Geography 11–12

Ecosystems and global biodiversity learning program

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# Rationale

The NSW Department of Education publishes a range of curriculum support materials, including samples of lesson sequences, scope and sequences, assessment tasks, examinations, student and teacher resource booklets and curriculum planning and curriculum evaluation templates. The samples are not exhaustive and do not represent the only way to complete or engage in each of these processes. Curriculum design and implementation is a dynamic and contextually specific process. While the mandatory components of syllabus implementation must be met by all schools, it is important that the approach taken by teachers is reflective of their needs and faculty or school processes.

NESA defines [programming](https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/understanding-the-curriculum/programming) as the process of ‘selecting and sequencing learning experiences which enable students to engage with syllabus outcomes and develop subject specific skills and knowledge’ (NESA 2022a). A program is developed collaboratively within a faculty. It differs from a unit in important ways, as outlined by NESA on their [Advice on units](https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/understanding-the-curriculum/programming/advice-on-units) page. A unit is a contextually specific plan for the intended teaching and learning for a particular class for a particular period. The organisation of the content in a unit is flexible and it may vary according to the school, the teacher, the class and the learning space. They should be working documents that reflect the thoughtful planning and reflection that takes place during the teaching and learning cycle. There are mandatory components of programming and unit development, and this template provides one option for the delivery of these requirements. The NESA and department guidelines that have influenced this template are elaborated upon at the end of the document.

This resource has been developed to assist teachers in NSW Department of Education schools to create learning that is contextualised to their classroom. It can be used as a basis for the teacher’s own program, assessment, or scope and sequence, or be used as an example of how the new curriculum could be implemented. The resource has suggested timeframes that may need to be adjusted by the teacher to meet the needs of their students.

# Overview

**Description**: this program of learning addresses the syllabuses focus area – Ecosystems and global biodiversity. The lessons and sequences in this program of learning are designed to allow students to develop the knowledge and skills to investigate the functioning of ecosystems and trends in global biodiversity. They examine the value of ecosystems and biodiversity, the global state of ecosystems and the role of Indigenous Peoples in contemporary management practices.

**During Weeks 1 and 2 of the program**, students examine the nature and complexity of ecosystems and the various values they offer. They will investigate events that cause stress to ecosystems, the vulnerability of ecosystems to these stress events and the resilience of ecosystems in recovering from stress events.

**During Weeks 3 and 4 of the program**, students will investigate the global state of biodiversity including current and future trends and potential tipping points. They will evaluate the various strategies for managing ecosystems, locally, nationally and globally. A successful case study of management will be used at this stage to illustrate strategies.

**During Week 5 of the program,** students will investigate the role of Indigenous people in contributing to contemporary ecosystem management.

**During Weeks 6 to 14 of the program**, students will investigate 2 different types of ecosystems, with one of these being in Australia and the other outside Australia. The case studies of The Great Barrier Reef (GBR) and the Tropical Rainforest Heritage of Sumatra will be used.

**Duration**: this program of learning is designed to be completed over a period of approximately 14 weeks in 60-minute lessons but can be adapted to suit the school context.

**Explicit teaching**: suggested learning intentions and success criteria are available for some lessons provided. Learning intentions and success criteria are most effective when they are contextualised to meet the needs of students in the class. The examples provided in this document are generalised to demonstrate how learning intentions and success criteria could be created.

# Planning considerations

Consider the [Universal Design for Learning](https://education.nsw.gov.au/teaching-and-learning/curriculum/planning-programming-and-assessing-k-12/about-universal-design-for-learning) principles of [engagement](https://education.nsw.gov.au/teaching-and-learning/curriculum/planning-programming-and-assessing-k-12/about-universal-design-for-learning/strategies-and-resources-for-curriculum-planning-engagement), [representation](https://education.nsw.gov.au/teaching-and-learning/curriculum/planning-programming-and-assessing-k-12/about-universal-design-for-learning/strategies-and-resources-for-curriculum-planning-representation) and [expression](https://education.nsw.gov.au/teaching-and-learning/curriculum/planning-programming-and-assessing-k-12/about-universal-design-for-learning/strategies-and-resources-for-curriculum-planning-expression) in conjunction with this sample program of learning when planning for teaching and learning.

Suggested [learning intentions](https://education.nsw.gov.au/teaching-and-learning/curriculum/explicit-teaching/explicit-teaching-strategies/sharing-learning-intentions) and [success criteria](https://education.nsw.gov.au/teaching-and-learning/curriculum/explicit-teaching/explicit-teaching-strategies/sharing-success-criteria) have been provided to demonstrate how they might be written. Learning intentions and success criteria are most effective when they are contextualised to meet the needs of students. Teachers may edit those provided and can write and use additional learning intentions and success criteria. Learning intentions and success criteria are both an [Explicit teaching](https://aus01.safelinks.protection.outlook.com/?url=https%3A%2F%2Feducation.nsw.gov.au%2Fteaching-and-learning%2Fcurriculum%2Fexplicit-teaching&data=05%7C02%7CElizabeth.Clifford4%40det.nsw.edu.au%7Cfeb7b021e1d041b6ed9908dc89c13146%7C05a0e69a418a47c19c259387261bf991%7C0%7C0%7C638536710066219387%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C0%7C%7C%7C&sdata=RJgOnXpF4KuMXMGINqB66I77nmzgz%2FleA5014uJ18sk%3D&reserved=0) and formative assessment strategy.

Program registration and evaluation supports enhanced student outcomes. Evaluation is an important, ongoing part of the programming cycle and must be considered before program implementation. [Evaluating teaching and learning programs for HSIE 7–12](https://education.nsw.gov.au/teaching-and-learning/curriculum/hsie/leading-hsie-k-12/leading-hsie-7-12/hsie-7-12-evaluating-teaching-and-learning-programs) provides advice to support this process. Ensure registrations and evaluations are in line with school procedures, department policies and NESA requirements.

Controversial issues might be questions, subjects, topics or problems which create a difference of opinion, causing contention and debate within the school or the community. Controversial issues will differ across schools and communities.

In many of the topics covered within the HSIE syllabuses teachers are required to address controversial issues. Stage 6 geography has content that can be deemed controversial. As per the [Controversial issues in schools policy](https://education.nsw.gov.au/policy-library/policies/pd-2002-0045), teachers in HSIE must deliver lessons ensuring content is for ‘educational purposes consistent with the delivery of curriculum and provision of school programs and activities’.

The manner in which teachers approach the delivery of controversial issues in NSW public schools is guided by the Department of Education’s [Controversial issues in schools policy](https://education.nsw.gov.au/policy-library/policies/pd-2002-0045) and the [Code of Conduct policy](https://education.nsw.gov.au/rights-and-accountability/department-of-education-code-of-conduct). These documents call for a sensitive, objective and balanced approach to coverage of controversial issues. [Values in NSW public schools](https://education.nsw.gov.au/policy-library/policies/values-in-nsw-public-schools) is also a useful reference document which sets out the values to be promoted in classrooms.

# Outcomes

A student:

* **GE-12-01** analyses rural and urban places, ecosystems, global biodiversity and economic activity, for their characteristics, spatial patterns, interactions, and nature and extent of change over time
* **GE-12-02** analyses geographical processes and influences, at a range of scales, that form and transform places and environments
* **GE-12-03** assesses geographical opportunities and challenges, and the role of varying perspectives and responses in their management
* **GE-12-04** evaluates responses and management strategies, at a range of scales, for sustainability
* **GE-12-05** synthesises and evaluates relevant geographical information from a variety of sources
* **GE-12-06** justifies geographical methods used in geographical inquiry and their relevance in the contemporary world
* **GE-12-07** selects and applies geographical inquiry skills and tools, including spatial technologies, fieldwork, and ethical practices, to investigate places and environments
* **GE-12-08** applies mathematical ideas and techniques to analyse complex geographical data
* **GE-12-09** communicates and applies geographical understanding, using geographical knowledge, concepts, terms and tools, in appropriate form

[Geography 11–12 Syllabus](https://curriculum.nsw.edu.au/learning-areas/hsie/geography-11-12-2022/overview) © NSW Education Standards Authority (NESA) for and on behalf of the Crown in right of the State of New South Wales, 2022.

Teacher advice

For Year 12 one task must be based on a fieldwork activity with a weighting of 20 to 30%.

Fieldwork

The Year 12 geography course includes 12 hours of mandatory fieldwork. This hands-on learning experience allows students to explore and analyse various aspects of ecosystems and global biodiversity, enabling them to gain a better understanding of the world around them. Fieldwork enables students to connect theoretical knowledge with real-world applications. It enhances their critical thinking, problem-solving and observational skills while also promoting a sense of stewardship for the environment. When planning fieldwork activities for this focus area, please consider how [Environmental and zoo education centres](https://education.nsw.gov.au/teaching-and-learning/curriculum/sustainability/environmental-zoo-centres) might be able to support learning outcomes for students.

When conducting fieldwork involving people, ethical practices must be adhered to, including respecting intellectual property (IP) rights. For example, if students are gathering data from community members, informed consent should be obtained, and participants should be made aware of how their information will be used. Additionally, any copyrighted material or resources must be appropriately cited and used with permission.

Fieldwork involving Aboriginal sites or focused on Aboriginal and/or Torres Strait Islander peoples and cultural heritage, requires special consideration of Indigenous cultural and intellectual property (ICIP) rights. To ensure ethical practices, students and teachers should familiarise themselves with cultural protocols for working with Aboriginal communities. Appropriate consultation with local communities and education consultants is necessary to establish respectful and mutually beneficial relationships. For more information, refer to [Aboriginal and Torres Strait Islander principles and protocols](https://curriculum.nsw.edu.au/teaching-and-learning/aboriginal-education).

In accordance with the NSW Department of Education’s [Excursion policy](https://education.nsw.gov.au/policy-library/policies/pd-2004-0010), risk assessments must be conducted prior to any fieldwork activities. This includes identifying potential hazards, assessing risks and implementing control measures to mitigate those risks. Teachers must ensure that adequate supervision is provided and that all necessary permissions and approvals are obtained before commencing fieldwork.

## Geographical tools

Geographical tools are to be embedded into classroom activities as appropriate. Students should have more than one opportunity to demonstrate their skills. The following geographical tools have been integrated into this program:

* maps – topographic maps, choropleth maps, relief maps, land use maps, thematic maps, political maps, latitude and longitude
* graphs and statistics – compound and composite column and bar graphs, line graphs, scatter graphs, climate graphs
* spatial technologies – virtual maps, satellite images, GPS and Geographical information systems (GIS)
* visual representations – photographs, vertical and oblique aerial photographs, satellite images, flow charts, annotated diagrams and [mind map](https://miro.com/mind-map/)s.

Geographical inquiry skills

The geographical inquiry skills content is to be integrated throughout the course. ‘Applying geographical understanding’ is an addition to the geographical inquiry skills. It includes:

* evaluating options in response to a geographical challenge by
* developing evaluation criteria based on environmental, social and economic considerations
* making an on-balance judgement about the most appropriate option(s)
* proposing actions and predicting outcomes
* developing a plan to implement a proposal
* assessing how causes, impacts, opportunities, challenges and/or responses relevant to one geographic context might be applicable to another.

**Prior to planning for teaching and learning, please consider the following**:

**Engagement**

* How will I provide authentic, relevant learning opportunities for students to personally connect with lesson content?
* How will I support every student to grow in independence, confidence and self-regulation?
* How will I facilitate every student to have high expectations for themselves?
* How will I identify and provide the support each student needs to sustain their learning efforts?

**Representation**

* In what ways I can present content to enable every student to access and understand it?
* How will I identify and address language and/or cultural considerations that may limit access to content for students?
* How will I make lesson content and learning materials more accessible?
* How will I plan learning experiences that are relevant and challenging for the full range of students in the classroom?

**Expression**

* How will I provide multiple ways for students to respond and express what they know?
* What tools and resources can students use to demonstrate their understanding?
* How will I know every student has understood the concepts and language presented in each lesson?
* How will I monitor if every student has achieved the learning outcomes and learning growth?

# Overview of Ecosystems and biodiversity

## Week 1 – the nature and complexity of ecosystem functioning and global biodiversity – the value of ecosystems and biodiversity

**Teacher note:** examples included in the syllabus are provided to support delivery of course content. These examples are not mandatory, and teachers might choose to use the examples provided or select appropriate alternatives.

### Learning intentions

These learning intentions and success criteria are general and should be contextualised to suit your school and students’ needs.

Students:

* understand the nature and complexity of ecosystems through the study of food chains, trophic cascades and biotic-abiotic interactions, using the Wolves of Yellowstone case study
* apply ecological concepts, such as dynamic equilibrium, feedback loops and the role of ecosystems in global cycles, including the water cycle
* understand and apply the HUGIN values (Heritage, Utility, Genetic diversity, Intrinsic and Natural change) to assess the significance of ecosystems, particularly focusing on reefs and tropical rainforests.

### Success criteria

Students can:

* accurately create and label a simplified food chain, identifying the roles of organisms (for example, producers, consumers, decomposers) explaining energy flow and describing the impact of cascade effects on the ecosystem with the reintroduction of wolves in Yellowstone
* explain the concepts of dynamic equilibrium and feedback loops, providing specific examples from the Crown of Thorns starfish and the water cycle in different ecosystems
* accurately describe and differentiate the HUGIN values, providing examples from either the reef or tropical rainforest biome and assess how significant the HUGIN values are in influencing conservation efforts, explaining the benefits ecosystems provide at local to global scales.

Table 1 – the nature, complexity and value of ecosystem functioning and global biodiversity

