2016)

Analysis and interpretation [5–6]

thorough identification of relevant trends, patterns or relationships

The identified relationships are adequate for the purpose of responding to the research question and can support a valid conclusion. They have direct bearing upon and are applicable to the formation of the scientific argument.

In comparison Australia's southern Bluefin tuna fishery was relatively stable from 1989 to 2009 (Australian Fisheries Management Authority AFMA 2016). Since adopting new management procedures (also called the Bali Procedure) as part of the CCSBT in 2011 Australia's TAC and catch increased in 2015 (refer to Figure 2) (Patterson et al 2016). Figure 2 shows that 2015 had the highest Annual retained catch since 2005.

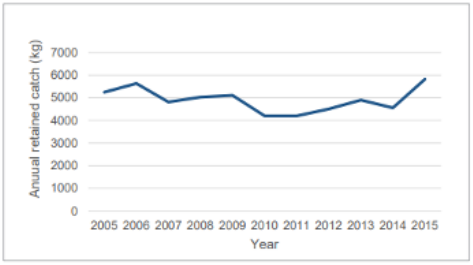


Figure 2: Annual retained catch (kg) of Australian Southern Bluefin Tuna

(Source: Patterson & Stobutzki, 2016)

These CCSBT management procedures (analogous to a harvest strategy) aimed to reduce uncertainty and improve transparency in the decision-making process. That is, the CCSBT identified that 'a procedure should be developed as a set of rules, agreed in advance, to dictate how a Total Allowable Catch for the SBT fishery would be adjusted as data becomes available' (The Organisation for Economic Co-operation and Development, OECD 2012). The aim was to support the recovery target of the biological stock to '20 per cent of unfished biomass by 2035 with 70 per cent probability' (Australian Fisheries Management Authority, AFMA 2016). However, reviews have indicated numerous issues associated with the reliability of the data collected. Firstly, the impact of unreported catches on the estimates of past total catch. Consequently, this lead to the re-evaluation of the initial management procedures. Secondly the carry-forward procedure for member's annual total allowable catch. Members may 'carry forward TAC from the previous year if they have not met quotas' (Extended Commission for the Conservation of Southern Bluefin Tuna, 2014). This makes it difficult to set a sustainable TAC using a specific guideline each year as the carry-forward numbers can impact substantially on the target set. And most importantly, significant over-catch may have occurred in reported data with 'little or no knowledge of the domestic management authority' (OECD, 2012).

Analysis and interpretation [5–6]

thorough identification of relevant trends, patterns or relationships

The identified relationships are adequate for the purpose of responding to the research question and can support a valid conclusion. They have direct bearing upon and are applicable to the formation of the scientific argument.

In addition to this the Southern Blue Tuna spawning stock biomass has declined by 85.4% between 1973 and 2009 (Collette et al 2011). Spawning stock biomass (SSB) measurements are used in fisheries science as a means of stock assessment and fisheries management (Lart, 2017). Spawning stock biomass (SSB) is defined as the total weight of all sexually mature fish in the stock (International Council for the Exploration of the Sea n.d.) and has associated sources of error. The two main methods to approach pelagic stock assessment are cohort analysis and statistical catch-at-age (Dowling 2007). However, the 2011 assessment conducted by CCSBT Extended Scientific Committee reported the estimated biomass of SBT using a proxy based on fish of 10 years an older (B10+). They later revised this in 2014 based on scientific aerial studies of juveniles to incorporate 'relative fecundity, residency time on the spawning grounds and resting times, which vary with age' thus allowing the proxy age to be decreased (B8+) (Patterson *et al* 2016). This resulted in an increase in the estimates of the size of the spawning stock. The current global population trend however is decreasing with no indication from recent stock assessment that the spawning stock is rebuilding (CCSBT 2009). The decline of SSB for SBT classifies this species as critically endangered on the IUCN Red List (Collette *et al* 2011) and based on evidence from AFMA the biological stock is classified as overfished (AFMA 2016).

Analysis and interpretation [5–6]

thorough and appropriate identification of limitations of evidence

The response identifies limitations of the evidence that are not superficial or partial. The limitations are suitable for determining the reliability of the evidence in responding to the research question.

Communication [2]

appropriate use of genre conventions

The use of headings and paragraphs fits the purpose of an essay.

Evaluation

Limitations of the data

The strength of reliability of the global data shown in Figure 1 should be considered due to the uncertainty about the models used by each country to collect the data and the significant under-reporting of SBT in past years (OECD 2012). The data shown in Figure 2 is calculated from the date the fish was landed at port and does not include information on catch by gear type. It should be noted that catches can be lower based on management measures such as 'total allowable catch, closing fishing areas, reducing boat numbers or banning the catch of a particular species' and market demand (AFMA 2016) thus affecting the reliability of the data. The potential sources of unaccounted catch mortalities including recreational catches, unreported catch, mortalities of releases, and discarding of fish also needs to be considered with regards to Figure 1 and Figure 2 (Patterson *et al* 2016).

