CIEE Perth, Australia

Course name:	Marine Biology and Ecology of Western Australia
Course number:	BIOL 3002 FREO/ECOL 3001 FREO
Programs offering course:	Summer Tropical Marine Ecology
Language of instruction:	English
U.S. Semester Credits:	3
Contact Hours:	45
Term:	Summer 2020

Ningaloo, Western Australia Photo credit: Alicia Sutton

Course Description

The marine environment of Western Australia is known as a biodiversity hotspot with species of fish, invertebrates and other organisms not found anywhere else in the world. This course is intended to provide some of the ways in which the properties of the oceans affect marine organisms. It also introduces coral reefs and other marine ecosystems, together with their productivity, biological

oceanography, the reproductive biology of marine organisms, and marine biological resources. The course provides an opportunity to study tropical marine biology and ecology in a coral reef setting. It provides an introduction to Western Australian biogeography and habitats, covering topics in oceanography, and biology and ecology of marine plants and animals. Human impacts and conservation of tropical marine environments will be addressed. The practical elements will provide the core skills and techniques that will equip students to perform field studies in marine biology. The unit will introduce appropriate methodologies for the collection, handling and analysis of data; the scientific principles underlying experimental design; and the effective communication of scientific information.

This course will be conducted in Perth and Fremantle with Fieldwork and practical exercises at Ningaloo Marine Park. Ningaloo Marine Park contains one of the largest fringing reefs in the world and a natural centerpiece of the wonderful complexity and beauty of Western Australian marine life. The field period provides training and experience in field techniques. Students will be collecting data of direct benefit to the management of the Ningaloo Marine Park.

Learning Objectives

On successful completion of this marine component of the CIEE Biology and Ecology Field Studies course, students should be able to:

1. Describe the key physical and chemical aspects of the marine environment and their role in influencing marine organisms and marine communities
2. Describe the physical processes that characterize the WA marine environment
3. Explain the key ecological processes that occur in WA marine ecosystems
4. List the plants and animals that dominate the tropical marine environment of Western Australia
5. Understand marine experimental design concepts and benthic ecology field methodologies

Course Prerequisites

This unit is aimed at students majoring in wildlife biology, biology, zoology, conservation, or other natural resource programs.

- Overall GPS 2.75
- 2 semesters of college-level biology required
- Upper-level coursework in ecology and/or zoology recommended

Methods of Instruction

This course covers the following topics:

- Introduction to marine biology and ecology, marine life, marine environments and oceanography
- Introduction to the marine environment off Western Australian

- Tropical marine habitats off Western Australia
- Tropical marine biodiversity off Western Australia
- Tropical marine ecological processes off Western Australia
- Human impacts and management
- Experimental research and data analysis

This course comprises approximately 30 hours of class. This includes lectures and video material along with additional presentations during the fieldwork. There are also a number of workshops, activities and field trips included covering a range of topics and activities such as field sampling, and a visit to the WA Aquarium. These sessions have been scheduled, with the aim of encouraging further discussion of material covered in lectures. Lectures and workshops will be interspersed with an intensive field-based research project. Students will work in groups to undertake their field-based research; however project reports will be written up individually. During our stay at Coral Bay, a presentation will be given by Frazer McGregor on manta rays. An optional field trip will be available to view and swim with these creatures including an opportunity for snorkeling on Ningaloo Reef.

Students are required to attend all lectures and activities. Students are expected to arrive on time and participate in al class discussions, workshops, activities and fieldtrips. The following will be provided during the teaching period:

- Lecture slides
- Digital media
- Workshop handouts
- Journal articles

Assessment and Final Grade

Students will be assessed on the basis of:

Assessment Item	Value
Oral presentation	15%
Scientific drawing	15%
Project report	25%
Participation	10%
Examination	35%
	100%

Course Requirements

All pieces of assessment must be submitted to pass the course.
There is a deliberate emphasis on the continuous assessment on communication and teamwork skills, because these are regarded by practitioners as essential to successful conservation, and by employers as critical for new graduates.

Assessment 1: Oral Presentation (15%): Due Week 2

The oral presentation involves each student presenting a 10 minute presentation on a marine species of choice from the tropical Western Australian marine environment. The aim of the presentation is twofold:

- To gain a deeper understanding about one marine organism of interest
- To develop communication skills important for marine ecology.