|  |  |  |
| --- | --- | --- |
| Outcomes and content | Teaching and learning activities | Registration and evaluation notes |
| **GE-12-01, GE-12-02, GE-12-05, GE-12-06, GE-12-07, GE-12-08**  The nature and complexity of ecosystem functioning and global biodiversity, including:   * energy flows and nutrient cycles * dynamic equilibrium and feedback loops * relationships between natural systems   **Geographical tools/skills**   * Political maps * Flow diagrams * GPS/GIS * Topographic mapping * Visual representation * Contour lines | **Teacher note**: check video for language to ensure it’s appropriate for your class.  Conduct a [hook activity](https://www.nytimes.com/2021/11/08/learning/lesson-plans/18-warm-up-activities-to-engage-students-before-they-read-nonfiction-text.html), by showing students the [Wolves of Yellowstone](https://www.youtube.com/watch?v=KWblV23OeQc) (13:28) video to introduce the complexity of ecosystems. Afterward, facilitate a class discussion, drawing attention to key ecological concepts illustrated in the video, such as food chains, trophic cascades, trophic levels and biotic-abiotic interactions. Students reflect on how the reintroduction of wolves impacted not just the prey population, but also vegetation, rivers and overall ecosystem balance. Highlight the interconnectedness within ecosystems and provide a foundation for deeper exploration of ecological processes.  Explain key concepts such as ‘food chains’ and ‘webs’, ‘producers’, ‘heterotrophs’, ‘consumers’, ‘autotrophs’, ‘decomposers’ and ‘apex predators’. Use visual aids to highlight each element’s role in the ecosystem. Show an example of a food chain from a different ecosystem (for example, polar food web) and explicitly label each part. The [Nature Education Knowledge Project’s Food Web: Concept and Applications](https://www.nature.com/scitable/knowledge/library/food-web-concept-and-applications-84077181/) provides information and diagrams to support an explanation. Discuss how energy flows from producers to consumers and onto decomposers, clarifying the meaning of each term.  Split the class into 2 groups. One group researches the Tropical Rainforest Heritage of Sumatra (TRHS), and the other group investigates the Great Barrier Reef (GBR). Provide students with a structured research worksheet (see Activity 1). Circulate to the classroom and guide students to relevant resources for their ecosystems. Offer guidance in selecting organisms for each part of the food chain. Students independently or in small groups create a simplified food chain based on their research. Provide labels (on cards or digitally) like producer, consumer and apex predator, that they can apply to their food chain. Students to use an [Affinity diagram](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/576?clearCache=910b6da-7192-16a2-d630-d0b4705fdd84) to show the order of the food chain, with arrows representing energy flow. Recap the main points and check for understanding. Use a quick quiz or discussion prompts like ‘What would happen if the apex predator was removed from the food chain?’ (see Activity 2).  While viewing [Ecosystem Dynamics (16:17)](https://www.youtube.com/watch?v=JHyGcy6bXkU), present concepts of dynamic equilibrium and feedback loops. Define dynamic equilibrium as a state where an ecosystem maintains balance despite ongoing changes. Use simple examples like predator-prey relationships to illustrate how ecosystems adjust to maintain this balance. Use the clip to explain feedback loops and select sections appropriate to student context. Explain positive and negative feedback loops:   * Positive feedback – where changes in the system amplify further changes (for example, deforestation leading to soil erosion, which causes more deforestation). * Negative feedback – where the system works to reverse or reduce the effect of changes (for example, predator-prey dynamics where increased predator numbers decrease prey, with fewer prey to feed on, this leads to a drop in predator numbers).   Introduce the Crown-of-thorns starfish (Acanthaster planci) as an example of an organism whose population dynamics can significantly impact coral reefs, particularly the GBR. Use [Crown-of-thorns starfish control program](https://www2.gbrmpa.gov.au/our-work/programs-and-projects/crown-thorns-starfish/Crown-of-thorns-starfish-control-program) to support the explanation. Check understanding of how population explosions of this starfish are an example of a positive feedback loop where reduced predators and increased food (coral) lead to starfish overpopulation, which can devastate coral ecosystems.  Students research the Crown-of-thorns starfish, focusing on its role in the coral reef ecosystem. Students investigate how its population affects coral health (positive feedback loop) and the impacts of human interventions or natural predators as potential stabilisers (negative feedback loop). Use [Australian Institute of Marine Science](https://www.aims.gov.au/), [Crown-of-thorns starfish](https://www.aims.gov.au/research-topics/marine-life/crown-thorns-starfish) to assist research. Students present their findings in small groups, using diagrams to explain the feedback loops associated with the Crown-of-thorns starfish. As a class, discuss how the starfish is an example of dynamic equilibrium in action, emphasising the importance of balance between starfish and coral for reef health.  Check prior knowledge and review the basic components of the water cycle, including evaporation, evapotranspiration, condensation, precipitation, infiltration, groundwater recharge and runoff. Use a simple diagram to visually demonstrate the movement of water through these stages. Emphasise how water travels through various ecosystems and how ecosystems, such as oceans, mangroves, rainforests and reefs, play a role in this cycle. Students draw a diagram of the water cycle, incorporating nearby ecosystems:   * open ocean – as the primary source of evaporation * mangroves – as a filtration system for water runoff and an area for water retention * rainforest – a major contributor to precipitation and transpiration * reef – where water from rivers and coastal systems flows, impacting the marine ecosystem.   Students label key processes (for example, evaporation, precipitation) and identify the specific role of each ecosystem within the water cycle. As a class, discuss the impacts that interactions between these ecosystems might have, focusing on:   * How water from the rainforest affects mangrove ecosystems and eventually the reef. * How pollution or deforestation in one ecosystem can impact water quality or ecosystem health downstream (for example, how deforestation in the rainforest can lead to sediment runoff affecting coral reefs). * The role of mangroves as buffers for coastal ecosystems, filtering runoff before it reaches reefs.   Students to work in groups and list how changes in one part of the cycle (for example, reduced rainfall due to climate change) could affect the other ecosystems.  Using Activity 3 explain the volcanic activity in Sumatra and its broader environmental effects. Highlight the focus on how volcanic ash affects soil composition, leading to shifts in fungal and bacterial dominance in ecosystems. Divide students into small groups. Assign half the groups to investigate the volcanoes in Sumatra and the other half to investigate the [Salmon’s life cycle and their incredible impact on our ecosystem (3:47)](https://www.youtube.com/watch?v=P_ROqvC59D4) and forests. Discussion questions:   * What are the key ecological processes influenced by volcanoes or salmon migration? * How do fungi/bacteria or selenium play essential roles in these ecosystems? * What might be the broader environmental implications of changes in these processes?   Use driving questions for further research on volcanoes in Sumatra:   * Describe how volcanic eruptions deposit ash rich in minerals, altering soil chemistry. * Explain how this disruption leads to a shift in the microbial community, favouring certain fungi or bacteria. * Discuss potential impacts on plant life, nutrient cycling and long-term ecosystem health.   Use driving questions for further research on salmon and selenium:   * Describe how salmon transport selenium from the ocean to inland ecosystems, particularly North-Western Coniferous forests. * Explain how selenium affects tree growth and forest health and how the decline in salmon populations could disrupt this micronutrient flow. * Analyse the interconnectedness between aquatic and terrestrial ecosystems.   Each group shares key takeaways from their discussion. Encourage students to highlight how these case studies demonstrate the complexity and interconnectedness of ecosystems, even across different regions and biomes. On the board summarise the importance of understanding how specific organisms and natural events, like volcanoes or salmon migrations, contribute to ecosystem health and function.  Explain that the [ArcGIS Hub](https://hub.arcgis.com/datasets/37ea320eebb647c6838c23f72abae5ef_0/about) is a global mapping tool that provides detailed data on ecosystems, biodiversity and land-use changes. It allows students to visualise and analyse spatial patterns of various ecosystems across the globe, identifying critical habitats, protected areas and regions facing ecological threats. The system integrates information from multiple sources, including satellite imagery and conservation databases, to monitor changes over time, assess the impacts of human activity and support sustainable management efforts. Display the [Resolve Ecoregions and Biomes GIS map](https://hub.arcgis.com/datasets/esri::resolve-ecoregions-and-biomes/explore) on the screen. Demonstrate how to use the data layers (for example, vegetation, water bodies, human impact). Model how students can use it to visualise and analyse spatial data, particularly for ecosystems. Focus on specific regions that have clear patterns (for example, dense forests, fragmented ecosystems, areas affected by human activities). Demonstrate toggling between different data layers (for example, vegetation, human footprint, wildlife corridors). Point out key patterns like the distribution of forests, agricultural lands, urban areas or protected regions. Students identify and describe the spatial patterns they observe (for example, clustering of certain ecosystems, fragmentation due to urbanisation, corridors for wildlife). Students explain how these patterns might affect ecosystem connectivity, biodiversity or human land use. Using the tool, make comparisons between different regions to highlight how geography and human activity influence ecosystem patterns globally. As a class, assess the usefulness of this site as a tool for conducting geographical inquiry. Does it provide relevant information for the topic being studied? How relevant and accurate is the data provided?  Links to topographic map examples, [Geoscience Australia – Topographic maps](https://www.ga.gov.au/scientific-topics/national-location-information/topographic-maps-data/topographic-maps), [US Geological Survey (USGS) topoView](https://ngmdb.usgs.gov/topoview/).  **Teacher note**: using [past HSC exam papers](https://educationstandards.nsw.edu.au/wps/portal/nesa/11-12/resources/hsc-exam-papers) ensure the exercise includes tasks where students must:   * Measure the gradient between 2 points using contour intervals and horizontal distances. * Draw a cross section of the terrain between 2 given points on the map. * Find the bearing between 2 points and describe the direction. * Identify features using AR and GR. * Calculate the area of a designated space on the map.   Guide students through the process, answering questions and clarifying procedures as they work. Students summarise the importance of each skill in topographic mapping, ensuring they understand how these skills are used in real-world geographic analysis.  **Differentiation and adjustments**  Introduce and define key terms like ‘ecosystem’, ‘food chains’, ‘trophic levels’, ‘biotic’ and ‘abiotic’. Provide a glossary and allow bilingual dictionaries for technical terms. Use closed captions and transcripts for videos to support understanding. Offer visual aids and [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) to model ecological concepts.  Facilitate class discussions with prompts like ‘What impacts did the reintroduction of wolves have on vegetation?’ Provide sentence starters for scaffolding and vocabulary cards for students with lower language proficiency. Allow visual or written responses for students who prefer not to speak.  Explicitly teach terms such as ‘producers’, ‘heterotrophs’, ‘consumers’, ‘decomposers’, and ‘apex predators’ before research. Use diagrams of food chains from various ecosystems and provide a structured worksheet for investigating the TRHS or the GBR. Model how to create simplified food chains using flow diagrams to show energy flow.  Provide definitions and visual diagrams for ‘dynamic equilibrium’, ‘positive feedback’ and ‘negative feedback’. Model feedback loops and facilitate guided practice using the [Crown-of-thorns starfish](https://www.aims.gov.au/research-topics/marine-life/crown-thorns-starfish). Provide sentence frames for research and allow multiple formats for presenting findings (for example, digital slides, posters).  Review water cycle terms like ‘evaporation’, ‘condensation’, and ‘precipitation’. Use videos or diagrams to illustrate the water cycle and ecosystem interactions. Facilitate discussions about deforestation or pollution impacts using guiding questions. Provide sentence stems for lower-level learners and allow individual or partner work for students needing alternatives.  Define technical terms like ‘volcanic ash’ and ‘micronutrient’ before discussions and provide a glossary with bilingual dictionary support. Use driving questions to guide group discussions and visual aids to clarify complex ecological processes. Assign roles in groups to focus tasks and offer guiding questions for structured research.  Introduce terms like ‘biodiversity’, ‘ecosystem types’, and ‘human footprint’. Provide a visual guide for using GIS, modelling how to analyse maps and identify spatial patterns. Facilitate comparison activities and offer simpler GIS tasks for students needing extra support.  Review terms like ‘gradient’, ‘bearing’, and ‘cross-section’ before the mapping activity. Model each skill visually and use templates for cross-section drawings. Break tasks into smaller steps for students who struggle and provide additional practice or peer support. Use visual aids or manipulatives to help grasp abstract mapping concepts. |  |
| **GE-12-01, GE-12-02, GE-12-05**  The value of ecosystems and biodiversity  **Geographical tools/skills**   * Visual representations * Charts and diagrams * Graphs and statistics * Photographs and satellite imagery | Recap on key points of previous lesson such as food chains, dynamic equilibrium and trophic cascades. Introduce the key features of the HUGIN values (Heritage, Utility, Genetic diversity, Intrinsic and Natural change):   * Heritage values – explain how ecosystems like reefs and rainforests are integral to cultural, historical and ecological heritage, particularly for Indigenous peoples and local communities. * Utility values – highlight the practical uses of these biomes, such as tourism, fisheries, medicine and climate regulation. * Genetic diversity values – discuss the role of these ecosystems in preserving biodiversity, acting as reservoirs for genetic material essential for adaptation and survival of species. * Intrinsic values – emphasise the inherent worth of nature, independent of human use and how these ecosystems contribute to overall planetary health. * Natural change values – show how these ecosystems naturally evolve and adapt, providing essential ecoservices like carbon sequestration, water purification and flood regulation.   See Activity 4 in the resource booklet. Focus on Reef and Tropical Rainforest Biomes by using examples from the GBR and TRHS to illustrate each value. Include visuals like biodiversity hotspots, coral bleaching events and ecosystem services provided by mangroves or rainforests.   * Local scale – discuss how these ecosystems support nearby communities by providing livelihoods (for example, fishing, tourism) and how they are intertwined with local culture. * National scale – explain the economic benefits of conserving these ecosystems, such as tourism revenue, and their role in national biodiversity strategies. * Global scale – explain how these biomes play a crucial role in regulating global climate patterns, contributing to carbon storage and maintaining the Earth’s environmental balance.   As a class discuss the benefits these biomes provide at local, national and global scales. Provide feedback and challenge students with questions to think about how protecting these ecosystems can benefit the local communities and the global population in terms of climate stability and biodiversity conservation.  Have students choose either the reef or tropical rainforest ecosystem and summarise the benefits it provides at the 3 scales (local, national, global) using examples. Students use their notes and further research to complete this task, which reinforces the concepts.  Recap the different values (heritage, utility, genetic diversity, intrinsic, natural change) and their significance. Ask a reflection question: ‘How can understanding these values influence conservation efforts at different scales?’  **Differentiation and adjustments**  Provide key definitions for terms like ‘heritage values’, ‘utility values’, ‘genetic diversity values’, ‘intrinsic values’ and ‘natural change values’. Offer a glossary and allow bilingual dictionaries for unfamiliar terms. Use visual aids and real-world examples to illustrate each value, including multimedia examples like biodiversity hotspots, coral bleaching images and ecosystem service diagrams.  Model analysis of each value at local, national and global scales, using examples from the GBR and TRHS. Facilitate class discussions with structured prompts, such as the economic impact of these ecosystems at the national level, and provide closed captions or transcripts for videos.  Provide sentence frames and [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) to help summarise benefits at each scale. For students needing extra support, offer simplified tasks with more direct guidance and allow alternative responses (for example, diagrams, flowcharts, short written paragraphs). Review ‘local’, ‘national’ and ‘global’ scales before starting, giving clear examples of ecosystem benefits.  Model summarising benefits at each scale, such as the GBRs role in local fishing, national tourism and global climate regulation. Provide templates for structuring summaries and scaffolded worksheets for those needing additional assistance. Allow various presentation formats (oral, visual, written) and encourage pair or small group work for collaborative learning.  Recap key values through a class [mind map](https://miro.com/mind-map/) or diagram and model reflective questioning about their influence on conservation strategies. Use structured discussion groups or partner ‘turn and talk’ activities to promote participation. Provide question stems for students needing help formulating answers and allow a range of reflection modes (written, verbal, visual). |  |

## Week 2 – the relationship between ecological and human stresses, and the vulnerability and resilience of ecosystems, including ecological integrity and biocapacity

### Learning intentions

Students:

* understand the concepts of vulnerability and resilience in ecosystems, using case studies, such as coral reefs and coastal communities to explore factors that influence these dynamics
* use climate graphs and synoptic charts to analyse the resilience of ecosystems, particularly in weather-impacted areas like the GBR and participate in citizen science activities to contribute to real-world ecological research.

### Success criteria

Students can:

* explain the factors that contribute to ecosystem vulnerability and identify resilience-building processes, supported by examples like coral bleaching and coastal community responses
* accurately interpret climate graphs and synoptic charts to assess weather impacts on ecosystem resilience, particularly in cyclone-prone areas like the GBR
* actively participate in citizen science projects, demonstrating their understanding of how data collection aids ecological research and conservation efforts globally.

Table 2 – the relationship between ecological and human stresses and the vulnerability and resilience of ecosystems

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| --- | --- | --- |
| Outcomes and content | Teaching and learning activities | Registration and evaluation notes |
| **GE-12-01, GE-12-02, GE-12-05, GE-12-07, GE-12-08**  The relationship between ecological and human stresses, and the vulnerability and resilience of ecosystems, including ecological integrity and biocapacity  **Geographical tools/skills**   * Satellite images * Field and photo sketches * Visual representations * Geographic Information Systems (GIS) * Venn diagrams * Maps * Climate graphs * Synoptic charts | Introduce vulnerability and resilience. Define vulnerability by explaining that vulnerability refers to the degree to which an ecosystem, community or individual is susceptible to harm due to exposure to hazards or changes (for example, natural disasters, climate change). Use examples like coastal communities facing rising sea levels or coral reefs affected by ocean acidification.  Define resilience by describing that resilience has the ability of a system to recover from disturbances or adapt to changing conditions while maintaining essential functions. See Activity 5 in the resource booklet. Illustrate with examples such as forests regrowing after wildfires or communities rebuilding after floods.   * For vulnerability factors use examples, such as poor infrastructure making communities more vulnerable to floods, or fragile ecosystems like mangroves being sensitive to pollution. * For resilience attributes discuss resilience-building factors like diversity (biological, social), connectivity (between ecosystems, support systems) and learning/adaptation.   Provide examples of case studies such as the GBRs resilience to coral bleaching events due to certain resilient coral species. Describe actions or processes that build resilience (for example, biodiversity, sustainable practices). Recap the differences and relationships between vulnerability and resilience. Ask reflective questions like, ‘What strategies can we use to reduce vulnerability and increase resilience in both ecosystems and human communities?’  Explain that biocapacity refers to the ability of an ecosystem to produce useful biological materials and absorb waste, especially carbon dioxide. It’s a measure of the ecological productivity of a country’s land and water areas. Provide information and diagrams to support explanation, for example, [Global Footprint Network – What Biocapacity measures](https://www.footprintnetwork.org/what-biocapacity-measures/#:~:text=The%20biocapacity%20metric%2C%20therefore%2C%20quantifies,is%20called%20people's%20ecological%20footprint.), [MapMaker : Human Footprint](https://education.nationalgeographic.org/resource/mapmaker-human-footprint/). Identify how different countries have varying biocapacity based on their ecosystems, population density and land management practices. For example, countries with extensive forests, agricultural lands or natural resources tend to have higher biocapacity. Provide students with reputable websites or databases (for example, [Global Footprint Network](https://www.footprintnetwork.org/)) where they can find up-to-date information on the biocapacity of various countries.  Students create a list of 10 countries ranked in order of their biocapacity. Check understanding and ask students to include details, such as the total biocapacity in global hectares per capita, and note which countries are biocapacity-rich or poor. Students compare their list of ranked countries with the [Resolve Ecoregions and Biomes Map](https://www.arcgis.com/home/item.html?id=37ea320eebb647c6838c23f72abae5ef) to identify the dominant types of biomes in each country. For example, countries like Brazil and Canada might have high biocapacity due to large areas of tropical rainforest and boreal forest biomes, respectively. Countries like Australia might have mixed biomes, such as deserts and forests, affecting their biocapacity. Students share their findings and discuss:   * How the types of biomes present in each country affect its biocapacity. * Why some countries with large landmasses might still have lower biocapacity due to biome characteristics (for example, desert regions).   Check for understanding and ask students questions to consider, for example, how land management, conservation efforts and resource use impact biocapacity.  Provide students with the link to the [World Weather Information Service](https://worldweather.wmo.int/) website and demonstrate how to access climate data for a country. Then have students follow you in selecting another country to access its data and then let students access data for other countries on their own. Choose ecosystems by assigning or allowing students to choose 2 different ecosystem types (for example, a tropical rainforest and a desert) and download the relevant climate graphs. Use example ecosystems:   * for tropical rainforests, they might choose locations like the Amazon or Southeast Asia * for deserts, locations like the Sahara or central Australia can be used.   Explain that climate graphs are used to display average monthly temperature and precipitation over a year for a specific location. They are a combination of bar and line graphs, where the bars represent precipitation and the line represents temperature. Provide explicit instruction:   * For reading the graph – teach students how to interpret the axes * the x-axis represents months of the year * the y-axis on one side shows temperature (°C or °F) and the other side shows precipitation (mm). * Show an example climate graph and demonstrate how to read it. Point out seasonal variations, wet and dry periods and temperature fluctuations.   For further information see Activity 6 in the resource booklet.  Using a [Venn diagram](https://www.canva.com/graphs/venn-diagrams/), students compare the 2 climate graphs, noting differences in temperature ranges, precipitation patterns and seasonal changes. They should answer questions such as:   * What is the range of temperatures in each ecosystem? * How does the precipitation vary throughout the year in these ecosystems? * How do these climatic patterns support the dominant vegetation and wildlife in these ecosystems?   Have students summarise their findings in a short written response.  Explain that synoptic charts show the atmospheric conditions over a large area at a given time, commonly used for weather forecasting. Introduce tropical cyclones and their characteristics, such as low pressure, strong winds and heavy rainfall, often affecting areas like the GBR. See Activity 7 in the resource booklet. Explain the key symbols and elements on a synoptic chart:   * isobars – lines that connect points of equal air pressure * wind speed and direction – indicated by the closeness of isobars and wind barbs * pressure systems – areas of high and low air pressure marked with ‘H’ and ‘L’ * cyclone features – such as low-pressure zones, cloud cover and the eye of the storm.   Students use a synoptic chart of the GBR during a tropical cyclone event. Students to identify areas of low and high pressure by interpreting the isobars. The closer the isobars, the stronger the winds. Students determine the wind speed and direction based on the spacing of the isobars and the wind barb symbols. Guide students through the process of making weather predictions using the chart:   * What direction is the cyclone moving? * How will the weather change in the next 24 to 48 hours?   Students work independently to answer a series of questions related to the synoptic chart, including:   * What is the current pressure at the centre of the cyclone? * How fast are the winds around the cyclone? * In what direction are the winds blowing and how does this relate to the cyclone’s path? * What weather conditions (for example, rain, wind) are likely in the next 24 hours?   As a class, using the synoptic chart to explain how weather forecasting works in cyclone-prone areas. Using a [Think-Pair-Share](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/645?clearCache=778a557d-50b3-45fd-8396-6f62b2e28ce3) students to discuss how understanding synoptic charts can help with disaster preparedness, particularly in areas like the GBR that are vulnerable to cyclones. Highlight the importance of synoptic charts in understanding weather patterns, particularly in relation to tropical cyclones. Check for understanding and ask students to consider how climate change might affect cyclone frequency and intensity in the future.  Explain how climate graphs and synoptic charts can be used as evidence to evaluate the resilience of ecosystems, particularly in weather-impacted areas like the GBR. Provide students with the climate graphs and synoptic chart sources related to their previous lessons (for example, the GBR). Students to write a structured response that answers:   * How do the climate and weather patterns, as shown in the climate graph and synoptic chart, affect the resilience of the GBR or similar ecosystems? * What resilience functions (for example, recovery mechanisms, biodiversity, adaptive strategies) are at play in these ecosystems? * How might these functions be impacted by climate change or increasing frequency of extreme weather events?   Guide students to structure their response as follows:   * Introduction – briefly define resilience and its importance in ecosystems. * Body paragraph 1 – discuss the climate graph data and its relevance to understanding the conditions that challenge the resilience of ecosystems (for example, temperature, precipitation patterns). * Body paragraph 2 – analyse the synoptic chart and explain how extreme weather events, such as tropical cyclones, disrupt ecosystems and test their resilience. * Body paragraph 3 – evaluate the resilience functions in the chosen ecosystem, using the data to support their points. * Conclusion – summarise how resilience functions help ecosystems recover and what challenges climate change poses to these processes.   Students exchange their writing and provide feedback on how well the evidence from the climate graphs and synoptic charts was used to support their arguments. Provide a model answer or guide the class through common points to reinforce proper use of data in written tasks. Recap the importance of using data (climate graphs and synoptic charts) to support explanations of resilience functions in ecosystems.  Explain that citizen science involves volunteers, including students, collecting and analysing data for scientific research. These programs contribute valuable data to large-scale ecological studies. Introduce the following programs:   * [Penguin Watch](https://www.zooniverse.org/projects/penguintom79/penguin-watch) – explain that this project allows volunteers to analyse photos of penguins in their natural habitats to monitor populations and behaviour. * [Reef Life Survey](https://reeflifesurvey.com/) – highlight the program where volunteers can collect data on marine species and reef health by snorkelling or diving, helping scientists monitor biodiversity in the world’s reefs.   Show students how to participate in Penguin Watch by identifying penguins in photos on the project’s platform. Provide a tutorial on how to tag and count penguins, noting behaviours and environmental conditions in the images. Have students log onto the Penguin Watch platform and begin tagging and counting penguins.  For Reef Life Survey, if students are unable to participate directly in underwater surveys, show them how to analyse existing survey data from reefs. Explain how data is used for tracking. Alternatively, guide students through the Reef Life Survey data portal, where they can explore real data sets, analyse species presence and assess reef health based on survey results, species diversity and reef health over time.  Students can work individually or in small groups to complete data tagging or analysis tasks. Students to reflect on how their contributions help researchers understand species and ecosystem health. Discuss how citizen science projects like these can enhance conservation efforts globally. Check for understanding and complete reflection questions:   * What did you learn about penguin behaviour or reef ecosystems through your participation? * How can citizen science improve data collection and support biodiversity research? * What is the significance of student involvement in real-world research?   Emphasise how these projects contribute to broader ecological knowledge and conservation.  **Differentiation and adjustments**  Provide clear definitions for ‘vulnerability’, ‘resilience’, ‘biocapacity’, ‘climate graphs’ and ‘synoptic charts’, using visual aids to illustrate each concept. Offer a glossary of key terms and allow bilingual dictionaries for unfamiliar vocabulary.  Use visual examples of vulnerable ecosystems (for example, coastal areas affected by sea-level rise) and resilient ecosystems (for example, forests recovering from wildfires). Introduce reputable websites like the [Global Footprint Network](https://www.footprintnetwork.org/) for biocapacity data, guiding students on accessing and interpreting this information.  Model how to interpret climate graphs and synoptic charts, showing their relevance to ecosystem resilience. Engage students in hands-on activities like analysing citizen science data (for example, [Penguin Watch](https://www.zooniverse.org/projects/penguintom79/penguin-watch) or [Reef Life Survey](https://reeflifesurvey.com/)) to connect theory with real-world applications. Provide sentence starters and scaffolded [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) to help summarise and compare climate graphs and synoptic charts.  Use closed captions and transcripts for multimedia materials and simplify tasks for students needing extra support with pre-labelled diagrams or partially completed research prompts. Allow group work for those who struggle with individual tasks.  Use diagrams to explain how biological diversity, connectivity and adaptation contribute to resilience, providing sentence stems for students to describe vulnerable and resilient ecosystems. Use visual organisers, such as T-charts, to compare the 2 concepts, and offer alternative ways for students to demonstrate understanding (for example, posters or infographics).  Explain ‘biocapacity’ and its significance in resource management, modelling how to access biocapacity data. Provide simplified ranking templates or pre-researched examples for more structure, along with scaffolded worksheets to help identify biomes and their impact on biocapacity. Allow various formats for presenting rankings, such as oral or visual presentations.  Introduce climate graphs and synoptic charts, explaining how to read temperature and precipitation data, as well as key elements like isobars and pressure systems. Use model graphs and charts to guide interpretation of seasonal variations and weather patterns, providing partially labelled examples for additional support. Use [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) to compare climate graphs from different ecosystems, offering sentence stems for summarising findings. Introduce ‘citizen science’, explaining its role in research, and demonstrate participation in [Penguin Watch](https://www.zooniverse.org/projects/penguintom79/penguin-watch) or data exploration from [Reef Life Survey](https://reeflifesurvey.com/). Provide step-by-step guides for students unfamiliar with data analysis, simplify tasks to focus on basic observations for those needing extra help. Encourage group work for added support and use reflection questions with structured prompts to guide responses. Allow students to express reflections in various formats (visual, oral, written) and offer additional time as needed. |  |

## Week 3 – the global state of ecosystems and biodiversity

### Learning intentions

Students:

* understand the concept of Shifting Baseline Syndrome (SBS) and its implications for ecosystem management, public perception and environmental policy
* explore the significance of tipping points and analyse how ecosystems respond to environmental stressors using case studies, such as coral reefs and the Amazon rainforest.

