Department of
Education

GOVERNMENT OF
WESTERN AUSTRALIA

CURRICULUM RESOURCE MODULE

Ecosystem rehabilitation and management

YEAR 11

THE STEM LEARNING PROJECT

scitech

STAWA
SCIENCE TEACHERS' ASSOCIATION OF WESTERN AUSTRALIA

Acknowledgements

The STEM Learning Project respectfully acknowledges the Traditional Custodians of the lands upon which our students and teachers live, learn and educate.

The STEM Learning Project is funded by the Western Australian Department of Education (the Department) and implemented by a consortium in STEM education comprising the Educational Computing Association of WA, the Mathematical Association of WA, the Science Teachers Association of WA and Scitech. We acknowledge and thank the teachers and schools who are the co-creators of these resources.

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The STEM Learning Project

The aim of the STEM Learning Project is to generate students' interest, enjoyment and engagement with STEM (Science, Technology, Engineering and Mathematics) and to encourage their ongoing participation in STEM both at school and in subsequent careers. The curriculum resources will support teachers to implement and extend the Western Australian Curriculum across Kindergarten to Year 12 and develop the general capabilities.

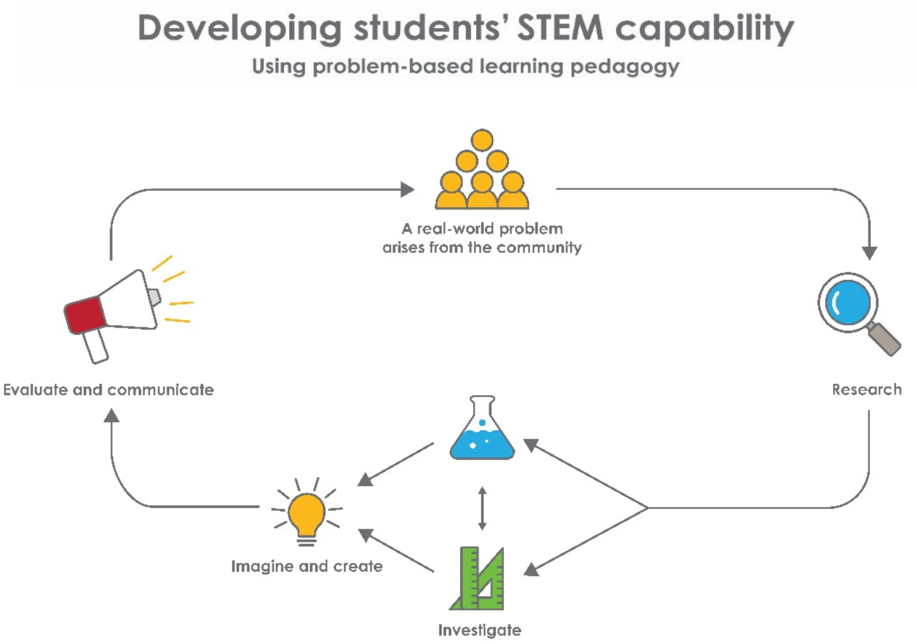
Why STEM?

A quality STEM education will develop the knowledge and intellectual skills to drive the innovation required to address global economic, social and environmental challenges.

STEM capability is the key to navigating the employment landscape changed by globalisation and digital disruption. Routine manual and cognitive jobs are in decline whilst non-routine cognitive jobs are growing strongly in Australia. Seventy-five per cent of the jobs in the emerging economy will require critical and creative thinking and problem solving, supported by skills of collaboration, teamwork and literacy in mathematics, science and technology. This is what we call STEM capability. The vision is to respond to the challenges of today and tomorrow by preparing students for a world that requires multidisciplinary STEM thinking and capability.

The approach

STEM capabilities are developed when students are challenged to solve open-ended, real-world problems that engage students in the processes of the STEM disciplines.



STEM Consortium

Year 11 Biology Unit 1 – Ecosystem rehabilitation and management

Overview

The biosphere is made up of natural, urban and agricultural ecosystems. These ecosystems sustain life, cycle nutrients and facilitate the transfer and transformation of energy. Ecosystems are dynamic in that they change over time and space.

Many natural ecosystems have been degraded through human activities such as the introduction of invasive species, the unsustainable use of natural resources and pollution which damages habitats. Survey data from 'pristine' and degraded areas of an ecosystem can inform the development of plans for the rehabilitation and management of ecosystems. These plans are based on the interpretation of and extrapolation from sample data derived from ecosystem surveying techniques. The reliability of the data is determined by the representativeness of the sampling and the integrity of data interpretation.

What is the context?

Many natural ecosystems have been degraded through human activity, resulting in changes to species diversity, population size and sustainability. Investigation, mapping and analyses of data can provide the evidence required to develop plans for the rehabilitation and management of degraded ecosystems.

What is the problem?

How can we develop a management plan to guide the restoration of the ecosystem?

How does this module support integration of the STEM disciplines?

This module presents students with an authentic problem of planning how they would rehabilitate a degraded ecosystem. Students investigate, map and analyse data to provide the evidence required to develop plans for the rehabilitation and management of the ecosystem. Students engage with science inquiry skills, biology understandings, digital technologies, mathematical processes and representations and the design process as they address the problem.

Science

Year 11 ATAR *Biology* students will engage with the following curriculum content:

Biology Understandings

- ecosystems are diverse, composed of varied habitats, consisting of a range of biotic and abiotic factors, and can be described in terms of their component species, species interactions and the abiotic factors that make up the environment

- relationships and interactions within a species and between species in ecosystems include predation, competition, symbiosis (mutualism, commensalism and parasitism), collaboration and disease
- in addition to biotic factors, abiotic factors, including climate and substrate, can be used to describe and classify environments
- the biotic components of an ecosystem transfer and transform energy, originating primarily from the Sun, and matter to produce biomass; and interact with abiotic components to facilitate biogeochemical cycling, including carbon and nitrogen cycling; these interactions can be represented using food webs and biomass pyramids
- the dynamic nature of populations influence population size, density, composition and distribution
- keystone species play a critical role in maintaining the structure of the community; the impact of a reduction in numbers or the disappearance of keystone species on an ecosystem is greater than would be expected, based on their relative abundance or total biomass
- fire is a dynamic factor in Australian ecosystems and has different effects on biodiversity
- human activities that can affect biodiversity and can impact on the magnitude, duration and speed of ecosystem change include examples of: habitat destruction, fragmentation or degradation; the introduction of invasive species; unsustainable use of natural resources; the impact of pollutants, including biomagnification; and, climate change
- conservation strategies used to maintain biodiversity are genetic strategies, including gene/seed banks and captive breeding programs; environmental strategies, including revegetation and control of introduced species; management strategies, including protected areas and restricted commercial and recreational access

Science as a Human Endeavour

- identification and classification of an ecological area as a conservation reserve also requires consideration of the commercial and recreational uses of the area, as well as Indigenous Peoples' usage rights
- keystone species theory has informed many conservation strategies. However, there are differing views about the effectiveness of single-species conservation in maintaining complex ecosystem dynamics
- *Australia's Biodiversity Conservation Strategy 2010–2030* presents a long-term view of the future and the actions that need to be implemented to conserve biodiversity
- international agreements about biodiversity encourage international cooperation in the protection of unique locations, including: World Heritage sites, for example, Shark Bay, Great Barrier Reef; biodiversity hotspots, for example, south west WA; international migration routes and areas used for breeding, for example, by birds, whales, turtles, whale sharks
- contemporary technologies, including satellite sensing and remote monitoring, enable improved monitoring of habitat and species population change over time

Science Inquiry Skills

- identify, research and construct questions for investigation; propose hypotheses; and predict possible outcomes
- design investigations, including the procedure(s) to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics, including animal ethics
- conduct investigations, including using ecosystem surveying techniques (quadrats, line transects and capture-recapture) safely, competently and methodically for the collection of valid and reliable data
- represent data in meaningful and useful ways; organise and analyse data to identify trends, patterns and relationships; qualitatively describe sources of measurement error, and uncertainty and limitations in data; and select, synthesise and use evidence to make and justify conclusions
- interpret a range of scientific and media texts, and evaluate processes, claims and conclusions by considering the quality of available evidence; and use reasoning to construct scientific arguments
- select, construct and use appropriate representations, including classification keys, food webs and biomass pyramids, to communicate conceptual understanding, solve problems and make predictions
- communicate to specific audiences and for specific purposes using appropriate language, nomenclature, genres and modes, including scientific reports

Technology

Year 11 ATAR *Applied Information Technology* and *Design* students will have the opportunity to engage with the following curriculum content:

- apply data organisation techniques for user and/or client needs
- composition, layout and design considerations for the construction of spreadsheets
- apply the elements of design and the principles of design relevant to a particular design brief
- interpretation of the design brief
- application of a design process relevant to the design context, including the development of thorough connected documentation (visual and other information) for each of the stages of the design process
- interpretation and/or creation of diagrams, layouts, plans and drawings
- reflective analysis to devise and evaluate solutions to design problems
- design for specific audiences with a cultural focus
- identification of specific audiences in terms of lifestyle behaviour, cultural values and beliefs

The *Design process guide* is included as a resource to help teachers understand the complete design process as developed in the Technologies curriculum.

