# Option C - Ecology

**1.** *[6 marks]*

Discuss, using **three** examples, how alien species have impacted ecosystems.

## Markscheme

a. the alien species can compete with existing species for resources / interspecific competition with native species;

b. appropriate example for competition with existing species;

c. alien species can be a predator of native species;

d. different appropriate example for predator of native species;

e. alien species can cause extinction of local species;

f. different appropriate example for causing extinction;

g. alien species can be deliberately added for biological control;

h. different appropriate example for biological control;

i. deliberate introduction of alien species for economic/other reasons;

j. different appropriate example for economic/other reasons;

*Each impact must have a different example.*

 **2.** *[6 marks]*

Describe a **named** method for determining the size of fish populations and the challenges in conserving world fish stocks.

## Markscheme



*challenges:*d. maintain fish as an important food source for humans/other animals;e. a sustainable yield means not overfishing an area/not causing a decline in the population/ not catching faster than the fish can replace themselves / OWTTE;f. pollution threatens world fish stocks/habitat;g. disagreements as to what is a sustainable population;h. disagreements in the collection of data of population sizes;i. requires international cooperation to define conservation measures/regulations/quotas;j. difficult to reinforce/control regulations / monitor practices / *OWTTE*; *Award* ***[4 max]*** *if only challenges addressed.*

*Named method could be any of the three examples given above but the description and limitation must be based on one named method only.*

 **3a.** *[6 marks]*

Discuss how international efforts can contribute to the conservation of fish stocks.

## Markscheme

a. oceans are huge ecosystems with no borders / many important fishing grounds are in international waters;b. fishing vessels often have a large geographical range / operate outside of national jurisdiction;c. marine organisms migrate so need protection across their full range / breeding sites may be distant from feeding grounds so both need to be protected;d. agree on maximum sustainable yields/quotas;e. apply the precautionary principle in determining the level of exploitation;f. agree on allowed fishing sites and exclusion zones;g. agree on fishing seasons and moratoriums;h. identify and agree on species that may be fished and those that may not;i. determine and agree on which fishing methods are allowed and which are not/net and mesh size limitations;

 **3b.** *[3 marks]*

Outline the biogeographical features of nature reserves that promote the conservation of diversity.

## Markscheme

a. nature reserve is a well defined/limited region with a protective framework/legislative protection;b. large reserves promote biodiversity more effectively than small reserves;c. size must be enough to have a well defined community of organisms;d. edge effect is seen at or near the boundary between ecosystems;e. leads to differences in population densities/biodiversity/levels of predation in central areas compared to edges;f. habitat corridors allow organisms to move between parts of a fragmented ecosystem;g. example of habitat corridors such as hedges/canals/drainage channels/tunnels/underpasses/overpasses;

 **4.** *[6 marks]*

Explain the causes and consequences of biomagnification with reference to a **named** example.

## Markscheme

a. named example of chemical;b. chemical absorbed by organism low in the food chain;c. chemical not excreted/accumulates in body fat;d. organism eaten by other organisms in higher trophic levels;e. causing it to be much more concentrated at each trophic level;f. substance accumulates in species at the highest trophic level;g. may reach toxic levels;h. named example of species at top of food chain;i. harmful effect caused by the chemical; *Award* ***[5 max]*** *if specific name of chemical is not given or chemical does not bioaccumulate.*

*eg:*a. mercury;b. absorbed by small fish;c. (mercury) not excreted (by small fish) / accumulates in (small fish) tissues;d. eaten by tuna;e. (mercury) becomes more concentrated at each trophic level;f. (mercury) accumulates in species at the highest trophic level;g. may reach toxic levels;h. humans may eat the tuna;i. leads to brain damage / birth defects / mercury poisoning;

 **5.** *[6 marks]*

Discuss the advantages of *in situ* conservation of endangered species, using examples.

## Markscheme

*in situ* conservation is carried out in nature reserves/natural habitats;named example of a species that is being conserved *in situ*;*in situ* conservation reduces possibility that habitat disappears and the whole community is lost / may prevent the total number of species that become endangered from increasing;allows species to live in an environment for which they are adapted / they are able to fit into their normal food chains;threatened species in a reserve may be monitored for further deterioration in numbers / remedial steps can be taken;offspring acquire skills from parents/peers around them / offspring acquire natural behaviour;reserves and protected areas in various parts of the world can share experience on how to manage them successfully;nature reserves are popular sites for the public to visit maintaining awareness/education/scientific study;reserves are places to return endangered individuals from breeding programmes as they provide realistic conditions for re-adaptation / *OWTTE*;

 **6.** *[6 marks]*

Explain, with examples, the use of specific indicator species and biotic indices to detect changes in the environment.