The presentation should include the following information about the species:

- Its distribution off Western Australia and globally, if applicable
- Its habitat and adaptation to the habitat
- The threats and management strategies for the species
- The key ecological studies important for that species
- Conclude with your thoughts on future research topics for the species

It will not be possible to go into too much detail about each of the points above and students should decide on which points they will discuss the most. Each presentation will be followed by five minutes for questions from the audience. You will also need to submit a hard copy of the key points from your talk including list of references used.

Assessment 2: Scientific drawing (15%): Due Week 3

This activity involves each student providing an illustration of two organisms they have observed in the field at Ningaloo. The aim of the activity is twofold:

- To demonstrate the ability to identify an animal from the field
- To record a specimen and its features

The student will sketch one invertebrate and one vertebrate organism whilst in the field at Ningaloo, noting the features that may assist with their identification. These sketches should then be used to identify the animal using books of online resources. A final scientific drawing of each organism will be produced and assessed.

Assessment 3: Project Report (25%): End of semester

One detailed field report presenting results and analysis of the field research at Ningaloo Reef. The report is expected to be represented as a journal article. *Note that the field work will require working in groups, but the reports are individual pieces of work.* Students will be collecting standardised data on the density and size distribution of coral reef clams (Tridacna spp.) in the intertidal and near shore zone (e.g. Bundegi, NW Cape, South Mandoo, Oyster Stacks,). Photos will be taken of each quadrat for post-analysis on percentage cover of sediment types and benthic growth.

Assessment 4: Participation (10%): Throughout whole course

Participation throughout the course and engagement with field work will be assessed. Students will be graded upon:

- Attitude
- Willingness to help other students
- Commitment to deliver high quality work

- Ability to learn and adapt
- Openness to learning
- Contributing to open discussions

Assessment 5: Exam (35%): End of semester

The final exam consists of 30 multiple choice, 10 short answer questions and 2 essay questions (select 2 out of 4 questions. Approx. 2 pages in length). The exam will be 2 hours in duration.

Assignment submission

Electronic submission of assignments is required via Canvas.

Attendance

Students are required to attend all lectures and activities. Students are expected to arrive on time and participate in all class discussions, workshops, activities, and fieldtrips. Rollcall will be taken and absences noted.

Grading

To qualify to pass the unit students must attend all class activities and submit all written assessment. Where students cannot fulfil these obligations, a satisfactory prior arrangement must be organised with the course coordinator. The final grade will be reported by a letter grade according to the aggregate percentage of the previously described assessment components and their weightings.

Lecture 1 – Marine Ecology 101

About this lecture

This lecture introduces basic concepts of marine biology. It covers topics such as:

- Background to marine biology and introduction to this course
- A brief history of the oceans in time and space
- Importance of geological history in understanding our marine environments
- Key environments and substrate availability

Learning objectives

The learning objectives of this lecture are for students to understand:

- What marine biology is – who does it, when and how
- How the oceans were formed and the key oceans of the world
- Key marine environments of interest to marine biologists.

Study questions

1. Why is geological history important in terms of understanding our marine environment?
2. What are the key marine environments of interest for marine biologists and why?
3. What are the main oceans of the world?

Reading

Kemp, H. (2010). *Ningaloo: Australia's Untamed Reef Book*. Perth, Western Australia: MIRG Australia.

Nybakken, J., & Bertness, M. (2004). Chapter 1: Introduction to the Marine Environment. In J. Nybakken, & M. Bertness (Eds.), *Marine Biology: An Ecological Approach* (pp.1-7). San Francisco: Pearson Education Inc.

Turekian, K.K., 2001. Origin of the oceans. In: Steele, J.H., Thorpe, S.A., Turekian, K.K. (Eds.), *Encyclopedia of Ocean Sciences, vol. 2* (pp.2055-2058). Amsterdam: Elsevier Science & Technology Books.

Lecture 2 – Classification of marine life

About this lecture

This lecture is a general lecture introducing students to marine life, key organisms and how they utilize marine habitats. The aim of the lecture is to get students thinking about the key organisms and marine habitats that may of interest to them in terms of further study. The unique adaptations of various marine organisms will be discussed along with why these adaptations are of interest to marine biologists.

Learning objectives

The objectives of Lecture 2 are for students to gain an understanding of:

- Different biological components of the marine environment primarily focusing on the different animals that have adapted to different environments
- How organisms utilize different habitats particularly focusing on substrate availability
- To be able to describe a few key organisms and their ecological importance.