Limitations of data collection

There are key challenges for assessing migratory pelagic fish stocks where the quality of data may be more important than quantity. That is, catch history which correctly identifies the species and standardises the length measurements must be considered to ensure reliability. Length measurements relating to cohort age were based on direct sagittae otolith calculations (Farley & Basson 2005). Given the migratory nature of the SBT spatial issues therefore introduce a significant complexity to the assessment of stock based on these two factors. Southern Bluefin Tuna abundance is generally based on a catch-per-unit-effort (CPUE) but it is difficult to independently survey this.

'Assuming CPUE-based abundance indices, the major challenges are:

- ensuring that the spatial/temporal coverage of the fishery is adequate to obtain a reliable abundance estimate, and
- standardizing the nominal CPUE, as the latter typically is influenced by confounding factors unrelated to abundance.

Statistical CPUE standardization is typically achieved using generalized linear modeling (GLM) techniques (Dowling 2007).'

Conclusion and evaluation [1–2]

cursory or simplistic statements about the quality of evidence

The response communicates an oversimplified understanding of the features of the evidence that affect how well it can be used to respond to the research question.

Analysis and interpretation [5–6]

thorough and appropriate identification of limitations of evidence

The response identifies limitations of the evidence that are not superficial or partial. The limitations are suitable for determining the reliability of the evidence in responding to the research question.

Conclusion and evaluation [3–4]

reasonable conclusion/s relevant to the research question

The conclusion is appropriate and is connected to the research question. However, the response does not use evidence to support the conclusion.

application of relevant findings of the research to the claim

The response uses some pertinent outcomes of the research to address the claim. However, the response does not identify the plausible implications of other conclusions.

suggested improvements and extensions to the investigation that are relevant to the claim

The improvements and extensions to the investigation are applicable to the claim but do not show evidence of careful or deliberate thought.

There have been fishery-independent aerial surveys conducted in the Great Australian Bight (Eveson *et al* 2007) which therefore do rely on direct sampling techniques. However, these did not continue past the initial trial due to needing two trained observers and a specially trained pilot. This directly impacts on the reliability of the source of SBT data for the Australian region as only one form of data collection technique is being used.

Limitations of data analysis and use of models

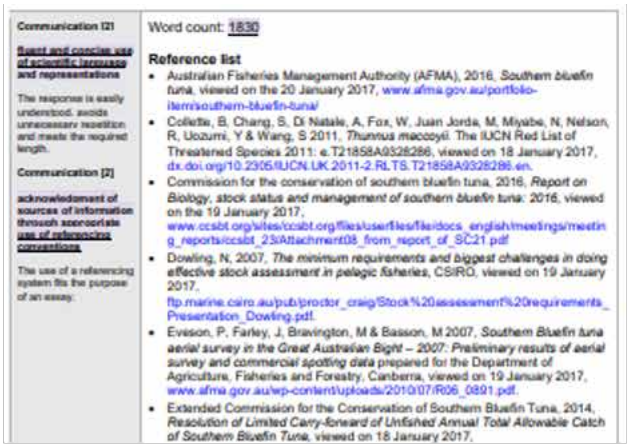
In addition to this there are also limitations of using the maximum sustainable yield (MSY) model in conjunction with fisheries in general. The CPUE (catch-per-unit-effort) index was used in the 1950s by Milner Schaefer in conjunction with Verhulst's equation 'which was specifically constructed to deal with numbers of humans or animals' not 'by total weight against an index of the abundance of fish in the population' (Holt 2011) to generate the model of maximum sustainable yield in relation to fisheries management. This became the proposed model for the MSY of tuna stock for management purposes in Schaefer's paper published in 1954 (Holt 2011). Unfortunately, this does not consider the age and size composition of the stock, which is critically important to population viability. Due to the variability and uncertainty in fishing, illegal catches of undersize stock are inevitable. In regulated fisheries, when combined with setting minimum legal sizes and regulating total catch (TAC), the combination has resulted in a global issue of increasingly large quantities of discarded bycatch (Holt 2011).

A confounding problem to the above issues is associated with the limited source of the data (which is referenced in multiple reliable sources). All global data appears to be based solely on the collection from the Commission for the Conservation of Southern Bluefin Tuna which cannot guarantee the reliability of the methods used by each country to estimate their numbers of Southern Bluefin Tuna.

Conclusion

In conclusion, the annual total allowable catch in Australia, set by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), does not effectively sustain the population of Southern Bluefin Tuna at 20% of its original monitoring levels. A model-based MP was undertaken by the CCSBT in 2005 which avoided stock collapse. However due to the limitations outlined in the evaluation section, namely 'underreporting of historical catches' (Kurota *et al* 2010) the implementation of this was aborted. The current scientific advice suggests that Southern Bluefin Tuna stock are at a low level, that is '3–8% of median unfished spawning stock biomass' (CCSBT 2016) and therefore a precautionary approach of closing the fishery should be taken to allow the stock to rebuild.

Further research should include recording the age and size composition of the stock, utilizing fishery independent aerial surveys (such as the Great Australian Right trial) and organisations other than the CCSBT producing comparative data.



