Studying Mesophotic Reefs in SA Teaching Notes

Overview

Nestled in the twilight zone of the ocean, mesophotic reefs present a mysterious and less explored realm between the well-lit shallow waters and the dark abysses. These unique ecosystems, found at depths of 30 to 150 metres, are treasure troves of biodiversity, hosting an array of life forms adapted to low-light conditions. In this lesson, designed for Year 6 science students in South Australia, we delve into the captivating world of mesophotic reefs, focusing particularly on the temperate reefs along the Great Southern Reef.

Leveraging the cutting-edge technology of Baited Remote Underwater Video Systems (BRUVS), students will get an up-close look at the mesophotic zones' inhabitants through recently captured video footage. This immersive experience brings South Australia's mesophotic reefs to life and underscores the importance of these ecosystems in the broader marine landscape.

This resource is designed to be used alongside the new BRUVS sharks and rays resource as well as marine park teacher resources (year 5-6) and (year 7-10).

Resource Summary

Background

Mesophotic (Greek for middle light) reefs occur around the world and sit in the middle layer between the sunlit, shallower photic zone and the deep, dark parts of the ocean, where sunlight can't reach. Sitting between 30 to 150 metres depth, between the very different shallow and deep areas of the ocean, they provide an important link and a transition zone- stepping stones between these. Mesophotic reefs are fascinating environments that provide a unique habitat for a diverse range of marine life making them an important part of the ocean ecosystem.

In Australia, both tropical/coral mesophotic reefs and temperate mesophotic reefs exist. Along the Great Southern Reef, these reefs are mainly temperate. In South Australia, we only have temperate mesophotic reefs. On these reefs, filter feeders such as sponges, sea fans, and other suspension feeders play an important role in the ecosystem by filtering small particles out of the water, such as plankton or detritus. Filter feeders are particularly well-suited to living in areas with low food availability and low light because they are able to extract nutrition from the surrounding water.

Mesophotic reefs can also support a variety of unusual and rare species that are not found in shallower waters, such as deep-sea sharks, rays, and other fish that have adapted to living in low light conditions. Some mesophotic reefs may also support species that are new to science, as these reefs are still relatively unexplored and understudied.

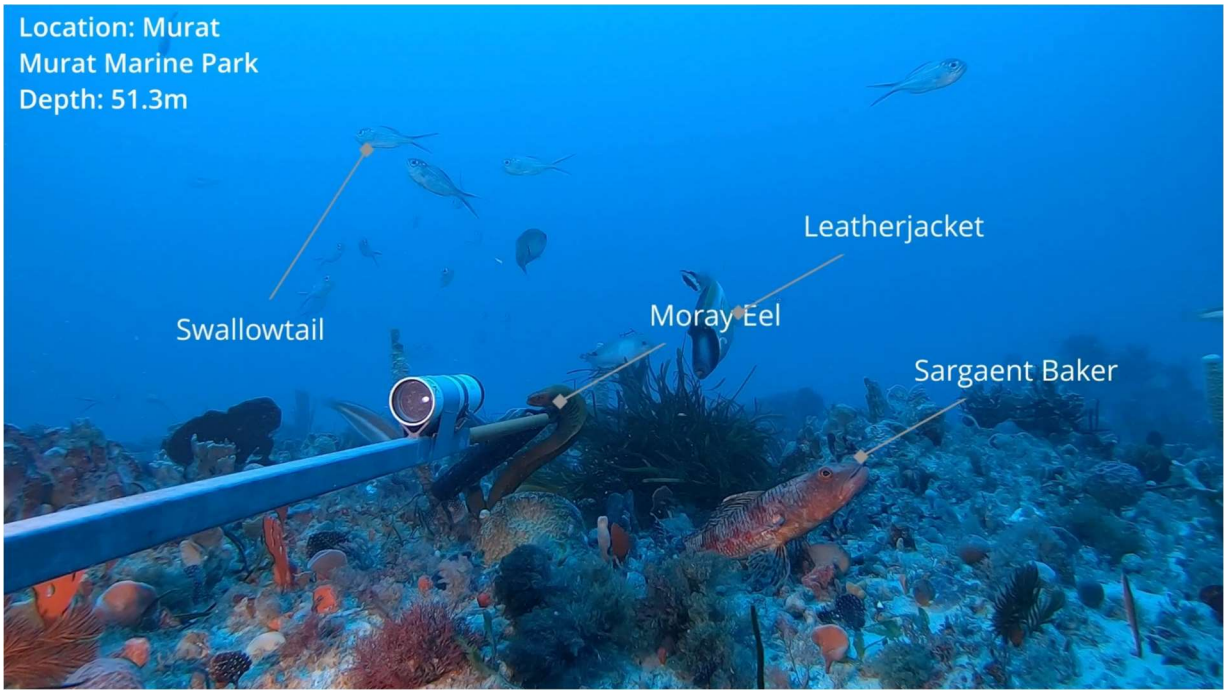
Mesophotic reefs are a relatively new area of study, as their depth makes them harder to explore. However, recent advances in technology and research have helped scientists learn more about these unique ecosystems.