Success criteria

Students can:

* explain how SBS affects perceptions of environmental degradation and propose strategies to counteract its effects in ecosystems like the GBR
* identify and analyse tipping points in different ecosystems, comparing their significance and potential for recovery based on evidence from assigned articles
* use photo orientation techniques and zoning maps to interpret environmental management zones and present their reasoning for time of day and activities depicted in photos near the GBR.

Table 3 – global state of ecosystems and biodiversity

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| --- | --- | --- |
| Outcomes and content | Teaching and learning activities | Registration and evaluation notes |
| **GE-12-01, GE-12-02, GE-12-03, GE-12-08, GE-12-09**  The global state of ecosystems and biodiversity, including:   * current and future trends, and reasons for the trends * shifting baselines and tipping points   **Geographical tools/skills**   * Zoning maps * Field and photo sketches * Visual representations * GIS * Climate graphs * Thematic maps * Latitude and longitude * Photo orientation * Photo time of day | Recap synoptic charts with students by displaying a chart and have students identify key features. Access [Shifting Baseline Syndrome](https://www.youtube.com/watch?v=EwGOTiPi1Iw) (4:03), [The ocean’s shifting baseline](https://www.youtube.com/watch?v=Hui5YH-D6Go) (8:58) and [Our selective blindness is lethal to the living world](https://www.theguardian.com/commentisfree/2017/dec/20/selective-blindness-lethal-natural-world-open-eyes-environment-ecosystem) to provide a background and grasp the concept of the Shifting Baseline Syndrome (SBS). Explain that SBS occurs when each generation perceives the environmental conditions, they are familiar with as ‘normal’, even if significant degradation has already occurred over time. This leads to a gradual acceptance of deteriorated ecosystems as the baseline. Use an example like declining fish populations or coral cover in the GBR, where each generation might view a diminished reef as normal without realising how much it has changed from its historical state. See Activity 8 in the resource booklet.  Provide students a list of key points to focus on while accessing videos and reading, such as:   * How does SBS manifest in ecological studies? * What are the long-term consequences of SBS on environmental policy and management? * How can SBS impact public perception and conservation efforts?   Lead a discussion with the questions:   * How might SBS influence how people perceive the health of the GBR? * How could SBS affect decision-making in the management of the reef? * What steps can be taken to ensure that current management practices are based on historical baselines rather than shifting baselines?   In small groups, students continue discussing these questions and then share their insights with the class. Students to [brainstorm](https://app.pre.education.nsw.gov.au/learning-tools-selector/LearningActivity/Card/542?clearCache=391415c4-a1bf-e9be-3f6b-c9ea55961374) management strategies that could help counteract SBS in the GBR or rainforest. They might consider:   * restoration efforts based on historical data * public education campaigns to raise awareness of historical reef conditions * policy changes that set ambitious conservation goals to restore the reef closer to its original state.   Students recap the concept of SBS and its potential implications for ecosystem management. Check understanding and emphasise the importance of maintaining accurate historical records to guide conservation efforts. Asks questions like, ‘How might SBS affect other ecosystems beyond the GBR or rainforest?’  Provide students with articles (see below) that discuss tipping points in different ecosystems or global systems. For example:   * Article 1 might focus on marine ecosystems, such as coral reefs or fisheries. * Article 2 could explore terrestrial ecosystems, like the Amazon rainforest or Arctic permafrost.   **Teacher note**: students will need to sign up to [Nat Geo](https://www.nationalgeographic.com/science/article/earth-tipping-point) to read some articles. It might be appropriate to project the article on the class board or print a copy for students.  Provided are examples of articles, [NOAA – Coral Reef Tipping Points](https://www.germanwatch.org/en/87912) , [Coral Reefs May Have Reached Their Tipping Point](https://climatebase.org/blog/coral-reefs-may-have-reached-their-tipping-point), [Warm is the new norm for the Great Barrier Reef,](https://theconversation.com/warm-is-the-new-norm-for-the-great-barrier-reef-and-a-likely-el-nino-raises-red-flags-206750) [Climate change driving entire planet to dangerous ‘tipping point’](https://www.nationalgeographic.com/science/article/earth-tipping-point), [Amazon rainforest could reach ‘tipping point’ by 2050](https://www.theguardian.com/environment/2024/feb/14/amazon-rainforest-could-reach-tipping-point-by-2050-scientists-warn), [Critical transitions in the Amazon forest system](https://www.nature.com/articles/s41586-023-06970-0) (note: higher level research articles might need to be summarised). Conduct guided reading by encouraging students to annotate key features related to tipping points, including:   * the ecosystem being discussed * the specific threshold or tipping point * potential consequences of crossing that tipping point * possible mitigation strategies.   Students use [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) to compare the 2 articles. The organiser should include:   * similarities – common themes or features, such as the triggers for tipping points, the types of feedback loops involved or the scale of impact * differences – unique aspects of each ecosystem or the way tipping points manifest in different environments.   Have students work in pairs or small groups to complete the organiser and discuss their findings. Based on the 2 articles, students rank the significance of the tipping points discussed, considering:   * the scale of impact (local, regional, global) * the likelihood of crossing the tipping point * the potential for recovery after crossing the threshold.   Students share their rankings and justify their reasoning. Check understanding and facilitate a discussion on how different ecosystems might be more or less resilient to tipping points and why certain tipping points might be more significant on a global scale.  Introduce Photo Orientation and Zoning Maps. Explain how to use landmarks, shadows and sun angles to determine the orientation of photos (for example, using known geographic features or the position of the sun in relation to cardinal directions). See Activity 9 in the resource booklet. Introduce the zoning map of the area near the GBR. Explain how zoning is used to manage different activities like fishing, tourism and conservation. As a class, discuss how maps show different zones (for example, protected areas, fishing zones) and how they relate to ecosystem management. Demonstrate how to estimate the time of day by analysing the length and direction of shadows in the photos. For example:   * Using shadows – explain that the sun rises in the east and sets in the west and that shorter shadows indicate midday while longer shadows suggest early morning or late afternoon. * Landmarks and sun position – demonstrate how to use natural or man-made landmarks in the photos to establish orientation, helping to determine where the sun is in the sky and consequently, the time of day. * Real-world example – highlight through a sample analysis with one of the photos, explaining your thought process and demonstrating how to combine shadow length and sun position to estimate the time of day.   Provide students with the 2 photos and the zoning map of the same area near the GBR. Guide students through photo orientation and zoning map use.   1. Students to orient the photos using landmarks visible in both the photos and the zoning map. Have them mark the direction they believe the camera was facing when the photos were taken. 2. Students estimate the time of day based on shadow length, sun position and orientation. 3. Students relate the photos to the zoning map, identifying what activities might be taking place in the photographed areas based on the zoning designations (for example, fishing, tourism, conservation).   Students present their orientation and time of day estimates, explaining their reasoning. As a class, discuss how the areas shown in the photos are managed according to the zoning map and what potential environmental or human impacts might occur in those zones. Check for understanding and recap the key techniques of orienting photos and estimating time of day based on shadows and landmarks. Ask questions emphasising how these skills can be applied in geographical analysis and environmental management.  Provide a brief overview of the [Living Planet Report 2024](https://livingplanet.panda.org/en-US/), explaining its focus on biodiversity, ecosystem health and the human impact on the environment. Highlight key global statistics from the report, such as species decline, loss of natural habitats and factors driving biodiversity loss (for example, climate change, pollution, deforestation). Students individually or in groups summarise the key findings of the report. Focus on important aspects such as:   * overall trends in biodiversity loss * causes and drivers of these trends * the role of human activity in altering ecosystems.   Have students share their summaries and as a class discuss the broader implications of the report on global ecosystems and human societies. As a class, discuss the significance of the findings and why they matter for global environmental health. Assign each student or group a different country. Countries could include a mix of developed, developing and biodiversity-rich nations (for example, Brazil, Australia, China, Kenya, the U.S.). Students prepare a 2-minute reply to the Living Planet Report from the perspective of their assigned country. Students should consider:   * the environmental challenges facing their country (for example, deforestation, pollution, species decline) * actions the country is taking or could take to address these challenges * how the report findings relate to their country’s current environmental policies and goals.   Students conduct quick research or use prior knowledge to prepare their replies. Check for understanding and facilitate a discussion comparing the responses from different countries. Lead students through a reflection on:   * How different countries face unique challenges in managing biodiversity. * The role of international cooperation in addressing the global biodiversity crisis. * How countries might implement the report’s findings into national policies.   Check for understanding about the global biodiversity trends presented in the Living Planet Report and the varied national responses to these challenges. Ask questions like ‘What global actions are needed to effectively respond to the biodiversity crisis outlined in the report?’  **Differentiation and adjustments**  Introduce key terms like ‘Shifting Baseline Syndrome (SBS)’, ‘tipping points’, ‘photo orientation’, ‘zoning maps’ and ‘Living Planet Report’. Provide a glossary and allow bilingual dictionaries to support understanding. Use visual aids, examples and case studies to clarify concepts, including images of declining fish populations and coral cover in the GBR to illustrate SBS.  For tipping points, provide summaries aligned with student reading levels and model annotation strategies. Use diagrams to explain photo orientation with landmarks and shadows, and how zoning maps manage ecosystems like the GBR. Present key statistics from the [Living Planet Report](https://livingplanet.panda.org/en-US/living-planet-report-2024-key-messages/) using bullet points or visual summaries for accessibility. Use [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) for summarising key findings and allow students to choose their response format.  Provide sentence starters and [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) for comparing tipping points and summarising the [Living Planet Report](https://livingplanet.panda.org/en-US/living-planet-report-2024-key-messages/). Offer simplified readings or summaries for students needing extra support, allowing expression of understanding through various formats (written, verbal, visual).  Define ‘Shifting Baseline Syndrome’ with real-world examples and provide key questions to focus on during readings. For extra support, provide summaries with highlighted key points and visual aids like ‘before and after’ images of coral degradation. Introduce ‘tipping points’ and explain their ecological implications. Provide guided reading strategies and summaries of complex articles. Use [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) like [Venn diagrams](https://vizzlo.com/data-viz-guide/venn-diagram/what-is-a-venn-diagram) for comparison and encourage collaboration in pairs or groups.  Explain how to use landmarks and shadows for photo orientation, and introduce zoning maps, explaining conservation and tourism activities. Offer step-by-step guides to relate photos to zoning maps, providing simplified versions for analysis. |  |

## Week 4 – strategies for the sustainable management of ecosystems at a range of scales, including at least one successful conservation program

### Learning intentions

Students:

* evaluate management strategies for ecosystems at local, national and global scales, linking actions to sustainability goals
* assess international management systems like [UNESCO World Heritage Convention](https://whc.unesco.org/en/about/), [IPCC Process](https://www.ipcc.ch/documentation/procedures/), [World Wildlife Fund](https://www.worldwildlife.org/) (WWF) and [IUCN Red List](https://www.iucnredlist.org/) and compare them to local ecosystem management strategies.

### Success criteria

Students can:

* create a detailed [mind map](https://miro.com/mind-map/) of management strategies for ecosystems, linking actions at different scales to specific sustainability goals
* assess international management systems, assigning grades based on criteria like effectiveness, global cooperation and conservation impact and justify their reasoning
* write a structured report comparing a local ecosystem management strategy with international efforts, providing a well-supported evaluation of its sustainability and effectiveness.

Table 4 – strategies for the sustainable management of ecosystems

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| Outcomes and content | Teaching and learning activities | Registration and evaluation notes |
| **GE-12-03, GE-12-04, GE-12-05, GE-12-09**  Strategies for the sustainable management of ecosystems at a range of scales, including at least one successful conservation program  **Geographical tools/skills**   * Field and photo sketches * Photographs and diagrams * Fieldwork * GIS * Graphs and statistics * Visual representations * Thematic maps | As a class, create a [mind map](https://miro.com/mind-map/) of management strategies at various scales (local, national, global) for an ecosystem like the Amazon Rainforest, linking specific actions to sustainability goals. Facilitate a class discussion on how global conventions (like the Convention on Biological Diversity) influence national-level conservation programs, with students giving examples from case studies.  Introduce International Management Systems. For example:   * [UNESCO World Heritage List](https://whc.unesco.org/en/list/) – explain how [UNESCO](https://www.unesco.org/en) designates and protects sites of cultural and natural importance, emphasising the criteria for selection and the role of international cooperation in conservation. * [IPCC procedures](https://www.ipcc.ch/documentation/procedures/) – introduce the Intergovernmental Panel on Climate Change (IPCC) and the COP (Conference of the Parties) process, which focuses on global climate agreements, such as the Paris Agreement, to mitigate climate change. * [IUCN Red List](https://www.iucnredlist.org/) – describe how the International Union for Conservation of Nature (IUCN) compiles the Red List to assess the conservation status of species worldwide, serving as a key tool for biodiversity protection.   Students create a report card for the 3 international management systems. Each system will be assessed on several criteria, such as:   * Effectiveness – How well does the system achieve its goals (for example, protecting sites, influencing climate action, conserving species)? * Global cooperation – How successful is it in fostering international collaboration? * Impact on conservation/climate action – What are the measurable results of its efforts? * Challenges – What are the main obstacles or limitations? * Public awareness and influence – How well-known and influential is the system on a global scale?   Students grade by assigning letter grades (A, B, C, and so on) to each category for each management system. Students write a brief explanation of the grade and why. Students can work independently or in small groups to research and evaluate the 3 systems based on the given criteria. They should consider:   * success stories and failures for each system * real-world examples, such as [UNESCO World Heritage List](https://whc.unesco.org/en/list/), the outcomes of recent COP meetings or species status changes on the [IUCN Red List](https://www.iucnredlist.org/).   Students create a report card, grading each system across the different criteria and providing explanations for their grades. Students or groups present their report cards to the class, explaining the grades they assigned for each management system. Facilitate a discussion comparing the strengths and weaknesses of the 3 systems. Ask guiding questions such as:   * Which system seems to be the most effective in achieving its goals? * What common challenges do these international systems face? * How might these systems be improved to better address global environmental issues?   Check for understanding about the role of international management systems in addressing global environmental challenges, highlighting their successes and areas for improvement. Ask students to reflect on the question, ‘What could be done to enhance international cooperation and effectiveness in managing global environmental issues?’  Explain how local-scale management strategies focus on addressing specific environmental challenges within a particular ecosystem, such as a national park, marine reserve or wetland area. Complete a [predicting and inferring activity](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/662?clearCache=f40f6df9-3cf-8fee-dd6-41b36e73deae) about how local-scale management strategies address specific environmental challenges within an ecosystem. Demonstrate how to make comparison with international efforts by introducing the idea that similar ecosystems around the world might use different management strategies, which can be influenced by international agreements, such as the [IUCN](https://www.iucnredlist.org/) guidelines or [UNESCO’s](https://www.unesco.org/en) efforts in preserving World Heritage sites. Students write a response evaluating the sustainability of a local ecosystem management strategy. Students will:   * Describe the local ecosystem (for example, a nearby national park, marine reserve, forest). * Analyse the management strategies in place, focusing on sustainability, conservation practices and community involvement. * Compare the local strategy with international efforts in managing similar ecosystems. * Provide an evaluation of the effectiveness and sustainability of the local strategy.   Students gather information on both the local ecosystem and international management practices. Provide a report structure:   * Introduction – briefly describe the local ecosystem and the management strategy being evaluated. * Local management strategy – explain the goals of the local management strategy. Discuss key actions or practices used to sustain the ecosystem (for example, reforestation, wildlife protection, pollution control). * International comparison – choose one or 2 international efforts in similar ecosystems. For example, compare a local marine reserve to international marine conservation efforts under [UNESCO](https://www.unesco.org/en) or the [Ramsar Convention](https://www.dcceew.gov.au/water/wetlands/ramsar). Highlight similarities and differences in approach, scale, funding and community involvement. * Evaluation – evaluate the sustainability of the local strategy, considering factors such as long-term viability, adaptability and success in preserving biodiversity. Compare its effectiveness to international practices, noting any strengths or weaknesses. * Conclusion – summarise key findings and suggest any potential improvements to the local strategy.   Provide guidance on finding reliable resources and structuring their arguments. Check for understanding and encourage students to use credible sources for both local and international examples. Students present key findings from their reports to the class, highlighting interesting comparisons between local and international ecosystem management strategies. Check understanding of the importance of sustainability in ecosystem management and how local efforts can be enhanced through learning from international best practices.  Have students evaluate sustainable management strategies at local, national and global scales, focusing on a successful conservation program. Highlight key principles of sustainable ecosystem management, including precautionary principles, conservation of biological diversity and ecological integrity. Show examples of different scales of management: local, national and global. Provide examples of a successful conservation program, such as the [Great Barrier Reef Marine Park Authority (GBRMPA)](https://www2.gbrmpa.gov.au/) or [Sumatran Orangutan Conservation Programme](https://sumatranorangutan.org/).  Divide the class into small groups and assign each group one of the following scales:   * local scale (for example, community-led reef restoration projects) * national scale (for example, the Australian Government’s Reef 2050 Plan) * global scale (for example, [UNESCO World Heritage List](https://whc.unesco.org/en/list/) or [IUCN Red List](https://www.iucnredlist.org/) conservation efforts).   Each group must research their assigned scale, focusing on:   * the strategies used for conservation * how these strategies align with principles of sustainable development * key challenges and successes of the program.   Check understanding and ask:   * How do these strategies complement each other across scales? * Which scale seems most effective in the long-term sustainability of ecosystems? * Can a global strategy succeed without strong local actions?   Students write a short response to the prompt ‘Explain the effectiveness of one sustainable management strategy in your assigned ecosystem and scale. Discuss how this strategy contributes to long-term ecological integrity.’  **Differentiation and adjustments**  Introduce key terms such as ‘management strategies’, ‘sustainability goals’, ‘international cooperation’ and ‘ecosystem management’. Provide a glossary of terms related to [UNESCO](https://www.unesco.org/en), IPCC, COP, [IUCN](https://www.iucnredlist.org/) and local-scale management strategies. Use visual aids like [mind map](https://miro.com/mind-map/)s to connect local, national and global strategies with sustainability goals, incorporating case studies like the Amazon Rainforest management.  Introduce international management systems ([UNESCO](https://www.unesco.org/en), IPCC, [IUCN](https://www.iucnredlist.org/)) with examples such as ‘World Heritage Sites’ and ‘species conservation’. Offer structured guidance for creating report cards to evaluate these systems, along with sentence starters and [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) for support. Provide simplified reading materials for those needing extra help and allow evaluations to be expressed in various formats (written, visual, oral).  Define key terms like ‘local’, ‘national’ and ‘global’ management strategies, using the Amazon Rainforest as an example. Link specific management actions to sustainability goals, such as local deforestation control and global biodiversity protection. Provide a partially completed [mind map](https://miro.com/mind-map/) template and allow group work for peer collaboration.  Introduce ‘[UNESCO](https://www.unesco.org/en)’, ‘IPCC’, ‘COP’ and ‘[IUCN](https://www.iucnredlist.org/)’, discussing their operations and sharing success stories and challenges for evaluation guidance. Offer scaffolded report card templates and allow pairs or groups to research and complete them. Provide summaries of complex case studies for additional understanding.  Explain local ecosystem management strategies and compare them with international efforts using examples from national parks and marine reserves. Provide a structured report outline and [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) for comparison. Use sentence stems for writing evaluations and offer completed report examples for guidance.  Use clear sentences for students needing support in introductions and offer a checklist of criteria for evaluating strategies. Use reflection prompts like ‘What are the strengths of this local strategy and how could it be improved?’ Allow for presentations in multiple formats and provide extra time or peer support for preparation. |  |

## Week 5 – the role played by Indigenous Peoples in contemporary management practices

### Learning intentions

Students:

* understand Indigenous management practices, such as controlled burning, sustainable harvesting and water management and their role in fostering ecosystem resilience and sustainability
* analyse Indigenous rock art and the relationship between Native American tribes and bison to understand how traditional knowledge systems inform contemporary ecosystem management.