Communication [2]

Word count: 1830

Reference list

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Instrument-specific marking guide (ISMG)

Criterion: Research and planning

Assessment objectives

2. apply understanding of oceans of the future or managing fisheries to develop research questions
5. investigate phenomena associated with oceans of the future or managing fisheries through research

The student work has the following characteristics:	Marks
• informed application of understanding of oceans of the future or managing fisheries demonstrated by a considered rationale identifying clear development of the research question from the claim • effective and efficient investigation of phenomena associated with oceans of the future or managing fisheries demonstrated by – a specific and relevant research question – selection of sufficient and relevant sources.	5–6
• adequate application of understanding of oceans of the future or managing fisheries demonstrated by a reasonable rationale that • effective investigation of phenomena associ fisheries demonstrated by – a relevant research question – selection of relevant sources.	
• rudimentary application of understanding of demonstrated by a vague or irrelevant ratio • ineffective investigation of phenomena asse fisheries demonstrated by – an inappropriate research question – selection of insufficient and irrelevant sou	
• does not satisfy any of the descriptors abo	

Criterion: Analysis and interpretation

Assessment objectives

3. analyse research evidence about oceans of the future or managing fisheries
4. interpret research evidence about oceans of the future or managing fisheries

The student work has the following characteristics:	Marks
• systematic and effective analysis of qualitative data and/or quantitative data within the sources about oceans of the future or managing fisheries demonstr – the identification of sufficient and relevant evidence – thorough identification of relevant trends, patterns or relationships – thorough and appropriate identification of limitations of evidence • insightful interpretation of research evidence about oceans of the fu fisheries demonstrated by justified scientific argument/s.	
• effective analysis of qualitative data and/or quantitative data within t oceans of the future or managing fisheries demonstrated by – the identification of relevant evidence – identification of obvious trends, patterns or relationships – basic identification of limitations of evidence • adequate interpretation of research evidence about oceans of the fu fisheries demonstrated by reasonable scientific argument/s.	
• rudimentary analysis of qualitative data and/or quantitative data with oceans of the future or managing fisheries demonstrated by – the identification of insufficient and irrelevant evidence – identification of incorrect or irrelevant trends, patterns or relations – incorrect or insufficient identification of limitations of evidence • invalid interpretation of research evidence about oceans of the futur demonstrated by inappropriate or irrelevant argument/s.	
• does not satisfy any of the descriptors above.	

Criterion: Conclusion and evaluation

Assessment objectives

4. interpret research evidence about oceans of the future or managing fisheries
6. evaluate research processes, claims and conclusions about oceans of the future or managing fisheries

The student work has the following characteristics:	Marks
• insightful interpretation of research evidence about oceans of the future or managing fisheries demonstrated by justified conclusion/s linked to the research question • critical evaluation of the research processes, claims and conclusions about oceans of the future or managing fisheries demonstrated by – insightful discussion of the quality of evidence – extrapolation of credible findings of the research to the claim – suggested improvements and extensions to the investigation that are considered and relevant to the claim.	5–6
• adequate interpretation of research evidence about oceans of the future or managing fisheries demonstrated by reasonable conclusion/s relevant to the research question • basic evaluation of the research processes, claims and conclusions about oceans of the future or managing fisheries demonstrated by – reasonable description of the quality of evidence – application of relevant findings of the research to the claim – suggested improvements and extensions to the investigation that are relevant to the claim.	3–4
• invalid interpretation of research evidence about oceans of the future or managing fisheries demonstrated by inappropriate or irrelevant conclusion/s • superficial evaluation of the research processes, claims and conclusions about oceans of the future or managing fisheries demonstrated by – cursory or simplistic statements about the quality of evidence – application of insufficient or inappropriate findings of the research to the claim – ineffective or irrelevant suggestions.	1–2
• does not satisfy any of the descriptors above.	0

EXAMPLE
EA (Exam)

Questions from 2020 Exam

QUESTION 4

Ocean water resists changes in pH more than fresh water because ocean water has a greater concentration of

(A) hydrogen ions.

(B) carbonate ions.

(C) dissolved carbon dioxide.

(D) dissolved sodium chloride.

QUESTION 10

101 coral trout (*Plectropomus leopardus*) were caught, marked and released. Five months later, 64 fish were recaptured at the same site. 12 of the recaptured fish were tagged.

Calculate the total population of coral trout using the Lincoln index, $N = \frac{M \times n}{m}$

(A) 153

(B) 539

(C) 1212

(D) 6464

QUESTION 16 (4 marks)

Explain how marine protected areas (MPAs) can be used to improve the health of a highly connected but degraded marine ecosystem.

QUESTION 22 (3 marks)

Explain how upwelling influences the distribution of fish populations.

QUESTION 20 (8 marks)

Changes to ocean chemistry and pH were estimated using modelling, and the effects of these changes on calcified marine organisms are shown.

