2021 ASSESSMENT REPORT
ESS315118 - ENVIRONMENTAL SCIENCE

General Comments

The written examination was well received by students and teachers. Most students felt the examination paper was accessible and allowed ample scope for them to demonstrate their knowledge. Teachers appreciated the range of complexity in questions from those that assessed basic understanding through to questions that required greater analysis of interrelated concepts, as is the nature of Environmental Science.

In most cases, students provided very good answers. Where students performed poorly it was mostly due to inadequate in incorrect detail in their response. Students are advised to carefully read the questions, seek out exactly what is being asked of them and make connections to the course content they have covered during the year. This should provide scope for all students to attempt all questions.

Students can expect questions that have non-routine contexts, these are questions that use geographic areas or scenarios that are not covered in the course content. Students should read these questions carefully and identify exactly what is being asked and align this with content they have been taught and construct their response accordingly.

Students are reminded that the Information Sheet be used as a reference to assist them in constructing their responses. Responses that are written word-for-word from the sheet reveal little understanding of the required knowledge, and often yield little if any credit. Students should use the information and apply it to the question. It is also advisable for future students to equip themselves with an approved English dictionary, this may prove to be an invaluable asset if terms used in the question challenge their understanding of what is being asked.

Written Examination

The following section specifically comments on students' performance. Markers have offered suggested answers to each question, followed by specific comment on aspects such as how the question was assessed, where students gained or lost marks, where they had difficulty in interpreting the question, or where students failed to comprehend what was required to successfully answer the question. The suggested answers are by no means prescriptive. Students providing different but valid answers were rewarded accordingly as noted by the examiners.

Suggested Answers and Comments
Section 1 (Criterion 2)

Question 1

a) Fin whales

b) There is an overall increase with a slight decrease for the period 1940-49 (possibly due to World War II).

c) One mark was given for trends in Blue and Fin whale statistics. One mark given for use of data. One mark for providing a possible reason for the observed trend.

There is an increase in numbers killed up to a maximum (Blue Whales between 1930-39, and Fin Whales between 1950 -59) and then a decrease in both with the lowest number of Blue whales in 1960 -69 (7434). This is possibly due to the whale populations declining and therefore they are harder to find and kill. The ban on commercial whaling did not come into place until 1986, so these numbers probably reflect a drop in populations of whales and perhaps drop in catch effort as a result.

Credit was also given for alternative reasons including overfishing of Blue Whales in 1930-39 period led to a switch to Fin Whale fishing in the following years to compensate for the decrease in Blue Whales, until a decrease in catch in 1960-69.

Comments

a) Most students performed well in this question.

b) Most students identified the overall trend was an increase in whale kills. Many overlooked the decrease from 1940-49.

c) Most students were able to identify the increase in whale kills before declining at the dates indicated in the sample response. Students need to include more data in their response (years and kill numbers). Most students offered good reasons as to the decline in whale kills. Several students incorrectly related the data to population growth curves.

Question 2

a) Independent variable – planting (presence or absence) of Monterey Pines (½). This could be manipulated by establishing plantations in shallow valleys (i.e., ''frost hollows'') with varying numbers of trees or tree density (1). Shallow valleys without pine plantations should be included too (½).

b) Dependent variable - The severity of frost (½). This could be measured by deploying weather stations at the study sites that record time and surface temperature (1) at or below 0oC (½).

OR

Dependent variable - The number of days of frost in 'frost hollows' (½). This could be measured by using Bureau of Meteorology data to show the number of days with frosts (1½) or temperatures (1) below 0oC within the study area (½).

Credit was also given for responses that included:

- Temperature recorders could be set up in suitable frost hollow locations with and without pines during cold months (June – September).
- Factors such as humidity, surface wind and cloud cover also influence frost potential and severity and these factors could be measured too.
- Severity of frost could also include measuring the area of land effected.

Credit was not given for responses that stated the dependent variable was the frost hollow or mentioned growth of eucalypts as a measurement of frost.

c) This part of the question is investigating the effect of frost on growth of eucalypt seedlings.

Independent variable – temperature (including very low temperatures leading to frost)

Dependent variable – growth or survival of eucalypt seedlings

Conduct the experiment in a laboratory with eucalypt seedlings and subject them to different overnight temperatures that simulate the severity of frosts (1). Take 50 seedlings (replicates/sample size) (1) for each sample temperature and reduce the overnight temperature to a range of temperatures from –4 to 2 oC with intervals of 0.5 oC (treatments) (1). Determine the temperature at which a certain percentage of the number of seedlings die (1). Controlled variables include, same species, same age, same set-up with volume of soil, size of pots, watering regime, same diurnal temperature and length of time for the overnight freezing (1).

Severity of frosts could also mean the length of cold overnight from just a few hours to a full 12-14 hours and this could be manipulated (1).

A field-based experiment is also possible and credit was given for experiments with adequate outline of design considerations.

Comments

a) Students generally performed well in the question, although confusing the IV with the DV was a common error.

b) This question was poorly answered. Many students incorrectly identified the "frost hollows" as the dependent variable and failed to mention frost as a measurable variable. Others overlooked the hypothesis and suggested impact on eucalypt seedlings as a measure of frost.

c) Student success in this question varied. The best responses included experimental terminology and clearly investigated the possible impact of frost on eucalypt survival. Many students failed to recognise the change of variable from parts (a) and (b) and discussed manipulating Monterey Pines and the impact on eucalypts.

Question 3

a) The number of devils killed prior to the trials beginning (1) (data already exists since these have been identified as high roadkill areas). Controls are necessary for comparison, in this case before and after the trial to see if the change in numbers killed (1), the dependent variable, can be attributed to the change in conditions, the installation of judder bars, the Independent Variable (1).