Success criteria

Students can:

* use sentence starters on Indigenous management practices by providing detailed evidence and examples, demonstrating a clear understanding of these traditional methods
* analyse Indigenous rock art as a source, identifying the insights it provides into cultural and environmental history, relating to contemporary management practices
* write well-supported responses on the role of Indigenous Peoples in modern ecosystem management, incorporating specific practices and their contemporary relevance.

Table 5 – role played by Indigenous Peoples in contemporary management practices

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| Outcomes and content | Teaching and learning activities | Registration and evaluation notes |
| **GE-12-05, GE-12-07, GE-12-09**  The role played by Indigenous Peoples in contemporary management practices  **Geographical tools/skills**   * Spatial technologies * Graphs and statistics * Photographs * Visual representations * Thematic maps | Review key points from the previous lesson by asking questions to check for understanding. Provide a brief explanation of Indigenous management practices, emphasising traditional knowledge systems that have sustained ecosystems for thousands of years. Highlight practices such as controlled burning, sustainable harvesting and water management. Highlight cultural significance by mentioning the importance of these practices in maintaining biodiversity, supporting ecosystems and fostering resilience to environmental changes. Provide students with a set of incomplete sentences related to Indigenous management practices. Students expand on these sentences by adding detailed evidence or examples. Sentence starters could include:   * ‘Controlled burning by Indigenous communities helps reduce the risk of large bushfires by ...’ Sample answer ‘... removing dry vegetation that can act as fuel, as evidenced by studies in Northern Australia that show a decrease in severe bushfires where traditional fire management is practiced.’ * ‘Indigenous fire-stick farming techniques help promote animal diversity by ...’ Sample answer ‘... creating a mosaic of different habitats, which supports species that thrive in varying stages of vegetation growth, such as the kangaroo and emu populations that benefit from these practices in central Australia.’ * ‘Indigenous management of marine ecosystems, such as the use of traditional fishing methods, contributes to sustainable fish populations by ...’ Sample answer ‘... limiting overfishing through seasonal restrictions and selective fishing techniques, as seen in the Torres Strait Islanders’ traditional practices, which ensure the long-term survival of species like the dugong and green sea turtle.’ * ‘Traditional Indigenous knowledge of plant cycles allows for sustainable farming practices by ...’ Sample answer ‘... ensuring crops are planted and harvested in harmony with natural cycles, such as the Yorta Yorta people’s careful observation of the river gum trees to predict the best time for yam daisy cultivation.’ * ‘The protection of sacred sites by Indigenous peoples supports environmental conservation by ...’ Sample answer ‘... preventing the overdevelopment or exploitation of critical ecosystems, as demonstrated by the Djab Wurrung people’s protection of culturally significant birthing trees, which also act as important biodiversity hubs.’   Check understanding and encourage students to use specific examples or research findings to complete the sentences. Students share some of their completed sentences with the class, focusing on how they incorporated evidence and examples into their responses. Check understanding and ask questions on the broader benefits of Indigenous management practices, including their role in modern conservation efforts and how they contribute to sustainable ecosystems. Provided in Activity 10 are additional questions to check understanding and encourage deeper thinking about the broader benefits of Indigenous management practices and contemporary management.  **Teacher note**: students will need to subscribe to access the Reef 2050 Traditional Owner implementation plan.  Watch the video [Healing Country Statement (3:15)](https://youtu.be/usmonj7Q4MU) and have students investigate the [Reef 2050 Traditional Owner implementation plan](https://reefto.au/). Using the plan demonstrate on the board how to identify what the implementation plan is and summarise why it is important. Break the class into 6 groups and have students navigate to the working areas section in the document. Have each group summarise one of the 6 working areas and present their summary to the rest of the class. Further information on the implementation plan can be found at [Department of Climate Change, Energy, the Environment and Water, Traditional Owners of the Great Barrier Reef](https://www.dcceew.gov.au/parks-heritage/great-barrier-reef/governance-partners/traditional-owners).  Provide students with articles on [Native American tribes and their relationship with bison](https://americanindian.si.edu/nk360/plains-belonging/itbc) and [Native Nations lead the way to returning bison to their traditional homelands](https://www.worldwildlife.org/stories/native-nations-lead-the-way-to-returning-bison-to-their-traditional-homelands), focusing on traditional practices and the importance of bison in their cultural and ecological management systems. Explain how Indigenous peoples historically managed ecosystems with specific reference to the sustainable use of bison by Native American tribes, including hunting practices, land management and resource utilisation. Students read the article, paying attention to the relationship between Native American tribes and bison and how their traditional management practices contributed to the sustainability of the bison population and the broader ecosystem. Check understanding and ask guiding questions:   * How have Native American management practices maintained balance in the ecosystem? * What is the impact of colonial disruption on bison populations? * What is the relevance of these practices in contemporary ecosystem management?   Students write a short response, using evidence from the articles and other research to support their answer. Students respond to the following question, ‘Explain the role Indigenous peoples make to contemporary ecosystem management practices’. The response should address:   * specific Indigenous practices (for example, sustainable hunting, fire management, land stewardship) * how these practices are applied or adapted in contemporary ecosystem management * the benefits of incorporating Indigenous knowledge into modern environmental strategies.   Provide feedback on the responses, looking at the clarity and depth of arguments, use of evidence from the article and structure and coherence of the response.  Highlight areas where students successfully addressed the role of Indigenous peoples and suggest improvements for expanding their arguments or adding more specific examples. Students receive feedback, then facilitate a class discussion on the role of Indigenous peoples in ecosystem management, emphasising the relevance of traditional knowledge in modern conservation practices.  **Differentiation and adjustments**  Introduce key terms like ‘Indigenous management practices’, ‘traditional knowledge systems’, ‘rock art’, ‘sustainable ecosystems’ and ‘bison conservation’. Provide a glossary of Indigenous terms and examples from various groups to highlight the diversity of traditional knowledge systems. Use real-world examples, such as controlled burning and sustainable fishing, to illustrate the cultural and ecological importance of these practices.  Provide sentence starters to help students expand their ideas with evidence related to Indigenous management. Encourage annotation of articles on Indigenous rock art and bison management, focusing on key details reflecting traditional knowledge significance. Offer sentence frames and [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) to structure responses, along with simplified readings for those needing additional support. Use closed captions or transcripts for multimedia resources.  Introduce key practices like controlled burning and sustainable harvesting, emphasising their cultural and ecological significance in maintaining biodiversity. Provide sentence starters and encourage pair or small group work to build on ideas with evidence. Allow students to express their expanded sentences through verbal discussion or written responses.  Highlight the significance of Indigenous rock art as a cultural record, showing themes such as spiritual beliefs and ceremonies. Guide students in annotating articles and offer sentence stems and reflective questions for written reflections. For additional support, provide visual examples of rock art alongside reading materials.  Explain the relationship between Native American tribes and bison, focusing on sustainable hunting practices and the impact of colonial disruption on bison populations. Provide summarised articles for easier reading and guiding questions to help organise responses about Indigenous practices in ecosystem management. Allow multiple presentation formats (written, visual, oral) and provide feedback on clarity and evidence use in responses.  Engage students in [Think-Pair-Share](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/645?clearCache=1ef07439-9489-7521-76a9-caa7bbf22f) activities to reflect on Indigenous knowledge systems. For those finding discussions challenging, provide prompts or discussion cards to help articulate their ideas. |  |

# Overview of Investigation of ecosystems

## Weeks 6 to 14 – investigate 2 different types of ecosystems (The Great Barrier Reef and the Tropical Rainforest Heritage of Sumatra)

**Teacher note:** students investigate TWO different types of ecosystems, The Great Barrier Reef and the Tropical Rainforest Heritage of Sumatra. They undertake a study to illustrate each type of ecosystem selected. At least ONE study is to be selected from outside Australia (Sumatra). Students investigate 2 different types of ecosystems (not 2 examples of the same ecosystems in different locations). They undertake a study to illustrate features and management of each type of ecosystem selected. The selected studies have considered the availability of contemporary data on biodiversity and link closely to the first section of the focus area – Ecosystems and biodiversity.

### Learning intentions

Students:

* understand the spatial distribution, biodiversity and significance of the Great Barrier Reef (GBR), focusing on how environmental factors like water temperature, ocean currents and depth influence its ecosystem
* explore how human activities, such as climate change, pollution and overfishing, are modifying the GBR and investigate current management and conservation strategies in place to protect this ecosystem
* explore the biodiversity and ecosystems of the Tropical Rainforest Heritage of Sumatra (TRHS) and understand the impact of human activities like deforestation and habitat fragmentation on endemic species
* use geographical tools, such as thematic, dot, choropleth and flowline maps, to analyse patterns of biodiversity, human pressures and land use changes in the TRHS
* interpret synoptic charts and climate graphs to assess the potential impacts of tropical cyclones on the GBR and explore how this information can support reef conservation
* develop skills in interpreting aerial and satellite photography, annotating areas of resilience and disturbance and linking these to broader spatial patterns through comparative analysis
* explore the impact of human-induced modifications on ecosystems like the GBR and the TRHS and analyse the consequences for biodiversity and ecosystem services
* compare different reef management strategies, such as coral transplant, the Reef 2050 Plan and reef zoning, focusing on their goals, methods, successes and sustainability
* explore the role of human actions, both positive and negative, in managing ecosystems like the GBR and the TRHS, emphasising conservation efforts and Indigenous practices
* compare the economic, political and sociocultural factors that influence reef and rainforest management, focusing on the GBR, Coral Triangle, TRHS and Daintree Rainforest
* analyse the role of local, national and international strategies in conserving ecosystems, with a particular focus on community-based conservation, economic drivers and long-term sustainability
* investigate how technological advancements, scientific research and innovations are applied in managing ecosystems like the TRHS and GBR
* explore the benefits, challenges and real-world examples of using technology in conservation, monitoring and restoration efforts.

### Success criteria

Students can:

* accurately identify key zones of the GBR using a map and explain how biodiversity varies across these zones based on environmental factors, such as water temperature and depth
* label a food web of the GBR with appropriate vocabulary (for example, producer, primary consumer, tertiary consumer) and explain the flow of energy through the ecosystem from producers to apex predators
* analyse a specific human-induced modification to the GBR, describe its ecological impact and propose conservation strategies, using credible sources like the [UNESCO World Heritage Inscription document](https://whc.unesco.org/en/documents/) and the [GBRMPA](https://www2.gbrmpa.gov.au/) (Great Barrier Reef Marine Park Authority) website
* accurately research and identify key species in the TRHS, using maps to plot biodiversity hotspots and human activities like deforestation
* collect and interpret climate data to create climate graphs, analysing how climate affects species distribution in the TRHS
* evaluate the impact of land use changes on endangered species, using land use maps and satellite data to analyse habitat fragmentation and human pressures
* explain how factors like coral bleaching, pollution and overfishing contribute to the GBRs vulnerability and identify factors that enhance its resilience
* analyse case studies of ecological disturbances, such as cyclones or bleaching events, to demonstrate understanding of the GBRs vulnerability and resilience during recovery
* accurately interpret synoptic charts and climate graphs to predict the effects of tropical cyclones on the GBR, including wind damage, wave action and rainfall impacts and use these predictions to discuss conservation strategies
* create and interpret bar and scatter graphs showing trends in deforestation and biodiversity loss, identifying patterns across regions and ecosystems
* use GIS technology to map ecosystem resilience and disturbance, demonstrating an understanding of how resilience factors and disturbances are spatially distributed
* accurately annotate aerial and satellite photographs, identifying areas of disturbance and resilience and link their findings to larger ecosystem patterns using satellite images and maps
* explain how human activities, such as climate change, pollution and deforestation, affect ecosystems like the GBR and TRHS and propose solutions for mitigating these impacts
* create and interpret maps and data to analyse patterns of deforestation and land use changes, identifying areas of high risk and their effects on biodiversity
* explain and compare the objectives, methods and successes of reef management strategies, identifying key differences in approach and effectiveness
* interpret satellite images and maps to identify human-induced modifications and management strategies in the TRHS, explaining how these actions impact ecosystem sustainability
* compare and contrast the economic, political and sociocultural factors that impact the management of the GBR and Coral Triangle, using structured research and note-taking
* evaluate the effectiveness of local, national and international strategies in managing the TRHS and Daintree Rainforest, identifying the challenges and successes of each
* explain the economic activities and alternative strategies that both threaten and support the conservation of the TRHS and Daintree, providing examples of how these approaches contribute to sustainability
* explain the application of a specific technology or scientific research area in managing the TRHS or GBR, providing case studies and real-world examples
* identify the benefits and potential impacts of using the selected technology for ecosystem conservation or restoration
* discuss the challenges and limitations of implementing these technologies, considering both ethical and logistical factors in their presentations.