Mathematics

Year 11 ATAR *Mathematics Applications* students will have the opportunity to:

- 1.2.4 use matrices for storing and displaying information that can be presented in rows and columns; for example, databases, links in social or road networks
- 2.1.1 review the statistical investigation process; identifying a problem and posing a statistical question, collecting or obtaining data, analysing the data, interpreting and communicating the results
- 2.1.4 with the aid of an appropriate graphical display (chosen from dot plot, stem plot, bar chart or histogram), describe the distribution of a numerical data set in terms of modality (uni or multimodal), shape (symmetric versus positively or negatively skewed), location and spread and outliers, and interpret this information in the context of the data
- 2.1.5 determine the mean and standard deviation of a data set using technology and use these statistics as measures of location and spread of a data distribution, being aware of their limitations
- 2.1.11 compare groups on a single numerical variable using medians, means, IQRs, ranges or standard deviations, and as appropriate; interpret the differences observed in the context of the data and report the findings in a systematic and concise manner
- 2.1.12 implement the statistical investigation process to answer questions that involve comparing the data for a numerical variable across two or more groups; for example, are Year 11 students the fittest in the school?

General capabilities

The general capabilities encompass the knowledge, skills, behaviours and dispositions that will assist students to live and work successfully in the twenty-first century. STEM skills are mapped to the *General capabilities and cross-curriculum priorities* table in this module.

What are the pedagogical principles of the STEM learning modules?

The STEM Learning Project modules develop STEM capabilities by challenging students to solve real-world problems set in authentic contexts. The problems engage students in the STEM disciplines and provide opportunities for developing higher order thinking and reasoning, and the general capabilities of creativity, critical thinking, communication and collaboration.

The design of the modules is based on four pedagogical principles:

- Problem-based learning
  All modules are designed around students solving an open-ended, real-world problem. Learning is supported through a four-phase instructional model: research the problem and its context; investigate the parameters impacting on the problem; design and develop solutions to the problem; and evaluate and communicate solutions to an authentic audience.

- Developing higher order thinking
  Opportunities are created for higher order thinking and reasoning through questioning and discourse that elicits students' thinking, prompts and scaffolds explanations, and requires students to justify their claims. Opportunities for making reasoning visible through discourse are highlighted in the modules with the icon shown here.

- Collaborative learning
  This provides opportunities for students to develop teamwork and leadership skills, challenge each other's ideas, and co-construct explanations and solutions. Information that can support teachers with aspects of collaborative learning is included in the resource sheets.
- Reflective practice
  Recording observations, ideas and one's reflections on the learning experiences in some form of journal fosters deeper engagement and metacognitive awareness of what is being learnt. Information that can support teachers with journaling is included in the resource sheets.

These pedagogical principles can be explored further in the STEM Learning Project online professional learning modules located in Connect Resources.

Activity sequence and purpose

Activity 1

RESEARCH

Human impacts on ecosystems

Students research examples of human activities that disrupt natural ecosystems and examples of ecosystem rehabilitation projects. Students visit a degraded ecosystem to determine which biotic and abiotic factors should be investigated and how they might be sampled so that valid and reliable data are collected.

Activity 2

INVESTIGATE

Fieldwork

Students gather, analyse and interpret the data from a test site. They evaluate the impact of human activity on the site and begin to identify the changes required to initiate rehabilitation.

Activity 3

IMAGINE & CREATE

Design a management plan

Students use their scientific understanding and findings from the fieldwork study to design a management plan to restore the habitat to a more natural and sustainable condition. Students identify salient human impacts on the ecosystem, the changes required to rehabilitate it, and how rehabilitation will benefit the community.

Activity 4

EVALUATE & COMMUNICATE

Pitch the plan

Student teams pitch their management plans to each other and guests. The pitch will justify the proposed strategies using evidence from the fieldwork study. Feedback from guests and peers will be used to evaluate the plans and identify rehabilitation strategies that are likely to be most effective.

Background

Expected learning	Students will be able to: 1. Explain how classification helps to organise, analyse and communicate data about biodiversity. 2. Explain that ecosystem diversity and dynamics can be described and compared with reference to biotic and abiotic components and their interactions. 3. Use science inquiry skills to design, conduct and evaluate investigations into biodiversity in a degraded ecosystem and communicate findings. 4. Evaluate, based on empirical evidence, human impacts, claims about relationships between and within species and diversity within an ecosystem. 5. Identify what changes are needed to rehabilitate a degraded ecosystem and develop a management plan. 6. Communicate biological understanding using qualitative and quantitative representations in appropriate modes and genres. 7. Implement the statistical investigation process in contexts requiring the analysis of univariate data. 8. Communicate their arguments and strategies, when solving mathematical and statistical problems, using appropriate mathematical or statistical language. 9. Interpret mathematical and statistical information and ascertain the reasonableness of their solutions to problems and answers to statistical questions. 10. Communicate arguments and strategies when solving problems using appropriate scientific and mathematical language. 11. Choose and use digital technologies appropriately and efficiently to collect, record, organise, represent and communicate information. 12. Use appropriate digital platforms and file sharing tools to co-construct and share documents. 13. Engage with the technology design process to develop a prototype management plan.
Vocabulary	This module uses subject-specific terminology, some of which is shown in the School Curriculum and Standards Authority (SCSA) *Year 11 Biology syllabus: Appendix 2 - Glossary*. Also, note the terminology shown in the SCSA support document *Year 11 and 12 Glossary of keywords used in the formulation of questions*.

Timing	There is no prescribed duration for this module. The module is designed to be flexible enough for teachers to adapt. Activities do not equate to lessons; one activity may require more than one lesson to implement.
Safety notes	There are potential hazards inherent in these activities and with the equipment being used, and a plan to mitigate any risks will be required. Potential hazards specific to this module include but are not limited to: • Possible exposure to cyber bullying, privacy violations and uninvited solicitations when using the internet • Fieldwork has several potential hazards. It is recommended that the teacher visit the proposed fieldwork site to identify and assess risks associated with travelling to the site and fieldwork. The risks should be documented, assessed and plans put in place to reduce the incidence and severity of any potential risks. • Risk management plans must follow school policy and be approved according to whether the site is on or off campus.
Assessment	The STEM modules have been developed to provide students with learning experiences to solve authentic real-world problems using science, technology, engineering and mathematics capabilities. *Links to the Western Australian Curriculum* indicates the expected learning for the Year 11 ATAR *Biology* course students will engage in as they work through the module. It also indicates the links to the Year 11 ATAR *Design, Applied Information Technology* and *Mathematics Applications* courses, as opportunities may arise for students to engage in learning from these Western Australian Certificate of Education courses. While working through the module, the following assessment opportunities will arise: **Human Biology** • Science Inquiry Investigation report - Students provide a fieldwork journal and a fieldwork report following the completion of *Activity* 2. The journal documents observations, choices made about methods and reflections on data. The report provides a systematic presentation of the plan for the investigation, how it was conducted, the data collected, analyses and

interpretations of the data, and conclusions on the implications for management of the ecosystem.

- Extended response - Following the presentation of their prototype management plans in *Activity 4*, students may complete an extended response task. In the task, they propose key elements of a strategy designed to rehabilitate the degraded ecosystem. They also draw on conceptual understandings and evidence gathered from the ecosystem investigation to justify their strategy choices.
- Contexts for test items on science understanding of ecosystems and science inquiry skills.

Design

- Production Portfolio documenting the design process
- Contexts for Design Response and Examination items

Applied Information technology

- Project creating digital solutions
- Contexts for Short answer, Extended answer and Examination items

Mathematics applications

- Investigation - Students use the mathematical thinking process and the statistical investigation process to plan, research, conduct and communicate, the findings of an investigation/project.

Contexts for response tasks and Examination items.

Activity 1: Human impacts on ecosystems

Activity focus

Students research examples of human activities that disrupt natural ecosystems and examples of ecosystem rehabilitation projects. Students visit a degraded ecosystem to determine which biotic and abiotic factors should be investigated and how they might be sampled so that valid and reliable data are collected.

Background information

Given limitations of time and resources, not all areas of the site nor all species or abiotic factors can be included in the scope of data collection

Sampling

Samples of area within the ecosystem can be made on a random, stratified random or purposeful basis. If the total area to be studied is fairly uniform in distribution of abiotic and biotic factors, random samples might be used, such as the random distribution of quadrats. If the total area comprises zones which have different assemblages of abiotic and biotic factors, then quadrats might be distributed randomly within each zone with equal numbers in each zone. This stratified random sampling ensures equal representation of data from the zones.

Some areas which have a gradient of elevation, soil types or distance from a river often have a gradient of distribution or succession in the species within the community. In these circumstances, a decision to purposefully sample along the gradient might be the sampling method of choice. For example, a line transect might be used.

The sampling method chosen will influence the conclusions that can be drawn from the data.

The distribution and frequency of species can only be documented for a sample of species. Sampling is likely to be influenced by the species that might be most severely impacted by human activity, species that are significant in the ecosystem such as keystone species, or species introduced by human activity that are displacing native species.