Some credit was given for suggesting the control could be a stretch of road with no judder bars in a similar environment. While this might seem like a good alternative, it really does not show if the judder bars have had an impact in the reduction of devil road kills.

d) Two uncontrolled variables were required (1½ for each depending on detail).

Sample response: The verge vegetation /density type (which is different in the two photos) (½). Devils may prefer to cross roads with shelter close to the road. The effect of this could be controlled by having replica areas, with similar verge vegetation and the two different types of judder bars in each (1).

There are many other possible uncontrolled variables and methods that could be described. These include:

- The number of devils in a particular area. The effect of this could be eliminated by assessing the populations in each area and then adjusting the data as a percentage effectiveness.
- Presence of roadkill attracting devils.
- Other animals (*e.g.,* wallabies) would need to be removed from the area as it may attract devils scavenging and impact the data.
- Speed of vehicles.
- Use of signage and speed limits.
- Loss of devils to predators.
- Other relevant answers included weather conditions, size and make of vehicles and installing cameras to collect data

b) Some way of measuring the true speed of cars, such as radar guns or other traffic monitoring (1), before and after the judder bar section (½) to see if the judder bars did slow down the vehicles (½).

Credit was given for other reasonable suggested improvements including:

- Measuring devil kills as dependent variable is unethical and other methods to determine vehicle speed reduction should be used.
- The speed control devices should be repeated in multiple locations to improve the validity of results.
- It would be more ethical to trial the speed control devices in areas of low wildlife densities to reduce risk of harm to native species. This would be coupled with other methods to determine effectiveness of devices.

Comments

a) Student success in this question varied. Several students described controlled variables rather than stating a control and why is would be necessary.

b) Most students were able to list two uncontrolled variables and explain how to minimise their effects. Some students incorrectly listed controlled variables, such as the spacing of the judder bars & height of bars.

c) A common error was to identify a way to improve the experiment itself and not the testing of the speed control devices.

Question 4

a) The study may have been carried out using a combination of transects and quadrats, evenly *spaced* every 10 metres along the track to the beach (1). The transect is a straight line of set distance (½). A quadrat is a square of fixed size (*e.g.,* 4x4m) (½). At each quadrat location vegetation information was recorded (½), such as individual plant species and abundance (½) or vegetation type and height (½).

Credit was also given for describing belt transects.

b) There are multiple acceptable responses to this question and credit was given accordingly. Marks were assigned as follows:

- Rows showing sample site or distance from beach in metres (1).
- Column headings relating to species type or name (1).
- Column heading relating to species abundance or height (1).

Sample Site	Species Present		No. of plants of each species	Approximate Height (m)
	Flower species	Tree species		
1				
2				
3				
4				
5				
6				

c) There are multiple acceptable responses to this question. Credit was given for outlining the improvement (1) and how it would make the survey more valid (1). Possible answers include:

- Accurate identification of the plant species and some estimation of the age of these plants to see if there is some trend along the transect line, possibly from youngest nearer the beach to oldest at the road.
- Use of drones or aerial photos of the area for comparisons and to confirm accuracy of sketch.
- Repeating the transect several times to enhance observations of trends in vegetation data.
- Sample another site further up the beach.
- Increase sampling to every 5 metres along the transect line.
- Sample at different times of the year.
- Do not use the walking track as a transect as it may have been exposed to clearing and pollution which could influence the vegetation.

Comments

a) Most students provided sound methods similar to the sample answer shown. Many students overlooked describing what vegetation data may have been collected. Some students provided vague responses such as "looked at photographs" or "walked around and made observations", these yielded little credit.

b) Students provided various table formats that were relevant to further study. Several students misread the question and drew graphs to represent the data, these did not receive any credit.

c) The question was well answered.

Question 5

a) *A. gouldii* is only found in rivers which are pristine (½) and therefore it is an indicator of good environmental health (½).

No credit was given for stating it is endangered or has a narrow range.

b) `Abiotic factor (1). Justification of choice (1). Two abiotic factors were required. Multiple responses are possible, examples include:

- Low turbidity (1). Turbid waters (i.e., with suspended solids) impede oxygen uptake by the gills of aquatic invertebrates (1). Turbid waters may also reduce photosynthesis leading to lower dissolved oxygen (1).
- Low nutrient concentrations (e.g., nitrates and phosphates) (1). High levels of these nutrients lead to the growth of algae, increase turbidity and decrease photosynthesis and dissolved oxygen (1). Excessive growth of algae causes a biological oxygen demand when dead algal cells are decomposed by respiring bacteria, leading to decreased dissolved oxygen (1).
- High dissolved oxygen (1)
- Low water temperature (1) leads to higher dissolved oxygen potential (½). Dissolved oxygen is required for survival (½).
- Flowing water (1). Ripples in streams and rivers aerate the water providing ample dissolved oxygen (1).
- Low salinity or electrical conductivity (1).
- pH within optimal range (1).
- Absence of pollutants which could reduce water quality by increasing heavy metal concentrations, impacting the growth and reproduction of the crayfish.

Rocks or other physical features only given credit if they are related to water quality (*i.e.,* not as place to hide)

Comments

a) Students found this question difficult. The term "index" was often confused with "Keystone" species or was commonly answered "because it is endangered". Many responses were left blank.