	Pre-industrial	1990	2 × pre-industrial	4 × pre-industrial	6 × pre-industrial
Atmospheric concentration of CO_2	280 ppm	380 ppm	560 ppm	1120 ppm	1680 ppm
Average pH of surface oceans	8.18	8.07	7.92	7.65	7.49
Calcite saturation	5.3	4.4	3.3	1.9	1.3
Aragonite saturation	3.4	2.8	2.1	1.2	0.9

Organisms	Form of calcium carbonate	Habitat
Macroalgae[1]	Aragonite or calcite	Benthic
Corals: warm water cold water	Aragonite Aragonite	Benthic Benthic
Crustaceans[1]	Calcite	Benthic or planktonic

[1] Not all members of the group are calcified.

a) Describe the consequences of ocean acidification and predict the impact on the complexity and diversity of the coral reef ecosystem. *[5 marks]*

b) Explain how resilience may partially offset ocean acidification responses in the short term. *[3 marks]*

Aquatic Practices syllabus

Aquatic Practices provides opportunities for students to explore, experience and learn practical skills and knowledge valued in aquatic workplaces and other settings. The subject promotes an appreciation of the role coastal waters and inland waterways play in tourism, recreation, transport and food production, and of the legal and safety issues and codes of practice associated with waterways. Through these learning experiences, students build their understanding of the conditions and expectations for work in aquatic settings and develop an understanding of career pathways, jobs and other opportunities available for participating in, and contributing to, aquatic and related fields and activities.

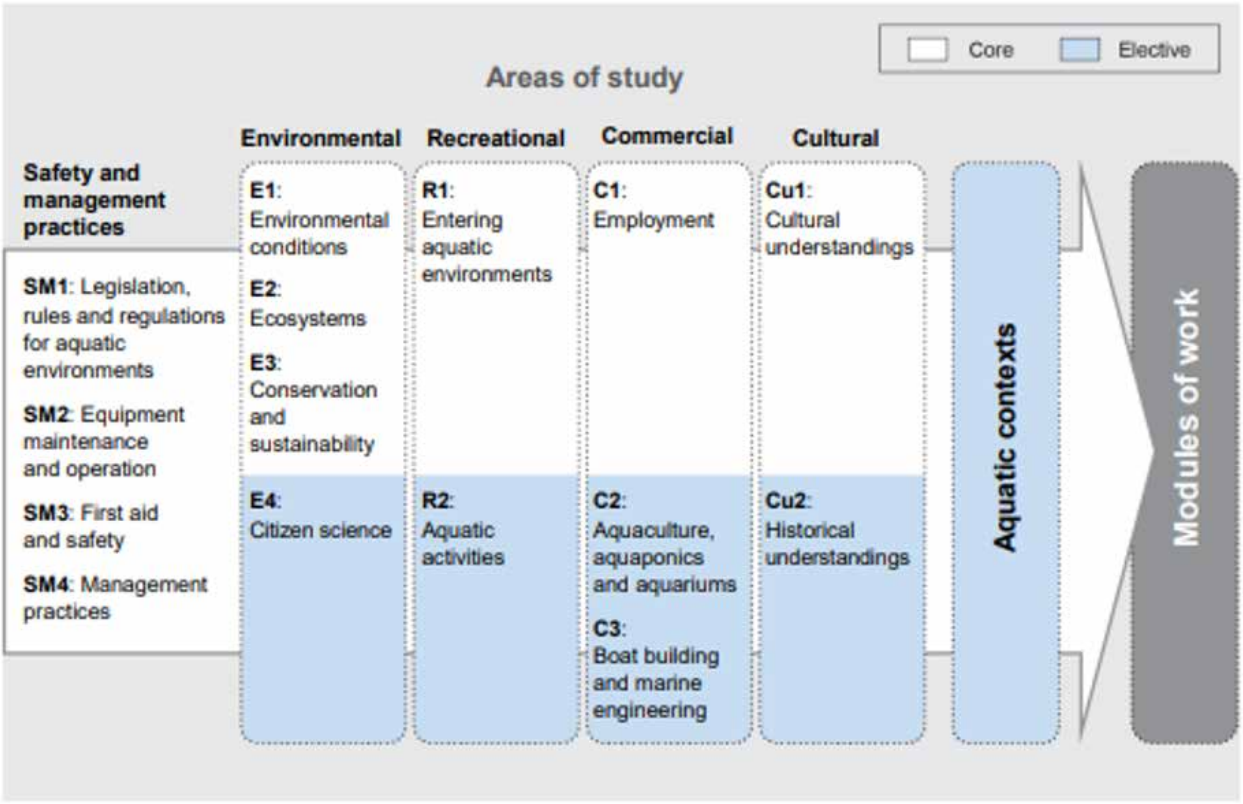
This applied syllabus describes learning in aquatic practices in four areas of study:

'Environmental', 'Recreational', 'Commercial' and 'Cultural'. 'Safety and management practices' are embedded in all four areas of study.

Core areas of study are compulsory. Electives are selected by the school.

The three dimensions of teaching and learning aquatic practices include (1) knowing and understanding (2) analysing and applying, and (3) planning and evaluating.

By the conclusion of the course of study, students should be able to (1) describe concepts and ideas in aquatic contexts (2) explain concepts and ideas in aquatic contexts, and (3) demonstrate skills in aquatic contexts.



