TASMANIAN ASSESSMENT, STANDARDS & CERTIFICATION

External Assessment 2023

Attach your candidate label here

ENVIRONMENTAL SCIENCE

ESS315118

Section A

Pages: 12
Questions: 5
Information Sheet: 1

Preparation time for this exam: 15 minutes

Suggested working time: 36 minutes

Instructions:

- Answer **all** questions and **all** items within each question.
- Write your answers in the spaces provided in this exam paper.
- The exam is **three (3) hours** in length. The suggested working time for this section is **approximately 36 minutes**.
- The Environmental Science Information Sheet can be used throughout the exam.
- All answers must be written in **English**.
- You **must** make sure your answers address the listed criterion.

Marker use	
C2	/ 36

Guide to Exam Structure

	Questions available	Questions to answer	Suggested working time	Marks available
Section A	5	5	36 minutes	36 marks
Section B	5	5	36 minutes	36 marks
Section C	5	5	36 minutes	36 marks
Section D	6	6	36 minutes	36 marks
Section E	5	5	36 minutes	36 marks
Totals	**26**	**26**	**180 minutes (3 hours)**	**180 marks**

Criterion

You **must** make sure your answers address:

- Criterion 2 develop, interpret and analyse experiments and investigations.

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Question 1

Marker use

Scientists were concerned about the levels of heavy metals, particularly lead, in sewage effluent released from a sewage treatment plant. They conducted an experiment using five (5) tanks containing water with different concentrations of lead. They placed 10 freshwater amphipods (a small type of crustacean) in each tank. The experiment's results are shown in Table 1:

Figure 1: Close-up photo of a freshwater amphipod.

Tank Number	Lead concentration (mg/L)	Number of amphipods alive after two days
1	0	9
2	0.01	10
3	0.02	9
4	0.10	1
5	0.20	0

Table 1

a) Identify the independent variable in this experiment. /1

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b) Identify the dependent variable in this experiment. /1

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c) Write an appropriate hypothesis for this experiment. /2

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Question 1 continues

Marker use

d) Explain whether this experiment has a control.

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e) Identify **four (4)** variables that the scientists would need to keep constant in the experiment.

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f) Explain **one (1)** problem that reduces the reliability or validity of this experiment.

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Total Q1

/10

Question 2

Marker use

Every year in Tasmania since 1975, nocturnal spotlight surveys have been conducted by the State Government. Staff drive slowly along 10 km stretches of road at night shining powerful lights. They count and identify all the mammals that they see along the route.

Figure 2 below shows the estimated number of brushtail possums from 2002 – 2020 recorded in these surveys, together with a linear trendline (dotted line).

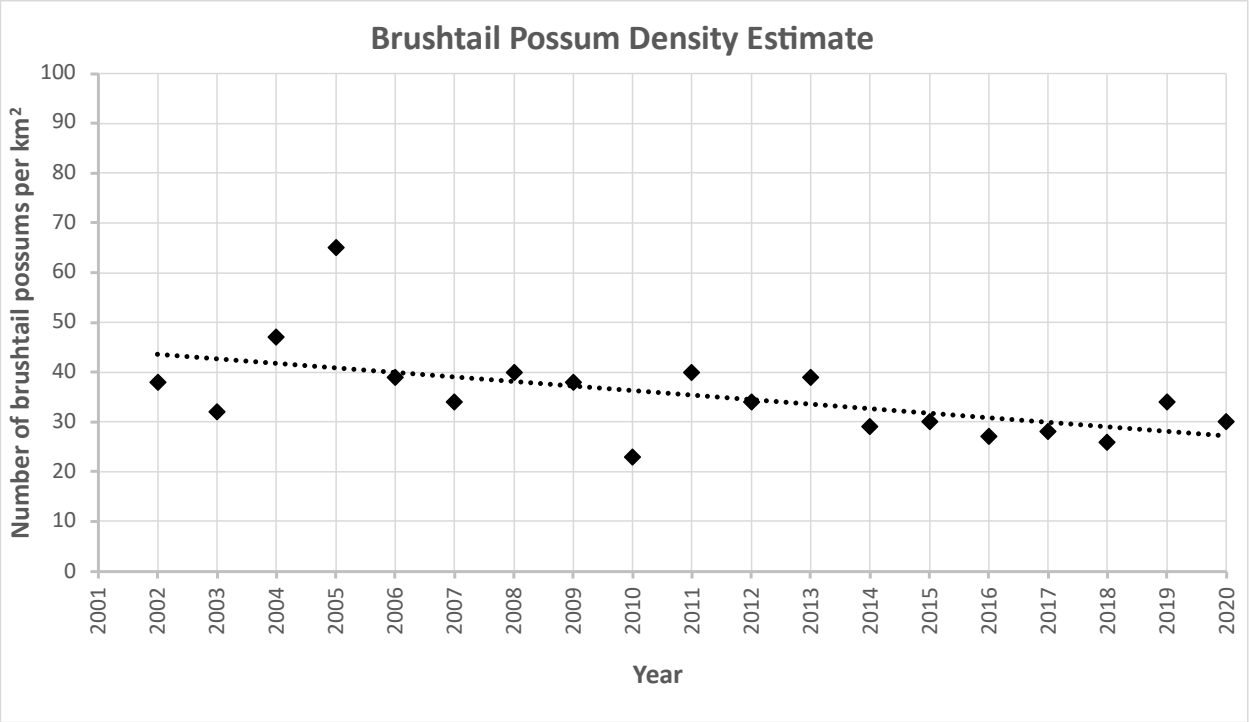

Figure 2: Graph of the estimated number of brushtail possums (per km^2).

Redrawn from *Annual Statewide Spotlight Surveys Tasmania 2020/2021*, DPIPWE 2021

a) Explain the purpose of this type of monitoring. /1

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b) Describe why it is important to use the same method every year. /2

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Question 2 continues

Marker use

c) Suggest **two (2)** reasons why this method might not provide an accurate estimate of the numbers of animals.

/2

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d) Referring to the data, describe the patterns in the numbers of brushtail possums over the period 2002 – 2020.

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e) Spotlight surveys are expensive and time-consuming. Suggest an alternative method that could be used to monitor the population density of brushtail possums.

/1

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Total Q2

/8

Question 3

Marker use

A group of students noticed that a tomato plant growing in a shady corner of a room was taller and yellower than a tomato plant growing on the window ledge. They formulated the following hypothesis:

"Why are plants yellower and taller? It is colder and darker in the corner of the room."