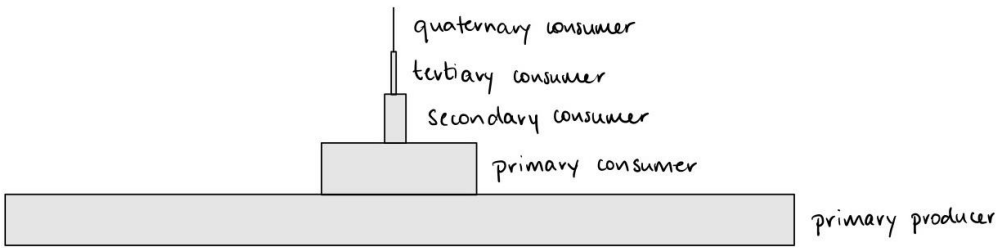
b) Most students were able to identify two abiotic factors and provide suitable justifications. A common error was to identify an abiotic factor without stating what water quality level should be observed suitable for crayfish habitation. Instead, students focused their response on how the factor can be detrimental rather than why it needs to be at appropriate levels. Other students provided simplistic justifications stating if the abiotic factor was not suitable the crayfish would struggle to survive. Some students incorrectly stated biotic factors such as the presence of prey or plants.

Suggested Answers and Comments

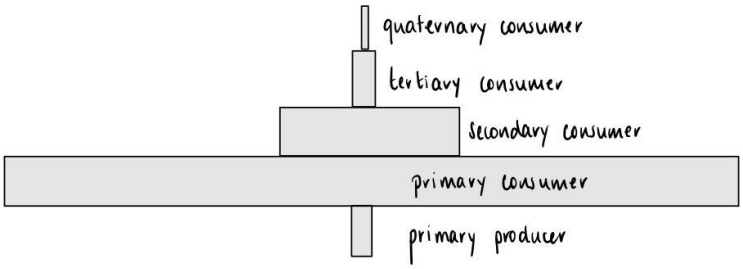
Section 2 (Criterion 5)

Question 6

a) Pyramid diagram with five levels of the correct shape (as per diagram below) (1). Note - pyramid can be inverted as per the second diagram as this is an oceanic/phytoplankton food web. Each level should be about 10% of the previous level (as best as practical) (1). Labels of the trophic levels (1).



OR



b) Decomposers/detritivores (1). They break down dead organic material (e.g., C, N, P) (½), which enables the nutrients to be recycled through the ecosystem and taken up by other organisms (½).

c) The sun provides the original source of energy for this food chain (1). The energy is converted to chemical energy by the primary producers, using photosynthesis (½). This energy is then passed up the food chain as each trophic level feeds on the level below it (½). At each step only 10% of the energy is passed on, the other 90% of the energy is "lost" (½), converted to heat during the lifetime of the organism (2nd law of thermodynamics) with energy lost in respiration, incomplete digestion and growth of the organism (½).

Comments

a) A large number of students drew inverted pyramids that continued to increase in size up each trophic level (rather than just the second trophic level), possibly reflecting the size of the organisms provided in the picture.

b) and c) were generally done well. Marks were lost for lack of detail around the role of decomposers and where energy is ''lost'' in energy transfers.

Question 7

Abiotic Factors (any four valid factors from list below (½ mark for each):

- Temperature
- Light availability
- pH
- Water/rainfall/soil moisture
- Humidity
- Wind
- Turbidity
- Salinity
- Nutrient availability

Biotic factors – Members of Same Species (any 2 valid factors from list below (½ mark for each):

- Competition for food/resources/space
- Competition for mates
- Spread of disease
- Reproductive factors (e.g., birth rate, number of mating pairs etc.)

Biotic factors – Members of Other Species (any 2 valid factors from list below (½ mark for each):

- Interspecific competition for food/resources/space
- Predators
- Prey/food sources
- Parasites

Comments

Students performed well in the question with a large number achieving full marks.

Question 8

a) i. Predation; Predator/Prey

ii. Competition (interspecific)

b) Marks were allocated as follows:

- Definition of niche (1)
- No two species can have the exact same niche (1)
- Explanation of similarities and differences between the two organisms (2)

An organism's niche is the complete description of its role within the community, plus its habitat, interactions and tolerance levels. No two species can ever have the exactly the same niche or one will outcompete the other (Law of Competitive Exclusion). In this case both species are predators on lizards, frogs and small mammals. This tends to indicate that they are in competition with one another, but because they hunt by different methods they avoid direct competition. The Swamp Harrier, on the wing, may have a larger range than a stationary Kookaburra yielding more prey, whereas because the Kookaburra is stationary it may be more efficient and get a higher yield in a particular area.

Comments

a) Most students were able to identify the relationships between the species.

b) Many students stated that the two birds had the same niche, and they could survive due to the high amounts of their prey. This was marked as incorrect, although some marks were awarded if they could explain the similarities and differences between the two species. A number of students gave incomplete definitions of niche (just referring to the organism's role in the community) which scored half marks.

Question 9

a) The population of a particular species that can exist or be sustained in a certain area and persist over a longer time period.

b) Marks were allocated as follows:

- Two marks for understanding of causes of fluctuations, e.g., environmental resistance as populations approach or overshoot carrying capacity (the term "environmental resistance" was not required for full marks if correct understanding shown) and biotic potential when populations are below carrying capacity.
- Two marks for examples and how they impact carrying capacity.

The changes within the environment (environmental resistance – both abiotic and biotic factors) can cause fluctuations in the population, for example seasonal availability of food, temperatures changes or rainfall or more long-term effects such as droughts. The effects of predation may cause a temporary decline in the population or catastrophic events such as floods or bushfires would affect the population dramatically. Over the long-term, however, the population is "stable" around some figure that the environment can support.

c) Physiological stress is where the organism's body chemistry or behaviour is affected by some factor in the physical and/or chemical environment (1), for example temperature, pH, salinity. Most species live within an area defined by factors which meet their needs – 'zone of tolerance' - and outside this they will have reduced function, biotic potential or be under stress and only some members of the population can survive (1). One well explained example (*e.g.,* corals and temperature ranges, estuarine fish and salinity).