Appendix B

Aquatic Practices assessment examples

Table 4: Standards matrix (marking sheet)

	Standard A	Standard B	Standard C	Standard D	Standard E
Knowing and understanding	The student work has the following characteristics: • comprehensive description of concepts and ideas in aquatic contexts • concise and coherent explanation of concepts and ideas in aquatic contexts • proficient demonstration of a comprehensive range of skills in aquatic contexts.	The student work has the following characteristics: • detailed description of concepts and ideas in aquatic contexts • coherent explanation of concepts and ideas in aquatic contexts • precise demonstration of a range of skills in aquatic contexts.	The student work has the following characteristics: • description of concepts and ideas in aquatic contexts • explanation of concepts and ideas in aquatic contexts • demonstration of skills in aquatic contexts.	The student work has the following characteristics: • superficial description of concepts and ideas in aquatic contexts • disjointed explanation of concepts and ideas in aquatic contexts • basic demonstration of skills in aquatic contexts.	The student work has the following characteristics: • partial description of aquatic information • statements of information about aquatic contexts • guided demonstration of skills in aquatic contexts.
Analysing and applying	The student work has the following characteristics: • discerning and logical analysis of information, situations and relationships in aquatic contexts • discerning and proficient application of knowledge, understanding and skills in aquatic contexts • concise and coherent use of language conventions and features appropriate to aquatic contexts to communicate ideas and information, according to purpose.	The student work has the following characteristics: • logical analysis of information, situations and relationships in aquatic contexts • controlled application of knowledge, understanding and skills in aquatic contexts • coherent use of language conventions and features appropriate to aquatic contexts to communicate ideas and information, according to purpose.	The student work has the following characteristics: • analysis of information, situations and relationships in aquatic contexts • application of knowledge, understanding and skills in aquatic contexts • use of language conventions and features appropriate to aquatic contexts to communicate ideas and information, according to purpose.	The student work has the following characteristics: • identification of situations and relationships in aquatic contexts • basic application of knowledge, understanding and skills in aquatic contexts • use of basic language conventions and features to communicate ideas and information.	The student work has the following characteristics: • identification of aspects of situations and relationships in aquatic contexts • partial application of knowledge and skills in aquatic contexts • disjointed use of language conventions to communicate information.
Planning and evaluating	The student work has the following characteristics: • generation of insightful plans and procedures for activities in aquatic contexts • comprehensive and systematic evaluation of the safety and effectiveness of activities in aquatic contexts • justified and valid recommendations with detailed evidence for activities in aquatic contexts.	The student work has the following characteristics: • generation of considered plans and procedures for activities in aquatic contexts • detailed and reasoned evaluation of the safety and effectiveness of activities in aquatic contexts • valid recommendations with evidence for activities in aquatic contexts.	The student work has the following characteristics: • generation of plans and procedures for activities in aquatic contexts • evaluation of the safety and effectiveness of activities in aquatic contexts • recommendations for activities in aquatic contexts.	The student work has the following characteristics: • listing of aspects of plans and procedures for activities in aquatic contexts • identification of the safety and effectiveness of activities in aquatic contexts • statements of opinion about activities in aquatic contexts.	The student work has the following characteristics: • collection of information related to planning in aquatic contexts • statements about aspects of the safety and effectiveness of aquatic activities • statements about aspects of activities in aquatic contexts.

Key: Cognition Qualifier

EXAMPLE

Project

Subject	Aquatic Practices
Technique	Project
Unit number and module number and name	**Unit:** 3 **Module:** 5. Boating

Conditions	**Units 3–4**
Written component	500–900 words
Performance component	During field trip, with class time to develop skills required for the final assessment
Further information	
Duration (including class time)	6 weeks
Individual/group	Individual
Resources available	• Department of Transport and Main Roads 2017, *BoatSafe Workbook* 6th edition, www.tmr.qld.gov.au/-/media/busind/accreditations/BoatSafe/BoatSafe_Wkbk_6thEd.pdf?la=en • *Department of Transport and Main Roads*, 'BoatSafe training and accreditation', www.tmr.qld.gov.au/business-industry/Accreditations/Boatsafe-accreditation.aspx • Internet access on school computers • All boating equipment and charts required for the performance, including safety equipment as listed on the boat checklist

Context

During this unit, you have been learning about recreational boating rules, the International Association of Lighthouse Authorities (IALA) buoyage system 'A', basic navigation, boat maintenance, boat manoeuvring, safety at sea and responding to emergency situations. You have been preparing boats for use at sea, performing pre-departure checks, and practising skills in both theoretical and practical situations.

Task

Plan, conduct and evaluate a boating field trip to Peel Island.

The task includes two components.

- Component 1: Written — Trip plan and post-trip evaluation for the boating excursion, which departs Wellington Point Jetty at 9 am, anchors for lunch at Pelican Banks (or Horseshoe Bay, depending on weather) and returns by 3 pm.
- Component 2: Performance — During the planned trip you will be asked to demonstrate a series of boating skills and apply them in given scenarios.

To complete this task, you must:

Generate a trip plan, including:

- a report explaining how expected weather conditions for the day will affect the trip, considering factors such as air pressure, temperature, rainfall, wind speed and wind direction
- a proposed route (on the chart provided) to and from Pelican Banks (or Horseshoe Bay) and a suitable anchorage, considering the tides and weather conditions. Propose recommendations for alternative routes if weather conditions change. Provide a concise and coherent explanation of the reasoning behind your proposal/s, including fuel, time, safety and other resource requirements
- a risk assessment for the proposed trip, which identifies possible hazards and assesses and manages the risks.