Despite their deep location, mesophotic reefs are critical to the health of our oceans. As ocean temperatures rise, some species may be forced to migrate to cooler waters, while others may not be able to adapt quickly enough and could face extinction. Water temperatures on mesophotic reefs are more stable than in shallow waters, which may help protect species from extreme temperature changes associated with climate change. As a result, some species may be able to use mesophotic reefs as a refuge to avoid the negative effects of warming surface waters.

Protecting and managing mesophotic reefs is critical for the long-term survival of these ecosystems and the many species that depend on them. By understanding them more we can help better protect our unique marine life.

In South Australia, we are only just beginning to explore these understudied habitats. In a South Australian first, researchers from the Department for Environment and Water in South Australia have been deploying baited remote

underwater video systems (BRUVS) to capture footage of temperate mesophotic reefs throughout South Australia in both Commonwealth Marine Parks and State Marine Parks.



This resource is designed to involve minimal preparation time and to be easily implementable and provides links to a 4 minute video which showcases recently captured BRUVS footage. The video can be used to introduce the lesson and associated activities. Within these teacher notes you will find all the relevant background information, presentation slides, curriculum links, learning intentions, success criteria, student worksheets and suggested answers.

Teaching Sequence

This resource could be implemented over a a single lesson or up to several weeks worth of lesson time. It is suggested that this resource is used as a tool as a part of a unit on the Great Southern Reef and/or South Australian Marine Parks. You will find links to other complementary resources at the bottom of the teacher notes.

Ocean Literacy Principle Focus

Ocean Literacy Principle #7: The ocean is largely unexplored.

Learning Intentions

Students will...

- Understand the unique environmental conditions of mesophotic reefs and how they differ from shallower reef ecosystems.
- Explore the specific adaptations of sponges and soft corals that enable their survival in low-light, mesophotic conditions.
- Utilise digital tools to effectively communicate scientific information about the adaptations of mesophotic reef organisms.
- Evaluate the ecological significance of sponges and soft corals within the broader context of mesophotic reef ecosystems and their conservation.

- Analyse the benefits and limitations of baited Remote Underwater Video Systems (BRUVS) for conducting surveys on marine life, understanding how technological advancements contribute to marine science.
- Apply scientific inquiry skills to design a hypothetical research expedition, focusing on mesophotic reefs using BRUVS technology to gather data.

Success Criteria

Students can...

- Accurately describe the characteristics of mesophotic reefs, including depth, light availability, and temperature, and explain how these conditions influence the resident organisms.
- Identify and explain the key adaptations of sponges and other species that allow them to live in mesophotic reefs, such as their feeding mechanisms, symbiotic relationships, and structural features.
- Create a clear, informative digital presentation that showcases the adaptations of sponges and other species, using appropriate images, videos, and bullet points to enhance understanding.
- Articulate the importance of mesophotic reefs, and discuss potential conservation strategies to protect these ecosystems.
- Describe the functionality of BRUVS and articulate its advantages and drawbacks in marine research, demonstrating an understanding of its role in collecting non-intrusive marine data.
- Differentiate between mesophotic reefs and shallow rocky reefs in terms of depth, light availability, temperature, habitat types, and biodiversity, using appropriate scientific terminology.
- Construct a detailed plan for a research expedition to a mesophotic reef, including objectives, methods (using BRUVS), and expected outcomes, showcasing their ability to apply scientific inquiry processes.

V9 Australian Curriculum Links

Key science concept: Interdependence and ecosystems 1.

Year 6 - Science Understanding - Biological Sciences **- AC9S6U01-** Investigate the physical conditions of a habitat and analyse how the growth and survival of living things is affected by changing physical conditions.