## Markscheme

*indicator species:*indicator species are sensitive to/need specific environmental conditions/have specific/limited range of tolerance;their population growth/disappearance/reduction indicates specific changes in the environment;example of indicator species and what it indicates; (*e.g. decrease in the population of stonefly larvae indicates increasing pollution levels/dissolved oxygen loss*)*Allow any other example.*

*biotic index:*compares the relative frequency of indicator species;can be calculated for overall environmental assessment of an ecosystem;multiply number of individuals of each indicator species by its pollution tolerance rating;an abundance of intolerant species gives a high score / *vice versa*;indicating an unpolluted environment / *vice versa*;a change in the biotic index over time indicates a change in environmental conditions; *Award* ***[4 max]*** *if only indicator species or biotic indices are addressed.*

 **7.** *[6 marks]*

Discuss international measures that would promote the conservation of fish stocks.

## Markscheme

large areas of ocean under no government control therefore need for international agreement/legislation;fish stocks are a renewable resource if managed properly/should not be overexploited;total allowable catches/quotas to limit maximum catch;regulation of mesh sizes/selective fishing gear/limit size of fish caught/ban drift nets;limit fishing effort by reducing the number of fishing days at sea of fishing vessels;fix the number and type of fishing vessels authorized to fish;cooperation may be difficult as most laws made at national level;closed areas/total ban on fishing in threatened areas;closed seasons banning fishing during breeding season;use of fish farms;

 **8.** *[6 marks]*

Evaluate the use of indicator species in monitoring environmental changes.

## Markscheme

indicator species sensitive to/need specific environmental conditions to survive;monitor population size of indicator species over time;biotic index can be calculated;low overall score when abundance of tolerant species / lack of indicator species / *vice versa*;represent summation of factors/overall assessment of environmental conditions;time consuming / species not easy to identify (need keys) / species may not be present for other reasons such as season / another disadvantage;methodology is simple / minimum equipment needed;needs a reference study/guide to compare;example of variable e.g. oxygen level / temperature / heavy metals / sulphur dioxide in air / other;example of appropriate indicator species e.g. *Tubifex* to heavy metals / *Chironomis* to low oxygen levels / lichens to sulphur dioxide / other;

 **9a.** *[6 marks]*

Discuss international measures that would promote the conservation of fish.

## Markscheme

a- require international agreement/cooperation;b- difficulties of enforcing agreements / to determine maximum sustainable yield / to obtain and interpret data / monitor populations/stocks;c- economic consequences for livelihood of fishermen/associated trades;d- total ban on fishing in threatened areas/endangered species/exclusion zones;e- limiting size of fish caught / limits on size of net mesh / ban on drift nets / indiscriminate in species of fish caught;f- limiting size to total allowable catch/quotas;g- limiting fishing to non-productive periods of fish / closed seasons banning fishing during breeding season;h- reducing fishing days at sea / fixing number and type of vessels authorized to fish;i- regulation on pollution of bodies of water;j- use of fish farms;

 **9b.** *[6 marks]*

Explain with the use of a diagram, the role of the Bohr shift in the supply of oxygen to respiring heart muscle.

## Markscheme

*diagram with correct labels:*a- partial pressure O/percentage O saturation on *x*-axis and percentage saturation hemoglobin with Oon *y*-axis;b- exponential shape curve at lower partial pressure/concentration of CO;c- curve shifted to right (and lower) for higher partial pressure/concentration of CO;



d- hemoglobin carries (up to) four oxygen molecules; e- Bohr shift promotes the release of oxygen in respiring heart muscle; f- active respiration releases CO; g- partial pressure of CO increases; h- increases acidity/lower pH/increase lactic acid; i- hydrogen ions bind to hemoglobin / which decreases hemoglobin’s affinity for O; j- so O is released (from the oxyhemoglobin); k- allosteric effect / conformational change in hemoglobin which releases O more readily;

*Award* ***[4 max]*** *if no diagram provided.*

 **10a.** *[1 mark]*

Identify the phases labelled X and Y.

X:

Y:

## Markscheme

X: plateau phase

Y: exponential growth / log phase

*(both needed)*

 **10b.** *[2 marks]*

Outline how fossil records can provide evidence for evolution.