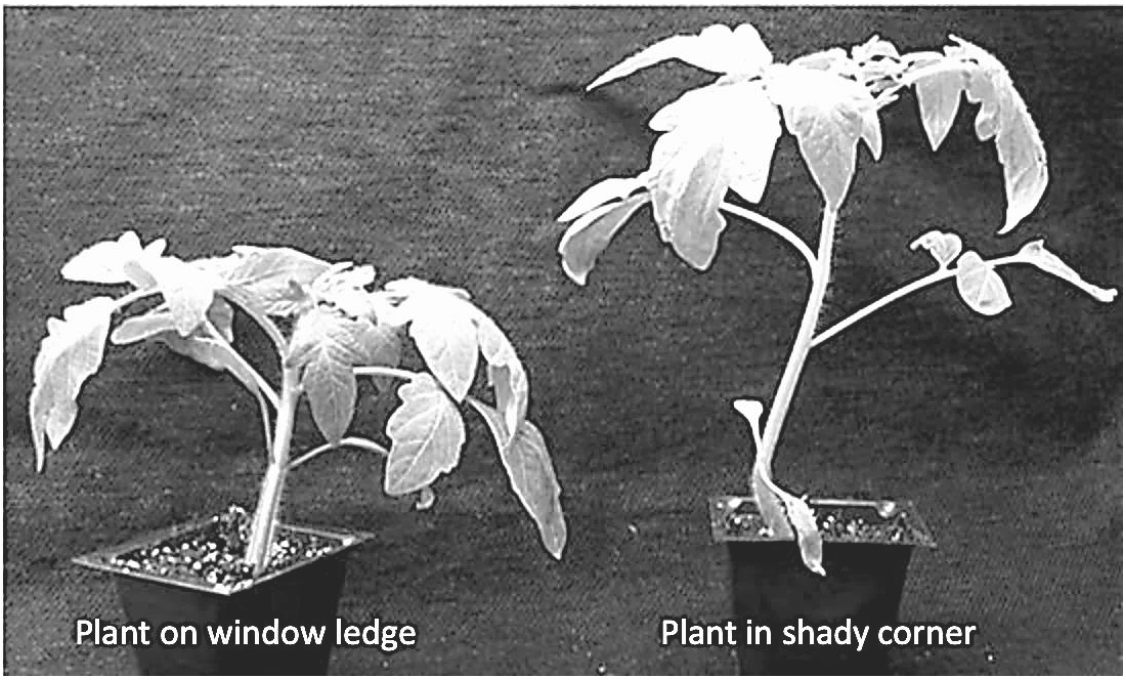

Figure 3: Photo of two (2) tomato plants, highlighting their different appearances.

a) Identify **two (2)** reasons why this is not a valid hypothesis.

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/2

b) Construct a valid hypothesis from the information given.

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Question 3 continues

Marker use

/6

c) Outline a laboratory experiment that could be used to test your hypothesis. Make sure that you include details of independent, dependent and controlled variables; replication; experimental procedure and data collection.

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Total Q3

/10

Question 4

Marker use

A local council is proposing to build a mountain bike track through a forested ecosystem. Ecological consultants have told them they must undertake a baseline study.

a) State the importance of a baseline study.

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/1

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b)

i. State **one (1)** example of a biotic variable and **one (1)** example of an abiotic variable that should be measured in the baseline study.

/3

Biotic: .....

Abiotic: .....

ii. Explain how you would measure **one (1)** of the variables identified in item i.

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Total Q4

/4

Question 5

Marker use

A student wanted to know how many snails were in her garden. She decided to use a capture-recapture study using small, numbered discs which she glued to the snails' shells.

Figure 4: Close-up photo of a snail with a small, numbered disc on its shell.

a) State **two (2)** assumptions of a capture-recapture study.

/1

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b) State an advantage of using a capture-recapture method rather than another method, such as direct counting.

/1

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c) Explain how a capture-recapture study can be used to estimate the size of a population of organisms.

/2

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Total Q5

/4

End of Section A

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ENVIRONMENTAL SCIENCE

ESS315118

Section B

Pages: 16
Questions: 5
Information Sheet: 1

Suggested working time: 36 minutes

Instructions:

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Marker use	
C5	/ 36

Guide to Exam Structure

	Questions available	Questions to answer	Suggested working time	Marks available
Section A	5	5	36 minutes	36 marks
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Section C	5	5	36 minutes	36 marks
Section D	6	6	36 minutes	36 marks
Section E	5	5	36 minutes	36 marks
Totals	**26**	**26**	**180 minutes (3 hours)**	**180 marks**

Criterion

You **must** make sure your answers address:

- Criterion 5 apply ecological concepts and processes.

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Question 6

Marker use

Figure 5 shows a representation of a soil food web:

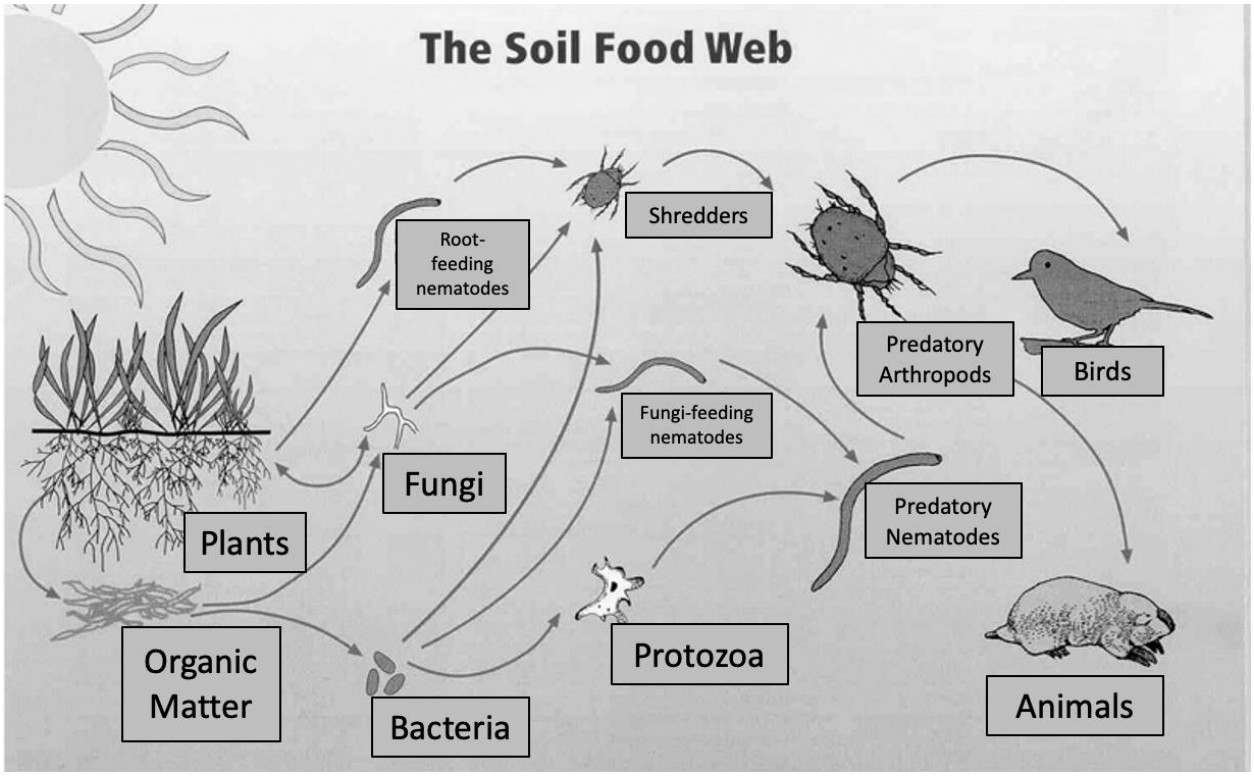

Figure 5: Diagram of the soil food web, highlighting a variety of organisms.

Image adapted from USDA Natural Resources Conservation Service, Creative Commons 3.0

a) Explain what the arrows represent in the food web.

/1

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b) Provide **one (1)** example of each of the following organisms:

/2

i. Producer: .....

ii. Organism in the third trophic level: .....

iii. Decomposer: .....

iv. Tertiary consumer: .....

Question 6 continues

Marker use

c) To control an outbreak of caterpillars, a farmer applied a large amount of pesticide which specifically affected the predatory arthropods in this food web. Describe **two (2)** changes that might occur in the ecosystem. /2

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d) Food chains are regularly taught in class. Explain why food webs are a better way of representing relationships between organisms. /2

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e) Explain why there is a maximum number of trophic levels in any food web. /2

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Total Q6 /9

Question 7

Marker use

a) To supply water to a vineyard, the owner constructs a small dam. Six (6) months later, the owner notices it is full of waterweed. They introduce six (6) fast-growing fish (three (3) males and three (3) females) to eat the waterweed. The owner monitors the populations of waterweed and fish regularly over the next two (2) years. Using the axes in Figure 6 below, sketch the changes in **both** the population of waterweed and fish before and after the fish were introduced.