Comments

Overall, this question was done poorly with students showing little understanding of physiological stress shown in (c). Answers to (b) were generally very superficial with not enough detail shown.

Question 10

a) Rainforests occur in areas where the annual rainfall is above 1500mm per year and this is generally in the west of the state where there are onshore winds bringing consistent rain. Rainforests are typified by species such as Myrtle, Sassafras and Celery Top Pine (no eucalypts) with dense moss and lichen coverage too. As rainfall deceases to the east more eucalypts are found. Wet Eucalypt Forests have eucalypt species, (*e.g., E. regnans, E. obliqua, E. delagatensis)* as the dominant vegetation. Beneath the canopy of these eucalypts the moist environment provides growing conditions for rainforest species as an understory and shrubs such as Dogwood, Musk *etc.* In the drier, eastern areas of Tasmania, Dry Eucalypt Forests exist with different eucalypt species, no rainforest species but an understory and ground cover of other sclerophyll plant species and a much more open canopy that allows for grasses and sedgeland species to thrive.

   Two marks was awarded for description of rainfall patterns and the distribution of forest types according to that rainfall. One mark was awarded for species found in forest types related to rainfall (*e.g.*, presence/absence of eucalypts and rainforest species - species names were not required). One mark was awarded for structure (*e.g.,* understory / canopy) related to rainfall/water availability. Credit was also given if the links between rainfall and fire were used to explain species and structure of the forest types.

b) Eucalypts are not just fire tolerant, but fire dependent and need fires to release new seeds to regenerate. Dry Eucalypt forests have more frequent fires as the forests are more open and drier.

   Wet Eucalypt fires are less frequent but more intense and occur only when the season is very dry.

   Many eucalypts have lignotubers and epicormic shoots, inflammable oils, decorticating (stringy) bark and large amounts of slow decaying litter. More open canopies, low moisture and light are all features that lend itself to fire.

   Rainforest species are not fire tolerant and will die if burnt. Rainforest regeneration after fire is a long, slow process. They have closed canopies and low light penetration, moist conditions and rapid decomposition. Generally, they have no fire promoting or tolerating features.

   Fire in Dry Eucalypt forests is spasmodic, often localised and of varying intensity. The forests are often a patchwork of multi-aged trees, some new trees and others that survived previous fires. Whereas in Wet Eucalypt forests, the trees tend to be all the same age since

they germinated after the same fire event, as usually much larger areas are burnt to the ground in appropriate weather conditions, due to more moisture and damp fuel material. Two marks were awarded for description of how fire assists forest regeneration. Three marks was awarded for the effect of fire on each of the three forest types (one mark each forest type).

Comments

A number of students left this question blank. Those who attempted it generally managed to achieve at least half marks.

Suggested Answers and Comments

Section 3 (Criterion 6)

Question 11

a) The Greenhouse Effect (½) is increasing due to more CO2 entering the atmosphere from humans burning fossil fuels (½). This enables the atmosphere to absorb and retain more heat, less is radiated out into space and the planet warms (½). Most of the excess atmospheric heat is absorbed by the water in the oceans (½).

b) As the atmospheric CO2 levels increase (+400ppm) (½), some of this dissolves into the world's oceans (½). CO2 + H2O combine to form H2CO3 (carbonic acid), which increases acidity and lowers pH (1) due to H+ ion concentration increasing.

c) Increased planetary temperatures are causing polar ice caps and alpine glaciers to melt (1) producing a greater volume of water in the oceans and hence a higher sea level (1).

d) Also, increased ocean temperatures mean that the water in the world's oceans are expanding (thermal expansion) (1), causing the sea level to rise (1).

Comments

a) Most students linked an increase in greenhouse gasses and the greenhouse effect to global warming. Many answers discussed the reduction of the Earth's albedo which earned partial marks. Students needed to explain the greenhouse effect and link global warming to rising ocean temperatures to gain full marks.

b) Generally, students identified carbon dioxide as the cause of ocean acidification, however many struggled to clearly outline the process of how an increase in CO2 causes carbonic acid in water. Chemical formulae were not required for full marks.

c) Most students were able to link ice melt with an increase in sea level, however many students struggled to name land ice, alpine glaciers or polar ice caps as the main contributor. Melting of icebergs was not awarded marks. More than half the students failed to identify thermal expansion as the second factor for sea level rise and as a result many students did not achieve full marks.

Question 12

a) Suggested answers:

Introduced species are generally better competitors for food resources, *i.e.,* more efficient predators (1) and rarely do they encounter predators that would keep their population in check or eliminate the species entirely (1).

OR

Successful introduced species fill an unoccupied niche and have few predators that are adapted to regulate their population (1). Introduced species are often generalists and can prey or forage on a range of species and therefore outcompete native species (1). Successful introduced species often have a high reproduction rates, which means they can increase in population rapidly and outcompete native species for resources (1).

b) Students needed to explain 4 aspects of barriers to eradication and traits of invasive species to gain full marks. Possible answers include:

- Eradication programs are rarely successful because these programs are often labour-intensive and therefore expensive (1).
- The species is often not identified until it is well established in (size and area) and it is identified as a problem (1), by which time it may be too late for effective eradication and focus must be on containment (1).
- Culling and other eradication strategies may be unethical and are rarely successful in eliminating all individuals and so there is a remnant population that can breed and re-establish (1). This means that control efforts must be directed across all available habitat and for a long period of time which is not usually feasible (1). Invasive animal species usually have high reproduction rates so the control efforts must be more effective than the birth rate and for a long period of time (1).