## Markscheme

a. the sequence in which fossils appear matches the expected sequence of evolution;

b. comparisons with fossils and living organisms (morphology) shows change in characteristics from an ancestral form / *OWTTE*;

*Vestigial organs and homologous structures are acceptable answers.*

c. fossils of extinct species show that (evolutionary) change has occurred;

d. fossils can be dated with radioisotopes / geological depth/strata indicates (relative) age/date of organism;

e. can yield DNA for molecular clock analysis;

f. example of any of the above can earn one mark (*eg*: reptiles follow amphibians);

 **10c.** *[1 mark]*

Distinguish between the terms genotype and phenotype.

## Markscheme

genotype is the genetic make-up/set of alleles (of an organism) while phenotype is the characteristics (expressed/shown in an organism)

 **10d.** *[1 mark]*

Outline a structural difference between the chromosomes of *Helicobacter pylori* and *Homo sapiens*.

## Markscheme

chromosome from bacteria has no protein associated/naked DNA / bacteria is circular, H. sapiens is linear / (chromosomes of) H. sapiens are much bigger/have many more base pairs than bacteria

*N.B.: Answer must refer to "chromosomes" not genomes of the two organisms.*

 **10e.** *[1 mark]*

Deduce the percentage of adenine in *Oryza sativa* if the proportion of guanine in that organism is 30 %.

## Markscheme

20 %

 **10f.** *[1 mark]*

Deduce the possible phenotypes of individual X.

## Markscheme

A, B, AB and O

*All four phenotypes must be shown to award the mark.*

 **10g.** *[1 mark]*

Describe ABO blood groups as an example of codominance.

## Markscheme

allele Iand the allele Iare (co)dominant as they are both expressed in the heterozygote/AB type blood / *OWTTE*

 **11.** *[2 marks]*

Outline the process of nitrogen fixation by a **named** free-living bacterium.

## Markscheme

a. atmospheric nitrogen is converted to ammonia;

b. by *Azotobacter*;

*Do not accept Rhizobium.*

 **12a.** *[1 mark]*

State which taxonomic group shows the greatest median shift.

## Markscheme

spider

 **12b.** *[1 mark]*

Calculate the percentage of ground beetles that are below the zero shift.

## Markscheme

16.75(%)

*Accept answer in the range of 16.5 (%) to 17(%).*

 **12c.** *[2 marks]*

Compare the changes in the range of ground beetles with the changes in the range of spiders.

## Markscheme

a. both taxonomic groups showed movement to the north;

b. slightly more spiders moved north;

c. spiders shows the furthest northern shift;

d. range of ground beetles extends further south (than spiders);

e. the spiders' biggest movement is 75 to 100 km to the north and the ground beetles' biggest movement is 50 to 75 km to the north;

f. overall spiders have a broader range;

 **12d.** *[2 marks]*

Spiders and ground beetles are both predators. Discuss possible effects on other species resulting from the latitudinal shift of the predators.

## Markscheme

a. competition for resources/food/space/other resource;

b. change in predation/number of other species;

c. change/decrease/increase in biodiversity;

d. food webs may change;

 **13a.** *[1 mark]*

State the process where pesticides such as DDT become more concentrated at each trophic level.

## Markscheme

biomagnification/bioaccumulation

 **13b.** *[3 marks]*

Explain what is meant by the niche concept.

## Markscheme

a. every organism in an ecosystem has their own role;

b. (includes) spatial habitat/space inhabited by organism;

c. (includes) feeding activities of organism;

d. (includes) interactions with other species;

e. valid description of an organism’s niche including habitat, feeding activities and interaction with other species;

 **14a.** *[1 mark]*

State **one** example of a bacterium that forms aggregates.

## Markscheme

*Pseudomonas aeruginosa / Vibrio fischeri*

*Accept other correct answers.*

 **14b.** *[2 marks]*

Outline the process of nitrogen fixation by a **named** free-living bacterium.

## Markscheme

a. (atmospheric) nitrogen is converted to ammonia;

b. by *Azotobacter*;

*Do not accept Rhizobium.*

 **14c.** *[3 marks]*

The image shows part of a sewage treatment plant.



Outline the role of bacteria in trickling filter bed treatment of sewage.