/4

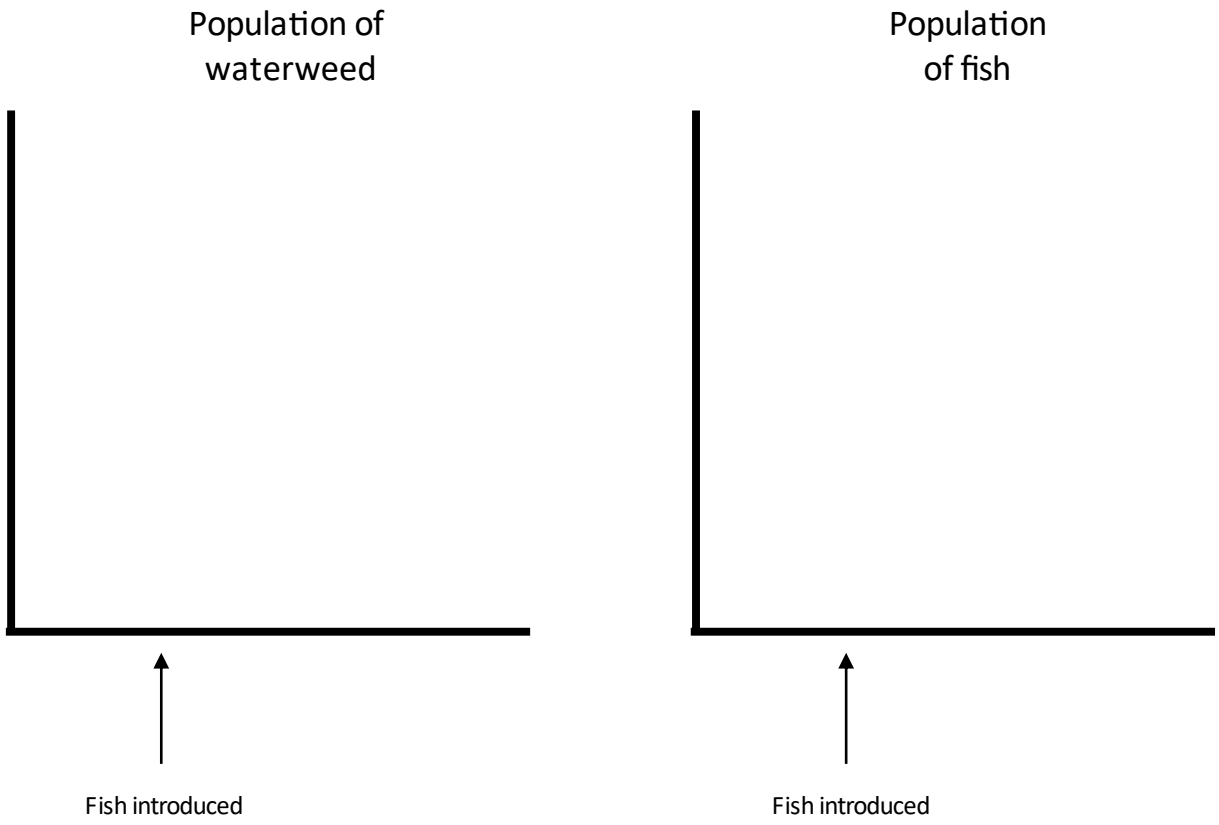

Figure 6: Graphs for sketching answer to Question 7 a).

Spare diagram used (X) ☐

b) Outline how the term 'carrying capacity' applies to the fish population in the dam.

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Question 7 continues

Marker use

/3

c) Describe the changes that would occur if a predatory species of fish was introduced into the dam, using the concept of negative feedback.

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Total Q7

/8

Question 8

Marker use

Figure 7 shows the nitrogen cycle for a terrestrial ecosystem.

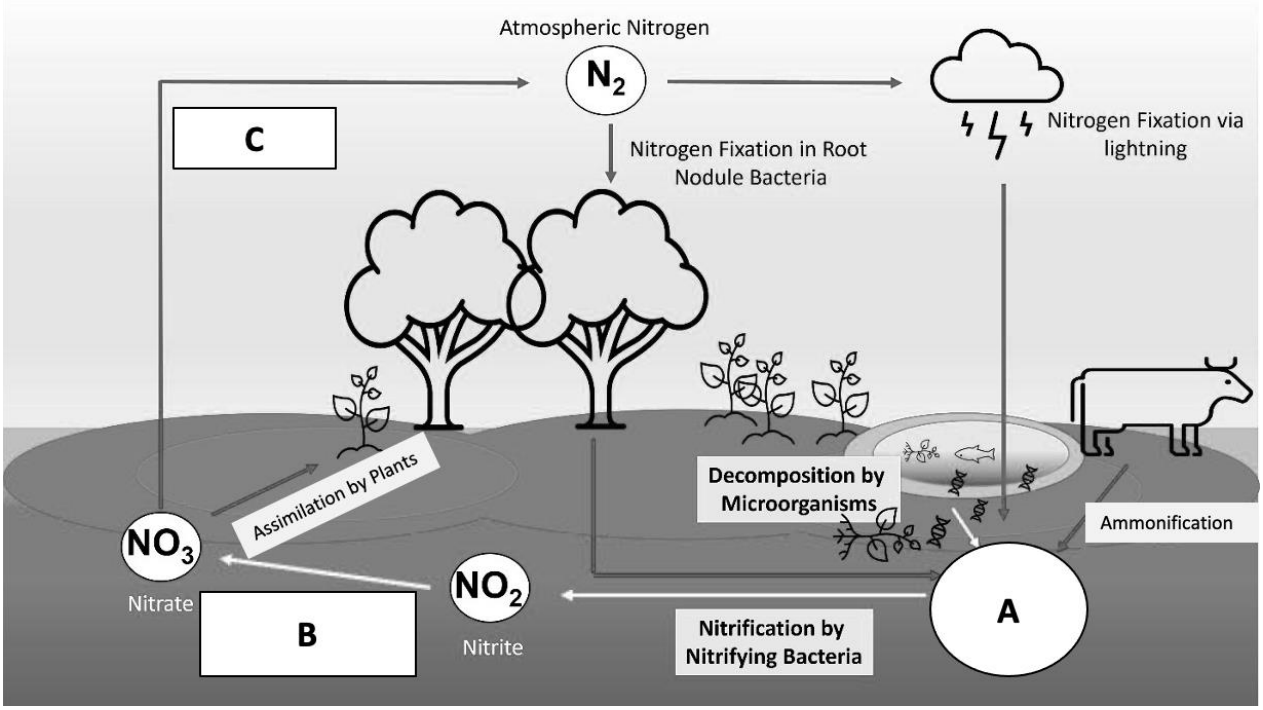

Figure 7: Diagram of the nitrogen cycle for a terrestrial ecosystem, highlighting A – C.

Modified from United States Geological Survey, Creative Commons 3.0

a) State the identity of the chemical compound A.

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b) State the process occurring at C.

..... /1

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c) Describe why process B is required for plants.

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Question 8 continues

Marker use

/2

d) Antibiotics are widely used in some countries to kill certain types of bacteria and promote animal growth. Explain what effect these antibiotics might have on the nitrogen cycle if they pass into the environment.

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Total Q8

/5

Question 9

Marker use

Tree hollows are very important habitats for many Tasmanian animals. Table 2 provides information about some animals which use hollows in blue gums:

Name	Body Size (cm)	Diet
Little forest bat	4-5	Flying insects – moths, beetles, flies
Louse fly	1-2	Blood of birds and mammals
Musk lorikeet	21-23	Nectar
Ring-tailed possum	30-35	Eucalyptus leaves from a range of species
Sugar glider	12-21	Eucalyptus sap, honeydew, insects, eggs, baby birds, lizards
Swift parrot	23-26	Nectar

Table 2

a) From the information given, identify **one (1)** generalist and **one (1)** specialist. /1

Generalist: .....