Abiotic factors

Similarly, only some of the abiotic factors can be studied. Possibilities include weather factors, soil factors and geomorphology. Within each of these factors, there are

	other considerations. For example, in a terrestrial site, soil depth, soil profile, soil water holding capacity, carbonate, organic matter, moisture content and pH, light intensity, shade and temperature could be considered. In an aquatic site, factors such as turbidity, dissolved oxygen, salinity, conductivity, pH and the concentrations of nitrates and phosphates could be considered.
Instructional procedures	The fieldwork conducted in *Activities 1* and *2* provides rich opportunities for planning and implementing sampling, data collection and documentation methods in the field, analysis of samples in the laboratory, and data collation and sharing. To accomplish the large scope of work, student teams will need to have responsibility for different aspects of the work, providing an opportunity for leadership and development of teamwork skills. Effective data collation and sharing will depend on using agreed spreadsheet formats so that all students can access the entire data set, which can be used for writing individual reports and for assessment purposes. Resources such as *Google docs* would provide a platform for data sharing and collaborative work. Teachers may find this a useful context and opportunity for students to: • use matrices for storing and displaying information that can be presented in rows and columns; for example, databases, links in social or road networks • review the statistical investigation process; identifying a problem and posing a statistical question, collecting or obtaining data, analysing the data, interpreting and communicating the results • apply data organisation techniques for user and/or client needs • composition, layout and design considerations for the construction of spreadsheets
Expected learning	Students will be able to: 1. Identify and discuss human activities that can affect biodiversity and impact on the magnitude, duration and speed of ecosystem change. 2. Identify, research and construct questions for investigation and predict possible outcomes. 3. Design investigations, including the procedure/s to be followed, the materials required, and the type and amount of primary or secondary data to be collected;

	conduct risk assessments; and consider research ethics, including animal ethics. 4. Explain that identification and classification of an ecological area as a conservation reserve also requires consideration of the commercial and recreational uses of the area, as well as those of Aboriginal and Torres Strait Islander people's usage rights. 5. Explain how contemporary technologies, including satellite sensing and remote monitoring, enable improved monitoring of habitat and species population change over time.
Equipment required	**For the class:** Computer and data projector Images of the local study area (eg *Google Earth* and *Google Maps*) Plant and animal identification keys 30 m tape measures Compass Binoculars
	For the students: Pens, notebook or devices for a field journal Digital devices and cameras to take photos
Preparation	Engage a local expert to explain the history of the site and identify plant and animal species. This could be a member of the local naturalist club or wildflower society, or Aboriginal community. Branches of the Wildflower Society of Western Australia in the Perth metropolitan area, Wheatbelt and South-West are listed in the Urban Bushland Council of WA (Inc.) community conservation groups (see *Digital resources*). Prepare a risk management plan that follows school policy for travelling to the site and conducting fieldwork there. Review the following three examples of rehabilitation projects from *Digital resources*, and select those that are most appropriate as stimulus material for your class: • *A woody meadow in the heart of the city* • *Northam Bypass Revegetation Case Study* • *Green shoots at Roe 8 site as native bushland begins*

	long road to recovery Decide how much prior teaching of ecology concepts and scaffolding students require for the fieldwork and sampling task. Review how to formulate a research question, design a fieldwork investigation and write a fieldwork report. Review appropriate sampling techniques for the relevant populations. Teachers can find details about the support provided by the Regional Laboratory Technicians for biology fieldwork on the Secondary Support webpage at: det.wa.edu.au/curriculumsupport/secondary/detcms/portal/ The team can be contacted at: rltteam@education.wa.edu.au Belmont Office Tel: 9479 2220 Padbury Office Tel: 9402 6244
Activity parts	**Part 1: Humans impact natural ecosystems** To gain an appreciation of human impacts on natural ecosystems on a broad scale, students use *Google Earth* and *Google Maps* (see *Digital resources*) to compare satellite images for one area that has plenty of natural vegetation and an area that is largely changed by human activity in their locality. Students select an appropriate scale that will enable them to estimate the proportion of natural vegetation, agriculture and built environments for the two areas. Discuss the differences between the two sites and changes that have occurred since European settlement, asking the following focus questions: • Which of these areas would have changed least since European settlement? • Which of these areas shows evidence of the impact of human activity? What changes have occurred? • Why are natural habitats being lost? What are the consequences of habitat loss? …*because*… • Why do we need to conserve natural ecosystems? Who benefits from this? Which agencies are responsible for conserving natural ecosystems? Engage students in researching remote sensing technologies used for monitoring ecosystems with a focus on:

- Which search terms will you use in your web browser to access information about remote sensing?
- Which modern technologies are being used to gather data about the composition, health and changes in ecosystems?
- What affordances do these technologies provide?

Part 2: Project review

There are many examples of natural ecosystems being degraded by human activity in Australia. This has led to many species becoming endangered. There are also examples of habitat rehabilitation projects that attempt to reverse some of the damage caused by human activity.

Share the *Digital resources* for one or more of the following rehabilitation projects:

- *A woody meadow in the heart of the city*
- *Northam Bypass Revegetation Case Study*
- *Green shoots at Roe 8 site as native bushland begins long road to recovery*

Students could pre-read *A woody meadow in the heart of the city* ready for class discussion and analysis using the following question prompts:

- What was the motivation for planting the meadow?
- What research was needed to determine what and how to plant the meadow?
- How 'natural' is this plant community?

Explain to students that the class will conduct a field study of a local ecosystem and develop a management plan for its rehabilitation. The problem to be solved is: *How can we develop a management plan to guide the restoration of the ecosystem?*

Show images of the study site and make plans for visiting the site in the next lesson. Conduct a teacher-led class discussion of the safety risks, mitigation and emergency procedures for the fieldwork to be conducted in the next session.

Part 3: Site visit

Visit the chosen study area. It will be beneficial to have a local naturalist support the class on this first visit to the site to:

- Scope the precise location of the field study
- Determine the questions to be researched
- Identify important species that are to be counted and

mapped
- Identify abiotic factors that need to be investigated.

Take the students on a walk-through of the area. Orient the students to the cardinal compass points and have them identify the location of the site on an image of the area. Ask questions to direct observations and give thought to the status of the ecosystem. For example:

- Do you see any changes in the plant communities across the site or are the communities distributed evenly across the site?
- What changes in elevation, soil type or ground cover exist across the site?
- Which are the most common plant species? Which are the dominant/tallest species?
- What types of animals are present?
- What evidence is there of human impact and degradation of the ecosystem?
- Can you identify any introduced 'weed' species?

Encourage students to take photographs of the site and any key features such as common or dominant plant species, changes in topography, evidence of human impact and introduced weed species.

Students use plant and animal guides and keys to classify and document the names and features of plants and animals found at the site in their journal. The local expert may be able to support the teacher and the students to identify the salient features of the site and how it has been changed by human activity.

Remind students that the purpose of the fieldwork is to study a degraded ecosystem and use the data to design and develop a management plan to guide the restoration of the ecosystem.

Engage students in a discussion about selecting an area to be studied and how it might be sampled. For example:

- Which part of this area should be studied?
- Should an area that is affected by human activity and an unaffected area both be included?
- Should we take samples along a line up the slope? Across the stream? From the damaged area to the more natural area?
- Can we count all the plants and animals and study the soil in the whole of our study area?
- What role will classification, dichotomous keys and field

guides play in identifying organisms and making sense of the assemblage of plants and animals?

- How should the samples be chosen so they are representative?
- Will quadrats or line transects best reveal changes in the frequency and distribution of organisms at the site?
- Should the samples be chosen randomly, in a stratified random way, or chosen purposefully to include particular parts of the site?
- How representative will these samples be, and will you be able to generalise from them?
- Based on your samples, will you be able to apply mathematical techniques to compare them?

Engage students in a discussion about the data to be collected. For example:

- Should the numbers and types of all plants and animals in the sample areas be recorded, or could a study of just a few key species reflect the impact of human activity?
- Which species should be included in the data collection? Would sampling include any keystone species?
- Which abiotic factors appear to be at play in this ecosystem? Do soil type, elevation, proximity to water, distribution of rubbish or other pollutants or human traffic impact on the ecosystem? Which ones appear to be salient and should be studied? How will they be sampled and measured/tested?

Students document decisions made from these discussions about the site and samples in their journals. They plot the area of study, take key measurements that locate the area and its dimensions and sites to be sampled on a map of the area. They include photographs of the species to be studied.

Part 4: Planning for data collection

Review the decisions made during the site visit and engage students in planning for data collection and recording for the next field trip by considering the following:

- Confirm the location of the study site and its representation on a map or *Google Earth* image.
- Finalise decisions about the sampling procedures and number of samples, and the justification of the validity and reliability of the sampling procedure to be adopted. List the plant and animal species to be counted in each sample. Why are these predicted to

	be the most important species to study? • Identify the abiotic factors to be studied and how samples or measurements will be taken. Why are these predicted to be the most important factors to study? • Decide on group sizes and roles, and what tasks each group will be assigned. • Decide on data recording and collation procedures. Will data be recorded into spreadsheets using devices in the field or onto recording sheets and then transferred into spreadsheets back at the classroom? See *Atlas of Living Australia* in the *Digital resources* section to support students in planning for their data collection. Engage students in a collaborative, whole-class activity to design a template that can be used by the groups for data recording so the data collected by each group can be collated into a common template. A file sharing platform such as *Google docs* may facilitate data collation. Questions to prompt discussion could include: • How will the location of sampling points be recorded? • What data will be recorded for biotic and abiotic factors for sampling points (eg quadrats)? • Will the design enable graphing of data? • Will the design enable formulae to be applied for the statistical comparison of different groups of samples? • How will data collected by different groups be recorded and then collated? How will file sharing be managed?
Digital resources	Google Earth earth.google.com/web/
	Google Maps www.google.com.au/maps/@-30.9817064,117.1899926,660871m/data=!3m1!1e3?hl=en
	Community conservation groups (Urban Bushland Council WA Inc., 2019) www.bushlandperth.org.au/groups/
	A woody meadow in the heart of the city (The University of Melbourne, 2017) pursuit.unimelb.edu.au/articles/a-woody-meadow-in-the-heart-of-the-city
	Northam Bypass Revegetation Case Study (Main Roads Western Australia, 2015)

	youtu.be/3dzlMbz2dFo
	Green shoots at Roe 8 site as native bushland begins long road to recovery (ABC, 2017) www.abc.net.au/news/2017-09-29/green-shoots-at-roe-8-site-as-native-bushland-begins-recovery/8992362
	Atlas of Living Australia www.ala.org.au

Activity 2: Fieldwork

Activity focus 	Students gather, analyse and interpret the data from a test site. They evaluate the impact of human activity on the site and begin to identify the changes required to initiate rehabilitation.
Background information	The interpretation of the data gathered through fieldwork and subsequent laboratory analyses needs to be considered in the light of the relationships between the underlying geomorphology, soil types, and association of vegetation and animal populations. George Seddon's *Sense of Place* (1972) reminds us of the role of geomorphology, time and weathering in forming variations of landforms and soil types, and how these, in turn, determine the plant communities that develop through succession and their associated animal communities. In this study of a degraded ecosystem, the additional variable to be considered is human activity, which can take different forms and have different impacts. Impacts often include soil degradation, rubbish dumping, species loss, or the introduction of invasive and non-native species. Impacts on keystone species can be particularly significant, given that their role within an ecosystem has a disproportionate effect on other organisms within the system. Evidence gathered about these changes will inform the development of an ecosystem rehabilitation or management plan.
Instructional procedures	Decisions about which abiotic factors to sample and which measurement or analytical techniques to be used will be influenced by the course requirements, available technologies, time required and costs. Resources can be accessed from the Regional Laboratory Technicians science loan pool. Any activities that impact on animals must comply with the *Australian code of practice for the care and use of animals for scientific purposes - 8th edition 2013* (see *Digital resources*). All flora that is native to Western Australia is protected under the *Wildlife Conservation Act 1950*. A licence from the

Department of Biodiversity, Conservation and Attractions is required for the taking of flora from Crown land. Further details are available at *Licences and Authorities, Plants and Animals* (see *Digital resources*).