Demonstrate the following boating skills and apply them during the field trip in given scenarios:

- identify the main parts of the vessel and its equipment (including safety equipment)
- conduct pre-departure checks (including a seaworthy assessment)
- demonstrate knowledge of the IALA buoyage system 'A' while navigating
- correctly use safety equipment, raise the alarm during emergencies, use distress signals and assist others in distress
- moor and anchor a recreational vessel
- safely manoeuvre a recreational vessel underway.

Complete an evaluation of the field trip, addressing:

- safety control measures
- management of hazards
- the accuracy of weather and tide predictions and the effect of these on the trip
- the suitability of the anchorage
- any justified recommendations or advice for the following year's students when they prepare for this trip.

Checkpoints

- ☐ Term [X] Week [X]/[Date]: Submit draft trip plan for review
- ☐ Term [X] Week [X]: Conduct Peel Island field trip, including performance assessment
- ☐ [Due date]: Submit final trip plan and post-trip evaluation

Authentication strategies

Your teacher will use ways to check that the work you are assessed on is your own work.

- Discuss with your teacher or provide documentation of your progress on the trip plan.
- Your teacher will observe you completing work in class.
- Take part in interviews or consultations with your teacher as you develop your response.
- Check you have not plagiarised any material, e.g by using plagiarism-detection software or other school processes.
- Acknowledge all sources used.
- Submit the declaration of authenticity.

Investigation

Subject	Aquatic Practices
Technique	Investigation — Magazine article
Unit number and module number and name	**Unit:** 4 **Module:** 8. Food from the sea

Conditions	**Units 3–4**
Written	600–1000 words
Further information	
Duration (including class time)	3 weeks
Individual/group	Individual
Resources available	Access to internet and computers. Presentation from the Queensland Boating and Fisheries Patrol and resources provided in the stimulus section.

Context

During this module, you have been exploring the concepts of conservation and sustainability and how these apply to the seafood industry, as well as the legislation, rules and regulations imposed on fisheries to conserve and sustain these resources. You have had a presentation from a Queensland Boating and Fisheries Patrol (QBFP) officer and have been learning about the various commercial fisheries in Queensland.

Task

Write an article for your local seafood magazine, aimed at readers interested in purchasing seafood harvested from sustainable sources. Your article will investigate an Australian commercial fishery and one of the species they target, including the fishing equipment and practices used, management controls in place, the current state or condition of the fishery, and how their products reach the consumer. In reading your article, consumers should be able to make an informed seafood choice.

To complete this task:

- investigate an Australian commercial fishery through research
- present the results of your investigation in a magazine article that
  - describes the fishery, one of the species they target, its final product/s and destination/s and the main catch method/s employed by commercial fishers
  - demonstrates your understanding of sustainability by explaining concepts and ideas related to your chosen fishery
  - analyses catch and population data (historical and current) for your chosen fishery and relates this information to the current status of the fishery
  - analyses how management methods (e.g. quotas, catch restrictions, bycatch technology, closed areas and seasons, and other relevant methods) are used to control overfishing and address the environmental risks associated with the fishery
  - reports on the product/s of the fishery, identifying possible sustainability issues with how the product reaches the consumer
  - uses the language conventions and features of a magazine article, including relevant visual images to complement communication of the presented information.

Checkpoints

- ☐ Term [X] Week [X]/[Date]: Consult with teacher to check research progress
- ☐ Term [X] Week [X]/[X]: Submit draft magazine article
- ☐ [Due date]: Submit final magazine article

Authentication strategies

Your teacher will use ways to check that the work you are assessed on is your own work.

- Your teacher will observe you completing work in class.
- Submit a draft and respond to teacher feedback.
- Acknowledge all sources used.
- Submit the declaration of authenticity.

Stimulus

The following websites are a guide to the types of resources that could be used for the assessment:

- *Australian Fisheries Management Authority*, 'Fisheries', www.afma.gov.au/fisheries
- *Business Queensland*, 'Commercial fisheries profiles', www.business.qld.gov.au/industries/farms-fishing-forestry/fisheries/fisheries-profiles
- *Department of Agriculture and Fisheries*, 'Commercial fisheries monitoring', www.daf.qld.gov.au/business-priorities/fisheries/monitoring-our-fisheries/commercial-fisheries
- *FRDC (Fisheries Research and Development Corporation)*, 'Welcome to the Status of Australian Fish Stocks Reports', http://fish.gov.au
- *Australia's Sustainable Seafood Guide*, https://www.sustainableseafood.org.au
- *Marine Stewardship Council*, 'Track a fishery', https://fisheries.msc.org/en/fisheries

EXAMPLE

Extended Response

3.2.3 Extended response

Purpose

This technique assesses the interpretation, analysis/examination and/or evaluation of ideas and information in provided stimulus materials. While students may undertake some research in the writing of the extended response, it is not the focus of this technique.