Specialist: .....

b) Using **two (2)** species from the table, describe the concept of niche overlap and interspecific competition. /2

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c) Describe **one (1)** other type of interspecific relationship shown by the animals in the table. /1

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Question 9 continues

Marker use

d) Little forest bats hibernate in winter, where they go into a dormant state to conserve energy. Suggest a reason for this behaviour.

/1

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Total Q9

/5

Question 10

Marker use

Tasmania has some unique and diverse ecosystems. Table 3 shows the biomass in different trophic levels in two (2) of these ecosystems.

Trophic Level	**Marine Ecosystem**		**Forest Ecosystem**	
	Organism	**Biomass (g/m^{-2})**	**Organism**	**Biomass (g/m^{-2})**
Producers	Phytoplankton	4	*Eucalyptus* spp.	585
Primary Consumer	Zooplankton	8	Insects	77
Secondary Consumer	Small fish	12	Insectivores	12
Tertiary Consumer	Large fish	16	Tasmanian devil	1.1

Table 3

a) State the ultimate source of energy for each ecosystem.

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/1

b) Describe how energy is captured and stored in **one (1)** of the ecosystems.

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/2

Question 10 continues

Marker use

c) Construct labelled pyramids of biomass for **both** ecosystems in the space below.

/4

d) Explain how both of these two (2) ecosystems can be sustainable with such large differences in producer biomass.

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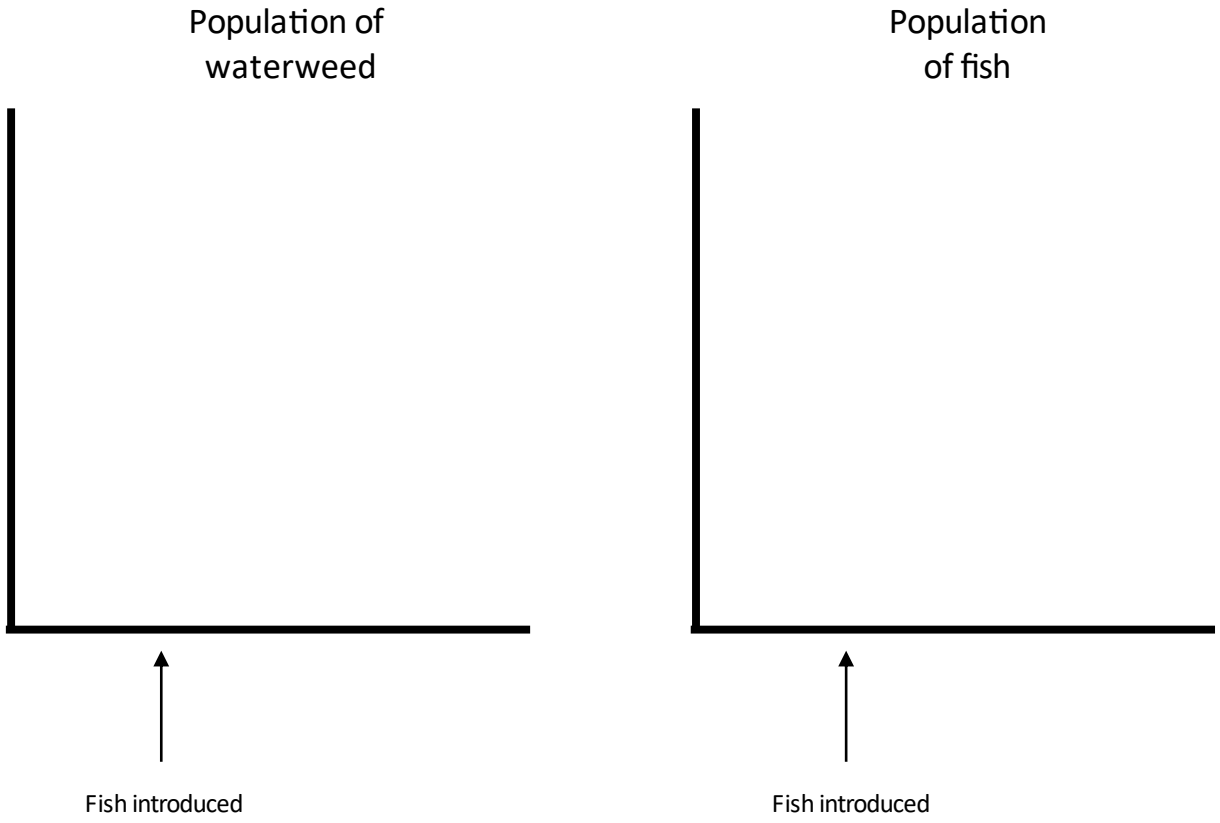
Total Q10

/9

Spare Diagrams

Question 7 a)



End of Section B

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TASMANIAN ASSESSMENT, STANDARDS & CERTIFICATION

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ENVIRONMENTAL SCIENCE

ESS315118

Section C

Pages: 16
Questions: 5
Information Sheet: 1

Suggested working time: 36 minutes

Instructions:

- Answer **all** questions and **all** items within each question.
- Write your answers in the spaces provided in this exam paper.
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Marker use	
C6	/ 36

Guide to Exam Structure

	Questions available	Questions to answer	Suggested working time	Marks available
Section A	5	5	36 minutes	36 marks
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Section C	5	5	36 minutes	36 marks
Section D	6	6	36 minutes	36 marks
Section E	5	5	36 minutes	36 marks
Totals	**26**	**26**	**180 minutes (3 hours)**	**180 marks**

Criterion

You **must** make sure your answers address:

- Criterion 6 apply concepts and processes of ecosystem change.

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Question 11

Marker use

Marine waters around Australia have been warming over the period 1900 – 2021. Temperature data has been collected regularly at many different locations around Australia at different time scales (from hours up to years). Figure 8 shows the changes in mean sea surface temperature (SST) per decade.

Figure 8: Diagram of the changes in sea surface temperature in Australia (℃ per decade).

State Of The Climate 2022, Bureau of Meteorology

a) State which coastal areas of Australia have experienced the greatest changes in SST **or** indicate these on the map. /1

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b) Evaluate the usefulness of displaying changes in SST at a decade scale compared with a yearly scale. /2

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Question 11 continues

Marker use

c) Describe **two (2)** changes, either biotic or abiotic, that could occur in the coastal waters of Tasmania due to increases in SST.

/2

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d) Propose how the changes in SST on the east coast of Australia might change the intensity of El Niño and La Niña events.

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Total Q11

/8

Question 12

Marker use

Figure 9 shows the course of the River Derwent in southern Tasmania from Lake St. Clair to the sea in Hobart. Four (4) different locations along the course of the river are shown. Salt water from the sea extends as far as Murphy's Flat.

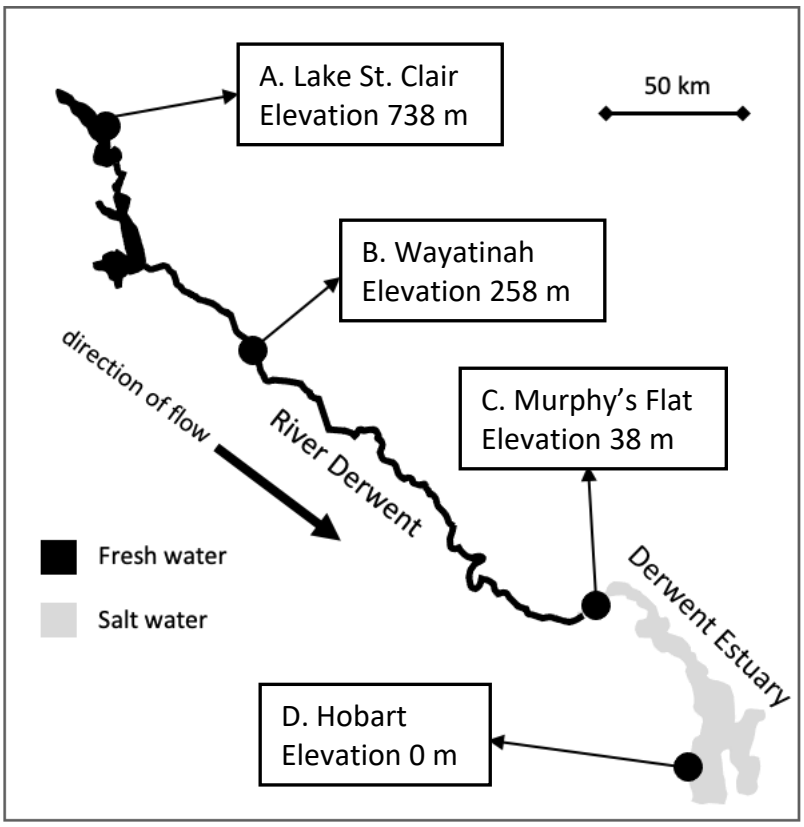

Figure 9: Diagram of the River Derwent course from Lake St. Clair to the sea in Hobart.