Capitalise on any opportunities for students to recognise the importance of Aboriginal and Torres Strait Islander Peoples' knowledge in developing a richer understanding of the Australian environment, the cultural significance of landscape, plants and animals, and the spiritual significance of Country.

This module provides a rich opportunity for developing the cross-curriculum priority of Sustainability.

There are opportunities for students to apply a range of mathematical techniques to the analysis of survey data using prior knowledge from Year 7–10 Mathematics, whilst students also enrolled in Year 11 Mathematics courses may apply more advanced techniques (eg standard deviations) to data analysis and interpretation.

Teachers may find this a useful context to engage students with the following mathematical skills and processes:

- with the aid of an appropriate graphical display (chosen from dot plot, stem plot, bar chart or histogram), describe the distribution of a numerical data set in terms of modality (uni or multimodal), shape (symmetric versus positively or negatively skewed), location and spread and outliers, and interpret this information in the context of the data
- determine the mean and standard deviation of a data set using technology and use these statistics as measures of location and spread of a data distribution, being aware of their limitations
- compare groups on a single numerical variable using medians, means, IQRs, ranges or standard deviations, and as appropriate; interpret the differences observed in the context of the data and report the findings in a systematic and concise manner
- implement the statistical investigation process to answer questions that involve comparing the data for a numerical variable across two or more groups

Learning outcomes	Students will be able to: 1. Identify, research and construct questions for investigation and predict possible outcomes based on evidence. 2. Design an investigation, including the procedure/s to be followed, the materials required, and the type and amount of primary or secondary data to be collected; conduct risk assessments, and consider research ethics (eg animal ethics). 3. Conduct an investigation using ecosystem surveying techniques safely, competently and methodically for the collection of valid, accurate and reliable data. 4. Use appropriate digital platforms and file sharing tools to co-construct and share documents. 5. Calculate and use measures of central tendency, location and spread within data distributions. 6. Represent data in meaningful and useful ways; organise and analyse data to identify trends, patterns and relationships; qualitatively describe sources of sampling error, and uncertainty and limitations in data; and select, synthesise and use evidence to make and justify conclusions. 7. Identify and discuss human activity that can affect biodiversity and impact on the magnitude, duration and speed of ecosystem change. 8. Analyse conservation strategies used to maintain biodiversity.
Equipment required	**For the class:** Computer and data projector *Google Earth* or *Google Maps* images of the local study area Plant and animal identification guides and keys Local expert 30 m tape measures Compass Binoculars
	For the students: Equipment for collecting data for the abiotic factors chosen (eg sample jars and sample bags, data loggers) Equipment for collection of population distribution and abundance data (eg 1 m^2 quadrats, string, measuring tapes, sample bags, hand lenses)

	Electronic or paper template for data collection Cameras and devices *Student resource sheet 2.1: Ecosystem investigation report task brief*
Preparation	Ensure the risk management plan and all approvals and any required licenses are in place for the fieldwork. Ensure all required equipment is available. Recruit a local naturalist to help you on site. Alternatively, a laboratory assistant may able to provide support with techniques and supervision. Print or provide digital access to *Student resource sheet 2.1: Ecosystem investigation report task brief*.
Activity parts	**Part 1: Site visit preparation** Make final preparations before departure to the site: • Small groups review and agree on a research question, prediction and experimental procedure for their fieldwork task. • Teacher-led review of safety issues and procedures. • Discuss how damage to the ecosystem caused by the students walking through the area can be minimised. • Distribution of field equipment.
	Part 2: Travel Move to the study site.
	Part 3: Site sampling Groups collect and record data in their templates and take additional photographs as required. Check on the progress of student groups, respond to their questions and prompt them to think about the purpose of their task, possible sources of experimental error and how to minimise them using the following question: • What is your research question for your fieldwork task? What did you predict you would find? Why is that? …*because*… • What difficulties are you having? How are you resolving them? • How are you ensuring that your data is reliable? Sampling error? Measurement error? Consistent procedures with control of variables?

Part 4: Review and pack up

Review and finalise the fieldwork tasks. Ensure all samples are labelled and data recorded.

Collect the field equipment (eg samples, data sheets etc.) and return to the school.

Part 5: Laboratory work

Laboratory work will be needed to complete the analysis of abiotic factors. Groups will need to review their recorded data and prepare it in digital form to share with the class. Student groups should analyse their data, identify patterns and trends, evaluate their research questions and predictions, and construct appropriate representations of their data to share with the class.

Conduct a whole-class data collation exercise in which each group reports on their data using a file sharing platform. The full set of data is made available to the students.

Challenge students to apply mathematical techniques to the analysis of the data. Trends in the distribution and densities of species can be revealed through graphs generated from data using programs such as *Microsoft Excel*. Differences in frequencies of species in samples from different locations can be analysed statistically, which will give insights into the uncertainty of data arising from sampling. Descriptive statistics such as means and modes, measures of spread such as standard deviations, are all possibilities depending on the Mathematics subjects being studied by the students.

Small groups can be established to review the full set of data and identify patterns and relationships within the data. Using a jigsaw type of strategy, groups could comprise one member from each fieldwork team (eg one plants group member, one animals group member, one soil group member, and one other abiotic factors group member).

Information about using the jigsaw strategy is provided in *Teacher resource sheet 1.2: Cooperative learning – Jigsaw*.

Groups share their insights from the data during a whole-class discussion. They discuss the emergent patterns and relationships, drawing on ecological concepts. Students represent the relationships within the community of

	organisms at the site as a food web, identifying the role of any keystone species and how the relationships are disrupted by human activity. Questions to focus the discussion would include: • Which of the abiotic factors appear to be influencing the diversity and distribution of organisms? • How are the plant species distributed across the site? Why? …*because*… • Are some species the key to the functioning of this ecosystem? Why? • How confident are you with your data? What are the main sources of uncertainty? • How have mathematical and technology tools and techniques helped conduct this investigation? • In what ways is the ecosystem degraded? • What appears to be causing this degradation of the ecosystem? • What actions could be taken to rehabilitate this ecosystem? Why these actions? Distribute *Student resource sheet 2.1: Ecosystem investigation report task brief* for students to use as they prepare their individual investigation reports. This will be the *Science Inquiry: Investigation* component of assessment as set out on page 17 of the Year 11 Biology syllabus. The report provides a systematic presentation of the plan for the investigation, how it was conducted, the data collected, analyses and interpretations, limitations of the methods used, and implications for rehabilitation of the ecosystem.
	Part 6: Reflection and journaling Students reflect on the processes of data collation and analysis and how they have provided insights into the questions being investigated, and the contributions that digital technologies and mathematical techniques make to revealing patterns and trends in the data.
Resource sheets	*Teacher resource sheet 1.2: Cooperative learning – Jigsaw* *Student resource sheet 2.1: Ecosystem investigation report task brief*

Digital resources	*Australian code for the care and use of animals for scientific purposes - 8th edition* (National Health and Medical Research Council, 2013) *www.nhmrc.gov.au/about-us/publications/australian-code-care-and-use-animals-scientific-purposes#block-views-block-file-attachments-content-block-1*
	Licences and Authorities, Plants and Animals (Department of Parks and Wildlife Service, 2019) *www.dpaw.wa.gov.au/plants-and-animals/licences-and-authorities*
	Google Maps *www.google.com.au/maps/@-30.9817064,117.1899926,610834m/data=!3m1!1e3?hl=en*

Activity 3: Design a management plan

Activity focus

Students use their scientific understanding and findings from the fieldwork study to design a management plan to restore the habitat to a more natural and sustainable condition. Students identify salient human impacts on the ecosystem, the changes required to rehabilitate it, and how rehabilitation will benefit the community.

Background information

Two of the most common remediations required to rehabilitate a degraded ecosystem are the removal of rubbish which takes up space and limits access to light needed by plants, and the removal of invasive and non-native plants that compete with native plants for space, light, water and nutrients.

In the 1960s and 1970s, Joan and Eileen Bradley developed a series of weed control and native vegetation recovery techniques. The 'Bradley method' involved systematically clearing small areas in and around healthy native vegetation to make space for natives to recolonise the area and replace the weeds. Further weeding is often required during the recovery phase particularly in clearings, roadsides and creek banks.

The Bradley's recommend that:

- The areas with a good population of natives are weeded first as they are the easiest to work with and give the best results
- Minimise soil disturbance
- Don't over clear and allow the regeneration of the bush to keep up with clearing.

Further information about the Bradley method is available at *Bush Regeneration* (see *Digital resources*).