Dimensions to be assessed

This assessment technique is to be used to determine student achievement in objectives from at least two of the following dimensions:

- Knowing and understanding
- Analysing and applying
- Planning and evaluating.

Not every objective from each dimension needs to be assessed.

Types of extended response

An extended response occurs over a set period of time. Students may use class time and their own time to develop a response. Students respond to a question or statement about the provided stimulus materials.

Stimulus material could include:

- scientific texts, e.g. journal/research article
- media texts, e.g. letter to the editor, documentary
- data and statistics, e.g. tide chart, weather data
- maps and charts, e.g. map indicating reefs and other features.

An extended response occurs over a set period of time. Students may use class time and their own time to develop a response.

Written response

This response requires students to use written language to communicate ideas and information to readers for a particular purpose. A written response may be supported by references or, where appropriate, data, tables, flow charts or diagrams.

Examples may include:

- reports, which will usually be presented with section headings, and may include tables, graphs and/or diagrams, and analysis of data supported by references
- case studies, e.g. conservation and management, coastline engineering, and surfboard design
- articles for a magazine or journal
- letters to the editor
- essays, e.g. analytical, persuasive/argumentative, informative.

Spoken response

This response requires students to use spoken language to communicate ideas and information to a live or virtual audience (that is, through the use of technology) for a particular purpose.

Examples include:

- oral presentations
- debates
- interviews
- podcasts
- seminars.

Multimodal response

This response requires students to use a combination of at least two modes **delivered at the same time** to communicate ideas and information to a live or virtual audience for a particular purpose. The selected modes are integrated to allow both modes to contribute significantly to the multimodal response. Modes include:

- written
- spoken/signed
- nonverbal, e.g. physical, visual, auditory.

Examples include:

- digital presentations
- vodcasts
- seminars
- webinars.

A variety of technologies may be used in the creation or presentation of the response. Replication of a written document into an electronic or digital format does not constitute a multimodal response.

When making judgments about multimodal responses, teachers apply the standards to the entire response, i.e. to all modes used to communicate the response.

Assessment conditions	Units 1–2	Units 3–4
Written	500–800 words	600–1000 words
Spoken	2–4 minutes	3–4 minutes
Multimodal	3–5 minutes	4–7 minutes

Exam

3.2.4 Examination

Purpose

This technique assesses the application of a range of cognition to provided questions, scenarios and/or problems. Responses are completed individually, under supervised conditions and in a set timeframe.

Dimensions to be assessed

This assessment technique is to be used to determine student achievement in objectives from at least two of the following dimensions:

- Knowing and understanding
- Analysing and applying
- Planning and evaluating.

Not every objective from each dimension needs to be assessed

Type of examination

Short response test

- Short response tests typically consist of a number of items that may include students responding to some or all of the following activities:
  - drawing, labelling or interpreting equipment, graphs, tables or diagrams
  - calculating using algorithms
  - responding to seen or unseen stimulus materials
  - interpreting ideas and information.
- Questions, scenarios and problems are typically unseen; if seen, teachers must ensure the purpose of this technique is not compromised.

Assessment conditions	Units 1–2	Units 3–4
Recommended duration	60–90 minutes	60–90 minutes
Short response test	50–150 words per item (diagrams and workings not included in word count)	50–250 words per item (diagrams and workings not included in word count)

Further guidance

When implementing assessment instruments for the examination technique, teachers:

- format the assessment to allow for ease of reading and responding
- write clear questions, considering students' language needs
- ensure questions allow the full range of standards to be demonstrated
- establish the time requirement for the examination within the assessment conditions (see above)
- ensure stimulus materials are succinct enough to allow students to engage with them in the time provided; if they are lengthy, consider giving students access to them before the assessment
- clearly indicate the dimensions and objectives that will be assessed
- explain to students the requirements of the task, including instrument-specific standards
- outline any permitted material in the instrument conditions, e.g. one page of handwritten notes
- teach the objectives, knowledge, understanding and skills needed for the items in the examination, including opportunities for students to respond to unseen tasks using appropriate communication strategies.

EXAMPLE

Performance

3.2.5 Performance

Purpose

This technique assesses physical demonstrations as outcomes of applying a range of cognitive, technical and physical skills.
Performance assessments involve student application of identified skill/s when responding to a task that involves solving a problem, providing a solution, or conveying meaning or intent.

Dimensions to be assessed

This assessment technique is to be used to determine student achievement in objectives from at least two of the following dimensions:

- Knowing and understanding
- Analysing and applying
- Planning and evaluating.

Not every objective from each dimension needs to be assessed.

Types of performance

Students will demonstrate performances in a range of aquatic contexts. Contexts may include individual, and group environments. These may include:

- seafood preparation — filleting techniques
- snorkelling
- nautical knot tying
- participating in aquatic activities in recreational contexts, e.g. boating camp
- organising and managing events
- demonstration of health and safety mechanisms and procedures, e.g. first aid, lifesaving

Supporting evidence

Supporting evidence is required to substantiate teacher decisions made on performances for exit purposes.
Evidence to support performances may include:

- notes or annotations
- journal entries
- self and peer evaluations
- teacher observations and checklists
- a recording of the response (as appropriate).