a) Describe **one (1)** seasonal abiotic change that would be the same at locations A and D. /2

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b) Describe **one (1)** seasonal abiotic change that would be different at locations A and D. /2

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Question 12 continues

Marker use

/3

c) Explain which location (A, B, C or D) would be the most challenging for aquatic organisms to live in.

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Total Q12

/7

Question 13

Marker use

a) In Table 4, identify the type of biodiversity shown in each image and provide a definition. Two (2) answers have been provided for you:

/2

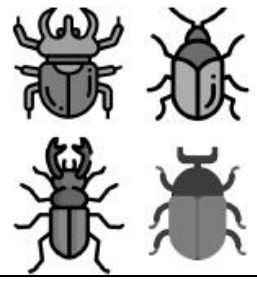
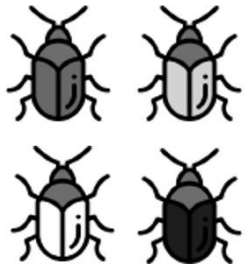
Example	Type of Biodiversity	Definition
		The number and relative abundance of different species in an ecosystem.
		
	Ecosystem	

Table 4: Table for entering information about three (3) biodiversity types to answer Question 13 a).

Spare diagram used (X) ☐

b) Explain how habitat loss or degradation can reduce genetic diversity.

/3

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Total Q13

/5

Question 14

Marker use

Fallow deer were introduced to Tasmania from Europe in the 1830s. They feed on grasses, herbs and shrubs in close proximity to cover. In 2019, their population in the state was estimated to be about 54 000. This number could increase to more than 200 000 within 10 years if no control measures are taken.

a) Explain why fallow deer have thrived in Tasmania.

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b) Describe negative effects that fallow deer might have on native Tasmanian plants and animals.

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c) Evaluate **one (1)** method to reduce the impact of fallow deer in Tasmania.

/2

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Total Q14

/6

Question 15

Marker use

Figure 10 shows the changes in concentrations of greenhouse gases in the atmosphere over the past 2 000 years.

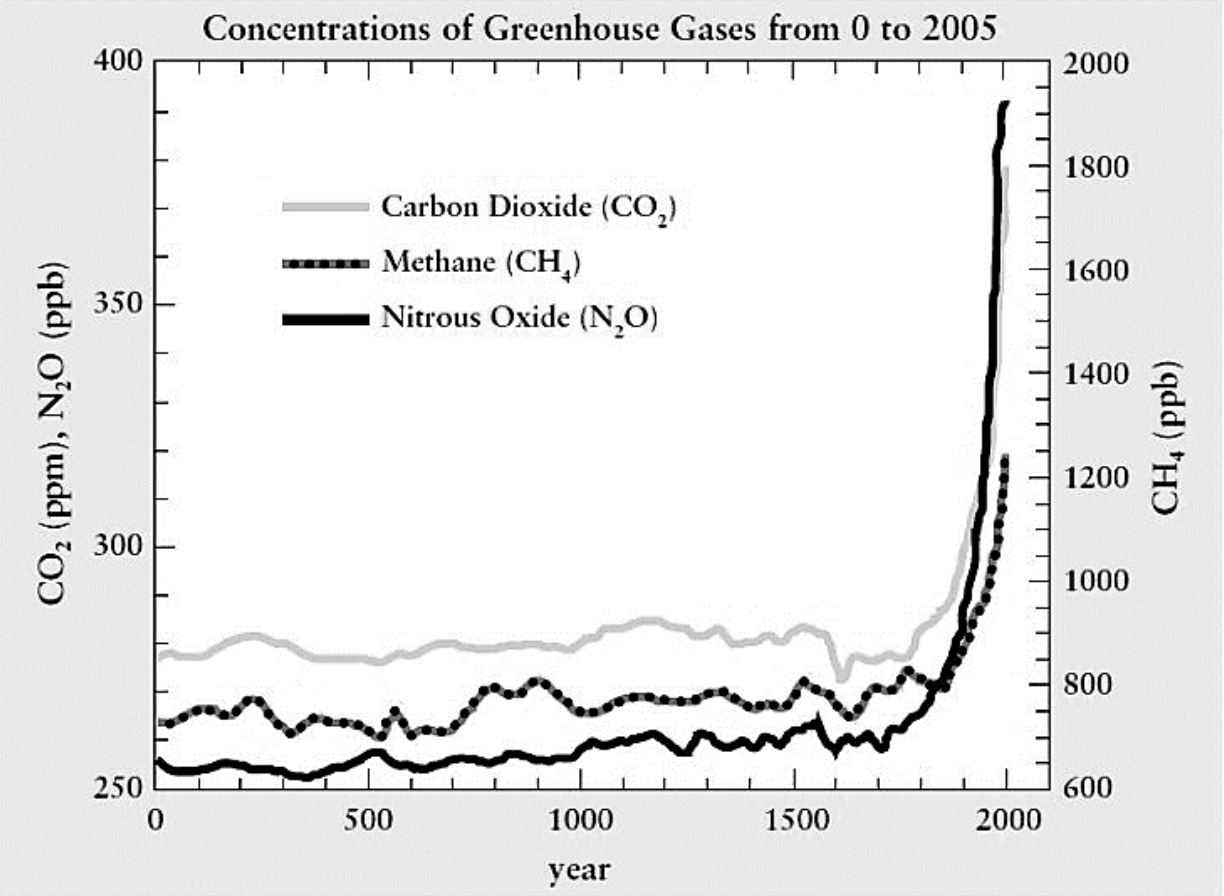

Figure 10: Graph of the changes in concentrations of greenhouse gases in the atmosphere.

Intergovernmental Panel on Climate Change, 2005

a) Referring to Figure 10, describe the trend in carbon dioxide levels shown in the graph for the entire period shown.

/2

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b) Calculate the change in methane concentration from Year 0 to Year 2000.

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Question 15 continues

Marker use

c) Direct measurement of greenhouse gases has only been undertaken in the last 100 years. Describe how scientists have estimated levels of greenhouse gases before direct measurement was available.

/2

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d) Explain the effect of increasing greenhouse gases on global temperature.

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e) Describe the consequences of global warming caused by the increased greenhouse effect on each of the following:

/2

i. Sea level .....

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ii. Timing of seasonal biological events .....

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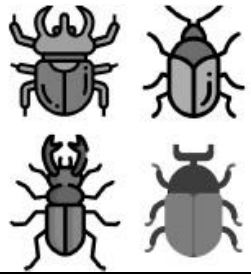
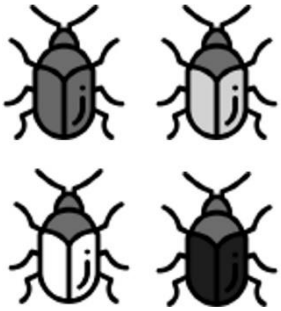
Total Q15

/10

Spare Diagrams

Question 13 a)

Example	Type of Biodiversity	Definition
		The number and relative abundance of different species in an ecosystem.
		
