Introducing the chapter

CHAPTER HOOKS

- Watch the National Oceans Office sea floor video Available from www.oceans.gov.au
- View the Classroom Video DVD on *Seas of Life*
- Read *the beginning of life - another view* on page 27 and invite an Aboriginal elder to class to discuss the significance of the *Rainbow Serpent* and local aboriginal marine stories in class.
- Discuss the implications of The Law of the Sea convention and the Timor Sea (read page 13).
- Begin Exercise 1.1 — *A matter of time*
- Try the Wet Paper Teachers Web Page activities - *Ocean Shapes and Make a sea mount* (see page 9).

WHY STUDY THIS CHAPTER

Plate tectonics helps us understand the shape of our coastline and lays the foundation for the chapters on coastlines and oceans.

It is also important for us to understand the significance of the Rainbow Serpent in Aboriginal culture.

Exciting new discoveries are being made by the Commonwealth Scientific and Industrial Research Organisation — CSIRO. These are essential if we are to claim our nationals Exclusive Economic Zone as discussed on page 13.

A knowledge of our ocean's topography also has enormous military significance. Deep oceans trenches near East Timor make it possible for submarines to travel between the Pacific and Indian Oceans.

CHAPTER OVERVIEW

KEY CONCEPTS

1. Scientists believe the earth was formed by the dust cloud hypothesis and that it is over 3,000 million years old.
2. Aboriginal people believe the earth was formed by the Rainbow Serpent who made laws for all animals to obey. She created humans from those who obeyed these laws and gave them the land and seas to manage.
3. The oceans lie on a thin layer of crust which is subject to enormous forces from within the earth.
4. The crust of the earth has different densities and can move around causing earthquakes and volcanoes. Earthquakes and volcanoes are caused by moving plates on the earth.
5. Australia was once part of a huge super continent which drifted apart due to plate movements.

   About 200 million years ago Australia was part of a super-continent called Pangaea.

   Pangaea broke up into two continents Laurasia and Gondwanaland.

   Laurasia was made up of North America and Asia, Gondwanaland comprised South America, Africa, India, Australia and Antarctica.
6. There are no lions and tigers in Australia because Gondwanaland split up before they had evolved.
7. Marine dinosaurs existed in Queensland because it was once a shallow inland sea.
8. Our coastline was given its unique features based on this movement. Some examples of this are:
   - Western Australia is flat and geologically very old.
   - The Great Australian Bight was formed as we split from Antarctica.
   - The East coast has the great dividing range with fast flowing rivers creating huge volumes of sand.
   - The tropical reefs have only formed in recent times and are a thin veneer on ancient reefs.
9. Modern oceanographic methods have established that the sea floor has mountains, plains, valleys and hills on a much grander scale that on land.
10. Using computer technology and advanced echo sounding, Australian marine scientists have began to map our oceans with a high degree of accuracy.

Essential references

Law of the Sea

Teacher Notes by Cindy Hann, Geoscience Australia, GPO Box 378, Canberra, ACT, 2601.

Classroom Video

www.classroomvideo.com.au

Foreword

In 1978, a Commonwealth Grant for $15,000 was given to establish the Gladstone Oceanographic Studies Program in Queensland. About the same time a similar grant was given to establish a Marine Studies Centre from an old scallop shed at Woodbridge Tasmania.

The idea of the innovative grants scheme was to light a spark in the imagination of young minds.

30 years later, Australian teachers and their students have a textbook in Marine Science and Marine Education Centres in every Australian State.

There are also tertiary courses to support higher levels of knowledge and skills needed for those planning careers in marine related fields.

The subject is supported by an excellent base of marine education associations and peak bodies (see Appendix 8) and with the impact of climate change on our world the time has come to place the Marine Science firmly in the Australian curriculum.

In thanking all those who have made this book possible, (please see page 4 and appendix 8), I would like to pay tribute to the dedication of the marine teaching profession and their sponsors – especially those who were the first to tackle the subject in their school and become involved in their subject associations.