Study questions

1. Provide an example of an organism and its adaptations to its environment for each of the following:

a) Neuston
b) Plankton
c) Benthos
d) Nekton

Reading

Lowry, L., & Pearse, J. (1973). Abalones and Sea Urchins in an Area Inhabited by Sea Otters. *Marine Biology*, 23, 213-219.

Nybakken, J., & Bertness, M. (2004). Chapter 1: Introduction to the Marine Environment. In J. Nybakken, & M. Bertness (Eds.), *Marine Biology: An Ecological Approach* (pp.1-7). San Francisco: Pearson Education Inc.

Nybakken, J., & Bertness, M. (2004). Chapter 2: Plankton and Plankton Communities. In J. Nybakken, & M. Bertness (Eds.), *Marine Biology: An Ecological Approach* (pp.42-77). San Francisco: Pearson Education Inc.

Lecture 3 – Marine ecological processes

About this lecture

Marine ecology is the discipline of understanding ecological processes and interactions between marine organisms and their habitat. It involves scientific processes involving hypothesis testing. There are a number of key ecological processes and studies that are of focus for marine ecologists around the world. This lecture touches on a few of these providing examples of well know ecological studies over time.

Learning objectives

The objectives of the lecture are for students to:

- Understand what marine ecology is
- Understand some of the ecological processes that have been a focus for marine ecologists over time
- Be able to describe a few examples of ecological studies for key marine ecological processes.

Study questions

1. For rocky intertidal zones what are some of the ecological processes that are most commonly studied?
2. Describe two ways you would understand competition interactions in intertidal areas?
3. How has the ecological monitoring of the Western Rock Lobster been used to manage this important commercial fishery?
4. What are the challenges with understanding the ecological impacts of recreational fishing?
5. What are some of the areas of ecological interest for marine protected areas?

Reading

Harrison, P. L., & Booth, D. J. (2007) Coral Reefs: Naturally Dynamic and Increasingly Disturbed Ecosystems. In Connel, S.D. & Gillanders, B.M. (Eds.). *Marine Ecology* (pp. 316 – 377). South Melbourne, Victoria: Oxford University Press

Underwood, A. J. (2000). Experimental ecology of rocky intertidal habitats: what are we learning? *Journal of Experimental Marine Biology and Ecology*, 250, 51-76.

Assessment due: *Oral presentation*

Lecture 4 – Introduction to oceanography with a focus on the Western Australian marine environment

About this lecture

This lecture introduces basic concepts of physical and biological oceanography in the marine environment, as well as chemical cycles. It includes some discussion of basic oceanographic features and how they influence the distributions and life cycles of various organisms. This includes considering the oceanographic features that are important in Western Australian.

Learning objectives

The learning objectives of this lecture are for students to understand:

- The basics of oceanography
- The effect of currents on organisms and understanding the influence of currents and chemical cycles on organisms
- The key physical and biological parameters that are important in marine organisms
- The chemical nature of the marine environment including the key chemical elements, the cycles that occur and the important nutrient flows for sustaining life in the oceans

Study questions

1. What are three physical oceanographic features?
2. What is the definition of biological oceanography?
3. What is the difference between a biological oceanographer and a marine biologist?
4. What chemical features of sea water influence marine life?
5. Provide an example of a marine system or organism that is affected by the nitrogen cycle, phosphorus cycle and/or carbon cycle?
6. What is the main current that affects organisms of the Western Australian coast?
7. Provide an example of an organism that is affected by the main current off Western Australia.

Reading

de Lestang, S., Caputi, N., Feng, M., Denham, A., Penn, J., Slawinski, D., Pearce, A. & How, J. (2015). What caused seven consecutive years of low puerulus settlement in the western rock lobster fishery of Western Australia? *ICES Journal of Marine Science*, 72, 49-58.

Rossi, V., Feng, M., Pattiaratchi, C., Roughan, M. & Waite, A. M. (2013). Linking synoptic forcing and local mesoscale processes with biological dynamics off Ningaloo Reef, *Journal of Geophysical Research: Oceans*,118, 1211–1225.

Lecture 5 – The marine environment of Western Australian

About this lecture

This lecture provides an introduction to the diverse marine environments off Western Australia. From granite coastlines of Albany to the tropical reefs of Ningaloo and the ancient archipelago of North West Broome, this lecture introduces the dominant habitats, geology and physical factors influencing Western Australia's marine environment.

Learning objectives

The objectives of the lecture are for students to understand:

- The coastal geography and geomorphology of Western Australia
- The key environmental factors influencing organisms in Western Australia
- The bioregions of Western Australia and their marine parks.
- Overarching management agencies for Western Australia marine environments.