Assessment conditions	Units 1–2	Units 3–4
Performances	Schools provide students with some continuous class time to develop and practise the performance.	

Further guidance

This technique requires teachers to observe a defined activity within an aquatic activity, such as performance of:

- physical responses required to perform an aquatic activity in a familiar environment, e.g. swimming in a pool
- relevant physical responses in an aquatic activity within a changing environment, e.g. reef snorkelling
- roleplaying of group or team situations, e.g. identification of group tasks and allocation of responsibilities
- applying knowledge or following industry guidelines and procedures in a workplace or workplace-related situation
- operating equipment, e.g. dive equipment, boats.

Rapid Monitoring

Australian Government Great Barrier Reef Marine Park Authority | EYE ON THE REEF | Queensland Government

Observer name: _____ **Phone:** _____ **Date:** _____

Email: _____ **Organisation:** _____ **Time:** _____

Vessel: _____

Observer category *(tick one)*: ☐ Reef visitor ☐ Marine tourism industry ☐ Fisher ☐ Traditional owner ☐ Other *(please specify)* _____

Number of visits to a reef: _____

Survey experience *(approximate number of surveys completed)*: _____

Reef ID *(e.g. 16-023)*: _____ **Reef name:** _____ **Site:** _____

Centre of survey: **Lat:** _____ S **Long:** _____ E **Marine Park Zone:** _____

Tick one GPS type: (examples over page) ☐ Decimal Degrees (preferred) ☐ Degrees Decimal Mins ☐ Degrees Min Sec **Water temperature:** _____ °C

Survey type *(tick one)*: ☐ **Snorkel** ☐ **Dive** ☐ **Viewing bucket** **Survey depth:** _____ metres

Habitat type *(circle one)*	**Flood plume** *(circle one)*	**Suspended algal bloom** *(circle one)*	**Tide at survey** *(circle one)*	**Visibility** *(circle one)*
LAGOON FLAT CREST SLOPE	YES NO	YES NO	LOW MID HIGH	<5m 5–10m >10m

Timed swim (10 minutes)

See over page for survey methodology

ANIMALS	TALLY	TOTAL
Sea cucumber (all species)		
Giant clam (larger than size of hand)		
Anemonefish (all species)		
Butterflyfish (all species)		
Grazing herbivores *See definition over page*		
Cods and groupers (over 50cm in length)		

ANIMALS	SIZE / SEX / TYPE	TALLY	TOTAL
Coral trout (all species)	<38cm		
	>38cm		
Maori wrasse	Male		
	Female		
Turtle (all species) * See images over page	Green Turtle*		
	Hawksbill Turtle*		
	Other *(please name)*		
Shark (all species)	Whitetip reef shark		
	Blacktip reef shark		
	Other *(please name)*		
Crown-of-thorns starfish	≤ Size of hand		
	> Size of hand		

☐ *360° survey (One 5 metre radius circle)*

See over page for information guide and survey methodology

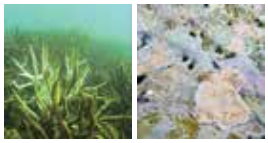
BENTHOS

Insert % for each benthos type to total 100%

Macroalgae	
Live coral	
Recently dead coral (white)	
Live coral rock	
Coral rubble	
Sand	
Total	**100 %**


MACROALGAE


LIVE CORAL


RECENTLY DEAD CORAL

CORAL ROCK *(includes dead coral)*


CORAL RUBBLE


SAND

PHOTOS TAKEN

(Please provide details e.g. image no./name, what it is, and a description)

CORAL IMPACTS *(Complete 1, 2 and 3 below. Circle **Y** or **N**)*

1 ***Is any coral white?*** **Y / N**

Is living coral tissue present? **Y / N** *If yes:* **BLEACHING**

Is coral being eaten? **Y / N** *If yes:* **PREDATION**

If yes, by what? *How many seen?*

Crown-of-thorns starfish

Juveniles *(size of hand or smaller)* _____

Adults *(larger than size of hand)* _____

Drupella snails *(all sizes)* _____

Is coral banded in appearance? **Y / N** *If yes:* **DISEASE**

Is coral competing with something else? **Y / N** *If yes:* **COMPETITION**

2 ***Is any coral broken or damaged?*** **Y / N**

If yes:

What is the likely main cause? *(Circle one)*

Storm Animal Vessel Anchor Divers Snorkellers

Unknown Other: _____

3 ***Is any rubbish present?*** **Y / N**

If yes:

Number of pieces in survey area:

Fishing line _____ Plastic _____

Netting _____ Rope _____

Other (please specify)

_____

_____

IMPACT DETAILS

(How much bleaching, predation, disease, damage? Other impacts?)

OTHER THINGS OF INTEREST?

(Mating, spawning, behaviour, etc.)

To submit your survey, go to **www.gbrmpa.gov.au/eye-on-the-reef** | Reply Paid PO Box 1379 Townsville QLD 4810 | Fax: (07) 4772 6093 | eyeonthereef@gbrmpa.gov.au

Australian Government

Great Barrier Reef
Marine Park Authority