Generations of students to come will benefit from their vision and hard work.

Bob Moffatt
Wet Paper Publications

January 2009

About the authors

Bob Moffatt

Bob Moffatt (BSc, Dip Ed, Grad Dip Ed Admin) is a marine educationalist and publisher. Formally attached to Education Queensland, Bob is best know for his tireless work in marine biology and education. Head of Wet Paper Publications which he founded in 1987, he is an active surfer. A former consultant to UNESCO, the Great Barrier Reef Marine Park Authority, Local and State Government he now is an active member of the Marine Teachers Association of Queensland and Surfrider Foundation.

Leon Zann

Leon Zann (BSc (Hons 1) PhD) is a marine environmental scientist and manager. He has wide experience in Australia and the Pacific Islands, and has worked at James Cook University, the Great Barrier Reef Marine Park Authority, University of the South Pacific in Fiji, and United Nations Food and Agriculture Organisation (Fisheries).

He compiled the first State of the Marine Environment Report for Australia (SOMER) and is now Professor of Environmental Management at Southern Cross University.

Tim Ryan

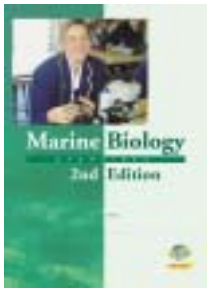
Tim Ryan (B. App. Sc, Dip. Ed.) is a highly experienced educator, educational consultant and author with wide-ranging experience in marine education and curriculum design. He has taught in Queensland State High schools for over 30 years and has been at the forefront of curriculum design and implementation in his present role of Educational Adviser (Curriculum). He has authored and co-authored text books in the marine area and produced supporting materials for use in classrooms across Australia using up to date research and the latest in educational pedagogy.

Contents

Illustration Sharyn Madder

Marine Science text and exercise books match

The following is a match between exercises found in our Marine Biology and Oceanography exercise books and Chapters 1 - 15 of this textbook.



Marine Biology Exercises Book

Chapter 8 Classification and marine biodiversity

C1. What lives in the tree of marine life?
C2. How are sharks and rays classified?
C3. Why do we need a system to classify marine life?
C4. What is the definition of a species?
C5. How are new species discovered?
C6. How are identification keys made and used?
C7. What structural characteristics separate out the Marine phyla?

Chapter 9 Marine Plants I

A13. How can I get fish poisoning?
A6. Where do mangroves and seagrasses live?
B2. What do phytoplankton do in the photic zone?
B4. What is a red tide?

Chapter 10 Marine Plants II

A1. What do mangroves look like?
A2. Which animals use mangroves for shelter?
A3. How do mangroves grow?
A4. How do mangroves reproduce?
A5. Which animals use seagrasses for shelter?
A7. What is a marine habitat?
A8. What lives in estuarine habitats?
A9. How do mangroves overcome salt and lack of air?
A10. How can we identify mangroves?
A11. What other links are there between the sea and mangroves?
A14. Why are mangroves and seagrasses important?

Chapter 11 Marine Invertebrates I

B3. What lives in the intertidal zone of an exposed shore?
B5. How do corals feed and reproduce?
B6. What is coral bleaching?
B7. How do molluscs feed, breathe and kill?*
E5. Can you dissect a squid?

Chapter 12 Marine Invertebrates II

B2. What are copepods?
B8. What's so unusual about spiky skinned animals?
E3. External features of a crayfish

Chapter 13 Marine Vertebrates I

C2. How are sharks and rays classified?
B10. How do turtles feed and reproduce?
B11. How do sharks move?
D7. How do sharks navigate and locate their prey?
E1. External features of a bony fish
E2. A sea mullet dissection

Chapter 14 Marine Vertebrates II

B9. Can you prepare some answers to whale questions asked by tourists?
B10. How do turtles feed and reproduce?
D2. How do sea birds survive?