Study questions

1. Provide a description of the different types of environments around Western Australia coastline.
2. What are some of the key conservation values of the south-west marine environment of Western Australia?
3. What are some of the key conservation values of the north-west marine environment of Western Australia?
4. What is the difference between a sanctuary zone, recreation zone, general use zone and special purpose zone of a marine park?
5. In Ningaloo marine park, what different types of management zones can be found?

Reading

Commonwealth of Australia. (2012). Chapter 12– The north-west Marine Region and its conservation values. In Marine bioregional plan for the North-west Marine Region. Commonwealth of Australia. pp11-20.

Commonwealth of Australia. (2012). Chapter 2 – The south-west Marine Region and its conservation values. In Marine bioregional plan for the South-west Marine Region. Commonwealth of Australia. pp12-23.

Lecture 6 – Tropical marine environment of Western Australian

About this lecture

This lecture provides students with an overview of coral reefs, seagrass communities and mangroves communities, with examples from Western Australia. The material in this lecture also provides a starting point for students to build on this knowledge through field work in Ningaloo.

Learning objectives

The objectives of the lecture are for students to gain an understanding of:

- Coral reefs, seagrasses and mangroves, both globally and from the north west of Australia
- The organisms associated with each of these habitats and their form and function
- Growth and reproduction of corals, seagrasses and mangroves

Study questions

1. What Phylum do corals belong to and what animals are they most similar to?
2. Draw the body plan of a coral polyp and describe the function of each feature.
3. Describe how corals reproduce sexually and asexually?
4. What are the key physical factors that limit the growth and distribution of corals?
5. Why are corals important to humans?
6. What does ocean acidification do to corals?
7. What are some of the animals that rely on mangroves to survive and why?
8. What are some of the animals that rely on seagrasses to survive and why?
9. What is the global importance of seagrass meadows?

Reading

Wilson, B. (2013). *The biogeography of the Australian North West Shelf; environmental change and life's response*. Philadelphia, PA: Elsevier Science Publishing Co., Inc.

Speed, C.W., Babcock, R.C., Bancroft, K.P., Beckley, L.E., Bellchambers, L.M., Depczynski, M., Field, S.N., Friedman, K.J., Gilmour, J.P. & Hobbs, J.-P.A. (2013). Dynamic stability of coral reefs on the west Australian coast. *PLoS One,* 8, e69863.

McKinnon, A. D., Meekan, M. G., Carleton, J. H., Furnas, M. J., Duggan, S., & Skirving, W. (2003). Rapid changes in shelf waters and pelagic communities on the southern Northwest Shelf, Australia, following a tropical cyclone. *Continental Shelf Research,* 23, 93-111.

Burkholder, D. A., Heithaus, M. R., Fourqurean, J. W., Wirsing, A. & Dill, L. M. (2013). Patterns of top-down control in a seagrass ecosystem: could a roving apex predator induce a behaviour-mediated trophic cascade? *Journal of Animal Ecology*, 82, 1192–1202.

Assessment due: *Scientific drawing*

Lecture 7– Threats to tropical marine environments and conservation actions

About this lecture

This lecture draws attention to the current and future threats facing tropical marine environments, the consequences of these threats, and the conservation actions in place to try and reduce these threats. Local threats, such as fishing and dredging, through to global threats, such as climate change will be discussed. Students will learn about some of the conservation efforts to protect the tropical marine environment, but also the challenges that such efforts face.

Learning objectives

The students will gain an understanding of:

- Key threats to tropical marine environments such as coral reefs, seagrasses and mangroves
- What a changing climate could mean for tropical marine life and their habitats
- Management and grass roots actions to conserve marine life and environments
- Threat and conservation case studies from Ningaloo Reef

Study questions

1. List four threats facing each of the following:

a) Coral reefs
b) Seagrass communities
c) Mangrove communities

2. Explain three challenges conservation management efforts face in trying to conserve the marine environment
3. Explain what global warming is and how it occurs, and what the leading contributors to global warming are?
4. What are the major threats facing Ningaloo Reef?

Reading

Gilmour, J. P., Smith, L. D., Heyward, A. J., Baird, A. H. & Pratchett, M. S. (2013). Recovery of an isolated coral reef system following severe disturbance. *Science,* 340, 69–71.

Ruppert, J. L. W. et al. (2013). Caught in the middle: combined impacts of shark removal and coral loss on the fish communities of coral reefs. *PLoS ONE,* 8: e74648.