## Markscheme

a. (saprotrophic) bacteria/biofilm fix on the surface of the rocks/material in the trickling filter;

b. bacteria decompose the sewage/organic matter as it runs over the filter bed;

c. bacteria break down organic matter aerobically;

d. the rocks increase the surface area for the decomposition of organic matter;

e. filter bed can treat high amounts of sewage quickly;

 **15a.** *[1 mark]*

State the relative use of the habitat by the Great Tit in the upper crown of the tree close to the trunk.

## Markscheme

medium to low

 **15b.** *[1 mark]*

Identify the section of habitat used least by the birds.

## Markscheme

lower crown, far from trunk

 **15c.** *[2 marks]*

Compare how the Varied Tit and the Marsh Tit use the habitat in the upper crown of the tree.

## Markscheme



 **15d.** *[1 mark]*

State how the distribution of birds changes with their size in the middle crown of the tree.

## Markscheme

smaller birds make more use of the habitat further from the trunk / larger birds make more use of the habitat closer to the trunk

 **15e.** *[1 mark]*

Suggest **one** reason why few Varied Tits were found far from trunk.

## Markscheme

their food is close to the trunk / fewer predators close to trunk / too big for small outside branches

*Accept any valid suggestion.*

 **15f.** *[2 marks]*

Discuss whether the results for the Varied Tit and Coal Tit indicate competitive exclusion.

## Markscheme

a. the competitive exclusion principle states that no two species can coexist if they occupy the same niche/compete for the same resources;

b. competitive exclusion is supported as there is little overlap between the two species in the habitat;

c. competitive exclusion is not supported as there is some overlap between the species;

d. we do not have enough information about the resources required by each species to say if competitive exclusion is occurring;

 **16a.** *[1 mark]*

Outline how habitat corridors can aid conservation of biodiversity in a nature reserve.

## Markscheme

a. they allow species to travel between habitats / *OWTTE*;

b. outline of an example of a habitat corridor;

 **16b.** *[3 marks]*

Explain how living organisms can change the abiotic environment during primary succession.

## Markscheme

a. lichens secrete chemicals/acid which break down inorganic material/rock;

b. lichens/plants/litter change pH of the soil (which prevents/assists some species to establish);

c. organisms increase the mineral/organic/humus content of the soil when they decompose;

d. (organic matter and humus) can increase water retention;

e. plant roots can bind soil preventing erosion / break down soil particles;

 **17a.** *[1 mark]*

Identify the most abundant animal type at

the *S. muticum* site: the control site:

## Markscheme

*S.muticum site: Corophiidae sp.*

*control site: S. squamataBoth needed for* ***[1]***.

 **17b.** *[3 marks]*

Describe the impact of invasive *S. muticum* on the shoreline animal community.

## Markscheme

a. fewer different types of organism / smaller diversity at *S. muticum* site;b. mean abundance at *S. muticum* site is higher for those organisms present;c. *Rissoidea sp*. and *P. maculata* found at control site but not at *S. muticum* site;d. *C. pagurus* only found at *S. muticum* site;*Comparisons are required but the control site does not need to be mentioned in each response.*

 **17c.** *[3 marks]*

Discuss possible reasons for the differences in the animal communities seen at the two sites.

## Markscheme

a. *S. muticum* provide habitat/shelter/protection from predators for some species;b. *S. muticum* change the environment to suit some species/example of a change;c. some organisms more successful because less (inter-specific) competition;d. more food may be available (for herbivores);e. some herbivores may rely on native algae that have been displaced;f. (other) conditions at the control site may not be identical to the test site;

 **18a.** *[3 marks]*

Explain the causes and consequences of biomagnification of a named chemical.

## Markscheme

a. named example of chemical (for example: mercury, DDT, PCBs, TBT, PAHs,heavy metals, selenium);b. long lived / do not biodegrade / stored in body tissues / fat soluble;c. present in small concentration in the environment;d. chemical becomes more concentrated in the bodies of organisms at each successive trophic level;e. reach toxic levels in top consumer/organisms near the end of the food chain / example of top consumer affected;*Award* ***[2 max]*** *if no named example of chemical.*

 **18b.** *[2 marks]*

Explain the concept of niche.

## Markscheme

a. includes all aspects of way of life of a species/role of the species in the ecosystem;b. includes relationships within the community;c. feeding relationships;d. interaction with environment/spatial habitat;

 **19a.** *[3 marks]*

State the role of *Rhizobium*, *Nitrobacter* and *Azotobacter* in the nitrogen cycle.

*Rhizobium: ..................................................................... Nitrobacter: ..................................................................... Azotobacter:* .....................................................................