Areas cleared of native vegetation in mining activity often results in the loss of topsoil which includes the seeds of native plants that are needed for regeneration. In these situations, it is necessary to replant with natives using seeds collected from nearby locations with similar genotypes.

The rehabilitation of land cleared and used for agriculture or affected by salinisation usually requires the planting of different species than those originally growing there. Species tolerant of higher soil phosphate levels from

	agricultural fertilisers or tolerant of high salt levels are required to revegetate these areas. Traditional landowners in many parts of Australia are using their traditional and cultural knowledge of ecology to work collaboratively with scientists to conserve and manage ecosystems on their Country. Ranger programs employ Indigenous landowners to care for country and work closely with school communities to support on-country learning of ecology, drawing on both traditional knowledge and western science. Rehabilitation of degraded ecosystems starts with the development of an ecosystem or rehabilitation management plan. Typically, these plans include: • A description of the location of the area to be rehabilitated, land ownership and current uses of the area, and any consultations with stakeholders that would be needed to approve any rehabilitation. • An outline of the current status of the existing ecosystem, including its flora, fauna, and abiotic factors, and how human activity has impacted on it based on evidence from fieldwork studies. • The objectives to be achieved through the rehabilitation and management plan. • The strategies and actions to be taken to rehabilitate and manage the site. • The benefits that will arise from the rehabilitation of the site.
Instructional procedures	The development of an ecosystem management plan engages students in moving from an understanding of environmental degradation towards action planning for rehabilitation and sustainability, and alerts them to the role they can play in environmental conservation. *Student resource sheet 3.1 Management plan task brief* is provided to scaffold students' development of a plan. Teachers may find this a useful context to engage students with the following design skills and processes: • Apply the elements of design and the principles of design relevant to a particular design brief • Interpretation of the design brief • Application of a design process relevant to the design context, including the development of thorough connected documentation (visual and other information) for each of the stages of the design

	process • Interpretation and/or creation of diagrams, layouts, plans and drawings • Reflective analysis to devise and evaluate solutions to design problems • Design for specific audiences with a cultural focus • Identification of specific audiences in terms of lifestyle behaviour, cultural values and beliefs.
Learning outcomes	Students will be able to: 1. Select, construct and use appropriate digital technologies and representations to communicate ecosystem investigation data, management plans and conceptual understandings. 2. Explain how keystone and other species play a critical role in maintaining the structure of the community and in the rehabilitation of an ecosystem. 3. Identify and discuss human activities that can affect biodiversity and the sustainability of an ecosystem. 4. Analyse conservation strategies used to maintain biodiversity including genetic, environmental and management strategies. 5. Explain that identification and classification of an ecological area as a conservation reserve also requires consideration of the commercial and recreational uses of the area, as well as the rights of Aboriginal and Torres Strait Islander people. 6. Engage with the technology design process to develop a prototype management plan.
Equipment required	**For the class:** Access to a management plan such as the *Site Rehabilitation and Environmental Management Plan for the Augusta Boat Harbour* (see *Digital resources*)
	For the students: Students' data collection tools Poster boards, laptops, writing and drawing equipment, printers *Student resource sheet 3.1 Management plan task brief*
Preparation	Read the *Site Rehabilitation and Environmental Management Plan for the Augusta Boat Harbour* (see *Digital resources*) as an example of a management plan.

A task brief which outlines the requirements of a management plan is included as *Student resource sheet 3.1: Management plan task brief*. This can be modified to better suit the context and assessment requirements, particularly if this is to be used as the extended response task.

Review group structures and strategies as appropriate for the class and consider how group and individual work will be required should the rehabilitation and management plan become an assessable extended response task.

Activity parts

Part 1: From fieldwork to management plan

Hold a class briefing that refers to the problem for this module: *How can we develop a management plan to guide the restoration of the ecosystem?*

Prompt questions can include:

- What problem are we trying to solve?
- Why is that important?
- What have we learnt about impacts on ecosystems that we want to communicate in our plan?
- What will a successful plan look like?

Explain to students that in this activity they will draw on findings from the fieldwork study to develop a plan to rehabilitate the site.

Explain the purpose, nature and components of an environmental management plan using an example such as the *Site Rehabilitation and Environmental Management Plan for the Augusta Boat Harbour* (see *Digital resources*), or a local example. *Student resource sheet 3.1: Management plan task brief* can also be used. If this is to be an assessment task, outline assessment requirements.

Part 2: Develop the plan

Establish groups to work on developing the management plan. Groups identify the implications from the findings of the fieldwork study for the rehabilitation of the site. Strategies/actions are identified and listed in order of priority, justifying choices and drawing on evidence from the fieldwork investigation.

Students progress through the stages of the design process to imagine, design, review and revise their plan, guided by the *Design process guide*. Ensure students reflect on the success criteria as they develop and evaluate their plans.

Conduct a whole-class review of their goals for rehabilitation, identify competing demands on the land uses and the need to balance sustainability, financial and community concerns to ensure these are addressed as required in their planning.

Challenge students to reflect on the potential challenges to implementing their plan, which may include balancing financial, ethical, sustainability and community concerns.

Part 3: Design and create a written presentation

Groups create a poster, or digital presentation, using a variety of digital formats (eg *Microsoft PowerPoint, Publisher)*, which will be used as a visual representation of their management plan to support an oral presentation.

Students decide on the content of their presentation by asking:

- What were we trying to achieve in our management plan?
- What decisions did we make as we developed our plan?
- How did our science, technology and mathematics knowledge help us develop our plan?

Assist students to plan and develop their presentations by asking the following questions:

- What headings most effectively represent our information?
- How can our explanations be summarised?
- What evidence will we use to justify our choice of strategies?
- How will relevant diagrams and photos be included to support our information?
- What features will make our written presentation engaging to our audience?
- How can the workload be divided to allow each group member to contribute to the presentation preparation?

	Part 4: Reflections and journaling Provide an opportunity for students to reflect on the effects of human activities on natural ecosystems, the importance of conserving ecosystems, the key challenges to the rehabilitation of the chosen ecosystem and the issues that need to be considered in developing a rehabilitation and management plan. Students' reflections should be recorded in their journal.
Resource sheets	*Design process guide* *Student resource sheet 3.1: Management plan task brief*
Digital resources	Bush Regeneration (Australian Native Plants Society, 2006) *anpsa.org.au/weeds4.html*
	Site Rehabilitation and Environmental Management Plan for the Augusta Boat Harbour (Department of Transport, 2012) *www.transport.wa.gov.au/mediaFiles/marine/MAC-PL-AugustaBH-SREMP.pdf*

Activity 4: Pitch the plan

Activity focus 	Student teams pitch their management plans to each other and invited guests. The pitch will justify the proposed strategies using evidence from the fieldwork study. Feedback from guests and peers will be used to evaluate the plans and identify rehabilitation strategies that are likely to be most effective.
Instructional procedures	In this activity, students present their management plans to an authentic audience. This provides an opportunity for the clarification and elaboration of students' thinking about the scientific, mathematical and design principles addressed through their problem-solving work. Teachers may find this a useful context to develop the following capabilities: • apply the elements of design and the principles of design relevant to a particular design brief • application of a design process relevant to the design context, including the development of thorough connected documentation (visual and other information) for each of the stages of the design process • interpretation and/or creation of diagrams, layouts, plans and drawings • reflective analysis to devise and evaluate solutions to design problems • design for specific audiences with a cultural focus • identification of specific audiences in terms of lifestyle behaviour, cultural values and beliefs There are also opportunities for further development of *General capabilities and cross-curriculum priorities* relating to sustainability, creative and critical thinking, ethical understanding and the culture and rights of Aboriginal and Torres Strait Islander people.
Learning outcomes	Students will be able to: 1. Identify and discuss human activity that can affect biodiversity and can impact on the sustainability of an ecosystem. 2. Analyse conservation strategies used to maintain biodiversity and justify the choice of strategies used in their rehabilitation and management plan. 3. Select, construct and use appropriate representations

	and digital technologies to communicate ecosystem investigation data, management plans and conceptual understandings using appropriate language, nomenclature, genres and modes. 4. Explain that the classification of an ecological area as a conservation reserve also requires consideration of the commercial and recreational uses of the area, as well as the rights of Aboriginal and Torres Strait Islander people.
Equipment required	**For the class:** A means to display and present written parts of the presentation (eg computer, digital projector and screens, overhead projector) An appropriate space to conduct student presentations
	For the students: Laptops for presentations or paper/card for posters (depending on the chosen presentation method) *Student activity sheet 1.0: Journal checklist* *Student activity sheet 4.1: Evaluation and reflections on management plan and presentation* *Student activity sheet 4.2: Peer evaluation* *Student activity sheet 4.3: Self-evaluation*
Preparation	Drafts of the content to be included in the digital presentations or posters could be submitted for formative feedback before the final presentation to peers and guests. Provide access to a collaborative online presentation app such as *Google Slides* or *Microsoft PowerPoint*. Set up a room for presentations. Print or provide digital access to resource sheets.
Activity parts	**Part 1: Outlining the presentation** Hold a class discussion to decide on the format for the pitch and who should be invited to the presentations. Ask students to consider: • What key people from the school and the wider community should be invited to presentations? (eg local councillor, Aboriginal Elder, naturalist, chairperson of school P&C)

- Why would these people benefit from a presentation of our solution? (eg A school P&C meeting with invited guests might be a suitable forum for the presentations if the site to be rehabilitated is on school grounds)
- How will our audience members be contacted and invited to the presentation in a professional manner?
- How can we effectively use our class members in the roles of a presentation to engage our chosen audience? (eg greeter, MC, chairperson)

Part 2: Presentation planning

The groups' posters or digital presentations will support an oral presentation to showcase their management plans to the class and other invitees. Provide a combination of class and homework time for the development, review and refining of the presentations, drawing on a range of resources including any shared documents such as *Google Docs*.