Underwood, J. N., Wilson, S. K., Ludgerus, L. & Evans, R. D. (2013) Integrating connectivity science and spatial conservation management of coral reefs in North-West Australia. *Journal for Nature Conservation,* 21, 163–72.

Lecture 8 – Field methods for data collection in the marine environment

About this lecture

The aim of this lecture is to provide students with an overview of the common methods for conducting ecological studies in the marine environment. The lecture will also explore in more detail the techniques used for coral reefs and seagrass communities, such as quadrats, transects and underwater videos. Scientific papers are considered and how methods vary from situation to situation. Practical and safety aspects of field methods are also considered.

Learning objectives

Through the completion of this lecture students will understand:

- Techniques and equipment used to collect biological, chemical and physical data
- The positive and negative aspects of quadrats, transects, underwater video and social research methods
- The importance of different methods for understanding ecological processes at different scales and for different organisms
- Various safety aspects of marine biology field work
- Practical aspects of conducting field work.

Study questions

1. What types of equipment can be used to measure:

a) physical properties of the water column
b) zooplankton
c) nutrients

2. What are the best methods for broad scale studies to understand percentage cover of corals?
3. What are the pros and cons of quadrats?
4. What are three ways transects can be used in an ecological study?
5. What are some common measurements taken for seagrass monitoring?
6. What are the key safety implications for conducting field work in marine environments?

Reading

Hill, J. & Wilkinson, C. (2004). Methods for Ecological Monitoring of Coral Reefs. Australian Institute of Marine Science, Townsville.

http://www.seagrasswatch.org/manuals.html

Kirkman, H. (1996). Baseline and monitoring methods for seagrass meadows. *Journal of Environmental Management*, 47, 191–201.

Lecture 9 – Experimental design and statistics

About this lecture

Good experimental design is crucial for marine ecology. Without good design, studies can easily

be discredited and efforts in the field work wasted. This lecture covers the basic elements of good experimental design and key considerations for statistical sampling. While common to all ecological research, the concepts in this lecture will be discussed in terms of the marine ecological field work to be undertaken through the course.

Learning objectives

After completing this lecture students should understand:

- The key considerations for designing an ecological study
- The importance of research questions and hypotheses
- The importance of scale in designing ecological studies
- Key aspects of statistical sampling such as sample size, sample layout, bias, errors, and descriptive statistics
- The concepts of basic statistical test such as t-test and regression.

Study questions

1. List the key things to consider when designing an ecological study
2. Where should you start when designing an ecological study?
3. Briefly describe hypothesis testing – what do you reject or accept?
4. What do you need to consider when determining your sample size?
5. Briefly describe random sampling, stratified random sampling and systematic sampling?

Reading

Borenstein, M., Rothstein, H., & Cohen, J. (2001) Chapter 2, Power and Precision. Biostat, New Jersey. p5-18.

Quinn, G.P., & Keough, M.J. (2002). Chapter 1. Introduction. In Experimental Design and Data Analysis for Biologists. Cambridge University Press, Cambridge.

Quinn, G.P., & Keough, M.J. (2002). Chapter 3. Hypothesis Testing. In Experimental Design and Data Analysis for Biologists. Cambrid.ge University Press, Cambridge

Lecture 10 – Data analysis and field report preparation

About this lecture

This lecture will be delivered after the fieldwork has been undertaken on the giant clams in Ningaloo. Students will learn how to clean up the data and a look into the summary statistics of the data, for example, to calculate the mean, median and range of values. Histograms and standard error bars are also covered. Assumptions of statistical tests will be explored, as well as t-tests, ANOVA and linear regression. The above is to be explored using the collected giant clam data and be used in the field report.

Learning objectives

The objectives of the lectures are for students to become familiar with:

- cleaning up data
- summary statistics, and
- data analysis using their own data collected from the clam fieldwork

Study questions

1. Which statistical analyses are required to be able to state if there is significance between two groups or not?
2. What is a normal distribution?