### The Great Barrier Reef

Table 6 – investigation of ecosystems – Great Barrier Reef

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| Outcomes and content | Teaching and learning activities | Registration and evaluation notes |
| **GE-12-01, GE-12-08 GE-12-09**  Students investigate TWO different types of ecosystems. They undertake a study to illustrate each type of ecosystem selected. At least ONE study is to be selected from outside Australia.  For each study, students investigate:   * The characteristics of the ecosystem, including its spatial pattern and the nature of its biodiversity   **Geographical tools/skills**   * Flow chart * Satellite images and GIS * Visual representations (diagrams) * Zonal maps * Graphs and statistics | Check prior knowledge of the GBR by emphasising its size, location and global significance. Use a set of true/false or agree/disagree statements related to the GBR and have students respond based on prior knowledge (see Activity 11). Highlight that it’s the largest coral reef system in the world, stretching over 2,300 kilometres along the north-eastern coast of Australia, and that the GBR is a [UNESCO World Heritage site](https://whc.unesco.org/en/list/) due to its outstanding universal value in terms of biodiversity and natural beauty. Students use a map to interpret the spatial distribution of the reef, noting how it runs parallel to the Queensland coastline. Check knowledge and refer to previous activities about the zonal arrangement by explaining the zonal structure of the GBR, including inner reefs, outer reefs, lagoons and islands. As a class, discuss how spatial patterns are influenced by water temperature, ocean currents and depth. For example:   * Water temperature variations and their influence on coral bleaching events. Particularly, how warmer waters due to climate change affect coral health, leading to shifts in spatial patterns of healthy versus bleached coral. * Ocean currents (for example, the East Australian Current) impact nutrient distribution and water temperatures in different parts of the GBR. * Depth affects coral species distribution and how shallow reefs might be more exposed to temperature fluctuations, whereas deeper corals might have different stress responses.   Ask students [branching scenario](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/597?clearCache=817af83-8a1c-90ea-51fe-67ad57fce607) questions about water temperature variations and their influence on coral bleaching events. Ask students to consider how warmer waters due to climate change affect coral health, check prior knowledge about the shifts in spatial patterns of healthy versus bleached coral. Provide a list of branching scenarios in Activity 12. Check understanding and highlight key areas of biodiversity within these zones and how they vary spatially. Use [Question formulation technique](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/568?clearCache=9025d849-4b49-e538-13e5-477087abae26)s to guide information on the Human Impact Zones by showing areas affected by human activities such as tourism, fishing and shipping and compare these zones to protected areas within the reef.  Provide students with geographical information about the GBR, such as it is home to over 400 species of coral, and describe the different types of coral (for example, hard and soft corals) outlining their role in building the reef structure. Highlight the biodiversity of the GBR, including 1,500 species of fish, 4,000 types of molluscs and numerous species of sharks, rays and marine turtles. Outline the presence of endangered species like the dugong and large populations of seabirds. Have students use a [quick write activity](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/548?clearCache=2b08209d-ce5c-feba-d9d1-4509304ed497) and take [notes](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/661?clearCache=79ed5996-ec1f-fda4-409b-6fd7855eeb9) on the spatial pattern and biodiversity of the GBR as you go through each section. Guide students with prompt questions such as:   * What are the key zones of the GBR? * How does biodiversity vary within the GBR? * What environmental factors influence the reef’s spatial pattern?   Check for understanding and explain how this biodiversity supports the reef’s health and provides essential services, including fisheries, tourism and coastal protection. Clarify any concepts related to reef zoning, species diversity or the environmental factors affecting the reef. Check for understanding about the spatial distribution of the GBR and the nature of its biodiversity, emphasising the importance of conservation efforts to protect this globally significant ecosystem.  Introduce key symbiotic relationships in the GBR, such as between coral and zooxanthellae (algae) and how these interactions are critical for the health of the reef ecosystem. For example:   * Coral and zooxanthellae: key relationship: one of the most critical symbiotic relationships in the GBR is between corals and tiny algae called zooxanthellae. This is a mutualistic relationship where both the coral and *zooxanthellae* benefit: * Zooxanthellae live inside the coral’s tissues and provide the coral with nutrients through photosynthesis. They convert sunlight into energy, producing oxygen and helping to remove waste products from the coral. * Corals provide the zooxanthellae with shelter and access to sunlight. The coral’s calcium carbonate skeleton offers a stable environment where the algae can thrive.   Activity 13 from the resource booklet allows students to engage with comprehension and analysis of symbiotic relationships. Also, identified is the importance for reef health:   * Energy production – zooxanthellae supply up to 90% of the energy the coral needs to grow and build the reef’s structure. Without this relationship, corals would struggle to survive, especially in nutrient-poor tropical waters * Coral colouration – the vibrant colours of coral reefs come from the pigments in zooxanthellae. When corals are stressed (due to rising water temperatures, pollution, and so on), they expel the zooxanthellae, leading to coral bleaching, where the coral turns white and is more vulnerable to disease and death.   Critical role in reef ecosystem:   * This symbiotic relationship is foundational for the entire reef ecosystem, as healthy coral provides habitat and food for many marine species. The degradation of this relationship, as seen during coral bleaching events, can lead to the decline of the entire reef ecosystem.   Referring to Activity 1, check prior knowledge on the concept of a food web and how it shows the complex feeding relationships in an ecosystem. Highlight that food webs demonstrate how energy flows from producers to consumers and decomposers within the GBR. Delve deep into the food web outlining the components of the GBR food web key elements, such as:   * producers – primary producers like phytoplankton and algae * primary consumers – herbivores, such as small fish and sea turtles that eat the producers * secondary consumers – carnivores like larger fish and some species of marine mammals * tertiary consumers and apex predators – top-level predators, such as sharks * decomposers – organisms like bacteria and fungi that break down organic material.   Provide students with a diagram of a food web from the GBR ecosystem or use previous diagrams that include organisms like corals, fish, sharks, sea birds and plankton. Give students a list of vocabulary terms to apply to the food web. These could include, producer, primary consumer, secondary consumer, tertiary consumer, apex predator, decomposer, herbivore, carnivore, omnivore, heterotroph. Students place the correct vocabulary labels at the appropriate locations on the food web, matching each term to the species or group it describes. Guide students through one or 2 examples from the food web, explaining why a particular organism fits a certain category. For example, phytoplankton as a producer, parrotfish as a primary consumer and herbivore and sharks as tertiary consumers and apex predators. Students label the food web with the supplied vocabulary. Check understanding about the energy flow and the roles of each organism in the ecosystem. Students compare their labelled food webs with a partner to check for accuracy and understanding. Ask guiding questions such as:   * What happens if one link in the food web is disrupted, such as the loss of a key species? * How does energy move through the GBR ecosystem from producers to apex predators?   Introduce and explain how human activities have modified the GBR ecosystem, affecting its health and biodiversity. As a class, discuss types of modifications such as pollution, climate change, overfishing and coastal development. Highlight why it’s essential to research these modifications to inform better management and conservation efforts. Students access to [UNESCO World Heritage Inscription document](https://whc.unesco.org/en/documents/), which outlines why the GBR is a World Heritage site and the threats it faces from human activities. Access the [Great Barrier Reef Marine Park Authority](https://www2.gbrmpa.gov.au/) (GBRMPA) which offers comprehensive information on the management, current state and threats to the GBR, including sections on climate change, water quality and sustainable fishing. Divide students into small groups, with each group assigned one area of human-induced modification to research in detail. Students use the provided resources and conduct further research on specific human-induced modifications to the GBR ecosystem, focusing on areas such as:   * climate change – the impact of rising sea temperatures, coral bleaching and ocean acidification * pollution – effects of agricultural runoff, plastic waste and other pollutants * overfishing and unsustainable practices – how fishing practices impact species populations and reef health * coastal development – the effects of tourism infrastructure, port expansions and land reclamation.   Students develop a detailed response that includes:   * a description of the human-induced modification * specific examples from [UNESCO World Heritage Inscription document](https://whc.unesco.org/en/documents/) or [GBRMPA](https://www2.gbrmpa.gov.au/) * the ecological impact on the GBR (for example, coral health, biodiversity loss, changes in water quality) * any management strategies currently in place to address the issue * a proposal of possible solutions or improvements for better conservation.   Students use diagrams (including food webs), maps or data visuals in their presentations to illustrate the modifications and their impacts. Each group presents their findings to the class, explaining in detail how their assigned human activity is modifying the GBR ecosystem. Check understanding of the main human-induced modifications discussed and the importance of ongoing conservation efforts to protect the GBR. Ask students to reflect how individual and collective actions can impact large ecosystems like the GBR and what role they can play in protecting it.  **Differentiation and adjustments**  Introduce key terms like ‘Great Barrier Reef (GBR)’, ‘coral bleaching’, ‘zooxanthellae’, ‘food web’ and ‘human-induced modifications’. Provide a map of the GBR and visuals to show its size, location and significance as a [UNESCO](https://www.unesco.org/en) site. Explain coral and zooxanthellae symbiosis and energy flow through food webs.  Use true/false statements to assess prior knowledge about the GBR, covering its biodiversity, spatial patterns and zones. Facilitate discussions on how water temperature, currents and depth affect the GBRs spatial patterns and ecosystem health. Provide a food web diagram for labelling and offer sentence starters and organisers for support.  Use simplified readings, labelled maps and guided worksheets for complex topics. Introduce GBR key facts and human impacts and discuss how these modifications affect reef health and conservation efforts. Provide options for students to present their findings (for example, visuals, reports, presentations) and offer sentence starters and reflection prompts on how personal actions impact ecosystems. Allow flexible reflection formats like written, discussion-based or digital submissions. |  |
| **GE-12-04, GE-12-05 GE-12-07, GE-12-09**  Students investigate TWO different types of ecosystems. They undertake a study to illustrate each type of ecosystem selected. At least ONE study is to be selected from outside Australia.  For each study, students investigate:   * The dynamics of ecosystem functioning, including vulnerability, resilience and ecological disturbance   **Geographical tools/skills**   * Photographs * Visual representations * GIS and satellite imagery * Climate graphs * Synoptic charts * Topographic map * Land use map | Check prior knowledge by referring to Activity 6 and explain that ecosystem functioning refers to the processes and interactions that maintain biodiversity and ecological balance. These include nutrient cycling, energy flow and species interactions. Develop a class definition, outlining the functioning and impact/challenge for each, vulnerability, resilience and ecological disturbance in the GBR.  Vulnerability of the GBR   * Vulnerability refers to the susceptibility of the reef to external stresses, such as climate change, pollution and human activities. * Key vulnerabilities – rising sea levels, ocean acidification, coral bleaching, and so on. * Coral bleaching – rising sea temperatures cause coral to expel zooxanthellae, leading to bleaching and increased vulnerability to disease and death. * Pollution – agricultural runoff and marine pollution increase sedimentation and nutrient loads, which harm water quality and reduce coral health. * Overfishing – disrupts food chains and can lead to the decline of key species like herbivorous fish that help maintain coral health. * Impact – these vulnerabilities reduce the ability of the GBR to function effectively, leading to a decline in biodiversity and ecosystem services.   Resilience of the GBR   * Resilience – resilience refers to the ability of the reef to recover from disturbances while maintaining its essential functions. * Resilience factors – resilience to coral bleaching events, where certain coral species survive better and help in reef recovery. * Biodiversity – the GBRs high species diversity contributes to its resilience. Multiple species perform similar roles, so if one species is impacted, others can step in to maintain ecosystem balance. * Ecosystem services – the reef’s ability to support fisheries, tourism and coastal protection highlights its resilience to certain disturbances. * Natural recovery – after events like cyclones or bleaching, some coral species and other marine organisms can regenerate and recolonise damaged areas. * Challenges to resilience – the increasing frequency and intensity of disturbances (for example, more frequent bleaching events) challenge the reef’s ability to recover fully between events.   Ecological disturbances   * Ecological disturbances are events that disrupt ecosystem structure and function, either naturally or through human influence. * Types of disturbances in the GBR * Cyclones – high winds and wave action break coral structures, displace species and lead to changes in the ecosystem. * Crown-of-Thorns Starfish (COTS) – this coral predator, when in outbreak numbers, can devastate coral populations and shift the balance of the ecosystem. * Bleaching events – coral bleaching, caused by heat stress, is a significant disturbance that reduces coral cover and alters the composition of reef species. * Effects of disturbances – short-term, immediate loss of biodiversity, habitat destruction and changes in species composition. Long-term disturbances occur too frequently or are too severe, they might prevent the reef from fully recovering, leading to a permanent shift in ecosystem structure.   As a class, apply the concepts through the guiding questions:   * What factors make the GBR vulnerable to disturbance? * How does the reef’s biodiversity contribute to its resilience? * What are the most significant threats to the resilience of the GBR and how can they be addressed?   In small groups, students analyse a case study of a disturbance (for example, a cyclone or bleaching event) and discuss how the reef’s vulnerability and resilience were demonstrated during recovery. Check understanding and key concepts of vulnerability, resilience and ecological disturbance as they relate to the GBRs ecosystem functioning. Ask students to reflect on how human actions can either increase the GBRs vulnerability or help enhance its resilience.  Check prior knowledge/activities and/or provide explicit instruction on synoptic charts and climate graphs explaining that synoptic charts provide a snapshot of atmospheric conditions, including pressure systems, wind speed, direction and weather fronts. Review key features of cyclones on synoptic charts, such as areas of low pressure, tightly packed isobars indicating strong winds and wind direction based on the rotation of the cyclone (clockwise in the Southern Hemisphere).   * Climate graphs display average monthly temperature and precipitation over a year for a specific location.   Students use a [writing scaffold](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/625?clearCache=8ddb906b-fb32-d322-5e3f-867f3462f74d) for how they can help interpret seasonal weather patterns and the likelihood of cyclone formation. Demonstrate how climate graphs for the GBR region can indicate periods of higher rainfall and warmer sea temperatures, which lead to increased cyclone activity.  Students use a synoptic chart showing a tropical cyclone approaching the GBR. The chart should include features such as low-pressure systems, wind direction and predicted storm paths. Students interpret the synoptic chart and describe the potential impacts of the tropical cyclone on the GBR. Check understanding by focusing on:   * Wind damage – high winds that can break coral structures and disrupt marine habitats. * Wave action – strong waves that can lead to coral breakage and coastal erosion. * Rainfall and flooding – intense rainfall leading to runoff from land, which might increase sedimentation and pollution on the reef. * Temperature changes – the potential for cooling of sea surface temperatures in the cyclone’s wake, which can influence coral recovery.   Guide students through a section of a synoptic chart, modelling how to interpret data. For example:   * Show how to determine wind speed and direction based on isobars. * Explain how to predict cyclone movement and potential impacts on the GBR based on the cyclone’s path.   Students work independently to complete their analysis of the synoptic chart, using specific terms like ‘low pressure’, ‘isobars’, ‘wind speed’ and ‘storm surge’.  Check understanding of how synoptic charts can help predict the impact of tropical cyclones on the GBR and why understanding these impacts is critical for reef management and conservation. Ask reflective questions like, ‘How can the information from synoptic charts be used to mitigate the effects of tropical cyclones on the GBR ecosystem?’  **Differentiation and adjustments**  Define key terms like ‘ecosystem functioning’, ‘vulnerability’, ‘resilience’, ‘ecological disturbances’, ‘synoptic charts’ and ‘climate graphs’, using real-world examples and visuals to show how these concepts apply to the GBR. Introduce synoptic charts for weather conditions and climate graphs for seasonal patterns. Demonstrate reading wind speed, direction and cyclone impacts using isobars. Use [Think-Pair-Share](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Browser) for reflections and offer written prompts for students who prefer written responses.  Highlight how synoptic charts and climate graphs help interpret weather patterns and predict cyclone impacts on ecosystems.  Explain ‘vulnerability’, ‘resilience’ and ‘ecological disturbances’ in the GBR through examples like coral bleaching and cyclones. Guide students in analysing case studies of disturbances and their effects on GBR recovery. Provide sentence starters, [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) and simplified charts for support. Use peer collaboration to discuss case studies and interpretations. |  |
| **GE-12-02, GE-12-03, GE-12-07 GE-12-08 GE-12-09**  Students investigate TWO different types of ecosystems. They undertake a study to illustrate each type of ecosystem selected. At least ONE study is to be selected from outside Australia.  For each study, students investigate:   * Human-induced modifications to the ecosystem   **Geographical tools/skills**   * Spatial technologies * Bar graphs * Scatter plots * Diagrams * Flowcharts * Thematic maps * GIS | Use a [four corners activity](https://www.theteachertoolkit.com/index.php/tool/four-corners) by labelling each corner of the room with a statement or answer choice. Students move to the corner that matches their view or prior knowledge on human-induced modifications to the ecosystem for GBR and TRHS. Check understanding and visual representation of understanding. Divide the class into small groups, with each group assigned one of the following topics:   * climate change and coral bleaching * agricultural runoff and water quality * plastic pollution in marine ecosystems * overfishing and its impact on reef biodiversity * tourism and coastal development.   Each group will explore how their assigned modification affects the reef, its biodiversity and ecosystem services.  Provide students with credible resources such as:   * the [UNESCO World Heritage Inscription document](https://whc.unesco.org/en/documents/) for the GBR * The Great Barrier Reef Marine Park Authority ([GBRMPA](https://www2.gbrmpa.gov.au/)) website * Recent articles, reports or case studies on the human impacts on the reef.   Student research tasks include:   * Cause and effect – identify how the human-induced modification affects the GBR ecosystem. For example:  1. climate change → coral bleaching → biodiversity loss 2. agricultural runoff → nutrient overload → algal blooms and coral decline.  * Consequences – explain the short-term and long-term ecological consequences. * Solutions – investigate what management strategies or restoration efforts are being implemented or proposed to address the issue.   Each group prepares a presentation (for example, poster, slide deck or oral presentation) on their findings. They should address:   * Human activity – briefly explain the human-induced modification. * Environmental impact – detail the effects on the GBR ecosystem, specifically biodiversity, coral health and other marine species. * Management or mitigation efforts – describe strategies in place to reduce or manage impacts. * Future recommendations – suggest what could be done to improve the situation.   Students use diagrams, graphs or maps to illustrate the impact of modification. Following presentations, conduct a class discussion on the cumulative impact of human activities on the GBR. Some guided discussion questions:   * How do different human-induced modifications interact or exacerbate each other (for example, pollution making coral more vulnerable to bleaching)? * What roles do local, national and international efforts play in protecting the GBR? * What actions can individuals take to reduce their impact on the reef?   Check understanding about the key human-induced modifications to the GBR ecosystem and the importance of integrated management approaches to reduce these impacts. Ask the following reflective question: ‘How might the GBR look in 50 years if no further action is taken to reduce human-induced modifications?’  Provide an overview of the GBRs World Heritage Status by explaining why the GBR was designated as a UNESCO World Heritage site, emphasising its biodiversity, cultural significance and ecological value. Introduce the main threats outlined in the UNESCO assessment, focusing on human-induced modifications that are putting the reef at risk. These threats include climate change, poor water quality from agricultural runoff, coastal development, overfishing and tourism. Provide students with sections of the [UNESCO World Heritage List](https://whc.unesco.org/en/list/). Students identify and describe the different human-induced modifications mentioned in the report. Check understanding, ask guiding questions and have students annotate the text, focusing on the following:   * What are the key human activities that threaten the GBR? * How does each modification impact the ecosystem (for example, coral health, marine biodiversity, water quality)? * What are the long-term consequences if these threats are not addressed?   Check for understanding of the task, students to rank the human-induced modifications in terms of their impact on the GBR. Provide students with a list of modifications, including:   * climate change – coral bleaching, rising sea temperatures and ocean acidification * agricultural runoff – increased sedimentation, nutrient pollution and algal blooms affecting water quality * coastal development – habitat destruction from port expansions, infrastructure development and urbanisation * overfishing – disruption of food chains and the depletion of key species that support the reef’s ecosystem * tourism – physical damage to coral reefs from boat anchors, diving and increased waste and pollution from tourist activities.   Students use the ranking criteria by considering factors such as:   * the scale and severity of the impact * the reversibility of the damage caused * the extent to which these threats are being managed or mitigated * the immediate versus long-term consequences.   Students share their rankings and discuss their reasoning for placing certain human-induced modifications higher or lower on the list. Check understanding and ask questions:   * Which human-induced modification is the most damaging to the GBR and why? * Are there any modifications that have more manageable solutions compared to others? * How do these modifications interact to amplify risks to the GBR ecosystem?   Check understanding of the major human-induced modifications that threaten the GBR and the importance of prioritising mitigation strategies for the most damaging activities. Pose a critical thinking question: ‘Which modification would you focus on mitigating first and why?’  **Differentiation and adjustments**  Introduce key terms like ‘coral bleaching’, ‘agricultural runoff’, ‘plastic pollution’, ‘overfishing’, ‘ecosystem services’ and ‘World Heritage Status’. Provide a glossary with examples to help students understand human impacts on the GBR.  Use visuals (diagrams, charts, maps) to show the impact of each modification on coral health, biodiversity and ecosystem services. Offer sentence starters, [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) and simplified reports for students needing support, and allow them to present in various formats (for example, posters, slides, verbal) based on their strengths.  For extra support, provide brief explanations of modifications and use a [Think-Pair-Share](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/645?clearCache=28886ff2-6ed2-a2f9-42b1-e64ae7f9b8) for students to discuss choices. Offer summarised documents, guiding questions and examples of visuals for presentations. Allow group or paired presentations if preferred. Provide a ranking template to organise thoughts, and guiding questions for students needing help with critical thinking. |  |
| **GE-12-04, GE-12-05 GE-12-07 GE-12-09**  Students investigate TWO different types of ecosystems. They undertake a study to illustrate each type of ecosystem selected. At least ONE study is to be selected from outside Australia.  For each study, students investigate:   * Responses and strategies, including for maintaining ecosystem functioning and actions for sustainability   **Geographical tools/skills**   * Graphs * Spatial technologies * Diagrams and tables * Satellite images * Latitude and longitude * Speed, time and distance calculations | Place a satellite image of the GBR inside a box or folder (or even virtually), the satellite image should highlight key geographical features such as areas of coral bleaching, protected zones and coral cays. Alternatively, use a map that shows the overlap between protected areas and human activity (tourism, fishing, shipping lanes). Present a blurred or partially hidden satellite image, map or object and ask students to guess what it is. Ask guiding questions:   * What do you think this image or object represents? * How might it relate to the strategies used to maintain ecosystem functioning in the GBR? * How do human actions, both positive and negative, influence the sustainability of this ecosystem?   After revealing the full image or map, lead a discussion on how specific management strategies, such as reef zoning, Reef 2050 Plan or Indigenous practices, help sustain the ecosystem.  Students research and compare the 3 strategies Coral Transplant (AIMS), Reef 2050 Plan (DCCEEW) and Reef Zoning ([GBRMPA](https://www2.gbrmpa.gov.au/)) using the following key questions:   * goals – What is the primary objective of each strategy? * methods – How does each strategy work to achieve its goals? What are the practical approaches used? * scale – At what level is the strategy implemented – local, regional or national? Is it a targeted or broad-scale approach? * successes – What has each strategy achieved so far in terms of impact on the reef’s health? * challenges – What are the limitations or challenges associated with each strategy? * long-term sustainability – How sustainable is each strategy in the long run?   Students use a [T-chart diagram](https://miro.com/graphs/what-is-a-t-chart/) or table to help students organise their comparisons. Students:   * Identify similarities, such as the goal of reef conservation. * Highlight differences in the methods used, the scale of implementation and their effectiveness.   Allow students to work in small groups to complete their comparisons, using both written materials and digital resources to deepen their understanding. Students compare findings to the class, summarising the strengths, weaknesses and overall effectiveness of each strategy. Check understanding and ask guiding questions such as:   * Which strategy seems most effective in addressing the root causes of reef degradation? * How could these strategies complement each other for a more holistic approach to GBR management?   Students compare the management of the Red Sea (or Indonesian coral areas) with the GBR. Explain the key challenges coral reefs face globally, such as climate change, overfishing, tourism and pollution.   * Case Study 1 – GBR: summarise the key strategies used to manage the GBR, including coral transplant (AIMS), the Reef 2050 Plan (DCCEEW) and reef zoning ([GBRMPA](https://www2.gbrmpa.gov.au/)). * Case Study 2 – Red Sea or Indonesian Coral Areas: provide a brief overview of reef management strategies in the Red Sea or Indonesia. Highlight differences in governance, conservation approaches and key challenges in these regions (for example, marine tourism in the Red Sea or community-based conservation in Indonesia).   Divide the class into 2 or more teams, with one side arguing for the effectiveness of GBR management and the other side arguing for the effectiveness of Red Sea or Indonesian coral management. One team could argue that both management strategies are successful but for different reasons.  Students research the specific management strategies used in their assigned region, focusing on:   * management techniques – What strategies are used to protect and restore the reef ecosystem? * successes and challenges – What has worked well in preserving coral health, biodiversity and sustainable use of resources? What challenges remain? * key comparisons – How does the approach differ from other coral management systems, such as GBR versus Red Sea or Indonesia?   Provide a debate structure:   * Opening statements – each team presents their argument, highlighting the strengths of their assigned region’s reef management strategies.  1. For GBR, discuss how reef zoning, coral transplants and the long-term Reef 2050 Plan have contributed to conservation and restoration efforts. 2. For Red Sea/Indonesia, present the successes of community-based conservation in Indonesia or innovative strategies to manage tourism in the Red Sea.  * Rebuttals – teams challenge the opposing arguments, pointing out weaknesses or areas where the other region’s management strategies have fallen short. * Closing statements – each team summarises their key points, reinforcing why their region’s management strategies are more effective (or equally important in their context).   After the debate, the class can vote on which region they believe has the most successful reef management strategies based on the arguments presented. Check understanding and facilitate a discussion on the complexities of managing coral reef ecosystems. Guiding questions include:   * How do geographic, economic and cultural factors influence reef management in different regions? * What can these regions learn from each other’s successes and challenges? * Is there a one-size-fits-all approach to coral reef management, or do different regions require unique strategies?   Check understanding about the key management strategies discussed during the debate, emphasising the importance of context when managing reef ecosystems. Ask, ‘Which management strategies could be adapted and applied across different coral reefs to improve global reef conservation?’  **Differentiation and adjustments**  Introduce key terms like ‘satellite imagery’, ‘ecosystem functioning’, ‘reef conservation’, ‘management strategies’, ‘coral transplants’, ‘Reef 2050 Plan’, ‘reef zoning’ and ‘Indigenous practices’. Explain how these strategies support ecosystem sustainability, focusing on coral reefs globally.  Use visual aids like maps, diagrams and charts to illustrate human impacts on ecosystems and management strategies to mitigate them. Provide sentence starters or guiding questions for students needing support with images or maps, and offer labelled maps as needed. Allow small group discussions before class sharing.  Provide T-charts or tables for comparing strategies, with pre-filled information or sentence starters for extra guidance. For students who prefer, allow written reflections and structured [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) for responses. Offer debate guides with sentence starters and allow written arguments for students not comfortable with verbal debate. Provide sentence stems and flexible reflection formats for students who prefer non-verbal participation. |  |
| **GE-12-04, GE-12-05 GE-12-09**  Students investigate TWO different types of ecosystems. They undertake a study to illustrate each type of ecosystem selected. At least ONE study is to be selected from outside Australia  For each study, students investigate:   * Differences in ecosystem management, compared with at least one other location, due to economic, political and sociocultural factors   **Geographical tools/skills**   * Diagrams and flowcharts * Spatial technologies * Graphs and statistics (comparative tables, economic data) * Political maps * Fieldwork methods | Provide an overview of ecosystem management principles and the specific challenges using comparative case study GBR versus Coral Triangle (Indonesia, Malaysia, Philippines). Use a political map to show the geographical location of the reefs. Divide the class into 2 groups. Group 1 researches the GBR, while Group 2 focuses on the Coral Triangle. Each group investigates:   * Economic factors – examine tourism revenue, the fishing industry and economic dependence on the reef. * Political influences – research government regulations, reef protection policies and international agreements such as the Convention on Biological Diversity (CBD) and Coral Triangle Initiative (CTI). * Sociocultural factors – investigate Indigenous sea management, community conservation efforts and local cultural connections to the reef.   Provided are links to support research, [Great Barrier Reef Marine Park Authority (GBRMPA)](https://www2.gbrmpa.gov.au/), [Coral Triangle Initiative](https://www.coraltriangleinitiative.org/), [UNESCO World Heritage Convention](https://whc.unesco.org/en/) and [NOAA Coral Reef Conservation Program](https://coralreef.noaa.gov/). Check understanding and provide guiding questions for research:  Economic factors (economic benefits from reefs, tourism, fishing industries, economic sustainability):   * How much revenue is generated by tourism in the GBR/Coral Triangle? * What is the economic value of the fishing industry in each region? * How economically dependent are local communities on the reef? * How do economic activities (for example, tourism, fishing) impact reef health?   Political influences (government policies, reef protection, international agreements):   * What national laws and policies exist to protect the GBR/Coral Triangle? * How do international agreements (for example, Convention on Biological Diversity) shape reef management? * How effective is the Coral Triangle Initiative in reef protection compared to policies for the GBR? * How do political decisions affect reef conservation efforts?   Sociocultural factors (Indigenous management, community involvement, cultural significance of reefs):   * How do Indigenous communities manage and protect reef ecosystems in the GBR/Coral Triangle? * What are the cultural connections between local communities and the reef? * How do community-based conservation efforts contribute to reef health? * What role does traditional knowledge play in reef management?   Highlight how to find reliable sources, assessing the credibility of information and citing their findings. Provide students a structured [note-taking](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/661?clearCache=b91ec4a5-84ba-208f-8c1d-cf6630bedceb) template for students to record their findings for each area. Check understanding and use guiding questions:   * What are the major differences between the economic roles of the GBR and the Coral Triangle? * How do political frameworks for reef management compare between the 2 regions? * In what ways do sociocultural influences on reef conservation differ and why?   Students individually write a comparative analysis on the differences and similarities in reef management between the GBR and Coral Triangle, focusing on economic, political and sociocultural factors. Provide possible options for questions:   * Assess which region has stronger political support for reef management. Justify your answer with examples. * Evaluate the economic activities in both regions that threaten or support reef conservation. * Analyse the ways Indigenous knowledge shapes reef management and how this influence can be enhanced.   **Differentiation and adjustments**  Introduce key terms like ‘ecosystem management’, ‘political influences’, ‘economic sustainability’, ‘Indigenous management’, ‘community conservation’ and ‘international agreements’. Provide an overview of ecosystem management principles and the challenges coral reefs face, using the GBR and the Coral Triangle as case studies. Show their geographical locations on a political map, highlighting their importance in reef management.  Offer structured note-taking templates and sentence starters to support students with research and allow collaboration in small groups or pairs. For additional support, provide a simplified research guide, [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) and sentence starters for articulating comparisons. Use small group discussions before class sharing, guiding students in a comparative analysis of GBR and Coral Triangle reef management focused on economic, political and sociocultural factors.  Provide writing templates, allow flexibility in submission formats and recap the importance of balancing economic, political and sociocultural factors in reef conservation. Use a [Think-Pair-Share](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/645?clearCache=fa0eeef8-8d26-3349-2301-99e4691bb7ef) and offer reflection prompts or visual aids, like a [Venn diagram](https://vizzlo.com/data-viz-guide/venn-diagram/what-is-a-venn-diagram), for comparing the regions. |  |
| **GE-12-04, GE-12-05 GE-12-09**  Students investigate TWO different types of ecosystems. They undertake a study to illustrate each type of ecosystem selected. At least ONE study is to be selected from outside Australia  For each study, students investigate:   * The role of contemporary research and innovation in the sustainable management of the ecosystem   **Geographical tools/skills**   * Diagrams and graphs * GIS, satellite imagery and remote sensing | Students complete a [KWLH chart](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/562?clearCache=2f3f40b0-5e3e-d1fa-4d84-3de0ec914cc3) and research the role of technological advancements, scientific research and innovations in managing the GBR ecosystems. Students to explore how these technologies are improving conservation, monitoring and restoration efforts.  Check prior knowledge and the potential focus areas for student research, such as:   * geospatial technology – the use of satellite imagery, GIS and remote sensing to monitor coral bleaching in the GBR * genetic research – advances in genetic techniques to improve species conservation, such as coral restoration * drone technology – drones are being used for mapping ecosystems, assessing reef health * agricultural research – innovations in sustainable farming practices to reduce or prevent agricultural runoff affecting the GBR * economics research – research into the economics of conservation, ecotourism and sustainable use of resources to fund management efforts.   Students select one area of technology, innovation or science and research its application in the management of the GBR. The research focus is on:   * how the technology or innovation is applied in ecosystem management * the benefits of using this technology for conservation, monitoring or restoration * any challenges or limitations of implementing this technology * case studies or real-world examples of the technology in action.   Provide students with access to credible sources, such as research papers, news articles or conservation organisation reports. Students prepare a presentation that includes:   * Introduction – briefly introduce the technology or research area they chose and why it is important for managing the GBR. * Application in ecosystem management – explain how the technology or research is being used to address specific environmental challenges. * Benefits and impact – outline the positive impacts of the technology on conservation or ecosystem restoration. * Challenges – highlight any limitations or challenges associated with the technology or innovation. * Conclusion – summarise why this technology is crucial for future ecosystem management efforts.   Students can use visuals such as diagrams, graphs and/or short videos to enhance their presentation. Students present their findings to the class and classmates take [notes](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/661?clearCache=b91ec4a5-84ba-208f-8c1d-cf6630bedceb) on the key points of each technology or research method. Students ask questions or provide feedback after each presentation, allowing a collaborative learning environment. Check understanding and ask:   * Which technologies or innovations seem to have the most significant potential for managing the GBR in the long term? * How might the use of these technologies evolve in the future to address climate change or other global environmental challenges? * What are the potential ethical or logistical challenges in implementing some of these technologies at a larger scale?   Check understanding about the importance of integrating technology, innovation and scientific research into ecosystem management. Highlight how each area plays a crucial role in addressing current challenges and improving the sustainability of the GBR ecosystems.  **Differentiation and adjustments**  Introduce key terms like ‘geospatial technology’, ‘genetic research’, ‘drone technology’, ‘sustainable agriculture’ and ‘economics research’. Explain how technological and scientific advancements support ecosystem conservation, monitoring and restoration, using the GBR as an example. Guide students through a [KWLH chart](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/562?clearCache=2f3f40b0-5e3e-d1fa-4d84-3de0ec914cc3) to organise knowledge and research goals related to these technologies in ecosystem management.  Provide sentence starters, guiding questions and curated resources to support students. Use examples, like satellite imagery and genetic research for coral restoration, to illustrate technology’s role in managing ecosystems. Allow students to work in pairs or small groups and offer structured note-taking templates for those who need help with research.  Guide students in choosing a focus area to research, explaining its role in managing the GBR. Provide a list of credible sources and pre-approved articles for those needing help with information gathering. Offer presentation templates and allow students to present in their preferred format (for example, PowerPoint, oral presentation, video). Encourage questions and feedback, using a [Think-Pair-Share](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/645?clearCache=116d40d7-5c55-20d-a8c8-7c09d18a91b3) to foster reflection and discussion. Provide prompts for students who prefer to reflect individually and allow flexible formats for submitting reflections (written, video, and so on). |  |