Assist students to plan and develop their oral presentations by asking the following questions:

- What format will our presentations need to take? (eg presentation and question time)
- What parts of the presentation will need a detailed explanation?
- What presentation skills will help our oral presentation make an impact on our audience?
- How can the workload be divided to allow each group member to contribute to the presentation delivery?

Each group will initially present to the class. Other students should write down at least one question they can ask each student group. The teacher chooses a few students to ask their question and allow the group to respond.

The strengths and weaknesses sections of *Student activity sheet 4.1: Evaluation and reflections on management plan and presentation* can be completed as a peer evaluation of each solution and presentation. Students can use this to guide final improvements to their presentations.

Students should add a link or embed their final presentation and peer assessments in their digital journal. Alternatively, they could print a copy and paste it into their journal.

Part 3: Presentation time

Groups present their work to an authentic audience. Students greet any visitors and chair the session so time is managed effectively for the presentations and discussion of the proposed management plans. Groups respond to questions from guests and peers and provide further justification for their plans as required.

After the guests have departed, students update their journal entries with reflections on their group's presentation.

Groups write thank you notes/cards to the members of the community they presented to. This could be an opportunity to collaborate with the students' English teachers.

Part 4: Project evaluation

Groups need to determine if their solution meets the success criteria developed in *Activity 3*. Collect and collate evidence to determine the success of the project. Students should evaluate how well they have answered the problem: *How can we develop a management plan to guide the restoration of the ecosystem?*

Students record the following in their journals:

- Did our plan meet the success criteria? If so, was the plan a success according to the criteria that were established?
- To what extent was it successful?
- Why was the plan successful, or not?
- Given more time and resources what would you do differently? Why?

The teacher conducts a review of the project and, if appropriate, identifies any opportunities to forward a revised management plan to local government, school P&C president, chair of the school board or other relevant agency.

Part 5: Reflection and journaling

Students complete *Student activity sheet 4.2: Peer evaluation* and *Student activity sheet 4.3: Self-evaluation*. They collect and collate any additional material from their learning experience for their journal. Students complete *Student activity sheet 1.0: Journal checklist* to ensure they have submitted all items. Advise students if they need to

	submit their journal for feedback and assessment. Debrief with the class by asking: • What activities did you enjoy? • What activities were challenging? Why? • What new information did you learn? • What skills did you get to practise? • What have you learnt that will enable you to contribute to the conservation of the natural world? Alternatively, students could be debriefed with a digital survey using an online tool such as *Survey Monkey*.
	Part 6: Extended response task If desired, students can complete an extended response task (See page 17 of the Year 11 Biology Syllabus) based on their work analysing the ecosystem and developing a rehabilitation management plan.
Resource sheets	*Student activity sheet 1.0: Journal checklist* *Student activity sheet 4.1: Evaluation and reflections on management plan and presentation* *Student activity sheet 4.2: Peer evaluation* *Student activity sheet 4.3: Self-evaluation*

Appendix 1: Links to the Western Australian Curriculum

This module focuses on the following science concepts and skills from the Year 11 ATAR Biology course curriculum.	ACTIVITY			
	1	2	3	4
SCIENCE **Year 11 ATAR Biology course**				
SCIENCE INQUIRY SKILLS				
identify, research and construct questions for investigation; propose hypotheses; and predict possible outcomes	●	●		
design investigations, including the procedure(s) to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics, including animal ethics	●	●		
conduct investigations, including using ecosystem surveying techniques (quadrats, line transects and capture-recapture) safely, competently and methodically for the collection of valid and reliable data		●		
represent data in meaningful and useful ways; organise and analyse data to identify trends, patterns and relationships; qualitatively describe sources of measurement error, and uncertainty and limitations in data; and select, synthesise and use evidence to make and justify conclusions		●		
select, construct and use appropriate representations, including classification keys, food webs and biomass pyramids, to communicate conceptual understanding, solve problems and make predictions		●	●	
communicate to specific audiences and for specific purposes using appropriate language, nomenclature, genres and modes, including scientific reports			●	●

This module focuses on the following science concepts and skills from the Year 11 ATAR Biology course curriculum.	ACTIVITY			
	1	2	3	4
SCIENCE **Year 11 ATAR Biology course**				
SCIENCE AS A HUMAN ENDEAVOUR				
contemporary technologies, including satellite sensing and remote monitoring enable improved monitoring of habitat and species population change over time	●			
keystone species theory has informed many conservation strategies. However, there are differing views about the effectiveness of single-species conservation in maintaining complex ecosystem dynamics	●	●	●	
identification and classification of an ecological area as a conservation reserve also requires consideration of the commercial and recreational uses of the area, as well as Indigenous Peoples' usage rights			●	●
Australia's Biodiversity Conservation Strategy 2010–2030 presents a long-term view of the future and the actions that need to be implemented to conserve biodiversity	●		●	
international agreements about biodiversity encourage international cooperation in the protection of unique locations, including: World Heritage sites, for example, Shark Bay, Great Barrier Reef; biodiversity hotspots, for example, south west WA; international migration routes and areas used for breeding, for example, by birds, whales, turtles, whale sharks	●			
SCIENCE UNDERSTANDING				
ecosystems are diverse, composed of varied habitats, consisting of a range of biotic and abiotic factors, and can be described in terms of their component species, species interactions and the abiotic factors that make up the environment	●	●		

This module focuses on the following science concepts and skills from the Year 11 ATAR Biology course curriculum.	ACTIVITY			
	1	2	3	4
SCIENCE **Year 11 ATAR Biology course**				
SCIENCE UNDERSTANDING				
relationships and interactions within a species and between species in ecosystems include predation, competition, symbiosis (mutualism, commensalism and parasitism), collaboration and disease	●	●		
in addition to biotic factors, abiotic factors, including climate and substrate, can be used to describe and classify environments	●	●		
the biotic components of an ecosystem transfer and transform energy, originating primarily from the Sun, and matter to produce biomass; and interact with abiotic components to facilitate biogeochemical cycling, including carbon and nitrogen cycling; these interactions can be represented using food webs and biomass pyramids	●	●	●	
the dynamic nature of populations influence population size, density, composition and distribution	●	●	●	
keystone species play a critical role in maintaining the structure of the community; the impact of a reduction in numbers or the disappearance of keystone species on an ecosystem is greater than would be expected, based on their relative abundance or total biomass	●	●	●	
fire is a dynamic factor in Australian ecosystems and has different effects on biodiversity	●			
human activities that can affect biodiversity and can impact on the magnitude, duration and speed of ecosystem change include examples of: habitat destruction, fragmentation or degradation; the introduction of invasive species; unsustainable use of natural resources; the impact of pollutants, including biomagnification; and, climate change	●	●	●	

This module focuses on the following science concepts and skills from the Year 11 ATAR Biology course curriculum.	ACTIVITY			
	1	2	3	4
conservation strategies used to maintain biodiversity are: genetic strategies, including gene/seed banks and captive breeding programs; environmental strategies, including revegetation and control of introduced species; management strategies, including protected areas and restricted commercial and recreational access			●	●

This module also provides opportunities to develop outcomes from Year 11 ATAR *Design* course, Year 11 ATAR *Applied Information Technology and* Year 11 ATAR *Mathematics Applications* syllabuses in the areas described below.

	ACTIVITY			
	1	2	3	4
TECHNOLOGIES **Year 11 ATAR Design course**				
Design process and methods				
interpretation of the design brief			●	
application of a design process relevant to the design context, including the development of thorough connected documentation (visual and other information) for each of the stages of the design process			●	
interpretation and/or creation of diagrams, layouts, plans and drawings			●	
reflective analysis to devise and evaluate solutions to design problems			●	●
Stakeholders				
identification of specific audiences in terms of lifestyle behaviour, values and beliefs			●	
design for specific audiences with a cultural focus			●	
TECHNOLOGIES **Year 11 ATAR Applied Information Technology course**				
Application skills				
apply data organisation techniques for user and/or client needs	●	●		
composition, layout and design considerations for the construction of spreadsheets	●	●		

	ACTIVITY			
	1	2	3	4
TECHNOLOGIES **Year 11 ATAR Applied Information Technology course**				
Project management skills				
apply the elements of design and the principles of design relevant to a particular design brief			●	
MATHEMATICS **Year 11 Mathematics Applications course**				
Topic 1.2 Algebra and matrices				
1.2.4 use matrices for storing and displaying information that can be presented in rows and columns; for example, databases, links in social or road networks	●	●		
Topic 2.1: Univariate data analysis and the statistical investigation process				
2.1.1 review the statistical investigation process; identifying a problem and posing a statistical question, collecting or obtaining data, analysing the data, interpreting and communicating the results	●	●		
2.1.4 with the aid of an appropriate graphical display (chosen from dot plot, stem plot, bar chart or histogram), describe the distribution of a numerical data set in terms of modality (uni or multimodal), shape (symmetric versus positively or negatively skewed), location and spread and outliers, and interpret this information in the context of the data		●		
2.1.5 determine the mean and standard deviation of a data set using technology and use these statistics as measures of location and spread of a data distribution, being aware of their limitations		●		

2.1.11 compare groups on a single numerical variable using medians, means, IQRs, ranges or standard deviations, and as appropriate; interpret the differences observed in the context of the data and report the findings in a systematic and concise manner		●		
2.1.12 implement the statistical investigation process to answer questions that involve comparing the data for a numerical variable across two or more groups		●		

Note: These syllabus outcomes are not assessment criteria. They are indicators which, when used collectively, represent the pitch for each grade standard for reporting purposes. They describe some of the things students may do at each standard but will vary depending on the specific tasks selected by the teacher. They should not be used as an assessment checklist. Grade judgements should occur at the end of a period of time (usually a semester or year) using several pieces of work.