Chapter 15 How they survive

D1. Why do we study the biotic and abiotic environments?
D2. How do sea birds survive?
D3. How do animals use structural adaptations to survive?
D4. How do animals use physiological adaptations to survive?
D5. How do animals in the intertidal zone survive and reproduce?
D6. How do animals use behavioural adaptations?
D8. How do abiotic and biotic factors affect life on a rocky shore?
D9. What is the difference between producers, scavengers and predators?
D11. What are three types of symbiotic relationships?

Chapter 16 Ecosystems

D10. What is the difference between a food chain and a food web?
D12. What is the difference between an ecosystem and a community?
D13. What is marine biodiversity?

Oceanography Exercises Book

Chapter 1 Ocean and coastline formation

A1. What does the topography of the ocean look like?
A2. What part of the world oceans does Australia own?
A3. What major geological movements have occurred in Australia?
A4. What happened in ice age Australia?

Chapter 2 Oceans and waves

A5. What is climate change and how does it affect the ocean?
A13. What causes Tsunamis?
B1. What are some characteristics of waves?
B2. How fast do waves travel?
B3. How does weather affect waves?
B6. Why do tides change over the month?
B17. Can we make a model to identify coastal ecosystems?
B18. Can we use a template to show wave refraction?

Chapter 3 Currents and weather

A6. How do ocean currents form?
A7. How does the El Niño current affect thermoclines in the sea?
A8. What effect does El Niño cause?
A9. What is so special about the EAC?
A10. What is so special about the Leeuwin current?
A11. When do Australian ocean sea temperatures change?
B4. What happens when currents approach a shore?

Chapter 4 Coastlines

B5. How is sand made and transported in a coastal system?
B7. What happens to waves as they approach a beach?
B8. How does sand get onto a beach?
B9. What are sand dunes and how are they made?
B10. Can we classify sand grain sizes found on a beach?
B11. Can we determine the percentage composition of sand on a beach?
B12. How do you draw a beach profile?
B13. How do the dune cycles occur?

Chapter 5 Coastal engineering

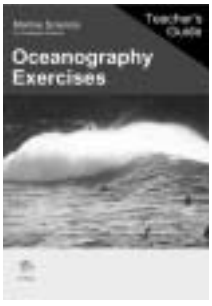
B14. What happens when the dune cycle is broken?
B15. When is beach nourishment a solution to coastal management?

Chapter 6 Seawater

C2. How much salt is in seawater?
C3. Can we make and establish a test for seawater?
C4. Can we determine how much oxygen there is in seawater?

Chapter 7 Marine pollution

C1. How much plastic pollution is there in the sea?



C5. What effect does marine pollution have on dolphins?
C6. Why is DDT a problem in the marine food chain?
C7. What are some of our seas contaminated with?
C8. What effect does oil have on feathers?
C9. What happens in an oil spill?
C10. What impact do acid sulfate soils have on the sea?
C11. What effect does water quality have on the marine environment?
C12. How can impacts of coastal development be minimised?

Chapter 8 Classification and marine biodiversity

A12. How is marine life in Australia governed by ocean temperature?

See page 435 for latest on Australia's seabed claim

The law of the sea

A knowledge of subsurface geology of the continental slope allows us to claim the resources of our continent under the 1982 international Law of the Sea Convention (UNCLOS).

Continental margin

Article 76.3 of this convention states that '*the continental margin comprises the submerged prolongation of the land mass of the coastal State, and consists of the sea-bed and sub soil of the shelf the slope and the rise.*

It does not include the deep ocean floor with its oceanic ridges or subsoil thereof'.

Figure 9.1 identifies the edge of the rise as the approximate area that Australia can claim but there is a continent - ocean transition region that extends from the edge of the rise to the foot of the slope.

The sediment aprons often cover this area making it difficult to accurately define our border with say Indonesia or New Zealand.

The subsurface geology in this area was created by plate tectonics when two continents rift apart.