Assessment due: *Project report*

Course Materials

Readings

1. Borenstein, M., Rothstein, H., & Cohen, J. (2001) Chapter 2, Power and Precision. Biostat, New Jersey. p5-18.
2. Burkholder, D. A., Heithaus, M. R., Fourqurean, J. W., Wirsing, A. & Dill, L. M. (2013). Patterns of top-down control in a seagrass ecosystem: could a roving apex predator induce a behaviour-mediated trophic cascade? *Journal of Animal Ecology*, 82, 1192–1202.
3. Commonwealth of Australia. (2012). Chapter 12– The north-west Marine Region and its conservation values. In Marine bioregional plan for the North-west Marine Region. Commonwealth of Australia. pp11-20.
4. Commonwealth of Australia. (2012). Chapter 2 – The south-west Marine Region and its conservation values. In Marine bioregional plan for the South-west Marine Region. Commonwealth of Australia. pp12-23.
5. de Lestang, S., Caputi, N., Feng, M., Denham, A., Penn, J., Slawinski, D., Pearce, A. & How, J. (2015). What caused seven consecutive years of low puerulus settlement in the western rock lobster fishery of Western Australia? *ICES Journal of Marine Science*, 72, 49-58.
6. Gilmour, J. P., Smith, L. D., Heyward, A. J., Baird, A. H. & Pratchett, M. S. (2013). Recovery of an isolated coral reef system following severe disturbance. *Science,* 340, 69–71.
7. Harrison, P. L., & Booth, D. J. (2007) Coral Reefs: Naturally Dynamic and Increasingly Disturbed Ecosystems. In Connel, S.D. & Gillanders, B.M. (Eds.). *Marine Ecology* (pp. 316 – 377). South Melbourne, Victoria: Oxford University Press
8. Hill, J. & Wilkinson, C. (2004). Methods for Ecological Monitoring of Coral Reefs. Australian Institute of Marine Science, Townsville
9. Kemp, H. (2010). *Ningaloo: Australia's Untamed Reef Book*. Perth, Western Australia: MIRG Australia.
10. Kirkman, H. (1996). Baseline and monitoring methods for seagrass meadows. *Journal of Environmental Management*, 47, 191–201.
11. McKinnon, A. D., Meekan, M. G., Carleton, J. H., Furnas, M. J., Duggan, S., & Skirving, W. (2003). Rapid changes in shelf waters and pelagic communities on the southern Northwest Shelf, Australia, following a tropical cyclone. *Continental Shelf Research,* 23, 93-111.
12. Nybakken, J., & Bertness, M. (2004). Chapter 1: Introduction to the Marine Environment. In J. Nybakken, & M. Bertness (Eds.), *Marine Biology: An Ecological Approach* (pp.1-7). San Francisco: Pearson Education Inc.

13. Quinn, G.P., & Keough, M.J. (2002). Chapter 1. Introduction. In Experimental Design and Data Analysis for Biologists. Cambridge University Press, Cambridge.
14. Quinn, G.P., & Keough, M.J. (2002). Chapter 3. Hypothesis Testing. In Experimental Design and Data Analysis for Biologists. Cambrid.ge University Press, Cambridge
15. Rossi, V., Feng, M., Pattiaratchi, C., Roughan, M. & Waite, A. M. (2013). Linking synoptic forcing and local mesoscale processes with biological dynamics off Ningaloo Reef, *Journal of Geophysical Research: Oceans*,118, 1211–1225.
16. Ruppert, J. L. W. et al. (2013). Caught in the middle: combined impacts of shark removal and coral loss on the fish communities of coral reefs. *PLoS ONE,* 8: e74648.
17. Speed, C.W., Babcock, R.C., Bancroft, K.P., Beckley, L.E., Bellchambers, L.M., Depczynski, M., Field, S.N., Friedman, K.J., Gilmour, J.P. & Hobbs, J.-P.A. (2013). Dynamic stability of coral reefs on the west Australian coast. *PLoS One,* 8, e69863.
18. Turekian, K.K., 2001. Origin of the oceans. In: Steele, J.H., Thorpe, S.A., Turekian, K.K. (Eds.), *Encyclopedia of Ocean Sciences, vol. 2* (pp.2055-2058). Amsterdam: Elsevier Science & Technology Books.
19. Underwood, A. J. (2000). Experimental ecology of rocky intertidal habitats: what are we learning? *Journal of Experimental Marine Biology and Ecology*, 250, 51-76.
20. Underwood, J. N., Wilson, S. K., Ludgerus, L. & Evans, R. D. (2013) Integrating connectivity science and spatial conservation management of coral reefs in North-West Australia. *Journal for Nature Conservation,* 21, 163–72.
21. Wilson, B. (2013). *The biogeography of the Australian North West Shelf; environmental change and life's response*. Philadelphia, PA: Elsevier Science Publishing Co., Inc.

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Referencing

For all written assessment, the APA referencing system should be used. Information for this style of referencing can be found at: http://libguides.murdoch.edu.au/APA