	Ecosystem	

End of Section C

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Section D

Pages: 12
Questions: 6
Information Sheet: 1

Suggested working time: 36 minutes

Instructions:

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Marker use	
C7	/ 36

Guide to Exam Structure

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Totals	**26**	**26**	**180 minutes (3 hours)**	**180 marks**

Criterion

You **must** make sure your answers address:

- Criterion 7 apply concepts relating to human dependence and impact on ecosystems.

Question 16

Marker use

Ecosystems provide humans with goods and services. One example of an ecosystem is shown in Figure 11 below:

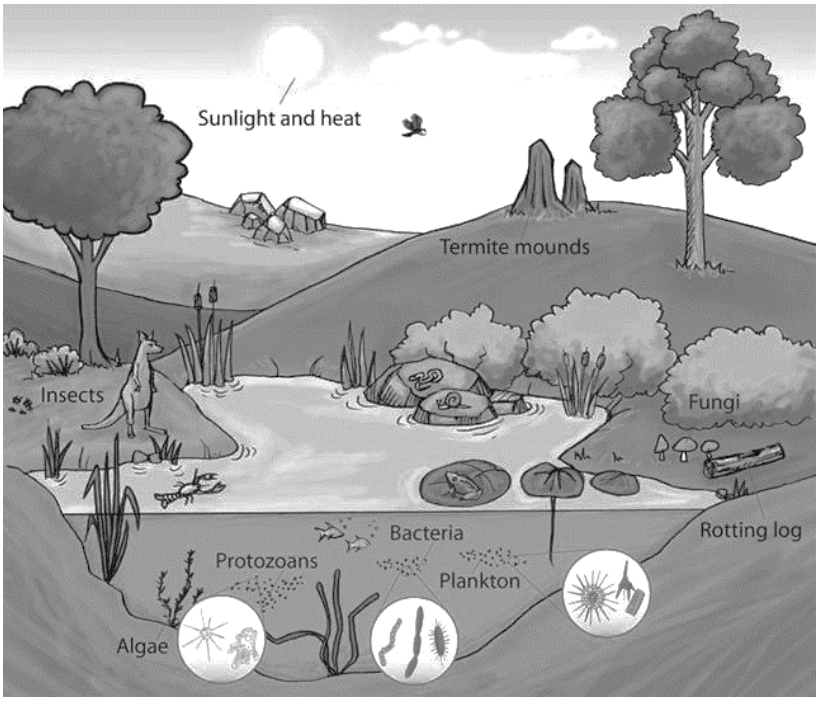

Figure 11: Diagram of an ecosystem, with various features highlighted.

Wikimedia Commons

a) Describe **three (3)** ecosystem services provided by this ecosystem. /3

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b) Explain how cultural services might be disrupted by the construction of a road through this ecosystem. /2

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Total Q16 /5

Question 17

Marker use

One way of considering ecological footprint is Earth Overshoot Day. This marks the date in the year when the demand of the human population for ecological goods and services exceeds what the earth can regenerate in that year. In 2022, Earth Overshoot Day fell on July 28.

a) State **four (4)** factors that contribute to humanity's ecological footprint.

/2

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Earth Overshoot Day can be calculated for different countries by considering the average ecological footprint. Table 5 below shows Earth Overshoot Day for five (5) different countries.

Country	**Earth Overshoot Day**
Australia	23 March 2023
Bangladesh	none
Japan	6 May 2023
New Zealand	19 April 2023
Solomon Islands	23 November 2023

Table 5

Global Footprint Network, www.footprintcalculator.org

b) State which country has the smallest ecological footprint.

/1

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Question 17 continues

Marker use

c) Suggest **two (2)** reasons why Earth Overshoot Day varies between countries.

/2

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d) Describe **one (1)** way to reduce the ecological footprint of a country.

/2

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Total Q17

/7

Question 18

Marker use

To boost agricultural productivity, farmers often use superphosphate fertilisers which they spread mechanically over their fields. Phosphate from these activities can be washed from the soil by heavy rain events into waterways such as ponds and rivers.

a) State whether superphosphate is a pollutant or a contaminant in both the soil and the water. /1

In soil: .....

In water: .....

b) Complete Table 6 for phosphate in the waterways by circling the correct answer: /2

Property	Answer
Point source	YES NO
Biodegradable	YES NO
Persistent	YES NO
Biomagnification	YES NO

Table 6

Spare diagram used (X) ☐

c) Explain the effects of phosphate on aquatic organisms once it enters the waterway. /3

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Question 18 continues

Marker use

/3

d) Pesticides such as neonicotinoids are also used on agricultural land. Describe the similarities and differences between superphosphate and pesticides in their interactions with the ecosystem and effects on organisms.

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Total Q18

/9

Question 19

Marker use

Orange roughy is a small fish that lives in cold, deep (180 – 1800 m) waters around the world including the seamounts south of Tasmania. Orange roughy can live to be more than 200 years old. Figure 12 shows global catches of orange roughy around the world.

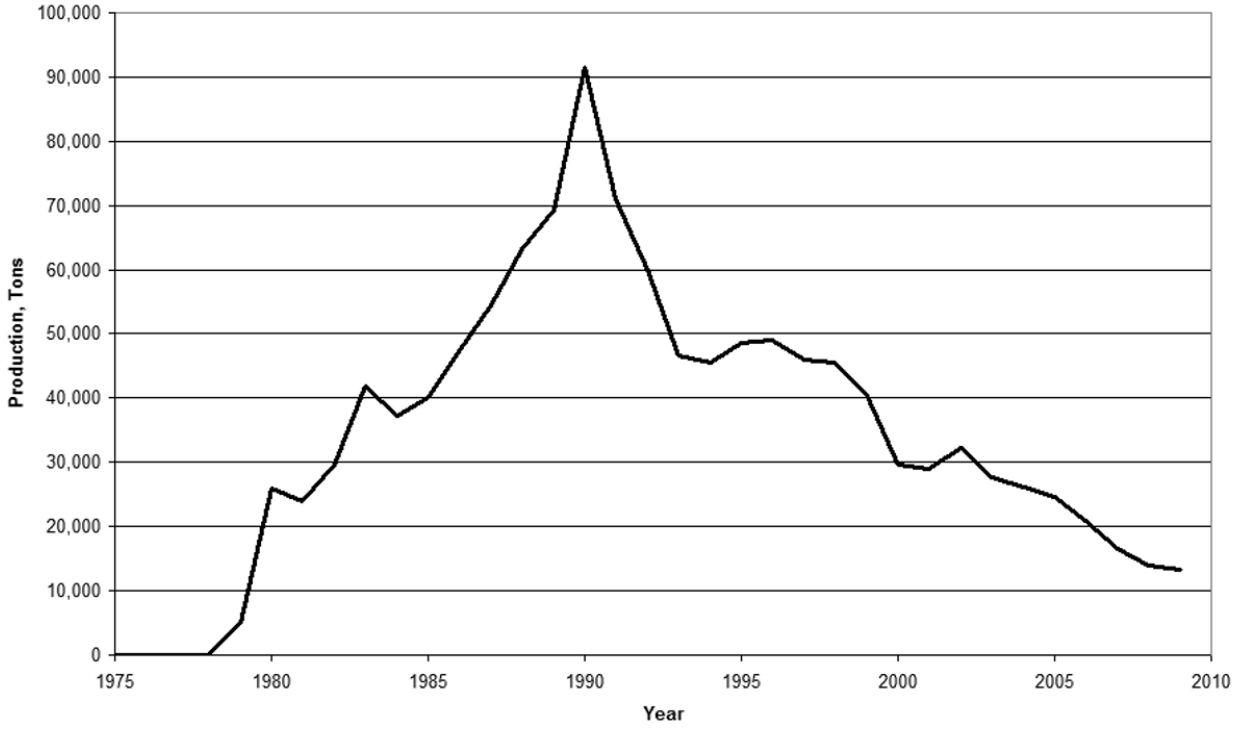

Figure 12: Graph of global catches of orange roughy (tonnes).