In the process, the continental crust was thinned and stretched and magma created underground sills or lava flows over Australia's ancient surface.

Why study plate tectonics

The reason you are going to study plate tectonics is so that you can understand the need to:

- appreciate the difficulty in mapping our continent's borders;
- identify what undersea resources Australia can claim as its own; and
- prepare management plans for these resources by implementing our Oceans Policy, marine parks and protected areas.

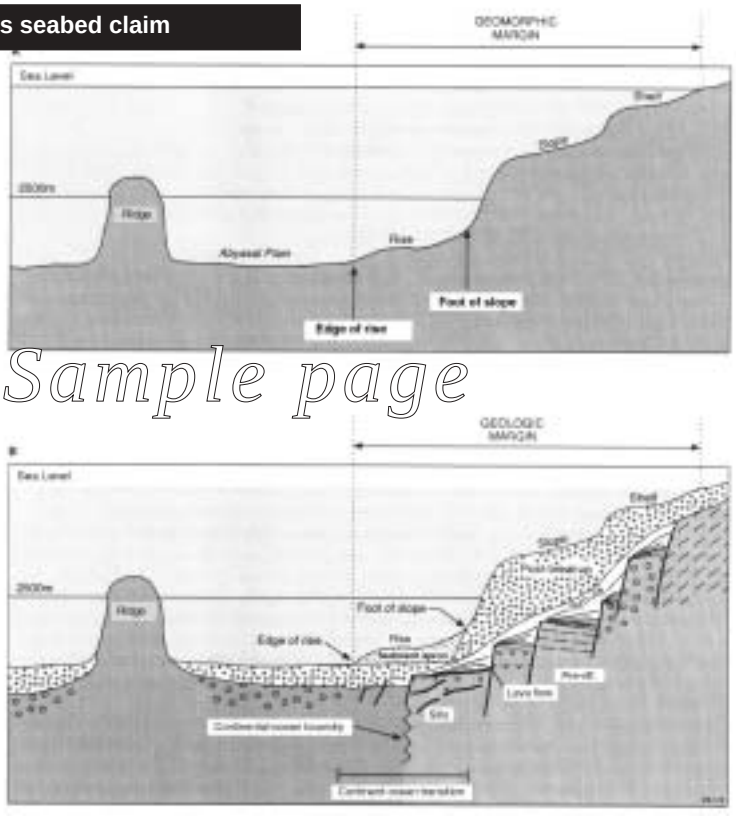


Figure 9.1 Effect of complex sub surface geology on application of UNCLOS in areas of extended continental shelf

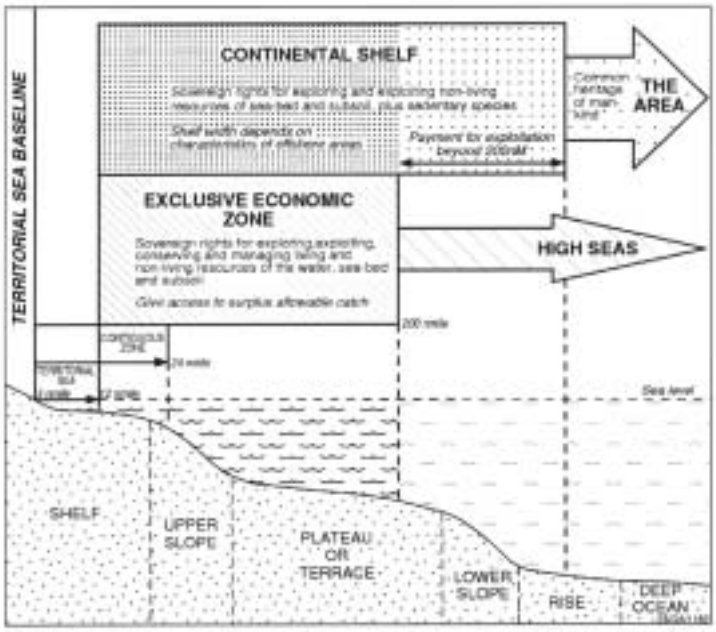


Figure 9.2 Maritime jurisdictional zones based on the United Nations Convention on the Law of the Sea 1982 (UNCLOS), linked to sea floor topography