## Markscheme

*a. Rhizobium:* nitrogen fixation;*b. Nitrobacter:* oxidizes/changes nitrites to nitrates;*c. Azotobacter:* nitrification / bind atmospheric nitrogen / nitrogen fixation;

 **19b.** *[4 marks]*

Explain the production of methane from biomass.

## Markscheme

a. anaerobic digestion of biodegradable material;b. fermentation (of carbohydrates) by bacteria;c. methanogens produce methane;d. methane/biogas used as energy;e. waste products used as fertilizer;f. CO produced (as a by-product);

 **20a.** *[1 mark]*

State the force required to detach a limpet with an area of foot of 2 cm .

## Markscheme

42 (N) *(allow answers in the range of 41 (N) to 43 (N))*

 **20b.** *[1 mark]*

State the smallest area of foot necessary to resist a force of 50 N.

 ...................cm

## Markscheme

2.6 (cm) *(allow answers in the range of 2.5 (cm) to 2.7 (cm))*

 **20c.** *[1 mark]*

Outline the relationship between area of foot and the force required to detach the limpet.

## Markscheme

Positive correlation / as area of foot increases so does force required.

 **20d.** *[3 marks]*

Smaller limpets can only be found at the back of crevices. Discuss the reasons for this.

## Markscheme

a. back of crevice less subjected to action of waves;b. (hypothesis supported as) small area of foot requires less force;c. amount of predators/food could be affecting the distribution;d. larger limpets may not fit in the back of the crevice;e. less competition with larger limpets at the back of the crevice;

 **20e.** *[1 mark]*

Limpets tend to live towards the high tide zone. State the method used to determine the distribution of limpets between the low and high tide lines.

## Markscheme

transect line / quadrat with transect line*Do not accept quadrat alone.*

 **21.** *[2 marks]*

Outline **one** example of biological control of a **named** invasive species.

## Markscheme

a. named example of invasive species;b. named example of biological control;

*possible examples:*



 **22a.** *[1 mark]*

State the depth range showing the most *Bythotrephes* during the night.

## Markscheme

0–10 meters

 **22b.** *[2 marks]*

Describe the distribution of *Bythotrephes* during the day.

## Markscheme

a. *Bythotrephes* found at all depths down to 20–30 m/none below 30 m;b. greatest number/density (of organisms) at 10–20 m;c. least number/density (of organisms) at 0–10 m;

 **22c.** *[2 marks]*

Deduce the responses of *Bythotrephes* to temperature and light.

## Markscheme

a. avoids/driven away by light (to colder water);b. in absence of light attracted to warmer water;c. can tolerate a wide range of temperature (*accept numbers in range of* *4/5–20/25°C*);

 **22d.** *[2 marks]*

Explain the change in distribution of *Bythotrephes* between day and night in terms of its position in the lake food chain.

## Markscheme

a. zooplankton found in (warmer) surface water where small plants / algae/phytoplankton are found due to light;b. as predator, *Bythotrephes* moves up to the surface to feed on zooplankton at night;c. as prey, *Bythotrephes* moves to lower/darker depths during the day to avoid being (easily) seen by predators/fish;

 **23a.** *[2 marks]*

Distinguish between the use of a quadrat and a transect in gathering field data.

## Markscheme



*Accept any horizontal set of ideas, up to two sets.*

 **23b.** *[1 mark]*

State the change in species diversity and the change in production during primary succession.

Species diversity: ...............................................Production: ........................................................

## Markscheme

*Species diversity:* rises*Production:* rises*Both needed for* ***[1]****.*

 **23c.** *[1 mark]*

State one difficulty in classifying organisms into trophic levels.

## Markscheme

an organism can occupy/feed at more than one trophic level

 **24a.** *[1 mark]*

Identify the site with the lowest average CFU of *E. coli* in the water samples.

## Markscheme

(site) 1

 **24b.** *[2 marks]*

Distinguish between the trends in the survival of *E. coli* on mat samples and in water samples over time.

## Markscheme

a. (CFU of) *E. coli* on mats remains higher/almost 10 more than in the water samples;b. over time in mats the values do not change much while in water they decrease/disappear;

 **24c.** *[2 marks]*

Scientists formerly related the population of *Cladophora* to changes in phosphorous levels in the lake. However, phosphorous quantities have decreased but *Cladophora* has recently increased along the shore. Suggest **two** reasons, other than phosphorous, for the change in population growth of *Cladophora* in the lake.