Fisheries and Agricultural Organization of the United Nations

a) With reference to Figure 12, explain the changes in the catches of orange roughy over the period shown.

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b) Outline **two (2)** strategies to make wild capture fisheries more sustainable.

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Total Q19

/5

Question 20

Marker use

Many countries in the world have plans to phase out vehicles powered by internal combustion engines and have mandated that all new vehicles must be electric by a certain date (e.g. 2035). Electric vehicles require large amounts of lithium and rare earth metals for their batteries. Additionally, large numbers of charging stations need to be installed.

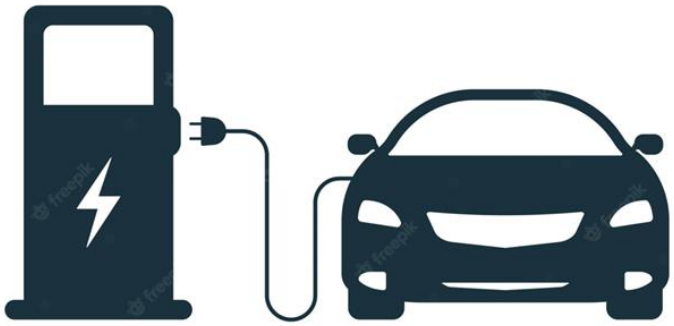

Figure 13: Illustration of an electric vehicle and a charging station.

a) Explain **one (1)** advantage and **one (1)** disadvantage of a swap to electric vehicles.

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b) Suggest **two (2)** other ways in which the environmental impacts of transport might be reduced.

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Total Q20

/6

Question 21

Marker use

Aquaculture is regarded as a vital contributor to human food production. However, there have been many concerns about the environmental effects of marine aquaculture. One proposed solution is the use of land-based recirculating aquaculture systems such as that shown in Figure 14 below.

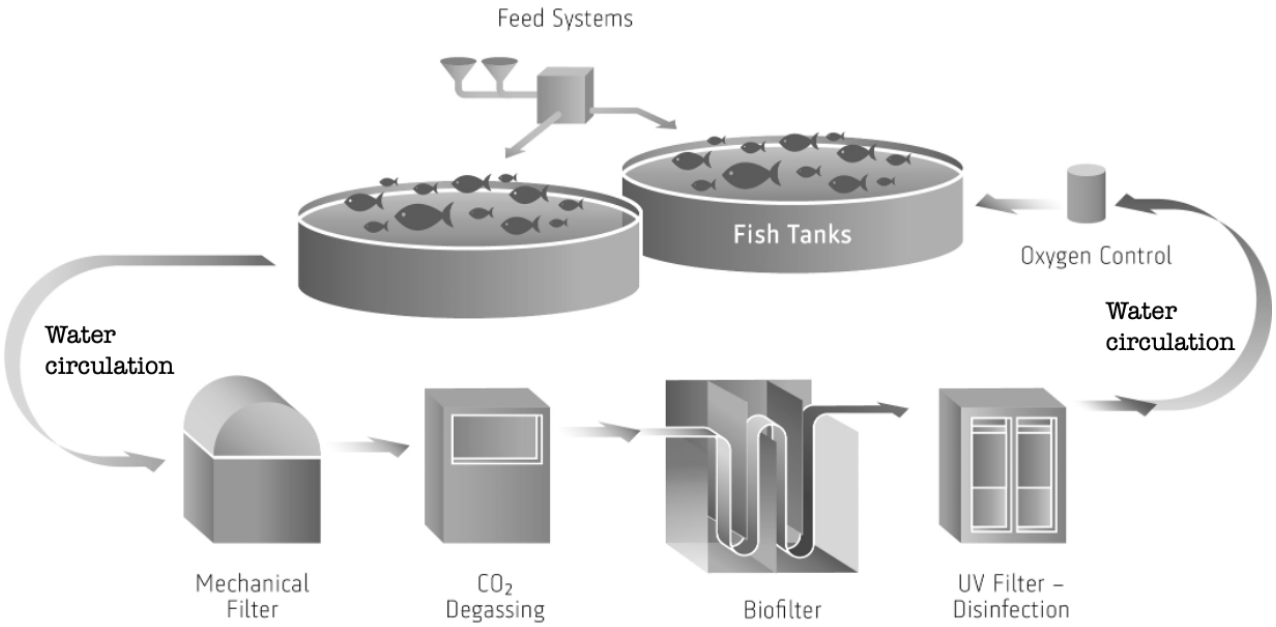

Figure 14: Diagram of a land-based recirculating aquaculture system.
Wikimedia Commons

Evaluate the use of land-based aquaculture as a sustainable alternative to marine aquaculture.

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Total Q21

/4

Spare Diagrams

Question 18 b)

Property	Answer
Point source	YES NO
Biodegradable	YES NO
Persistent	YES NO
Biomagnification	YES NO

End of Section D

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External Assessment 2023

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ENVIRONMENTAL SCIENCE

ESS315118

Section E

Pages: 16
Questions: 5
Information Sheet: 1

Suggested working time: 36 minutes

Instructions:

- Answer **all** questions and **all** items within each question.
- Write your answers in the spaces provided in this exam paper.
  - A spare diagram has been provided at the end of the section. Indicate using the box provided if you have used the spare diagram.
- The exam is **three (3) hours** in length. The suggested working time for this section is **approximately 36 minutes**.
- The Environmental Science Information Sheet can be used throughout the exam.
- All answers must be written in **English**.
- You **must** make sure your answers address the listed criterion.

Marker use	
C8	/ 36

Guide to Exam Structure

	Questions available	Questions to answer	Suggested working time	Marks available
Section A	5	5	36 minutes	36 marks
Section B	5	5	36 minutes	36 marks
Section C	5	5	36 minutes	36 marks
Section D	6	6	36 minutes	36 marks
Section E	5	5	36 minutes	36 marks
Totals	**26**	**26**	**180 minutes (3 hours)**	**180 marks**

Criterion

You **must** make sure your answers address:

- Criterion 8 apply principles and processes related to ecologically sustainable management of the environment.

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Question 22

Marker use

Tasmania has more than 680 species listed as 'Threatened' under the *Tasmanian Threatened Species Protection Act 1995.*

a) Explain how providing legal protection may help protect an endangered species.

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Two (2) of the species protected are the graveside leek orchid and the swift parrot. Details of these species are shown in Table 7:

 Graveside leek orchid (*Prasophyllum taphanyx)*	 Swift parrot (*Lathamus discolor*)
Organism type: Plant (orchid)	Organism type: Animal (bird)
Population size: <10	Population size: >300
Habitat: single site <1 hectare in Campbell Town	Habitat: breeds in old blue gum hollows all over Tasmania in different locations each year; migrates to Tasmania in summer, spends winter in Victoria
Other requirements: obligate (necessary) association with specific type of fungus needed for germination and growth.	Other requirements: needs flowering blue gums close to hollows. Blue gums flower in different locations each year.

Table 7: Table of information about the graveside leek orchid and the swift parrot.

Question 22 continues

Marker use

/4

b) Explain the advantages and disadvantages of using protected areas or reserves for each species.

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Total Q22

/6

Question 23

Marker use

Australia's longest river, the Murray, is fed by waters from throughout the Murray-Darling basin in four (4) States, as shown on the right of Figure 15. The Murray flows out to the sea through a system of lakes known as the Coorong (to the left of Figure 15), which is an important habitat for fish, birds and other animals. In some years, no water flows to the sea at all, partly because water is taken from the river to irrigate crops in Queensland or New South Wales. Water allocations are regulated by the Murray-Darling Basin Authority.