Read more at www.ga.gov.au/news/archive/2008/april

Case study 1.1 Submarine canyons off southeast Australia

Figure 10.1 Ms Andrea Leach (PhD student) examining a sea floor map of the survey area to select suitable coring targets, *RV Franklin*.
(Photo courtesy Prof. Jock Keene, University of Sydney)

This article reproduced from CSIRO with permission

In 2001, CSIRO-run research vessel *Franklin*, a national facility, completed a geoscience research expedition off Tasmania. Chief Scientist, Dr Neville Exon of Geoscience Australia, the national geological survey organisation, said "We carried out seismic profiling east of Tasmania and sea bed sampling in three different areas, each addressing different research questions.

The **seismic profiles** revealed a cross-section through the Earth's crust several kilometres thick, and the cores and dredges gave information about various aspects of the geological history of offshore Australia as far back as the Age of Dinosaurs, seventy million years ago."

Among the data brought back by the expedition for further study were 1300 kilometres of seismic profiles, 30 samples of surface sediments, 25 cores of the strata just below the sea bed, and 10 dredges of ancient rocks.

Of the eastern offshore margin of Tasmania Dr Exon said "This poorly known part of Australia extends 100 kilometres offshore with its outer limit 4500 metres deep, and is one-third the size of Tasmania. The margin supports a fishing industry and has some potential for petroleum, but our main aim was to better define its nature and its history since this part of Gondwana broke up 85 million years ago.

The Lord Howe Rise, now a sunken ridge extending from Lord Howe Island to New Zealand, was dry land east of Australia including Tasmania until it was rifted off. The cruise results show that, although the margin subsided steadily after its separation from the Lord Howe Rise, it was not covered by the thick blanket of younger sediment present on most of the world's margins. In fact, the submarine landscape sloping down to the abyssal plain would not be very different to that on dry land in Gondwana when the dinosaurs roamed the land," said Dr Exon.

Figure 10.2 Launching a one tonne corer from the stern of RV Franklin.
(Photo courtesy Prof. Jock Keene, University of Sydney)

"The granites, basalts, metamorphic rocks and sandstones familiar to many east coast Tasmanian are right there at the sea bed. Much of the sediment coming from the land has cut underwater canyons on its path to the abyssal plain, but some has been trapped in sedimentary basins that could have produced hydrocarbon deposits."

Of the cruise as a whole, CSIRO's on-board cruise manager Ron Plaschke said "This was my first geoscience research cruise and I was very pleased that we managed to get so much good work done. For me a highlight was the deployment of a one-tonne piston corer with a ten metre long sampling pipe from *Franklin* (Figure 10.2). I'll long remember the delighted smiles on the faces of the scientists when eight metres of Bass Lake sediments were cut up on deck. I understand that many thousands of years of climate change will be revealed by the core." Preliminary results were published by Geoscience Australia in 2002.

QUESTIONS/RESEARCH

1. Describe what happened in this article.
2. Explain the terms *Gondwana, abyssal plain, metamorphic rock, hydrocarbon deposit, seismic profile.*
3. Examine illustration 13.1B on page 13. Now redraw the illustration and shade in where the *RV Franklin* probably was when seismic profiling was done.
4. How far does the eastern offshore margin of Tasmania extend?
5. Explain what type of data could be derived from the deployment of a one-tonne piston corer with a ten metre long sampling pipe.

Exercises

From the Wet Paper Publication - *Oceanography Exercises See www.wetpaper.com.au*

A1. What does the topography of the ocean look like?

A2. What part of the world oceans does Australia own?

A3. What major geological movements have occurred in Australia?