### Tropical Rainforest Heritage of Sumatra

Table 7 – investigation of ecosystems – Tropical Rainforest Heritage of Sumatra

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| --- | --- | --- |
| Outcomes and content | Teaching and learning activities | Registration and evaluation notes |
| GE-12-01, GE-12-07 GE-12-08 GE-12-09  Students investigate TWO different types of ecosystems. They undertake a study to illustrate each type of ecosystem selected. At least ONE study is to be selected from outside Australia.  For each study, students investigate:   * The characteristics of the ecosystem, including its spatial pattern and the nature of its biodiversity   Geographical tools/skills   * Graphs and statistics * Climate graphs * Satellite images * Spatial technologies * Flowline maps * Choropleth maps * Land use maps * Dot maps * Thematic maps | Conduct a [hook activity](https://www.nytimes.com/2021/11/08/learning/lesson-plans/18-warm-up-activities-to-engage-students-before-they-read-nonfiction-text.html) by viewing a short immersive video or virtual reality tour ([Google Earth](https://earth.google.com/web/@0,0,0a,22251752.77375655d,35y,0h,0t,0r/data=CgRCAggBQgIIAEoNCP___________wEQAA) VR, [Tropical rainforest of Sumatra in Indonesia (2:42)](https://www.youtube.com/watch?v=DccFPWSOqpI), [Sumatra Jungle tour (3:20)](https://www.youtube.com/watch?v=WQgKXFoK7BU)) of the Sumatran rainforest, showing its lush vegetation, diverse wildlife and unique ecosystems. Students to take [notes](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/661?clearCache=39fafb64-ef62-9639-44ff-17b571b093ab) on key features of the rainforest and identify the species they encounter during the tour.  Provide clues about an endangered species native to the TRHS (for example, Sumatran tiger, orangutan, rhinoceros) and have students guess the species based on the information provided [IUCN Red List](https://www.iucnredlist.org/). After revealing the species, discuss why it’s endangered and how its habitat plays a crucial role in its survival.  Students research the different biodiversity hotspots within the TRHS, focusing on endemic species (for example, Sumatran orangutans and tigers). Using a thematic map and dot map, they plot areas of high biodiversity and compare them with areas of human activity or deforestation. Complete Activity 14 in the resource booklet. Define key terms such as endemic species, biodiversity, deforestation and thematic maps. Provide examples of these terms in context and have students create a glossary in their notes.  Provide students with a list of endemic species in the TRHS, including Sumatran orangutans and tigers (see Activity 15). Assign groups to research different species. Each group will collect information on the habitat, population and threats to their assigned species, focusing on human impacts such as deforestation or illegal poaching. For more information access the [UNESCO TRHS](https://whc.unesco.org/en/list/1167/) and the [World danger list](https://whc.unesco.org/en/danger/) links. Encourage the use of reputable websites, such as the [WWF](https://www.worldwildlife.org/) or [IUCN Red List](https://www.iucnredlist.org/), to find data on species populations and threats.  Show students examples of thematic maps and dot maps and draw previous activities and prior knowledge. Explain how each map type is used to represent different data, such as biodiversity distribution and human activities. Students use their research to create thematic maps showing areas of high biodiversity within the TRHS. Using dot maps, they will plot locations of endemic species populations, noting areas of overlap with human activities like logging or agriculture.  Demonstrate how to use online tools like [ArcGIS Hub](https://hub.arcgis.com/datasets/37ea320eebb647c6838c23f72abae5ef_0/about) or [Google Earth](https://earth.google.com/web) to create maps. Once maps are created, students compare areas of high biodiversity with areas of human activity, identifying conflicts. Check understanding and ask guiding questions, ‘What patterns do you notice between biodiversity hotspots and human activities?’ ‘How might deforestation in these areas affect the survival of endemic species?’ Facilitate a class discussion where groups share their findings. Use student maps to highlight areas of concern and discuss potential conservation strategies. Students write a brief reflection on the impact of human activities on biodiversity in the TRHS, using evidence from their maps and research.  Explain the climatic characteristics of the TRHS, focusing on its tropical rainforest climate (high rainfall, consistent temperatures). In small groups, discuss how climate influences the distribution of species and ecosystems. Introduce the idea that certain species thrive in specific climatic conditions, like high humidity or consistent rainfall. Provide students with a glossary of key terms and have them add notes during the lesson. Provide students with online resources where they can collect climate data for the TRHS (for example, [World Weather Online](https://www.worldweatheronline.com/), [Climate-Data.org](https://en.climate-data.org/)).  Demonstrate how to find climate data on the chosen websites. Provide a template or table where students can record monthly data for both temperature and rainfall. Students compare the climate data they have collected with the distribution of species and ecosystems. Check for understanding and ask guiding questions, for example:   * How does the amount of rainfall relate to the presence of lowland rainforests versus montane forests? * What climatic factors might contribute to the distribution of species like the Sumatran orangutan and tiger?   Facilitate a discussion where students share their climate graphs and findings on species and ecosystem distribution. Ask guiding questions:   * What trends do you see between climatic conditions and species distribution? * How might changes in climate affect the biodiversity of the TRHS?   Use a [Clines and continuum](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/566?clearCache=db0832e0-8349-9c63-7a13-f5bbac681573) activity about the main land use changes in the TRHS, such as deforestation, agriculture and human settlement expansion. On the board, draw a horizontal line representing the continuum. Label one end of the line as ‘Natural rainforest’ (least human impact) and the other end as ‘High-impact human development’ (most human impact). Discuss what each point on the continuum could represent in terms of land use. For example, the middle might represent moderate agricultural activity. Ask students to brainstorm different forms of land use that fall between these 2 extremes. Use the 3 main land use changes: deforestation, agriculture and human settlement expansion.   * Position deforestation closer to the high-impact end, as it involves total removal of forest cover. * Position agriculture in the middle, as it varies depending on the intensity and type (for example, palm oil plantations closer to high impact, sustainable farming closer to natural rainforest). * Position human settlement expansion close to the high-impact end but with variations based on population density.   Students discuss in pairs or small groups the ecological, social and economic impacts of each type of land use change along the continuum. Consider impacts on:   * biodiversity (for example, deforestation causing loss of species) * soil and water quality (for example, agriculture leading to soil degradation) * community (for example, human settlement affecting indigenous populations).   Provide specific examples or case studies of these changes in the TRHS. Ask students to place them on the continuum.   * Example 1 – [Managing oil palm plantations sustainably](https://www.asianagri.com/en/business/plantations/) could be placed closer to the high-impact end. * Example 2 – [Selective logging](https://eos.com/blog/selective-logging/#:~:text=What%20Is%20Selective%20Cutting%3F,selective%20cutting%20has%20higher%20productivity.) might be placed closer to the middle, depending on the scale and methods used.   Students reflect on how these land use changes impact the sustainability of the TRHS. Students add another layer to the continuum, noting which changes are least sustainable and which are potentially more sustainable. Check understanding and ask how different types of land use changes impact on the TRHS. Guide students in considering the long-term implications of each change on the environment and human populations.  Complete a [Fact claim activity](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/664?clearCache=f12b4afe-d017-c4a3-23f3-9418714d951e) about how these changes affect ecosystems and biodiversity, particularly for large species like the Sumatran rhinoceros and elephants. Define key terms such as deforestation, land use maps, satellite images, biodiversity, human settlement and habitat fragmentation.  Provide the following links for students to access land use and satellite data:   * [Global Forest Watch](https://www.globalforestwatch.org/) – interactive maps showing global forest cover, deforestation rates and other land use changes * [FAO Land Use](https://landportal.org/book/dataset/fao-lu) – comprehensive data on global land use changes, including agriculture, urban development and deforestation.   Demonstrate how to navigate [Global Forest Watch](https://www.globalforestwatch.org/) and FAO Land Use data, guiding students to find relevant data on the TRHS. Explain how to interpret land use maps and satellite images to identify deforested areas and human settlements. Using the provided tools, students identify areas within the TRHS that have experienced significant deforestation. Students locate human settlements, agricultural areas and roads that might contribute to habitat fragmentation. Mark these areas on a map or create a screenshot to share with the class. Provide background information on how deforestation and habitat fragmentation affect species like the Sumatran rhinoceros and Sumatran elephants. Explain the concept of habitat loss and fragmentation as key threats to these species. Students will evaluate the impact of identified land use changes on biodiversity by comparing areas of deforestation and human settlement with the known habitats of endangered species. Check understanding and ask questions related to the areas students have identified as deforested or impacted by human settlement.   * How do these areas overlap with habitats for species like the Sumatran rhinoceros and elephants? * What impact do these land use changes have on these species? * How does deforestation in specific areas of the TRHS affect the movement and population of species, such as the Sumatran rhinoceros and elephants? * What roles do human settlements and agricultural expansion play in the fragmentation of habitats?   Students share their findings with the class, showing their maps or screenshots of deforestation and human settlement areas. Check understanding and ask questions:   * What trends do you observe in the patterns of deforestation and human settlement? * How might continued land use change affect the future survival of species like the Sumatran rhinoceros and elephants?   Students write short responses explaining the impact of land use changes on biodiversity within the TRHS, particularly focusing on large species like the Sumatran rhinoceros and elephants.  Students use a [Think-Pair-Share](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/645?clearCache=ed5d6caf-e46d-3b5f-d03a-f0aaa4b07814) about the importance of conservation zones in the TRHS and their role in protecting biodiversity. Define key terms of choropleth maps, biodiversity concentrations, conservation zones, human pressures, flowline maps and spatial patterns. Access [Biodiversity Hotspots](https://www.conservation.org/priorities/biodiversity-hotspots) to gather information on biodiversity concentrations within the TRHS. Guide students through the process of identifying biodiversity-rich regions and mapping them for further analysis.  Teach students how to interpret a flowline map to show human pressures, such as migration, transportation and logging routes that affect conservation zones. Display a flowline map indicating human activities and discuss how to interpret the impact of these flows on biodiversity-rich areas. Students use a choropleth map showing biodiversity concentrations (for example, deforestation or agricultural expansion). Using the data students collected from sources interpret choropleth maps that show biodiversity levels across the TRHS. Check understanding and ask guiding questions:   * Which areas of high biodiversity face the greatest human pressures? * Are there conservation zones in place to protect these high-biodiversity areas?   **Differentiation and adjustments**  Introduce key terms like ‘endemic species’, ‘biodiversity’, ‘deforestation’, ‘thematic maps’, ‘choropleth maps’, ‘flowline maps’ and ‘conservation zones’. Use real-world examples to show biodiversity’s importance and human threats in the TRHS, using visuals and maps to link biodiversity with human activities.  Begin with an engaging video or virtual tour of the Sumatran rainforest, providing clues for students to identify endangered species from the [IUCN Red List](https://www.iucnredlist.org/). Guide students in researching species, creating thematic and dot maps, and interpreting human impacts with tools like [ArcGIS Hub](https://hub.arcgis.com/datasets/37ea320eebb647c6838c23f72abae5ef_0/about) or [Google Earth](https://earth.google.com/web). Provide sentence starters, organisers, simplified readings and multiple formats for expressing findings.  Define terms such as ‘thematic maps’, ‘dot maps’, and ‘endemic species’. Assign groups to research a list of endemic species’ habitats, populations and threats. Introduce thematic and dot maps to represent biodiversity distribution and human activity, with examples and templates for support.  For understanding climate impacts, use peer collaboration, a pre-filled graph template and digital tools to interpret data. Define terms like ‘deforestation’, ‘land use maps’ and ‘habitat fragmentation’, guiding students through [Global Forest Watch](https://www.globalforestwatch.org/) and [FAO Land Use](https://landportal.org/book/dataset/fao-lu) data with structured worksheets and clear instructions. Allow collaborative mapping activities, partially completed templates and varied presentation formats.  Define ‘conservation zones’, ‘choropleth maps’ and ‘flowline maps’. Provide checklists, templates and peer support for map analysis. Recap key terms, including ‘biodiversity’, ‘human pressures’, and ‘conservation zones’. |  |
| GE-12-04, GE-12-05 GE-12-07, GE-12-09  Students investigate TWO different types of ecosystems. They undertake a study to illustrate each type of ecosystem selected. At least ONE study is to be selected from outside Australia.  For each study, students investigate:   * The dynamics of ecosystem functioning, including vulnerability, resilience and ecological disturbance   Geographical tools/skills   * Remote sensing and satellite imagery * Vertical and oblique aerial photographs * Satellite images * GIS tools * Thematic maps * Bar graphs and scatter plots | As a class, develop an [affinity diagram](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/576?clearCache=86d6dc71-7d45-74a-34d6-3b7453ebeb95) about the importance of analysing ecological disturbances like deforestation and climate change and their impact on ecosystem resilience and biodiversity. Provided is a step-by-step guide in Activity 16 in the resource booklet. Check understanding of vulnerability and resilience in ecosystems and its importance for sustainability. Provide students with data on deforestation rates and biodiversity loss from reputable sources such as, [World Bank Group – Forest area (% of land area)](https://data.worldbank.org/indicator/AG.LND.FRST.ZS) and [UN environment programme – UNEP and Biodiversity](https://www.unep.org/unep-and-biodiversity). Briefly show students how to access and download datasets.  Demonstrate how to create bar graphs that compare deforestation rates over time and across regions ([how to guide](https://support.microsoft.com/en-au/office/create-a-bar-chart-14832c6e-0a66-458d-82e2-7fd3bce4d05a)). Or explain how scatter graphs can show the correlation between deforestation and biodiversity loss, comparing different ecosystems. Students use Excel or [Google Sheets](https://app.education.nsw.gov.au/digital-learning-selector/LearningTool/Card/69?clearCache=c2a825d5-7c1-77c2-aeb2-9892ca9cb312) for graph creation/interpretation, demonstrate how to input data, select appropriate graph types and customise graphs for clear presentation.  Check understanding about how to interpret graphs and ask guiding questions:   * What patterns do they see in deforestation rates across different regions? * How does biodiversity loss correlate with deforestation? * What does the graph reveal about areas impacted by deforestation compared to climate change?   Students to analyse the vulnerability and resilience of ecosystems based on the trends shown in their graphs. Facilitate a discussion on the differences in resilience based on the type of ecological disturbance. Provide feedback on graphs and their interpretations.  Highlight examples of how GIS technology is used to map ecosystem resilience and disturbance. Check understanding of [ArcGIS Hub](https://hub.arcgis.com/datasets/37ea320eebb647c6838c23f72abae5ef_0/about) and [QGIS](https://www.qgis.org/en/site/) as tools for spatial analysis and visual representation. Explain how to access remote sensing data (for example, NASA, Copernicus or UNEP) to integrate into their GIS projects. Support students through uploading satellite images and remote sensing data into [ArcGIS Hub](https://hub.arcgis.com/datasets/37ea320eebb647c6838c23f72abae5ef_0/about) or [QGIS](https://www.qgis.org/en/site/).  Check prior knowledge and model how to add layers for different resilience factors (for example, biodiversity hotspots, forest cover). Highlight how to distinguish between resilient areas and disturbed zones using colour coding, shading and elevation features. Demonstrate how to customise maps by adjusting transparency, scale and viewpoints for clearer visual representation. Students use [ArcGIS Hub](https://hub.arcgis.com/datasets/37ea320eebb647c6838c23f72abae5ef_0/about) or [QGIS](https://www.qgis.org/en/site/) to interpret the 3D maps of a rainforest ecosystem, focusing on:   * mapping biodiversity, connectivity and forest density * integrating satellite imagery to identify resilient and disturbed areas.   Students show the relationships between vulnerability, resilience factors and disturbances, such as deforestation and land use changes. Students present their interpretation of the maps to the class, explaining how resilience factors are spatially distributed and what disturbances are present. Check understanding and ask about visual patterns and the implications for conservation and management strategies.  Explain how aerial and satellite photography can be used to study environmental changes, resilience and disturbances in rainforests. Show examples of vertical and oblique aerial photographs, highlighting how they capture different perspectives of the landscape. Check understanding of photo annotation, where students will identify specific features in the photographs such as, areas of disturbance (for example, logging, land clearing), areas of resilience (for example, forest regrowth, biodiversity hotspots). Provide step-by-step instructions on how to annotate photographs. Use tools like Google Drawings, Microsoft PowerPoint or printed photos with markers. Focus on labelling key features, providing a brief description for each annotation (for example, ‘disturbed area’, ‘clear evidence of logging’, or ‘resilient area’, ‘visible signs of regrowth’). Demonstrate how to compare their annotated photographs with satellite images and maps. Demonstrate how to access satellite images from sources like the [Rainforest Conservation Foundation](https://www.rainforestconservationfoundation.org/) and/or [World Resources Institute](https://www.wri.org/). Demonstrate how to overlay satellite data with maps to gain a better understanding of the landscape, identifying patterns of disturbance and resilience. Check understanding and ask questions about how to link specific features in photographs to broader spatial patterns (for example, how deforestation captured in a photo relates to regional satellite data).  Provide students with vertical and oblique aerial photographs of the TRHS. For example, [UNESCO World Heritage Convention – Tropical Rainforest Heritage of Sumatra](https://whc.unesco.org/en/list/1167/), [Google Earth](https://earth.google.com/web), [AirPano.](https://www.airpano.com/) Students annotate these photographs, identifying and labelling areas of resilience and disturbance. They then compare their findings with satellite images and maps from the Rainforest Conservation Fund or World Resources Institute, analysing spatial patterns. Check understanding by asking questions related to the correlations between visual data (aerial photos) and satellite images to form conclusions about the ecosystem’s health. Use a [gallery walk](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/555?clearCache=4d93ed7c-8006-107b-5ca7-1268e6d48388), to present students’ annotated photographs and check understanding about student’s analysis of resilience and disturbance in the rainforest. Students reflect on how combining different types of visual data provides a more comprehensive understanding of the ecosystem.  **Differentiation and adjustments**  Define key terms like ‘ecological disturbances’, ‘deforestation’, ‘biodiversity loss’, ‘resilience’, ‘vulnerability’, ‘GIS technology’, ‘remote sensing’ and ‘photo annotation’. Use real-world examples to illustrate how disturbances, such as deforestation and climate change, impact ecosystems and how resilience supports recovery. Highlight the role of data analysis and GIS technology in studying these effects.  Provide datasets on deforestation rates and biodiversity loss from sources like the World Bank and UNEP and demonstrate graph creation using Excel or [Google Sheets](https://app.education.nsw.gov.au/digital-learning-selector/LearningTool/Card/69?clearCache=488e58fe-802e-2490-5314-5f3b5bd836f). Guide students in using GIS tools ([ArcGIS Hub](https://hub.arcgis.com/datasets/37ea320eebb647c6838c23f72abae5ef_0/about) or [QGIS](https://www.qgis.org/en/site/)) to map ecosystem resilience and disturbances with remote sensing data.  Show vertical and oblique aerial photographs, explaining how to annotate them to identify resilient and disturbed areas. Offer structured worksheets or [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) for data analysis, graph creation and GIS mapping tasks, including simplified examples for additional support. Allow students to present their understanding through digital maps, posters or verbal presentations.  Define ‘scatter graphs’ and ‘bar graphs’, and explain the importance of analysing deforestation and biodiversity loss data for understanding ecosystem resilience. Provide pre-selected datasets and guided worksheets for those needing extra support.  Demonstrate how to create graphs in Excel or [Google Sheets](https://app.education.nsw.gov.au/digital-learning-selector/LearningTool/Card/69?clearCache=488e58fe-802e-2490-5314-5f3b5bd836f), guiding students in data input, graph selection and customisation. Introduce [ArcGIS Hub](https://hub.arcgis.com/datasets/37ea320eebb647c6838c23f72abae5ef_0/about) and [QGIS](https://www.qgis.org/en/site/) as spatial analysis tools, showing how to integrate remote sensing data from sources like NASA and Copernicus. Provide step-by-step guides for GIS use and offer simplified templates for beginners.  Define ‘vertical and oblique aerial photographs’, ‘photo annotation’ and ‘spatial patterns’. Show how aerial and satellite photography are used to study environmental changes, providing pre-selected photographs with highlighted features for annotation. Offer digital or printed photographs based on students’ preferences and technology availability. |  |
| GE-12-02, GE-12-03, GE-12-07 GE-12-08 GE-12-09  Students investigate TWO different types of ecosystems. They undertake a study to illustrate each type of ecosystem selected. At least ONE study is to be selected from outside Australia  For each study, students investigate:   * Human-induced modifications to the ecosystem   Geographical tools/skills   * Photographs and annotated visuals * Graphic organisers * Satellite images (overlay of satellite data on maps) * Relief maps * Land use maps * Historical and current maps * Bar graphs and scatter plots * GIS | Explain how different types of maps provide unique insights into spatial patterns of deforestation and land use changes, including showing the physical geography of the area, such as elevation and terrain, to highlight how topography might influence deforestation. Use [Global Forest Watch](https://www.globalforestwatch.org/) and [Resolve Ecoregions and Biomes](https://www.arcgis.com/home/item.html?id=37ea320eebb647c6838c23f72abae5ef) maps as tools for accessing deforestation data, human induced modifications and exploring ecoregions. Check understanding of how to use [ArcGIS Hub](https://hub.arcgis.com/datasets/37ea320eebb647c6838c23f72abae5ef_0/about) and using thematic maps that illustrate deforestation and land use changes. Demonstrate how to overlay satellite images on maps to gain real-time insights into land use changes and to analyse the spatial distribution of deforestation in relation to protected areas, biodiversity hotspots and human activities.  Students compare maps from different periods, identifying key areas where deforestation and land use changes are most significant. See Activity 17 in the resource booklet. Students should also note the spatial patterns that emerge (for example, deforestation near roads, in lowland areas or near human settlements). Students analyse the factors influencing deforestation patterns in Sumatra. In pairs, students answer the following questions:   * How does elevation (from relief maps) affect deforestation rates? * What is the relationship between proximity to human settlements or infrastructure (roads, cities) and deforestation? * Are there areas where deforestation is more intense or less prevalent? Why?   Students form into larger groups and expand their understanding by answering the following questions:  Initial exploration of maps   * What differences can you identify between historical and current maps of Sumatra in terms of forest cover? * How do different regions of Sumatra compare in terms of deforestation rates? * Which areas have seen the most significant land use changes over time? What might explain these changes?   Deforestation patterns   * How does the proximity to roads, cities or infrastructure correlate with the deforestation rate in different parts of Sumatra? * Do deforestation rates appear higher in lowland or highland areas? What might account for this pattern? * How does the deforestation near national parks or protected areas compare to other regions? Are these areas effectively preventing forest loss?   Land use and deforestation trends   * How has the expansion of agricultural land (for example, palm oil plantations) impacted deforestation patterns? * What roles do economic activities, such as logging or mining, play in driving land use changes? * Are there any observable patterns linking population density and the rate of deforestation in nearby areas?   Factors influencing deforestation   * How does elevation (shown in relief maps) affect the suitability of land for agriculture or urban development and how does this relate to deforestation? * Does deforestation tend to increase in regions closer to human settlements, or are there areas further from settlements that are also affected? What might explain this? * How do natural barriers (for example, rivers, mountains) affect the spatial distribution of deforestation in Sumatra?   Human-environmental interactions   * How do human activities contribute to the fragmentation of ecosystems, as shown on the land use maps? * What are the environmental consequences of the land use changes you identified (for example, loss of biodiversity, soil degradation)? * How might changes in land use affect the ability of the forest to provide ecosystem services (for example, carbon storage, water regulation)?   Using spatial technologies   * How does using [Global Forest Watch](https://www.globalforestwatch.org/) data enhance our understanding of deforestation patterns compared to simply observing maps? * What insights can be gained from combining multiple layers (for example, deforestation rates, land use and elevation) in the [ArcGIS Hub](https://hub.arcgis.com/datasets/37ea320eebb647c6838c23f72abae5ef_0/about)? * How does technology allow us to predict future deforestation trends or identify areas at risk of further land use changes?   