Further information about these courses is available at:

senior-secondary.scsa.wa.edu.au/syllabus-and-support-materials/science/biology

senior-secondary.scsa.wa.edu.au/syllabus-and-support-materials/technologies/design

senior-secondary.scsa.wa.edu.au/syllabus-and-support-materials/technologies/applied-information-technology

senior-secondary.scsa.wa.edu.au/syllabus-and-support-materials/mathematics/mathematics-applications

Appendix 2: General capabilities and cross-curriculum priorities

Sub-element	Biology | ATAR | Year 11 syllabus: Representation of the general capabilities
Introduction	The general capabilities encompass the knowledge, skills, behaviours and dispositions that will assist students to live and work successfully in the twenty-first century. Teachers may find opportunities to incorporate the capabilities into the teaching and learning program for biology. The general capabilities are not assessed unless they are identified within the specified unit content.
Literacy	Literacy is important in students' development of Science Inquiry Skills and their understanding of content presented through the Science as a Human Endeavour and Science Understanding strands. Students gather, interpret, synthesise and critically analyse information presented in a wide range of genres, modes and representations (including text, flow diagrams, symbols, graphs and tables). They evaluate information sources and compare and contrast ideas, information and opinions presented within and between texts. They communicate processes and ideas logically and fluently and structure evidence-based arguments, selecting genres and employing appropriate structures and features to communicate for specific purposes and audiences.
Numeracy	Numeracy is key to students' ability to apply a wide range of Science Inquiry Skills, including making and recording observations; ordering, representing and analysing data; and interpreting trends and relationships. They employ numeracy skills to interpret complex spatial and graphic representations, and to appreciate the ways in which biological systems are structured, interact and change across spatial and temporal scales. They engage in analysis of data, including issues relating to reliability and probability, and they interpret and manipulate mathematical relationships to calculate and predict values.

Information and communication technology capability	Information and communication technology (ICT) capability is a key part of Science Inquiry Skills. Students use a range of strategies to locate, access and evaluate information from multiple digital sources; to collect, analyse and represent data; to model and interpret concepts and relationships; and to communicate and share science ideas, processes and information. Through exploration of Science as a Human Endeavour concepts, students assess the impact of ICT on the development of science and the application of science in society, particularly with regard to collating, storing, managing and analysing large data sets.
Critical and creative thinking	Critical and creative thinking is particularly important in the science inquiry process. Science inquiry requires the ability to construct, review and revise questions and hypotheses about increasingly complex and abstract scenarios and to design-related investigation methods. Students interpret and evaluate data; interrogate, select and cross-reference evidence; and analyse processes, interpretations, conclusions and claims for validity and reliability, including reflecting on their own processes and conclusions. Science is a creative endeavour and students devise innovative solutions to problems, predict possibilities, envisage consequences and speculate on possible outcomes as they develop Science Understanding and Science Inquiry Skills. They also appreciate the role of critical and creative individuals and the central importance of critique and review in the development and innovative application of science.
Personal and social capability	Personal and social capability is integral to a wide range of activities in the Biology ATAR course, as students develop and practise skills of communication, teamwork, decision-making, initiative-taking and self- discipline with increasing confidence and sophistication. In particular, students develop skills in both independent and collaborative investigation; they employ self-management skills to plan effectively, follow procedures efficiently and work safely; and they use collaboration skills to conduct investigations, share research and discuss ideas. In considering aspects of Science as a Human Endeavour, students also recognise the role of their own beliefs and attitudes in their response to science issues and applications, consider the perspectives of others, and gauge how science can affect people's lives.

Ethical understanding	Ethical understanding is a vital part of science inquiry. Students evaluate the ethics of experimental science, codes of practice, and the use of scientific information and science applications. They explore what integrity means in science, and they understand, critically analyse and apply ethical guidelines in their investigations. They consider the implications of their investigations on others, the environment and living organisms. They use scientific information to evaluate the claims and actions of others and to inform ethical decisions about a range of social, environmental and personal issues and applications of science.
Intercultural understanding	Intercultural understanding is fundamental to understanding aspects of Science as a Human Endeavour, as students appreciate the contributions of diverse cultures to developing science understanding and the challenges of working in culturally diverse collaborations. They develop awareness that raising some debates within culturally diverse groups requires cultural sensitivity, and they demonstrate open-mindedness to the positions of others. Students also develop an understanding that cultural factors affect the ways in which science influences and is influenced by society.

Sub-element	**Biology | ATAR | Year 11 syllabus: Representation of the cross-curriculum priorities**
Introduction	The cross-curriculum priorities address contemporary issues which students face in a globalised world. Teachers may find opportunities to incorporate the priorities into the teaching and learning program for the Biology ATAR course. The cross-curriculum priorities are not assessed unless they are identified within the specified unit content.
Aboriginal and Torres Strait Islander histories and cultures	Contexts that draw on Aboriginal and Torres Strait Islander histories and cultures provide opportunities for students to recognise the importance of Aboriginal and Torres Strait Islander Peoples' knowledge in developing a richer understanding of the Australian environment. Students could develop an appreciation of the unique Australian biota and its interactions, the impacts of Aboriginal and Torres Strait Islander People on

	their environments, and the ways in which the Australian landscape has changed over tens of thousands of years. They could examine the ways in which Aboriginal and Torres Strait Islander Peoples' knowledge of ecosystems has developed over time and the spiritual significance of Country/Place.
Asia and Australia's engagement with Asia	Contexts that draw on Asian scientific research and development and collaborative endeavours in the Asia Pacific region provide an opportunity for students to investigate Asia and Australia's engagement with Asia. Students explore the diverse environments of the Asia region and develop an appreciation that interaction between human activity and these environments continues to influence the region, including Australia, and has significance for the rest of the world. By examining developments in biological science, students appreciate that the Asia region plays an important role in scientific research and development, including through collaboration with Australian scientists, in such areas as medicine, natural resource management, biosecurity and food security.
Sustainability	The Sustainability cross-curriculum priority is explicitly addressed in the Biology ATAR syllabus. Biology provides authentic contexts for exploring, investigating and understanding the function and interactions of biotic and abiotic systems across a range of spatial and temporal scales. By investigating the relationships between biological systems and system components, and how systems respond to change, students develop an appreciation for the interconnectedness of the biosphere. Students appreciate that biological science provides the basis for decision making in many areas of society and that these decisions can impact on the Earth system. They understand the importance of using science to predict possible effects of human and other activity, and to develop management plans or alternative technologies that minimise these effects and provide for a more sustainable future.

Further information about this course is available at *senior-secondary.scsa.wa.edu.au/__data/assets/pdf_file/0010/10405/Biology-Y11-Syllabus-AC-ATARGD.pdf*

Appendix 3: Design process guide

Research

Finding useful and helpful information about the design problem.

Gathering information, conducting surveys, finding examples of existing solutions, testing properties of materials, practical testing.

Analysis

Understanding the meaning of the research findings.

Analysing what the information means, summarising the surveys, judging the value of existing solutions, understanding test results.

Ideation

Idea generation – turning ideas into tangible forms so they can be organised, ordered and communicated to others.

Activities such as brainstorming, mind mapping, sketching, drawing diagrams and plans, collecting colour samples and/or material samples and talking through these ideas can help to generate fu creative ideas.

Using the **SCAMPER** model can assist with this:
www.mindtools.com/pages/article/newCT_02.htm

www.designorate.com/a-guide-to-the-scamper-technique-for-creative-thinking

Development

Development of the design ideas. Improvements, refinements, adding detail, making it better.

Activities such as detailed drawings, modelling, prototyping, market research, gaining feedback from intended user, further research – if needed – to solve an issue with the design, testing different tools or equipment, trialling production processes, measuring or working out dimensions, testing of prototypes and further refinement.

Production

Safe production of the final design or multiple copies of the final design.

Fine tuning the production process, such as division of labour for batch or mass production.

Use of intended materials and appropriate tools to safely make the solution to the design problem.

Evaluation

Reflection on the process taken and the success of the design.

Evaluation can lead to further development or improvement of the design and can be a final stage of the design process before a conclusion is reached.

Could be formal or informal and verbal or written.

Appendix 4: Student journal

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When students reflect on learning and analyse their ideas and feelings, they self-evaluate, thereby improving their metacognitive skills.

These modules encourage students to self-reflect and record the stages of their learning in a journal. This journal may take the form of a written journal, a portfolio or a digital portfolio.

Using digital portfolios can help develop students' Information and Communication Technology (ICT) capability.

Reflective practice and recording can be supported in classrooms by creating opportunities for students to think about and record their learning through notes, drawings or pictures. Teachers should encourage students to revisit earlier journal entries to help them observe the progress of their thoughts and understanding.

Journals are a useful tool that gives teachers additional insight into how students value their own learning and progress, as well as demonstrating their individual achievements.

The following links provide background information and useful apps for journaling.

Reflective journal (University of Technology Sydney) www.uts.edu.au/sites/default/files/reflective_journal.pdf
Reflective writing (University of New South Wales Sydney)) student.unsw.edu.au/reflective-writing
Balancing the two faces of ePortfolios (Helen Barrett, 2009) electronicportfolios.org/balance/Balancing.jpg
Digital portfolios for students (Cool tools for school) cooltoolsforschool.wordpress.com/digital-student-portfolios
Kidblog – digital portfolios and blogging kidblog.org/home
Evernote (a digital portfolio app) evernote.com
Weebly for education (a drag and drop website builder) education.weebly.com
Connect – the Department of Education's integrated, online environment connect.det.wa.edu.au

Appendix 5: Student activity sheet 1.0: Journal checklist


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As an ongoing part of this module, you have been keeping a journal of your work.