A4. What happened in ice age Australia?

A5. What is climate change and how does it affect the ocean?

Questions

Knowledge

1. Who proposed the theory of continental drift? List some of the evidence to support the idea of continental drift.
2. What was the name given to the super continent when it was believed all continents were joined together?
3. When and where did ancient large marine reptiles inhabit Australia?
4. List the world leading techniques being developed by the CSIRO to rapidly assess sea bed environments.
5. What happens when the plate has a weak spot on it?
6. How fast is the Australia plate moving and in which direction are we moving?
7. Define the following terms: subduction, earthquakes, transverse faults.

Understanding

8. What are land bridges and how have they affected the distribution of animal species? Why did they not affect the distribution of plant species?
9. Draw a diagram of Australia 220 mya showing its nearest neighbours.
10. Describe the dust cloud hypothesis.
11. There are many marine fossils and coal deposits in Queensland. Suggest an explanation to account for their presence.
12. Draw a cross-section through oceanic crust to distinguish between oceanic and continental crust.
13. Explain how modern day reefs came to be in northern Australia.
14. Explain how the ocean plates are thought to move. How do mid ocean ridges form? Describe the age of rocks found at the midocean ridges.
15. Draw a diagram to explain the formation of volcanic island chains that are found in the Pacific Ocean.
16. Describe the Rainbow Serpent story and its significance for Aboriginal people.

Applying

17. Fossils of tropical plant species have also been found in the Antarctic. How do you explain the presence of these fossils?
18. Explain the glacial evidence that supports the idea of continental drift.
19. Use your knowledge of plate movements to explain the formation of the Great Dividing Range and the Kimberleys in WA.
20. Summarise the benefits of mapping Australia's ocean territory.

Analysing

21. How can the discovery of mineral nodules on the ocean floor demonstrate that the sea floor is spreading?
22. Suggest why earthquakes occur more frequently in Los Angeles than in Sydney.
23. Similar fossils are found in Australia, South America and South Africa. Suggest what this may indicate.
24. Many mineral resources are being found in undersea surveys. Outline some of the problems that might surface in developing deep ocean mining. Suggest some environmental problems that deep sea mining might cause. Do you believe off-shore oil resources, if found around the Australian coastline should be exploited?

Creating

25. Compose a rap, poem or rhyme to illustrate the difference between an earthquake and a volcanic eruption in terms of plate subduction.
26. Build a model to explain the difference between mountain building and ocean building plates.

Evaluating

27. Research earthquakes in newspaper cuttings. Can you relate these to plate movements?
28. Extrapolate the question "What studies are necessary for environmental monitoring to ensure that marine industries develop sustainably?"
29. Outline the reasons why the deep sea environments should be protected. Who should be in charge of the policing of this protection? Suggest some policies that should be included in this protection document.
30. Outline the reasons for the need to study plate tectonics and the Law of the Sea declaration.

Student projects, assignments, activities

Over 140 activities to download free using these details

www.wetpaper.com.au/teacher

Oceanography

Ch 1 Ocean and coastline formation
- *Make a seamount*
- *Ocean shapes*

Ch 2 Oceans and waves
- *Longshore drift field work*
- *Longshore drift lab work*
- *Point break*
- *Wave fetch*
- *Waves and beaches*

Ch 3 Currents and weather
- *Australian and NZ currents*
- *Local currents*
- *Ocean currents*

Ch 4 Coastlines
- *Active beach systems*
- *Beach profiles*
- *Beach sediment movement*
- *Beaches test*
- *Coastline models*
- *Erosion essay*
- *Hypothetical Bay*
- *Hypothetical Reef*
- *Sand composition*

Ch 5 Coastal engineering
- *Make a beach walkway*
- *Sand bypassing systems*

Ch 6 Sea water
- *Buoyancy*
- *Density*
- *Dissolved oxygen*
- *Field equipment*
- *Salinity*
- *Viscosity*