Critical thinking and reflection   * What challenges or limitations did you encounter when analysing deforestation patterns using these maps and tools? * How do you think government policies or international agreements could influence the spatial patterns of deforestation you identified? * What solutions or strategies could be proposed to reduce deforestation in high-risk areas based on the trends and factors you’ve observed?   Students will organise their findings in a short report or [[graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e)](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=76e19c9a-e9c8-699-795a-5aa0a7eb213c), highlighting the spatial patterns they’ve identified and the possible causes behind these trends.  Guide students through using the stimulus resources to analyse the vulnerability of the TRHS. Students use the [Climate Graph for Jambi Province,](https://en.climate-data.org/asia/indonesia/jambi-1207/) focusing on temperature and precipitation trends in Jambi Province, which is part of the TRHS. Explain how changes in climate can affect biodiversity and forest health. Students use the Resolve Ecoregions and Biomes GIS and how this GIS tool highlights the various ecoregions within the TRHS, including areas of high biodiversity and regions under threat from human activities like deforestation.  Explain how the [IUCN Red List](https://www.iucnredlist.org/) categorises species found in the TRHS, identifying those that are vulnerable, endangered or critically endangered. Demonstrate how this tool monitors forest cover change, deforestation rates and human impacts, providing real-time data on forest health in Sumatra. Students use information from the provided resources to write a short report identifying the most vulnerable aspects of the TRHS and explaining why these areas or species are particularly at risk. Students to focus on:   * Climate vulnerability – by analysing the climate graph to determine how shifting temperatures or rainfall patterns affect the TRHS. * Biodiversity at risk – by using the [IUCN Red List](https://www.iucnredlist.org/) to identify species in the TRHS that are highly vulnerable and explain how habitat loss or climate change contribute to their status. * Ecosystem degradation – by using the Forest Watch Dashboard to show the extent of deforestation and human encroachment, explaining how this exacerbates the vulnerability of both species and habitats. * Ecoregion sensitivity – by using the Resolve Ecoregions and Biomes GIS to identify areas within the TRHS that are particularly fragile due to their unique biodiversity or ecosystem services.   Students present their findings to the class. Students to compare which aspects of the TRHS they found most vulnerable and why. Check understanding on how climate change, habitat loss and human activity intersect to create vulnerability in ecosystems like the TRHS and the importance of synthesising data from multiple resources to understand ecosystem vulnerability, using the TRHS as an example.  **Differentiation and adjustments**  Introduce key terms like ‘deforestation’, ‘land use changes’, ‘spatial patterns’, ‘elevation’, ‘biodiversity’, ‘protected areas’, ‘ecosystem services’ and ‘GIS (Geographic Information Systems)’. Explain how various maps – relief maps, thematic maps and satellite imagery – offer insights into deforestation and human activities.  Use visuals to illustrate how elevation and proximity to human settlements shape deforestation patterns. Demonstrate tools like [Global Forest Watch](https://www.globalforestwatch.org/) and the [Resolve Ecoregions and Biomes Map](https://www.arcgis.com/home/item.html?id=37ea320eebb647c6838c23f72abae5ef) for accessing real-time data on deforestation, biodiversity and human impacts. Show how to overlay satellite images with maps to analyse land use changes in Sumatra, focusing on roads, settlements and protected areas. Guide students in comparing maps from different time periods to identify deforestation trends.  Provide step-by-step instructions for using [ArcGIS Hub](https://hub.arcgis.com/datasets/37ea320eebb647c6838c23f72abae5ef_0/about) and other spatial tools and offer simplified maps and summaries for those needing extra support. Encourage students to collaborate in pairs or small groups to discuss and interpret maps.  Introduce map types, explaining their uses in representing elevation, deforestation and land use changes. Provide structured worksheets with guiding questions, [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) and annotated maps for students needing additional help. Offer sentence starters for discussing the effectiveness of protected areas and allow students to present findings in various formats, including digital presentations, posters or written reports.  Explain how to use data from climate graphs, the [IUCN Red List](https://www.iucnredlist.org/) and the [Resolve Ecoregions and Biomes Map](https://www.arcgis.com/home/item.html?id=37ea320eebb647c6838c23f72abae5ef) to assess ecosystem vulnerability in the TRHS. Provide report templates or [[graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e)](https://education.nsw.gov.au/teaching-and-learning/curriculum/pdhpe/child-protection-and-respectful-relationships-education/teaching-and-learning-resources/teaching-strategies/graphic-organiser) for structuring findings and simplified data sources for extra support. For those who prefer not to present verbally, allow digital or visual presentations.  Use a [Think-Pair-Share](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/645?clearCache=5a2f3fb-5749-f9c9-6a4c-5919c4d0bb6) to help students articulate their thoughts before class discussions, and provide reflection prompts to guide critical thinking. Allow students to express their reflections in various formats (written, verbal or visual). |  |
| GE-12-04, GE-12-05 GE-12-07 GE-12-09  Students investigate TWO different types of ecosystems. They undertake a study to illustrate each type of ecosystem selected. At least ONE study is to be selected from outside Australia  For each study, students investigate:   * Responses and strategies, including for maintaining ecosystem functioning and actions for sustainability   Geographical tools/skills   * Relief maps * Land use maps * Zoning maps * Choropleth maps * Satellite imagery (before-and-after satellite images) * Spatial technologies * Diagrams * Visual representation | Highlight the significance of the TRHS and the threats it faces, such as deforestation and farming. In groups or individually, complete a [Plus, Minus, Interesting](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/551?clearCache=15064dc-c834-f496-3b76-5640ea5e3e7) about how maps can provide valuable insights into the spatial patterns of human activity and conservation efforts. Check understanding of relief maps (which show elevation and physical terrain) and land use maps (which depict human uses of the land, like agriculture or conservation). Explain that these maps help identify how geography impacts conservation efforts. Provide students with pre-made relief and land use maps of Sumatra. Ask them to identify regions that are prone to human intervention (for example, lowland areas suitable for agriculture) and conservation areas (for example, higher elevations). See Activity 18 in the resource booklet. Guide students in discussing how topography (from the relief map) affects land use and conservation strategies. Encourage them to interpret why certain areas are more vulnerable to human activities and which regions are more likely to be conserved. Facilitate a class discussion where students share their interpretations. Ask guiding questions like:   * Why are some areas more likely to be deforested? * How does elevation impact conservation success?   Check understanding of maps and how colour gradients are used to represent the intensity of a particular variable, in this case, human-induced modifications like deforestation, logging and farming.  Using [Global Forest Watch](https://www.globalforestwatch.org), students access the website to explore maps that show deforestation rates and conservation zones. Provide students with existing choropleth maps of Sumatra, showing levels of deforestation and human activity. Check understanding and students interpretation of the intensity of human-induced modifications in different regions. Ask questions to guide student interpretation, for example, Which areas show the highest levels of human impact? How effective are protected areas in reducing human activity? Are there patterns where protected zones fail to prevent deforestation? Students share their interpretation in small groups. Facilitate a class discussion around the questions:   * How do zoning and conservation strategies appear to influence the spatial distribution of human impact? * Which areas of the TRHS are most at risk? * How effective are current conservation efforts in protecting biodiversity? * What strategies could improve the effectiveness of these conservation efforts?   Students develop a SWOT analysis of the responses and strategies, including for maintaining ecosystem functioning and actions for sustainability (TRHS). Provide an explanation of a [SWOT analysis template](https://www.canva.com/graphs/templates/swot-analysis/) as a tool to evaluate strategies and responses. Students complete Activity 19.  Use a [graphic organiser](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) (for example, a 4-quadrant table) to demonstrate how to organise the SWOT information clearly. Discuss how SWOT analysis can help assess the effectiveness of strategies for managing ecosystems at the TRHS. Check understanding and questions about specific actions being taken to maintain ecosystem functioning, such as, protected area management, sustainable logging practices, community-based conservation efforts, restoration of degraded lands. Divide the class into groups and assign each group a specific strategy or response related to TRHS, such as, Indigenous land management practices, sustainable agricultural practices, wildlife corridors and habitat restoration.  Discuss the importance of conservation strategies and the interconnectedness of conservation efforts, such as sustainable agriculture, reforestation and legal frameworks with ecosystem health. Explain that students will create visual representations, such as annotated diagrams and photographs, to explore the strategies employed to protect and sustain the rainforest ecosystem.  Check understanding of annotated diagrams, where students illustrate conservation strategies and provide explanatory notes. Students use diagrams to visually represent complex processes such as sustainable agriculture or reforestation. Students create an annotated diagram of key conservation strategies like sustainable agriculture, reforestation and community-based conservation efforts. For example:   * students illustrate how sustainable farming techniques reduce deforestation * how reforestation restores biodiversity * how local communities engage in conservation.   Students label important components of each strategy, such as the type of crops used in sustainable agriculture, the species reintroduced during reforestation or the roles of different stakeholders in community-based conservation. Students share their diagrams in small groups, comparing strategies and discussing their potential effectiveness in maintaining ecosystem functioning. Students include before-and-after satellite images to understand the effects of conservation strategies. Students use these images to show deforestation, degradation and restoration efforts over time, highlighting changes in biodiversity and ecosystem services.  Use [NASA Earth Data](https://earthdata.nasa.gov), [Sentinel Hub](https://www.sentinel-hub.com) and [National Geographic](https://www.nationalgeographic.com) for case studies. Students write a short response describing the key conservation strategies, reinforcing how each contributes to maintaining ecosystem functioning. Check understanding about the importance of using visual representations to understand and communicate complex ecological processes.  **Differentiation and adjustments**  Introduce key terms like ‘relief maps’, ‘land use maps’, ‘choropleth maps’, ‘SWOT analysis’, ‘sustainable agriculture’, ‘reforestation’, ‘community-based conservation’ and ‘ecosystem functioning’. Explain how different maps provide insights into the spatial distribution of human activity and conservation efforts in the TRHS.  Use visual aids to illustrate the impact of topography and human activity on ecosystem functioning. Guide students through a PMI activity to explore maps revealing spatial patterns. Provide pre-made relief and land use maps of Sumatra, asking students to identify regions of human intervention and conservation.  Introduce choropleth maps, explaining how colour gradients represent deforestation and farming intensity. Use [Global Forest Watch](https://www.globalforestwatch.org/) to explore deforestation rates and conservation zones. Offer sentence starters for the PMI activity to help students organise their thoughts, and simplified maps for those needing additional guidance.  Encourage collaboration in pairs or small groups for map analysis and SWOT analysis. Provide a partially completed PMI template for additional support, with sentence starters like ‘One benefit of using maps is …’. Allow students to work with [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) to record observations about human activities and conservation.  For choropleth maps, provide an annotated example. Use guiding questions with sentence starters like ‘The region with the highest human impact is …’. Offer a visual organiser for the SWOT analysis and provide sentence starters to help articulate each component, such as ‘One strength of reforestation is …’.  Demonstrate how to label key components on diagrams and provide partially completed diagrams for those needing extra help. Allow students to work in pairs or small groups to complete these. Provide sentence starters for short responses, like ‘One key conservation strategy is …’. |  |
| GE-12-04, GE-12-05 GE-12-09  Students investigate TWO different types of ecosystems. They undertake a study to illustrate each type of ecosystem selected. At least ONE study is to be selected from outside Australia  For each study, students investigate:   * Differences in ecosystem management, compared with at least one other location, due to economic, political and sociocultural factors   Geographical tools/skills   * Economic graphs and statistics * SWOT analysis and annotated diagrams * Political maps * Comparative tables * Fieldwork methods | Students create a table that lists 3 local, 3 national and 3 international strategies for managing the TRHS, along with the actors involved in each strategy. Categories for the table:  Local strategies:   * community-based conservation (for example, forest restoration programs run by local communities) * sustainable agriculture (for example, reducing illegal logging by offering alternative livelihoods) * ecotourism initiatives (for example, small-scale sustainable tourism to support conservation).   National strategies:   * Indonesia’s moratorium on deforestation (national government policy) * national park expansions and protected area designation * national reforestation programs led by the Indonesian government.   International strategies:   * UN REDD+ program (to reduce emissions from deforestation) * [UNESCO World Heritage Convention](https://whc.unesco.org/en/about/) management guidelines * International NGO support (for example, [WWF](https://www.worldwildlife.org/) conservation projects).   Students use columns in the table:   * strategy – the name or description of the strategy * stakeholders – the group, government or organisation responsible * scale – local, national or international * goal – the main objective of the strategy (for example, conservation, reducing deforestation, promoting sustainable livelihoods) * challenges – any known challenges or limitations of the strategy.   Have students write a short response identifying which strategies are the most effective for managing the TRHS. Students are to address the following points:   * Effectiveness – Which strategies have been the most successful in protecting the rainforest? Why? * Scalability – Are local strategies more effective because they are specific, or are national/international strategies more impactful due to resources and global influence? * Challenges – What are the main obstacles to the success of these strategies and how are they being addressed? * Long-term sustainability – Which strategies are likely to have the longest-lasting impact on preserving the TRHS?   Students compare and contrast the management of the TRHS with the Daintree Rainforest in Australia. The comparison should focus on strategies used to manage both ecosystems and how different actors (local, national and international) contribute to their conservation. Key comparison areas:   * Local management – compare how local communities are involved in conservation efforts in both rainforests. * National policies – contrast Indonesia’s national deforestation policies with Australia’s management of the Daintree through the Queensland government and national park systems. * International involvement – discuss the role of UNESCO in managing both sites, as well as any involvement from international NGOs (for example, [WWF](https://www.worldwildlife.org/), [IUCN](https://www.iucnredlist.org/)).   Check for understanding and ask questions for contrast:   * How do the threats facing the TRHS differ from those facing the Daintree? (For example, logging and agriculture in Sumatra versus tourism and invasive species in Australia.) * What role does climate change play in managing these rainforests and how do responses vary between Sumatra and Australia? * How does the political landscape affect the success of rainforest management in both countries? * Outline the most effective strategies for managing the TRHS and highlight key differences in how the Daintree and TRHS are managed.   Emphasise the importance of local, national and international collaboration in ensuring the survival of these critical ecosystems.  As a class, discuss the role of local communities, including Indigenous knowledge and their involvement in managing the forest. For example, agroforestry systems and how local people adapt land use to conserve forest resources. For the Daintree rainforest, highlight community involvement, especially through eco-tourism and conservation initiatives driven by local organisations. For example, Daintree Rainforest Foundation and other community-led projects. Check understanding and ask the following questions:   * How do local communities contribute to the conservation of the TRHS and Daintree Rainforest? * How does the level of community involvement differ between these 2 regions?   Students compare the economic influences on the management of the TRHS and the Daintree Rainforest, focusing on how economic activities drive both conservation efforts and threats. Provided are economic drivers:   * TRHS – key economic activities that affect the TRHS include logging, palm oil production and illegal wildlife trade. These industries are lucrative but contribute to deforestation and biodiversity loss. The economic incentives for local communities, companies and the government to exploit the rainforest resources. Students consider alternative economic approaches, such as eco-tourism or sustainable agroforestry, that might help protect the forest while still providing economic benefits. * Daintree Rainforest (Australia) – tourism is the largest economic driver in the Daintree, with eco-tourism serving as a major contributor to the local economy. The region attracts thousands of visitors who come for its natural beauty, contributing to conservation funding. Sustainable development and conservation tourism are actively promoted to reduce the environmental footprint while maximising economic benefits. The importance of the balance between tourism income and environmental preservation is managed.   Students develop an [infographic](https://www.canva.com/create/infographics/) comparing the economic influences on the management of the TRHS and the Daintree Rainforest, focusing on how economic activities drive both conservation efforts and threats.  Check understanding and ask the following questions:   * What are the main economic activities in the TRHS and Daintree Rainforest? * How do these economic activities threaten or support the conservation of these ecosystems? * How do alternative economic strategies (for example, eco-tourism, sustainable agriculture) differ between the 2 regions?   Economic impact of conservation:   * How do conservation efforts in the TRHS and Daintree create economic opportunities? * What funding models exist for promoting conservation in each rainforest and how effective are they in balancing economic growth and environmental sustainability? * What are the biggest economic threats facing each rainforest and how do these affect long-term sustainability? * How do economic pressures from industries like palm oil in Sumatra differ from the tourism industry in Australia?   **Differentiation and adjustments**  Introduce key terms like ‘local strategies’, ‘national strategies’, ‘international strategies’, ‘stakeholders’, ‘conservation’, ‘economic’ and ‘sustainable development’. Provide an overview of the TRHS and the Daintree Rainforest, focusing on their threats and management strategies.  Explain how local, national and international actors contribute to rainforest management and provide economic incentives for both exploitation and conservation. Provide a table for students to fill in 3 local, national and international strategies for managing the TRHS, including strategy name, stakeholders, scale, goal and challenges. Guide students in completing the table and comparing strategies between the TRHS and the Daintree Rainforest.  Offer sentence starters and guiding questions for support, along with [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) to help structure comparisons. Provide a partially completed table for additional assistance and use digital tools like [Google Sheets](https://app.education.nsw.gov.au/digital-learning-selector/LearningTool/Card/69?clearCache=545e24e0-ac0f-126d-6303-41f515cc7e) for collaborative work. Allow students to discuss ideas in pairs or small groups before writing responses.  Guide students in comparing the management of the TRHS with the Daintree Rainforest, using political maps and visual aids to highlight similarities and differences. Use [Venn diagrams](https://vizzlo.com/data-viz-guide/venn-diagram/what-is-a-venn-diagram) or other [graphic organisers](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/599?clearCache=48718462-c90c-56fe-bc7a-6cc899d1e) for visual comparisons and provide sentence starters for analysis.  Explore economic activities that drive conservation efforts and threats in both rainforests, using charts or tables to help organise thoughts. Provide examples and sentence starters for discussing economic influences and analyse how conservation creates economic opportunities in both regions, using visual aids like economic flow charts.  Recap the main threats and conservation strategies, emphasising the roles of local, national and international actors. Use a [Think-Pair-Share](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/645?clearCache=66722fd7-bdca-e5b-81ee-f7d55ad537bd) for reflection before class discussions and provide reflection prompts or sentence starters for those needing support in articulating their thoughts. |  |
| GE-12-04, GE-12-05 GE-12-09  Students investigate TWO different types of ecosystems. They undertake a study to illustrate each type of ecosystem selected. At least ONE study is to be selected from outside Australia.  For each study, students investigate:   * The role of contemporary research and innovation in the sustainable management of the ecosystem   Geographical tools/skills   * Diagrams and graphs * Visual data analysis (VDA) * GIS, satellite imagery and remote sensing | Students complete a [KWLH chart](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/562?clearCache=2f3f40b0-5e3e-d1fa-4d84-3de0ec914cc3) and research the role of technological advancements, scientific research and innovations in managing either the TRHS or GBR ecosystems. Their goal is to explore how these technologies are improving conservation, monitoring and restoration efforts. Check prior knowledge and the potential focus areas for student research, such as:   * geospatial technology – the use of satellite imagery, GIS and remote sensing to monitor deforestation in TRHS or coral bleaching in the GBR * genetic research – advances in genetic techniques to improve species conservation, such as coral restoration or biodiversity preservation in rainforests * drone technology – how drones are being used for mapping ecosystems, monitoring illegal logging or assessing reef health * agricultural research – innovations in sustainable farming practices to reduce deforestation near the TRHS or prevent agricultural runoff affecting the GBR * economics research – research into the economics of conservation, ecotourism and sustainable use of resources to fund management efforts.   Students select one area of technology, innovation or science and research its application in the management of either the TRHS or GBR. The research focus is on:   * how the technology or innovation is applied in ecosystem management * the benefits of using this technology for conservation, monitoring or restoration * any challenges or limitations of implementing this technology * case studies or real-world examples of the technology in action.   Provide students with access to credible sources, such as research papers, news articles or conservation organisation reports. Students prepare a presentation that includes:   * Introduction – briefly introduce the technology or research area they chose and why it is important for managing the TRHS or GBR. * Application in ecosystem management – explain how the technology or research is being used to address specific environmental challenges. * Benefits and impact – outline the positive impacts of the technology on conservation or ecosystem restoration. * Challenges – highlight any limitations or challenges associated with the technology. * Conclusion – summarise why this technology is crucial for future ecosystem management.   Students use visuals such as diagrams, graphs and/or short videos to enhance their presentation. Each student or group presents their findings to the class. As students present, all classmates take [notes](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/661?clearCache=b91ec4a5-84ba-208f-8c1d-cf6630bedceb) on the key points of each technology or research method.  Students ask questions or provide feedback after each presentation. Check understanding and ask the following questions:   * Which technologies or innovations seem to have the most significant potential for managing the TRHS or GBR in the long term? * How might the use of these technologies evolve in the future to address climate change or other global environmental challenges? * What are the potential ethical or logistical challenges in implementing some of these technologies at a larger scale?   Check understanding about the importance of integrating technology, innovation and scientific research into ecosystem management. Highlight how each area plays a crucial role in addressing current challenges and improving the sustainability of the TRHS and GBR ecosystems.  **Differentiation and adjustments**  Introduce key terms like ‘geospatial technology’, ‘genetic research’, ‘drone technology’, ‘sustainable agriculture’ and ‘economics research’. Explain how technology and scientific research aid in conserving and restoring ecosystems like the TRHS and the GBR. Guide students through a [KWLH chart](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/562?clearCache=2f3f40b0-5e3e-d1fa-4d84-3de0ec914cc3) to organise research goals related to these technologies.  Provide sentence starters, guiding questions and curated resources for support. Explain technology’s role in ecosystem management with examples like satellite imagery for deforestation and coral restoration via genetic research. Allow pair or group work for brainstorming and chart completion.  Offer a brief overview of each technology focus area and its applications in ecosystem management. Guide students in choosing one technology to research, using structured note-taking templates and a list of credible sources as needed. Provide presentation outlines and allow various presentation formats based on student strengths.  Encourage questions and feedback after each presentation. Use a [Think-Pair-Share](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/645?clearCache=66722fd7-bdca-e5b-81ee-f7d55ad537bd) for reflection, offering sentence starters and written prompts for individual processing. |  |