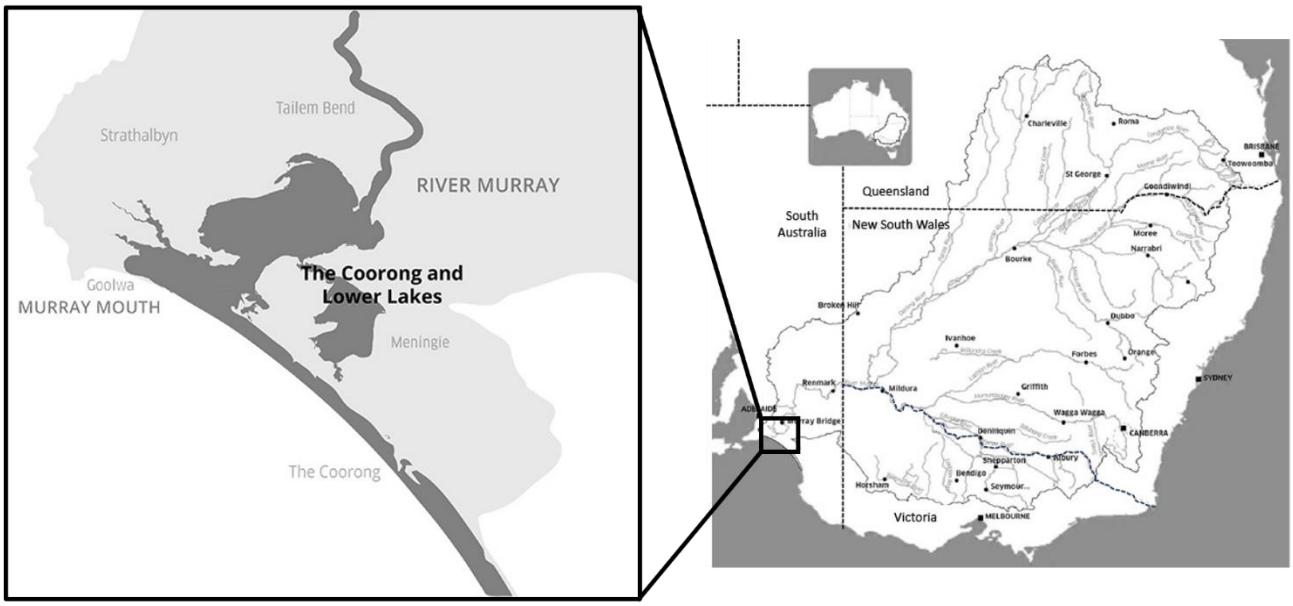

Figure 15: Diagram of the Coorong and the Murray-Darling Basin.

Adapted from Murray-Darling Basin Authority, 2022

a) Identify the common environmental resource in this example. /1

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Question 23 continues

Marker use

b) Evaluate whether the environmental conditions in the Coorong is a 'Tragedy of the Commons'.

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c) Discuss how full-cost pricing could be used to assist in delivering better environmental outcomes for the Coorong.

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d) Describe an alternative strategy to ensure that more water is retained in the Murray River to flow downstream.

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Total Q23

/10

Question 24

Marker use

Coffee is a crop which is widely grown in tropical areas. Usually native forests are completely cleared to establish coffee plantations. These consist of rows of coffee bushes up to 3 m tall which produce the coffee beans (seeds). Often, agricultural chemicals are used to control pests. Considerable amounts of waste material are produced during processing of the coffee beans.

a) Complete Table 8 by suggesting how coffee growing might breach each of the listed ecologically sustainable development principles.

/4

Principle	Example
Intergenerational Equity	
Intragenerational Equity	
Conservation Of Biodiversity	
Pricing Of Environmental Values	

Table 8

Spare diagram used (X) ☐

b) For **one (1)** of the examples of the breaches you have provided in item a), describe how coffee could be produced in a more sustainable manner.

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Total Q24

/6

Question 25

Marker use

Figure 16 shows global plastics production over the last 70 years.

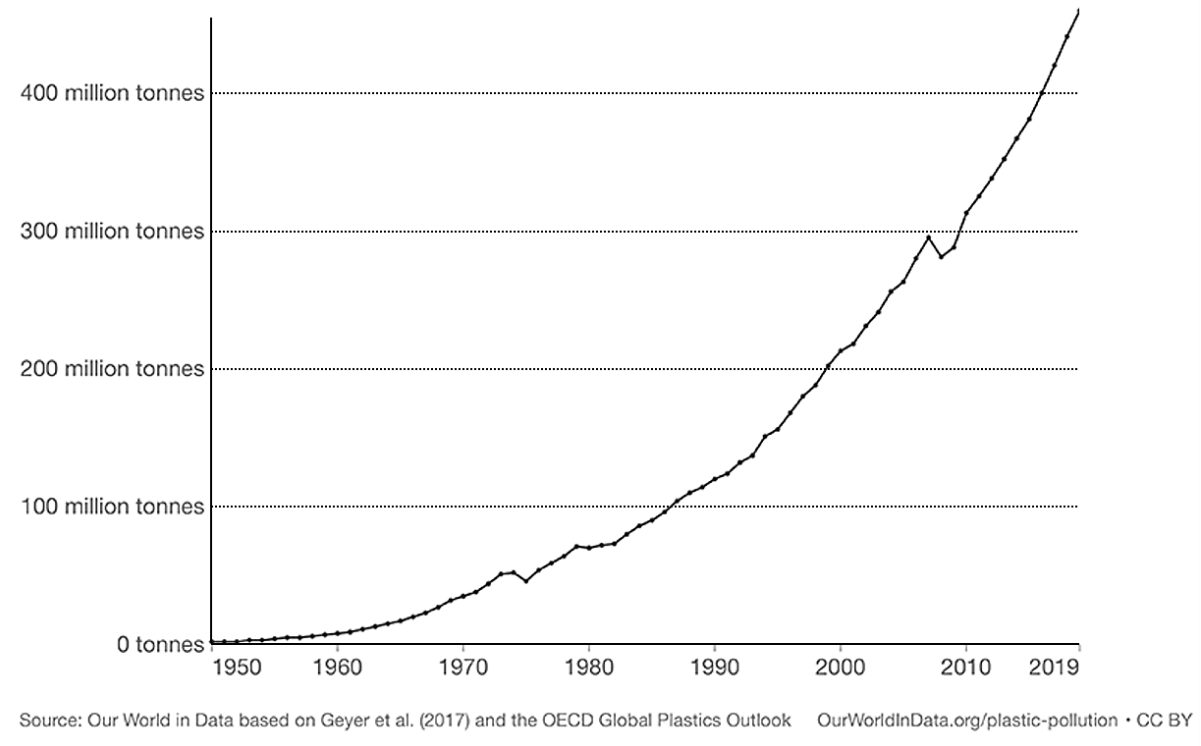

Figure 16: Graph of global plastics production (tonnes).

a) Describe the trend in global plastic production from 1950 – 2019.

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b) Describe strategies that could be used to reduce global plastic use.

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Total Q25

/4

Question 26

Marker use

There is a current proposal to build a wind farm with up to 122 turbines on Robbins Island in the northwest of the state. The site is close to a RAMSAR site and the migration routes of some threatened species of birds.

Figure 17: Photo of four (4) wind turbines at a wind farm.

Wikimedia Commons, CC 3.0

a) Describe what is meant by a social license to operate (SLO). /1

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b) Identify **four (4)** groups of stakeholders who should be consulted about the wind farm proposal. /2

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Question 26 continues

Marker use

c) Describe what specific biotic and abiotic factors would need to be considered when assessing the environmental impact of this project.

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d) Explain **three (3)** other considerations that authorities would need to consider before making a decision on whether the project should proceed.

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Total Q26

/10

Spare Diagrams

Question 24 a)

Principle	Example
Intergenerational Equity	
Intragenerational Equity	
Conservation Of Biodiversity	
Pricing Of Environmental Values	

End of Section E

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