Comments

a) Most students could identify reasons for introduced species being successful in new habitats, but many failed to explain them fully, which was required for full marks.

b) Overall, most students achieved 2-3 marks. Many students failed to link control measures and traits of invasive species with the challenges of achieving eradication. A large number of answers focused on pesticide resistance, and this was awarded partial marks.

Question 13

a)	1.	2.	3.	4.	5.
	No	No	No	Yes	No

b) Species 2 is a native species whose population has declined. Reasons for this decline include:

- Competition or predation from a species introduced with European occupation.
- Land clearing which has diminished its habitat or introduced disease has impacted species.
- It was hunted by Europeans as food source or was pest to agriculture and therefore culled.

Species 3 is a native species whose population has increased since European occupation. Reasons include:

- A decline of a predator or competitor.
- Land clearing for agriculture has provided it with more grazing area compared to possible forest habitat beforehand.
- It predates or eats an introduced species, therefore increasing in population.

Marks were assigned as follows: identifying both are native species (½). Explanations for changes in graph 2 and graph 3 (1½)

Comments

a) Students were awarded 1 full mark for correctly identifying species four as an introduced species and ¼ marks for correctly identifying native species. Most achieved full marks, however, there was confusion with some students about species 3, as it has increased since European occupation.

b) More than 40% of students achieved full marks for this question. Full marks were awarded to all plausible scenarios. However, no marks were awarded for answers that suggested that species 3 was domesticated by Europeans. There is no historical record of this in any colonies across Australia.

Question 14

a) Five descriptive statements were required (one mark awarded for each statement). Examples include:

- Removal of the riparian vegetation community has reduced the available habitat for species dependent upon the vegetation for food or shelter (1).
- A 'Simplification' of the ecosystem due to local extinctions has reduced biodiversity with less species in the food web (1).
- The ecosystem is less stable and more susceptible to changing conditions - droughts, floods, temperature fluctuations - which in turn change the numbers of the remaining species in a series of population boom and bust periods (1).
- Increased erosion and run off. With removal of riparian vegetation, there is more water run-off as there is less vegetation to slow and trap the water. This leads to less absorption of water by the ground (1).
- Reduction in DO in the water as shallow, photosynthesising algae cannot grow in deeper water, leading to loss of aquatic species (1)
- Increase in water turbidity due to increased erosion and increased water flow due to channelisation from retaining wall and loss of vegetation (1)
- Increase in dissolved CO2 due to loss overall loss of productivity from changed vegetation structure (1)
- Increase in flooding and water-logged soil by changing slope and natural gradient of river (1)

- Loss of overall nitrogen content in soil due to loss of nitrogen fixing native species and loss of regular flooding events from retaining wall that deposits nutrients as silt (1)

b) Students were required to describe two changes (two marks were allocated to each change).

i. The damming of rivers results in inundation of the catchment area and a loss of terrestrial ecosystems (1) in this area replaced by riparian communities around the water's edge. Often within the dam the water is too cold and deep, so the conditions are unfavourable for the development of aquatic communities (1). Downstream, the reduced environmental flows mean that pools dry up and the areas of suitable habitat for many species are reduced and therefore these populations decline (1).

ii. Cattle have hooves that cut the native vegetation and, as well as trampling, cause erosion which increases the amount of sediment flowing into the river (1). This increases the turbidity and also the nutrients present in the water. These alterations to the abiotic conditions mean that the populations of freshwater species are altered and can lead to reduced biodiversity (1). Cattle crossing the river may also lead to increased nutrient load leading to eutrophication (1).

Comments

a) Few students clearly understood the term ecosystem function, and as a result many students only received 1-2 marks. Many answers included the changes in ecosystem services, and these were awarded credit as long as they were relevant to the question. Other answers focused on the loss of biodiversity and/or habitat, however few students successfully described five aspects of the ecosystem that were altered.

a) i. Students generally identified a loss of habitat and water flow as a result of damming but failed to describe the changes to the river as a whole.

ii. This question was answered well, with a majority of students receiving 1½ - 2 marks. Many students lost marks by not specifying 'waste' that the cattle could cause in the water.

Question 15

Genetic Diversity increases with greater populations of the same species (½) due to the increased randomness of matings and number of potential mutations within a population. There is more genetic variety as numbers increase (1½).

Credit was also given for: Genetic variety reduces due a small starting population and therefore low genetic diversity (½), losing pre-existing genetic material from excluded communities creates a bottleneck effect within the species causing the future generations to have limited genetic variation (1½).

Species Diversity the number of different organisms/species present increases (½), not so much with mammal population that can't get through the fence but with plants, birds and invertebrates that can enter the area. Decrease in feral predators will also allow an increase in smaller species. Some species may also return to the area after being locally extinct (1½).

Ecosystem Diversity the number of different types of ecosystems on Earth (½), increases because this area provides another example of a more intact ecosystem. The ecosystem becomes more

robust and is able to cope with seasonal fluctuations due to dry conditions, rain and fire events, as organisms adapt to new food and shelter sources (1½).

Comments

This question was answered poorly with most students not able to articulate the link between the types of biodiversity and how the Arid Recovery Area contributes to them. Most students could define genetic and species diversity but not ecosystem diversity. Definitions of the types of biodiversity were awarded ½ a mark with a clear explanation and link to the recovery area earning 1½ marks. More than 50% of students achieved less than 3 marks with no students achieving full marks.

Suggested Answers and Comments
Section 4 (Criterion 7)

Question 16

Bees provide honey as a food to humans and other organisms (1). Bees are also responsible for the pollination of many plant species including a large number of crops (1). Without bees there would be a shortage of foodstuffs and many types of plants would become unavailable due to lack of pollination. This would transfer to a lack of energy flow to the entire terrestrial ecosystem (1). The loss of biodiversity and genetic diversity from the decrease of plant species, may result in decreased ability of ecosystems to cope with changes, especially Climate changes (1).