(Physical condition of habitat – including human activity, salinity, sunlight, temperature, environmental conditions can affects growth and survival of plants and animals in different stages of life, make predictions about impact of changes upon animals)

Year 6 - Science as a human endeavour - Nature and Development of Science - **AC9S6H01** examine why advances in science are often the result of collaboration or build on the work of others.

Year 6 - Science as a human endeavour - Use and Influence of Science - **AC9S6H02** Investigate how scientific knowledge is used by individuals and communities to identify problems, consider responses and make decisions.

Year 6 - Science Inquiry - Questioning and Predicting - **AC9S6I01** - Pose investigable questions to identify patterns and test relationships and make reasoned predictions

Year 6 - Science Inquiry - Processing, Modelling and Analysing **- AC9S6I04** - construct and use appropriate representations, including tables, graphs and visual or physical models, to organise and process data and information and describe patterns, trends and relationships

Starter

Mystery Image: Begin with a captivating image from the mesophotic reef (without revealing what it is) and have students guess what and where it might be. This sparks curiosity and sets the stage for the topic.

Intro for Students

Did you know that there is an underwater world that is hidden from our view, but is home to many fascinating creatures and plants? These are called mesophotic (middle light) reefs, and they are found between the sunlit, shallower photic zone and the deep, dark parts of the ocean, where sunlight can't reach.

Unlike the shallow coral and temperate reefs that you may have seen before, mesophotic reefs are found in depths of around 30 to 150 metres, which is about as deep as a football field is long! This makes them harder to explore, but they are still an important part of the ocean ecosystem.

In fact, mesophotic reefs are sometimes called "twilight zones" because they are just below the sunlit surface and have a dim, dusky light that makes it seem like the sun is always setting. Despite the lack of sunlight, these reefs are still able to support a diverse range of marine life, including colourful corals, fish, and other creatures.

So, get ready to dive deep and learn more about these amazing mesophotic reefs!

Activity 1 - Characteristics of Mesophotic Reefs

Interactive Discussion:

Initiate the activity with a guided discussion that encourages students to share any prior knowledge or assumptions about oceanic zones and reef ecosystems. Use probing questions like, "What do you think life would be like in a place with little to no sunlight?" or "How do organisms adapt to extreme conditions?"

Introduce the concept of **ecological niches** and discuss how different species in mesophotic reefs have adapted to their specific niche, emphasizing adaptations to low light and pressure.

Comparative Analysis:

Provide students with side-by-side images or videos of mesophotic reefs and shallow reefs. Ask them to note differences in colour, species, and apparent activity levels, leading to a discussion on the importance of light in marine ecosystems.

Incorporate a hands-on comparison by using different types of lighting (e.g., bright vs. dim) over a model reef (this could be a simple classroom setup with various objects representing reef life) to simulate the light availability in mesophotic vs. shallow reefs and observe how it might affect visibility and possibly behaviour.

Case Studies

Play video - Mesophotic reefs

Introduce the term **mesophotic** to the class.

Activity 2 - Recognising a Reef

Divide students into groups and assign each group a comparison point (e.g., Depth, Sunlight, Temperature).

Each group researches their assigned point, using both the introductory materials and additional resources provided (include specific resource link here). Allow students to re-watch the video at their own pace or use the video transcript to help find the answers.

Groups then present their findings to the class, creating a comprehensive comparison table on a shared document or classroom board.

Discuss the characteristics of mesophotic reefs compared to shallow reefs, focusing on depth, light availability, temperature, and habitat types, aligning with the curriculum's emphasis on physical conditions of habitats.

	Mesophotic Reefs	**Shallow Rocky Reefs**
Depth	> 30 metres	< 30 metres
Sunlight	Low	High
Temperature	Uniform	Fluctuates
Habitat	Soft corals, sponges, filter feeders	Kelp, seaweeds
Biodiversity	High	High
Primary Production	Low	High
Energy Source	Filter feeders, photosynthesis (less so due to light availability but can – decreases with depth and water clarity), predation	Filter, photosynthesis, predation
Predators	Sharks, deep-sea fish	Larger fish, sharks, marine mammals
Threats	Climate change – sea level rise, acidification, heating, overfishing, microplastics.	Climate change, pollution, overfishing, large plastic.

Wrap up the activity by discussing the importance of understanding these differences for conservation efforts and how this knowledge can help protect these vital ecosystems.

Activity 3 - Mesophotic Adaptations

The primary species that dominate mesophotic reefs are filter feeding sponges and soft corals.