# Overall program evaluation

This section has been provided for teacher evaluation notes. [Evaluating teaching and learning programs for HSIE 7–12](https://education.nsw.gov.au/teaching-and-learning/curriculum/hsie/leading-hsie-k-12/leading-hsie-7-12/hsie-7-12-evaluating-teaching-and-learning-programs) provides advice to support this process.

Capturing student voice when evaluating a program

Student voice is useful in the evaluation process for programs. The statements below could be useful as a starting point when asking students to provide feedback on their learning experiences. These statements are derived from some of the themes from [What works best 2020 update](https://education.nsw.gov.au/about-us/education-data-and-research/cese/publications/research-reports/what-works-best-2020-update) (CESE 2020) and could be useful in teacher reflection on how these themes could be incorporated into a teaching program. The statements could also prompt student reflection on their metacognitive processes while learning.

**Please rate how much you agree with these statements:**

* My teacher had confidence that I could achieve and improve in my learning. (CESE 2020 Chapter 1: High expectations)
* I had a clear idea of what I was learning and why. (CESE 2020 Chapter 2: Explicit teaching)
* I used the feedback provided to improve my performance. (CESE 2020 Chapter 3: Effective feedback)
* I understood the feedback on the assessment task. (CESE 2020 Chapter 3: Effective feedback)
* I was able to predict the marks I achieved in the assessment tasks. (CESE 2020 Chapter 5: Assessment)
* The activities in the unit prepared me for the assessment task. (CESE 2020 Chapter 5: Assessment)
* I found the activities in the lessons interesting to me. (CESE 2020 Chapter 7: Wellbeing)
* I made valuable contributions to the class during this unit. (CESE 2020 Chapter 7: Wellbeing)
* I ask questions in class when I don’t understand yet. (CESE 2020 Chapter 7: Wellbeing)

**Optional open-ended prompts:**

* The lessons and/or activities that I most enjoyed were when we … because …
* When the learning was difficult, the strategy I used was …
* If I was giving advice to a student who was starting this unit I would tell them to …
* If I was giving advice to a teacher who was teaching this unit I would tell them to …

# Support and alignment

**Resource evaluation and support**: all curriculum resources are prepared through a rigorous process. Resources are periodically reviewed as part of our ongoing evaluation plan to ensure currency, relevance and effectiveness. For additional support or advice, or to provide feedback, contact the HSIE Curriculum team by emailing [HSIE@det.nsw.edu.au](mailto:HSIE@det.nsw.edu.au).

**Differentiation**: further advice to support Aboriginal and/or Torres Strait Islander students, EAL/D students, students with a disability and/or additional needs and High Potential and gifted students can be found on the [Planning, programming and assessing 7–12](https://education.nsw.gov.au/teaching-and-learning/curriculum/planning-programming-and-assessing-k-12/planning-programming-and-assessing-7-12) webpage. This includes the [Inclusion and differentiation advice 7–10](https://education.nsw.gov.au/teaching-and-learning/curriculum/planning-programming-and-assessing-k-12/planning-programming-and-assessing-7-12/inclusion-and-differentiation-advice-7-10) webpage.

**Assessment**: further advice to support formative assessment is available on the [Planning, programming and assessing 7–12](https://education.nsw.gov.au/teaching-and-learning/curriculum/planning-programming-and-assessing-k-12/planning-programming-and-assessing-7-12) webpage. This includes the [Classroom assessment advice 7–10](https://education.nsw.gov.au/teaching-and-learning/curriculum/planning-programming-and-assessing-k-12/planning-programming-and-assessing-7-12/classroom-assessment-advice-7-10-). For summative assessment tasks, the [Assessment task advice 7–10](https://education.nsw.gov.au/teaching-and-learning/curriculum/planning-programming-and-assessing-k-12/planning-programming-and-assessing-7-12/assessment-task-advice-7-10) webpage is available.

**Explicit teaching:** further advice to support explicit teaching is available on the [Explicit teaching](https://education.nsw.gov.au/teaching-and-learning/curriculum/explicit-teaching) webpage. This includes the CESE [Explicit teaching – Driving learning and engagement](https://education.nsw.gov.au/about-us/education-data-and-research/cese/publications/research-reports/what-works-best-2020-update/explicit-teaching-driving-learning-and-engagement) webpage.

**Alignment to system priorities and/or needs**: [School Excellence Policy](https://education.nsw.gov.au/policy-library/policies/pd-2016-0468), [Our Plan for NSW Public Education](https://education.nsw.gov.au/about-us/strategies-and-reports/plan-for-nsw-public-education).

**Alignment to the School Excellence Framework**: this resource supports the [School Excellence Framework](https://education.nsw.gov.au/inside-the-department/directory-a-z/strategic-school-improvement/school-excellence-framework) elements of curriculum (curriculum provision) and effective classroom practice (lesson planning, explicit teaching).

**Alignment to Australian Professional Teaching Standards**: this resource supports teachers to address [Australian Professional Teaching Standards](https://educationstandards.nsw.edu.au/wps/portal/nesa/teacher-accreditation/meeting-requirements/the-standards/proficient-teacher) 3.2.2, 3.3.2.

**Consulted with**: Curriculum and Reform, Inclusive Education, Multicultural Education, Aboriginal Outcomes and Partnerships and subject matter experts.

**NSW syllabus**: Geography 11–12

**Syllabus outcomes**: GE-12-01, GE-12-02, GE-12-03, GE-12-04, GE-12-05, GE-12-06, GE-12-07, GE-12-08, GE-12-09

**Author**: Curriculum Secondary Learners

**Publisher:** State of NSW, Department of Education

**Resource:** Learning program

**Related resources**: further resources to support geography 11–12 can be found on the [Planning, programming and assessing geography 11–12](https://education.nsw.gov.au/teaching-and-learning/curriculum/hsie/planning-programming-and-assessing-hsie-11-12/planning-programming-assessing-geography-11-12) webpage.

**Professional learning**: relevant professional learning is available through MyPL and the HSIE statewide staffroom.

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# References

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