Comments

Many students added the category of the Ecosystem Service (Regulating or Supporting or Provisioning), this was not required in the question or answer but made marking much clearer and demonstrated a strong understanding of ecosystem services. Many students need to consider the marks allocated; for this 3-mark question, three different Ecosystem Services were expected. As this question asked to 'outline', marks were generous but if honey was listed without any other detail, this only achieved ½ mark.

Question 17

There are multiple possible impacts that could be explained in this question. Example responses include:

- Nutrient enrichment due to a build-up of excreted fish faeces can lead to poor water quality and eutrophication/dead zones beneath the pen (1). This will alter the native populations so that most bottom-living (benthic) species will die from lack of oxygen (1).
- Bottom dwelling seaweeds, molluscs and other species are impacted due to the lack of light and waste faeces from the pens above (1). Loss of habitat and biodiversity as areas under the pens become barren (1).
- Seals and sharks tend to be attracted and congregate around pens (1). This may lead to an increase in the seal population and a subsequent loss of other native fish species in the area (1).
- Overstocking of pens can result in diseases (1) and these may be transferred to native or other aquaculture species with a result in a decline in marine biodiversity (1).

Comments

Students had little trouble mentioning impacts but often omitted the impact upon the ecosystem. This meant they only achieved one mark. Misinformation was also common and could be attributed to various media releases this year.

Students commonly and incorrectly stated that:

- Escaped salmon feed upon native species, breed with native species and may genetically alter native populations. This does not occur in Tasmania as Atlantic salmon (Salmo salar) are not native, there are no other Salmonidae species with which to breed, and they do not feed upon native species (after they escape Atlantic salmon only associate the shape of pellets with food, so they have no ability to feed themselves and slowly starve). The true impact of a salmon release is a great amount of food for predators only.
- High levels of nutrients cause algae to bloom under the salmon pens. This does not occur as there is not enough sunlight available for photosynthesis under the pens. A dead zone does form but under the pens it is only due to the decomposition of waste. Algae do bloom from the high nutrient loads, but in other areas.
- Wasted food under the pens create high nutrient loads and this leads to Eutrophication. This currently does not occur in Tasmania (but has in the past). Pellets are expensive and recent technology allows pellets to be fed only until the fish are full and they stop eating. If an extra pellet falls past a sensor within the net, it triggers the automated feeding system to stop. The high nutrients that lead to eutrophication is only from the great amount of fish faeces, not wasted pellets.
- When the great number of fish in each pen respire, they use all available dissolved oxygen, and this reduces the ability of native species to thrive so biodiversity declines around the salmon pens. This is untrue as the stocking density in each pen is carefully designed for maximum growth and prosperity (varies with currents, temperature, and flow etc.). The business is not viable if the fish suffocate.
- Antibiotics are poured into the water and these may impact native species and the bacteria may develop resistance. This does not occur in Tasmania. Most fish are vaccinated individually and amoebic gill disease is treated using fresh-water bathing.

Question 18

a) Impact per capita means the impact/footprint per person (1). This is useful as a comparison between countries of different populations.

b) i. B

ii. Even though there are more people in a developing nation the overall impact is less because each person's impact is less (1). People in developed nations consume more in food (over-nourished) that is produced at an industrial scale and is usually transported internationally. This requires more energy and releases more emissions (1). In developed countries consumerism is higher as people are more affluent, and so a larger amount of energy from fossil fuel use increases emissions and each individuals' footprint (1). Houses are larger and so use more energy to heat and cool (1), many vehicles are owned by a household which also release more emissions as does air travel for international holidays (1).

c) The number of people the planet can support is it's carrying capacity (1). A person's Ecological Footprint assesses the impact they have on the environment measured in units that equate to how many planets that person would need to survive. Most people in developed nations have a footprint greater than one planet so they are living beyond Earth's capacity to support them, beyond its carrying capacity (1).

Comments

a) This was a poorly answered question. Many students should have brought an English dictionary into the exam. It would have benefitted about 1/4 of the students.

b) i. Many students were confused by this question. Then needed to concentrate on the rectangle showing Ecological Footprint, which usually relates to a global hectare (area). Developing countries are characterised by small footprints in comparison with developed countries.

ii. Generally, this was well answered as there were many possible points for full marks. Many students chose to focus upon why developing countries have a smaller per capita footprint. For example: there is generally less electricity and energy use; more local food that is grown with less processing and transport; a lower standard of living means less consumerism; more shared transport with less vehicles and no international holidays were all valid points. Any similar, well-explained three points achieve full marks.

c) The concept of carrying capacity was challenging, and many students did not achieve full marks.

Question 19

a) Electric vehicles have less or little reliance on fossil fuels as they do not burn LPG/Petrol/diesel when running (1) so there is less CO_2 emissions which means less contribution to the greenhouse effect and climate change (1). There are less pollutants such as lead, NOx or particulates PM2.5 or PM10 released which contributes to better air quality (1). There are fewer secondary pollutants like acid rain and photochemical smog as a result of less primary pollutants (1). The electricity to charge the batteries may be sourced from renewables/green energy (solar/hydro) further reducing CO_2 released from coal fired power stations (1).

b) Electric vehicles may add to emissions if the battery is charged using electricity that is generated from coal or gas. Emissions are thus created through charging. (1) There is a great deal of energy and resources required to produce the batteries and car parts. For example, mines and oil wells are needed to provide steel and the hydrocarbons for plastic parts and rare earth minerals such as lithium for batteries. These have impacts on habitats and land and pollution, not just emissions (1). EVs are all currently produced overseas, so shipping and transport adds to emissions (1). The batteries (and many conventional cars that EV replace) and car parts need to be disposed of in an environmentally friendly and non-polluting manner (1). The increasing demand for electricity due to charging batteries may have an impact if more rivers are dammed and habitats are flooded e.g., the Mekong river in Asia (1).