In this activity students will watch a video, utilise digital presentation tools to showcase the unique adaptations of these fascinating organisms in mesophotic reefs, and focus on how these adaptations enable survival in low-light conditions.

Discuss the concept of adaptation in biology – how organisms evolve features that are conducive or enable them to survive and thrive in their specific habitats. Next students watch the following video and take notes to assist with their presentations. Encourage students to take notes on key adaptation features and interesting facts about sponges.

Watch: The Mysterious Realm of Deep Sea Sponges

Students will create digital slideshows using tools like Google Slides or PowerPoint to create digital presentations highlighting the unique adaptations of soft corals and sponges living in mesophotic reefs, enabling them to thrive in low-light conditions. Presentations could incorporate images, videos, and bullet points to present their findings.

If time permits, or as an extension - students may be given the opportunity to choose another species from the mesophotic reefs video to investigate their adaptations and add to their presentation. Other species from the video include: moray eel, leatherjacket, sergeant baker, swallowtail, queen snapper, Port Jackson shark, harlequinfish and yellowtail kingfish.

Provide time for students to research their chosen organism, focusing on how it has adapted to the low-light conditions of mesophotic reefs. Ensure students have access to reliable sources of information. Encourage creativity in their presentation design but remind them that clarity and accuracy of information are important factors to consider.

Activity 4 - BRUVS - benefits and limitations

Students will understand the advantages and disadvantages of using Baited Remote Underwater Video Systems (BRUVS) in marine research through an interactive card sorting and ranking activity.

Pre-Activity Preparation:

Print and Prepare Cards: Ensure each card is clearly printed and, if possible, laminated for durability. Cards should be large enough for the text to be easily read by students when placed on a table or floor.
Setup Space: Arrange the classroom tables or designate floor areas for the card sorting activity. Each group will need enough space to spread out their cards and discuss among themselves.

Explain the activity, stating that each group will sort and then rank cards based on what they think are the most significant benefits and limitations of BRUVS.

Divide the class into small groups of 3-4 students. Distribute a set of benefit and limitation cards to each group.

Instruct groups to sort their cards into two categories: Benefits and Limitations.

Encourage discussion within groups about each card as they sort them, facilitating understanding and engagement.

Once sorted, ask each group to rank the cards in each category from most significant (top) to least significant (bottom).

Invite each group to present their top-ranked benefit and limitation, explaining their choices.

Benefit Cards	Limitation Cards
Non-Intrusive Observation	Limited View
Reaches Deep Waters	Misses Some Creatures
Safe for Researchers	Depends on Clear Water
Discovers Rarely Seen Creatures	Lots of Footage to Watch
Long-Term Watch	Can Get Lost or Stuck
Shows Real Behaviors	Affected by Weather and Currents
Helps Protect Oceans	Limited by Battery Life
Captures Lots of Data	High Costs
Easy to Use Many	Technical Problems
Inspires Curiosity	Data Overload

Extension:
Students will deepen their understanding of marine research methodologies by creating their own cards that explore the benefits and limitations of scuba diver surveys, another popular methodology for capturing data underwater - but in shallower environments.

Allow students time to research the benefits and limitations of scuba diver surveys. They can use classroom resources or, if appropriate, conduct supervised internet research.

Each student or pair creates their own set of cards, with at least 3 benefit cards and 3 limitation cards related to scuba diver surveys.

On one side of the card, students write the title (e.g., "Direct Interaction with Marine Life") and on the other side, a brief explanation or an illustrative drawing.

Discuss the differences and similarities between scuba diver surveys and BRUVS, emphasizing how different methods can complement each other in marine research.

Below are some examples of benefits and limitations

Benefits:

- Direct Observation: Provides immediate, firsthand observation of marine environments.
- Detailed Sampling: Enables precise collection of samples and data.
- High-resolution Photography: Allows for close-up, detailed images.
- Habitat Assessment: Offers insights into the health and composition of marine habitats.
- Immediate Data Verification: Divers can verify and validate data in real-time.
- Non-invasive Methods: Potential for low-impact research techniques.
- Us of standard boating equipment

Limitations:

- Depth Restrictions: Limited to relatively shallow depths due to safety concerns.
- Time Underwater: Dive time is limited by air supply and decompression limits.
- Physical Risks: Potential health risks associated with diving.
- Environmental Impact: Physical presence can inadvertently disturb habitats.
- Weather Dependency: Adverse weather can delay or restrict diving activities.
- Limited Coverage: Can only survey small areas at a time.
- Diver Skill Variability: Data quality can vary based on diver expertise and experience.
- Equipment Dependency: Relies heavily on diving and survey equipment.
- Data Subjectivity: Observations can be influenced by diver perceptions.
- Cost and Logistics: Organizing dive missions can be costly and complex – larger boats that require infrastructure to launch BRUVs etc

Activity 5- Designing a Mesophotic Reef Study

In groups, students plan a hypothetical research expedition to a temperate mesophotic reef using BRUVS. They'll consider factors like depth, location, target species, and what they hope to discover, incorporating digital tools for research and planning. This activity integrates digital literacy, collaborative skills, and applies the scientific inquiry process, from posing questions to predicting outcomes and planning data collection methods.

Encourage students to use Seamap Australia to turn on layers such as water depth etc. Have students explore the tools to work out which layers will be most useful to help them find mesophotic reefs. The box MERI ecosystem depth contours is a good one if they are stuck.

Students can learn their new knowledge about BRUVS, SCUBA surveys and mesophotic reefs in this suggested linked resource: Marine parks- National Parks and Wildlife Service South Australia. In this resource students will design a scientific technique to monitor or survey animals, plants and the environment in South Australia's marine parks.

Activity 6 - Mesophotic Reef Poster

Students will use this Temperate Reef Poster for inspiration to design their own poster to raise awareness to mesophotic reefs.

Encourage students to brainstorm ideas for their posters. What messages do they want to convey? What do you want people to 'think, feel and do'? What images or facts will best communicate the importance of protecting these reefs?

Students begin designing and creating their posters. They should aim to include: Illustrations of temperate reef biodiversity (e.g., macroalgae, fish, invertebrates). Facts about the uniqueness and ecological significance of these ecosystems. A clear conservation message, urging the protection of mesophotic reefs.

Digital Posters: For a tech-integrated approach, students could create digital posters using software like Canva or Adobe Spark

Allow students to present their posters to the class, explaining their design choices and the messages they hope to convey.

Glossary

- **Baited Remote Underwater Video Systems (BRUVS):** A research tool used to record marine life in their natural habitat by attracting them with bait placed in front of a remotely operated camera.
- **Biodiversity:** The variety of life in a particular habitat or ecosystem.
- **Conservation:** The protection, preservation, management, or restoration of wildlife and natural resources such as forests and water.
- **Climate Change:** A change in global or regional climate patterns, often attributed to increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.
- **Commonwealth Marine Parks:** Protected areas in Australia's ocean territory, managed by the Australian government to conserve marine biodiversity.
- **Detritus**: Waste or debris of any kind, including dead particles of organic material found in the water which can be a food source for many marine organisms.
- **Ecological Niche:** The role and position a species has in its environment; how it meets its needs for food and shelter, how it survives, and how it reproduces.
- **Ecosystem:** A biological community of interacting organisms and their physical environment.
- **Filter Feeders:** Marine animals that feed by straining suspended matter and food particles from water, typically using specialized filtering structures.
- **Habitat**: The natural environment where an organism lives, which provides the necessary conditions for its survival, growth, and reproduction.
- **Mesophotic Reefs:** Deep water reefs located between 30 to 150 metres depth, where light starts to fade. These reefs are a mix of light and shadow, supporting unique marine life.
- **Photic Zone:** The upper layer of the ocean that receives plenty of sunlight, allowing photosynthesis to occur.
- **Plankton**: Small and microscopic organisms drifting or floating in the sea or fresh water, consisting chiefly of diatoms, protozoans, small crustaceans, and the eggs and larval stages of larger animals.
- **State Marine Parks:** Marine areas protected and managed by individual Australian states, aiming to conserve local marine ecosystems and biodiversity.
- **Refugia:** Safe havens where species can find refuge from unfavourable environmental conditions, such as extreme temperatures or predators.
- **Suspension Feeders:** Organisms that feed by removing suspended matter from the water, typically small organisms or particles.
- **Temperate Reefs:** Rocky reefs found in temperate zones, supporting diverse ecosystems, dominated by kelp forests and other seaweeds.

Additional Links

- BRUVS resource and videos - Sharks & rays
- Video: Mesophotic Reef Surveys of Kangaroo Island
- Poster: Marine Park Monitoring and Research Methods
- Article: Mapping the life mesophotic
- Report: South Australian collaborative monitoring and research expedition 2018