Ch 7 Marine pollution
- *Oil spill*
- *Ballast water problems*
- *DDT in the food chain*
- *Metal pollution*
- *Oil on feathers*
- *Oil pollution*
- *Starfish pest study in Hypothetical Bay*

Marine Biology

Ch 8 Classification and biodiversity
- *Fish classification*
- *Mangroves & estuaries*
- *Research questions*
- *Sea weed classification*
- *Tree of marine life*

Ch 9 Marine plants (1)
- *Algae*
- *Key terms*
- *Make a plankton net*
- *Phytoplankton*
- *Plankton 3 level guide*
- *Plankton local area*

Marine Biology (cond't)

Ch 10 Marine plants (2)
- *Importance of mangroves*
- *Mangrove activity ideas*
- *Mangrove crossword*
- *Mangrove keys*
- *Mangrove life cycles*
- *Mangrove projects*
- *Mangrove role play*
- *Mangrove transect*
- *Pressing seaweeds*
- *Sand dune plants*
- *Seagrasses and seaweeds*

Ch 11 Marine Invertebrates (1)
- *Anemones and corals*
- *Barnacles*
- *Cephalopods*
- *Corals*
- *Gastropods*
- *Invertebrate adaptations*
- *Life cycles*
- *Sponges*

Ch 12 Marine Invertebrates (2)
- *Aquaculture farming*
- *Aquaculture projects*
- *Aquaculture research questions*
- *Artemia*
- *Crabs*
- *Echinoderms*
- *Prawn dissection*
- *Red claw farm excursion*
- *Underwater slate*

Ch 13 Marine Vertebrates (1)
- *Fibreglass fish*
- *Fish adaptations*
- *Fish classification key*
- *Fish dissection*
- *Fish streamlining*
- *Sharks and rays worksheet*
- *Water balance in fish*

Ch 14 Marine Vertebrates (2)
- *Adaptations in vertebrates*
- *Mammals worksheet*
- *Sea birds worksheet*
- *Turtles worksheet*

Ch 15 How they survive
- *Associations*
- *Osmosis in fish*
- *Rocky shore habitats*
- *Rocky shore life*
- *Sampling methods*

Ch 16 Ecosystems
- *Drawing food chains*
- *Food chains*
- *Marine ecosystems*
- *Rocky shore ecosystem study*
- *Sampling methods*

Management and Conservation

Ch 17 Problems in our seas
- *Oil and gas*
- *Orange roughy*
- *Riparian habitat assessment*
- *Shipping*
- *Sourcing litter pollution*
- *Territorial waters*
- *Trade waste*
- *Water velocity catchments*

Ch 18 Sustainable use of the sea
- *Adopt an NGO*
- *Are Marine Protected Areas necessary?*
- *Attitudes and values*
- *Conservation principles*
- *Dilemma exercise*
- *Ecological sustainable development*
- *Ecotourism survey*
- *Government management strategies*
- *Is tourism good for the community??*
- *Local management issues*
- *Marpol*
- *Multiple use*
- *Sea rights*

Ch 19 Biodiversity and Marine Life
- *Conflicts*
- *Dilemma exercise*
- *Future problem solving*
- *Tweed river walls*
- *Venetian Island*
- *Writing a newspaper article*

Ch 20 Fisheries Biology
- *Abalone stock*
- *Adopt a ship*
- *At the fish shop*
- *Commercial fishing game*
- *Locations of Australian fisheries*
- *Orange roughy*
- *Prawn fishery economics*
- *South east fishery*

Ch 21 Aquaculture
- *Aquaculture fish requirements*
- *Aquaculture research*
- *Live fish exports*
- *What type of farm for me?*

Ch 22 Marine Parks
- *Best environmental practices*
- *Drain stencilling*
- *Ecotourism*
- *Hypothetical bay 2020*
- *Management proposals*
- *Managers and user groups*
- *Traditional management methods*
- *Whale Bay game*