Comments

a) Most students did quite well as there were many possible points for full marks.

c) Again, most students did quite well as there were many possible points for full marks. Only a few students knew about lithium and the environmental harm of EV batteries, but there were many other general impacts that enabled them to score well.

Question 20

The bait has not been approved probably because of its effects on the environment. It may not be biodegradable and therefore is persistent in the environment (1). This means that it might bio-accumulate in some organisms and then become more concentrated up the food chain in the process of biomagnification (1). The effects of the poison may not be noticed until top order predators are affected. There is also the very realistic chance that it will kill non-target species, native mammals with a similar diet that will feed on the baits (1). The poison may also be present in runoff and flow into waterways and affect other aquatic or marine species (1).

Comments

This was an approachable question, but most students did not achieve full marks. Students should use all the space provided and pay close attention to the number of marks allocated to the question. Either two, very well-described points or four, single points were required for full marks. Very few students described biomagnification and bioaccumulation for two well-described points. If their answer had enough detail, they were able to achieve full marks. Underlining one heading for bioaccumulation and one heading for biomagnification is recommended to show very clear understanding. Often a bioaccumulation and/or biomagnification question is a 4-mark question. Refer to Q21 in the 2018 exam for the details/words needed to attain full marks.

Question 21

a) Fish (1). Fish and another species were only awarded a ½ mark.

b) i. The type of food consumed by immature sea birds is more varied. They consume all four types *i.e.,* cephalopods/fish/crustaceans (Graphs A, B, C and D) (1). Adults seem to focus only on krill/crustaceans (Graph B) with much less squid than immature sea birds (1).

ii. The younger birds ingest mainly hard plastic & balloons with smaller quantities of the 'Other' plastic (1). Adult birds ingest almost exclusively hard plastic and almost no balloons nor any of the five categories of plastic (1).

c) The sea birds ingest the plastic that resembles the shape of their natural food (1). For example, balloons resemble squid and hard plastic resembles krill (crustaceans) (1). When broken down hard plastic floating at the surface may glistens and resemble fish/krill near the surface. A deflated balloon would be very close in shape to a squid.

d) The prions are smaller and may ingest less plastic for it to be fatal. It would fill up their stomach, so they starve quickly compared to the larger albatross (1). Sharp hard plastic may also pierce the smaller and more fragile internal organs more easily than the larger gut in an albatross (1). Some species (Albatross) may be better at regurgitating and so survive ingesting the hard plastic than others (prions).

Comments

While this was a challenging question, most students did reasonably well. However, understanding that sea birds ingest plastic pieces floating on the sea surface (as they resemble their prey), in addition to, plastic via the gut of their prey was rarely understood. The graphs unfortunately appear to have reinforced the erroneous concepts that one, plastic is a food, two, that plastic can be digested, and three, plastic provides nutrients.

a) Almost all students had several crossed-out answers for this question, showing their confusion in understanding the graphs.

b) i. For full marks both adult and immature sea birds needed to be included, data was not required. The wording of this question confused some students and was marked generously.

ii. This part was completed with greater success than part i). For full marks both adult and immature sea birds needed to be included. Successful students simply stated which of the seven types of plastic were consumed by the adults, and then also the immature sea birds, and were able to gain full marks.

c) This question was answered poorly. Many students did not see the connection between food shape and the type of plastic. The similarity between deflated balloons and the shape of squid was the most common answer, if any relationship was given.

d) This was answered well and was quite straightforward.

Suggested Answers and Comments
Section 5 (Criterion 8)

Question 22

Intergenerational Equity

- Same family
- Electric car charging stations
- Protects native habitat
- The genetic library

Intra-generational Equity

- Not using pesticides
- Use of solar lowers carbon emissions
- Interpretation signs supporting wide range of nationalities (½)

Full Cost Pricing Principle

- The extra cost of the wines pays for the waste management.

Efficient Use of Resources

- The other property is used as genetic insurance
- Electric car charging station
- Birds used to remove pests (½)

Education

- Interpretation signs (½)
- Genetic library teaching about sustainability

Economic Sustainability

- Diversifying into dining and food retailing as well as winegrowing and making
- Pricing of wines covers cost of waste

Comments

The majority of students scored more than 50% on this question. The two aspects of sustainability that caused the most confusion were intragenerational equity and economic sustainability, with a number of students leaving these blank.

Question 23

a) Ecological sustainability depends upon maintaining ecological integrity and conservation of areas of intact habitat that provide this sustainable environment (1).

Biodiversity is maintained to some extent with remnant vegetation and landscape. The vegetation provides habitat for organisms, patches for food, nesting sites and shelter areas (1).

b) All developments are subject to planning approvals and for a development to proceed it cannot contravene local government laws, State government planning restrictions, Federal laws and international conventions (1).

An example of Federal Legislation is the Environmental Protection and Biodiversity Conservation Act EPBC (1999) (1), which provides legal protection for threatened species. In this case it may be bird-nesting habitat (1).

International conventions include RAMSAR (1), which is designed to protect the wetlands that are needed for migratory birds (1).

The World Heritage Convention would not be relevant here as it is not listed as World Heritage (1).

Migratory Bird agreements (*e.g.,* JAMBA) (1) may also be relevant depending on the location of the golf course and the presence of migratory bird species using the area (1).

Environmental Impact Assessment (EIA) could be used to determine the requirement of a potential Federal agreement (1)

c) Students were required to cover both advantages and disadvantages to gain full marks.