Before submitting your journal to your teacher please ensure you have included the following information.

- Tick each box once complete and included.
- Write N/A for items that were not required in this module.

Your name and group members' names or photographs	
An explanation of the problem you are solving	
Your notes from *Activity 1*	
Your notes from *Activity 2*	
Your notes from *Activity 3*	
Your notes from *Activity 4*	
Management plan	
Poster presentation or equivalent	
Student activity sheet 4.2: Peer evaluation	
Student activity sheet 4.3: Self-evaluation	

Student activity sheet 1.0: Journal checklist	

Appendix 6: Teacher resource sheet 1.1: Cooperative learning – Roles

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Cooperative learning frameworks create opportunities for groups of students to work together, generally to a single purpose.

As well as having the potential to increase learning for all students involved, using these frameworks can help students develop personal and social capability.

When students are working in groups, positive interdependence can be fostered by assigning roles to group members.

These roles could include:

- Working roles such as Reader, Writer, Summariser, Time-keeper
- Social roles such as Encourager, Observer, Noise monitor, Energiser.

Further to this, specific roles can be delineated for specific activities that the group is completing. It can help students if some background to the purpose of group roles is made clear to them before they start, but at no time should the roles get in the way of the learning. Teachers should decide when or where roles are appropriate to given tasks.

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Appendix 7: Teacher resource sheet 1.2: Cooperative learning – Jigsaw

Cooperative learning frameworks create opportunities for groups of students to work together, generally for a single purpose.

As well as having the potential to increase learning for all students involved, using these frameworks can help students develop personal and social capability.

The jigsaw strategy typically has each member of the group becoming an 'expert' on one or two aspects of a topic or question being investigated. Students start in their cooperative groups, then break away to form 'expert' groups to investigate and learn about a specific aspect of a topic. After developing a sound level of understanding, students return to their cooperative groups and teach each other what they have learnt.

Within each expert group, issues such as how to teach the information to their group members are considered.

<table>
<tr><td>Step 1</td><td>Cooperative groups
(of four students)</td><td colspan="2">1 2 3 4</td><td colspan="2">1 2 3 4</td></tr>
<tr><td>Step 2</td><td>Expert groups
(size equal to the number of groups)</td><td>1 1</td><td>2 2</td><td>3 3</td><td>4 4</td></tr>
<tr><td>Step 3</td><td>Cooperative groups
(of four students)</td><td colspan="2">1 2 3 4</td><td colspan="2">1 2 3 4</td></tr>
</table>

Appendix 8: Teacher resource sheet 1.3: Cooperative learning – Placemat


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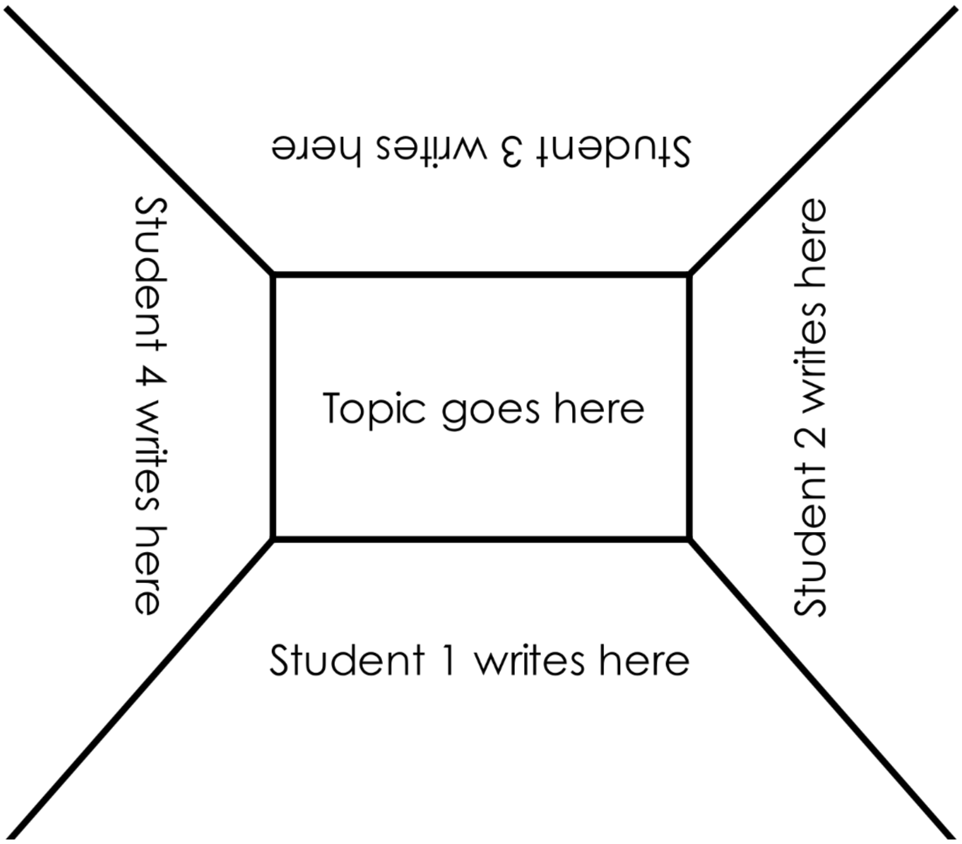
Cooperative learning frameworks create opportunities for groups of students to work together, generally for a single purpose.

As well as having the potential to increase learning for all students involved, using these frameworks can help students develop personal and social capability.

The placemat strategy involves students working collaboratively to record prior knowledge about a common topic and brainstorm ideas. It also allows teachers to readily see the contribution of each student. The diagram below shows a typical placemat template.



STEM Consortium

Appendix 9: Teacher resource sheet 1.4: Cooperative learning – Think, Pair, Share

Cooperative learning frameworks create opportunities for groups of students to work together, generally to a single purpose.

istockphoto.com

As well as having the potential to increase learning for all students involved, using these frameworks can help students develop personal and social capability.

In the 'think' stage, each student thinks silently about a question asked by the teacher.

In the 'pair' stage, students discuss their thoughts and answers to the question in pairs.

In the 'share' stage, the students share their answer, their partner's answer or what they decided together. This sharing may be with other pairs or with the whole class. It is important also to let students 'pass'. This is a key element of making the strategy safe for students.

Think–pair–share increases student participation and provides an environment for higher levels of thinking and questioning.

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Appendix 10: Student resource sheet 2.1: Ecosystem investigation report task brief

The ecosystem investigation report comprises a formal scientific report of the investigation with a structure summarised in the table below.

Report section	Outline	Assessment weighting (marks)
Introduction	Purpose and research questions investigated. Clearly drawn map of the study site. A description of the study site and why it was selected.	10
Materials and Method	Complete list of materials with sizes and quantities. Procedures for sampling, justification of the validity and reliability of the sampling methods, and the biotic and abiotic factors for which data were collected. Procedures for identification of species and gathering data about abiotic factors.	10
Results	Summaries of the data gathered and analysed represented as tables, graphs, images and text supported with interpretations of data that highlight patterns and relationships between organisms (eg food web), relationships between abiotic factors and the distribution and densities of plants and animals, and evidence of human impacts.	25
Discussion	Uses relevant science concepts to discuss findings in relation to the purpose and questions driving the investigation highlighting the impacts of human activity on the ecosystem. Describes any limitations to the validity and reliability of the investigation methods and suggests improvements.	30
Conclusion	Summarise the main findings of the investigation in relation to the purpose and questions driving the investigation. Reflections on the implications for possible strategies for remediation and management of the ecosystem.	15
References	References to sources of information cited in the management plan in the correct format as advised by teacher	5
Appendices	Appendices such as photographs and raw data gathered in the investigation	5

Appendix 11: Student resource sheet 3.1: Management plan task brief

The management plan will be set out in the suggested sections as outlined in the table below.

Section	Outline	Assessment weighting (marks)
Introduction	A description of the location of the area to be rehabilitated or developed, and an outline of who owns the land on which the ecosystem exists; the current uses of the area; and any consultations with stakeholders that would be needed to approve any rehabilitation.	20
Current status of the ecosystem	An outline of the current status of the existing ecosystem and the ways in which human activity has impacted on it based on evidence from the fieldwork study.	20
Objectives of rehabilitation	The objectives to be achieved through the rehabilitation and management plan (eg removal of weed species, increase the population of keystone species).	15
Rehabilitation strategies	The strategies and actions to be taken to rehabilitate and manage the site.	25
Benefits and call to action	The benefits that will arise from the rehabilitation of the site and a call to action from key stakeholders.	10
References	References to sources of information cited in the management plan	10

Appendix 12: Student activity sheet 4.1: Evaluation and reflections on management plan and presentation

Evaluation of the management plan		
Strengths	**Weaknesses**	**Improvements**
Evaluation of the presentation		
Strengths	**Weaknesses**	**Improvements**

Appendix 13: Student activity sheet 4.2: Peer evaluation

	Always	Usually	Sometimes	Rarely
Remains focused on tasks presented				
Completes set tasks to best of their ability				
Works independently without disrupting others				
Uses time well				
Cooperates effectively within the group				
Contributes to group discussions				
Shows respect and consideration for others				
Uses appropriate conflict resolution skills				
Comes to class prepared for activities				
Actively seeks and uses feedback				

Comments:

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Appendix 14: Student activity sheet 4.3: Self-evaluation

	Always	Usually	Sometimes	Rarely
Remains focused on tasks presented				
Completes set tasks to best of their ability				
Works independently without disrupting others				
Uses time well				
Cooperates effectively within the group				
Contributes to group discussions				
Shows respect and consideration for others				
Uses appropriate conflict resolution skills				
Comes to class prepared for activities				
Actively seeks and uses feedback				

Comments:

Notes