Advantages:

- The provision of accommodation on site at the golf course makes the golf course a more attractive option for interstate and overseas visitors because it is more convenient (1). Visitors can have an all-in-one, one-stop visit. The golf course benefits economically because the accommodation revenue is not going to another business. This benefits the local community (1).
- Promotion of the area and golf course globally raises ecological awareness and knowledge of biodiversity with a wider audience (1).
- Golf tourism would attract 'high end' tourists, potentially spending more money and providing an economic boost (1).

Disadvantages:

- Interstate and overseas visitors are dependent on air travel, which is not an environmentally sustainable practice because of the fossil fuel that airplanes use (1).
- Possible increases to infrastructure (e.g., water and sewage) which may result in more effluent and local water quality decline if not managed well (1).
- Possible biosecurity risks with soil microbes and seeds on golf shoes and clubs (1).
- Equity issue – maybe restricted to cashed up people so not an easily accessible resource (1).

Comments

a) Students generally identified a reason why maintaining vegetation and sand dunes is important to plant and animal species, however many lacked a connection with sustainability and ecological integrity.

b) Many students struggled to identify specific Federal laws and international agreements, with a number of responses discussing the need for EIA and Environmental Management Plans (EMP) which did not gain full marks. Students needed to link specific legislation and agreements with the golf course to explain why they would need to be considered.

c) This question was answered well with a majority of students receiving 3 or 4 marks. Most responses focussed on economic points rather than ecological ones.

Question 24

a) Following the Precautionary Principle demands that any action not proceed unless there has been a rigorous investigation into the possible consequences of an action. It is the opposite of just jumping in and hoping for the best (1). Conservationists warned that, although introducing devils to Maria Island was probably good for conservation of the Tasmanian Devil, it may have a devastating effect on the rest of the island's fauna due to the predatory behaviour of devils (1). Therefore, conservationists warned against and opposed this action, citing the Precautionary Principle (1).

b) Introducing devils to Maria Island is probably not ecologically sustainable because of the impact of introducing a new predatory and scavenging species onto an island where it has not been present in the past (1). Ecological sustainability depends on preserving

environmental integrity and the devils will change the Maria Island ecosystem (1). In this case it has had a detrimental impact on the island Little Penguin population which has declined rapidly (1).

OR

The Tasmanian Devil is under threat by the TFTD and having a backup population helps their survival and prevents these devils from getting TFTD (1). The relocation is supporting the future of their species thus contributing to the principles of sustainability (1).

Comments

a) Most students gave a solid definition of how the Tasmanian Devils could potentially harm the local flora and fauna of Maria Island, however they failed to specifically link it to the Precautionary Principle using the conservationists as an example.

b) The majority of students gave reasons for why it is not sustainable and generally performed well in this question. Students that chose to explain why the introduction is sustainable struggled to gain full marks if they did not mention potential impact to the local habitat and solely focussed of saving the devil species.

Question 25

a) The pricing model is a sustainable approach because of the economic sustainability for the service provider. They are covering the service charges (1) and it is a User Pays system/Full Cost Pricing Principle, which means there are no hidden environmental costs. Consumers pay for the resource used and there is an economic incentive to consume less (1).

b) Charging consumers for the utilities they consume according to a User Pays scheme encourages consumers to save money by using less (1). Ultimately, this is good for the environment because it reduces waste, energy consumption and eventually our ecological footprint (1). However, because the utilities are relatively cheap few consumers modify their behavior and consume less as is intended (1).

Comments

a) A large number of students received 1 mark for addressing the user pays component of the model but failed to mention the full cost/service charge.

b) Most students performed well in this question. Best answers covered the issue that unless the cost is significant it will not change the behaviour of wealthy citizens.

Question 26

a) All the user groups could have an impact. One user group need to be identified and a reason for their impact provided. Example answers include:

- Surfers could cause some erosion on tracks down to the beach.
- Day-trippers could leave their litter behind.
- Bird watchers may trample vegetation.
- Hunters could impact species by killing more than they need.

- Off-road vehicle users possibly have the most impact and could cause erosion and stray into vegetated areas and create more tracks that further damage the environment.

b) The Management Plan needs to balance the interests of all potential user groups, identify values and stakeholders. A good management plan would probably organise a way in which interaction between user groups is minimised by allocating specific areas for each activity. This is also likely to have the best outcome for the environment (1).

Management plans need to take into consideration facilities such as toilets for day-trippers, which also include surfers and bird-watchers. There should also be reserved areas (i.e., no-go zones) to protect the environment and maintain ecological integrity especially in the more sensitive areas of sand-dunes. To this end, it may be best to re-route the proposed road around the sand dunes (2-3 marks).

Baseline studies in the area to identify significant flora and fauna and communities of organisms (1).

Ongoing monitoring to record any changes – positive and negative - by user groups (½).

c) Nearby residents should have been consulted in the drafting of the Management Plan, that is usually a legal requirement and again, once the document is produced, they should be able to supply public comment (1). Once the Management Plan is in place there is always scope for local residents to act in a volunteer capacity with organisations such as Landcare, that undertake vegetation and track maintenance as well as weeding or citizen science projects involving ongoing monitoring (1). ''Friends of'' groups to act as penguin and mutton bird guides. Residents may participate in bird counts in the wetlands etc. They may also promote education of the area (1).

Comments

a) Most students performed well in this question and gained full marks.

b) This question was generally answered poorly with a significant number of students simply copying the steps shown from the information sheet and not specifically linking the management plan to the coastal reserve. Better answers addressed the actual management plans for the specific stakeholders using the reserve such as dedicated hunting zones or installing toilet facilities.

c) Students generally scored 1-2 marks on this question. A number of responses mentioned local residents catching visitors littering and reporting them which was not the focus of the question.