## Markscheme

a. excess nitrogen from fertilizers as run-off from agricultural lands;b. excess organic matter from sewage overflow;c. change in temperature/global warming;d. change in pH; *Do not accept a general statement of minerals or fertilizers in the water.*

 **24d.** *[2 marks]*

Discuss the possible ecological relationships between *E. coli* and *Cladophora*.

## Markscheme

a. *Cladophora* provide a habitat for *E. coli* so more *E. coli*/CFUs (in mats);b. *Cladophora* provide more food for *E. coli* so more *E. coli*/CFUs (in mats);c. *Cladophora* in mats are dead and decomposed by *E. coli* /*Cladophora* in water are alive so not decomposed by *E. coli*;

 **25a.** *[3 marks]*

(i) Label the diagram to complete the food web for the organisms in the table above.



(ii) Deduce the trophic level of Artic cod.

## Markscheme



 **25b.** *[2 marks]*

Distinguish between the movement of energy and nutrients in an ecosystem.

## Markscheme

energy moves through/enters and leaves ecosystems / need a constant source of energy;

nutrients cycled between biotic and abiotic environment/in cycles such as C/N;

 **26a.** *[1 mark]*

State the grass species that is most abundant in plant community 1.

## Markscheme

4

 **26b.** *[1 mark]*

Analyse the graph to find whether species 45 has a broad **or** narrow realized niche.

## Markscheme

broad (realized niche as present in many communities)

 **26c.** *[1 mark]*

Suggest a reason for this in community 1.

## Markscheme

lack of water

 **26d.** *[1 mark]*

Suggest a reason for this in community 17.

## Markscheme

shading from trees / lack of light /competition from trees and shrubs

 **26e.** *[3 marks]*

Evaluate the conclusion that there are trends in the distribution of plants along the transect of Serengeti grass communities.

## Markscheme

communities have different species present;

grass species 1 to 15 more common in communities 1 to 7/dry south east boundary; *(accept values within 3 of the upper and lower values given in the marking point)*

grass species 32 to 45 more common in communities 13 to 17/woodlands; *(accept values within 3 of the upper and lower values given in the marking point)*

pattern linked to variation in rainfall/abiotic factors;

appears to have clusters of distinct plant species with little overlap;

species are found in certain areas only;

 **27.** *[6 marks]*

Eight sub-species of tigers existed in 1950, but three of these former sub-species have now become extinct. Discuss the role of active management techniques to prevent the extinction of the remaining tiger species.

## Markscheme

*Award* ***[1]*** *for one argument for each of the following aspects:*

*identification/monitoring of tiger populations;*

*creation of in situ/nature reserves;*

*provision of corridors between nature reserves;*

*hunting/poaching;*

*development of ecotourism;*

*impact on local economy;*

*ban on tiger products trade / development of synthetic alternatives;*

*increase of public awareness;*

*need for international cooperation/funds to implement measures;*

*ex situ/captive breeding programs;*

*extraction of DNA for gene bank;*

 **28a.** *[2 marks]*

List **two** factors that could cause an increase in the size of an animal population.

1. ..................................................................2. ..................................................................

## Markscheme

a. natality / increased birth rate;b. immigration;c. extra food/water / breeding sites;d. expanding habitat;e. lack of predators/disease/parasites / reduced death rate;

 **28b.** *[4 marks]*

Outline how overpopulation of a species in a given environment may lead to evolution.

## Markscheme

a. more are born than can survive;b. there is variety/variability in the offspring;c. competition for resources / struggle for survival / selection pressure;d. only the most able/adapted survive / survival of the fittest;e. the survivors reproduce and pass on genes;f. genes of less able/adapted are eliminated / change in the gene pool;g. natural selection occurs;

 **29.** *[4 marks]*

Explain the consequences of releasing raw sewage and nitrate fertilizer into rivers.

## Markscheme

a. raw sewage contains pathogens;b. can contaminate drinking water / cause disease/death;c. nitrate fertilizers cause algal blooms/(aquatic) plant development;d. algae release toxins that can contaminate drinking water;e. more organic matter results / eutrophication;f. more oxygen required to decompose organic matter / increase in BOD;g. (leading to) death of aquatic animals/organisms;h. recovery follows since algae/plants release more oxygen;

 **30a.** *[2 marks]*

Discuss the difficulties of classifying organisms into trophic levels.

## Markscheme

a. consumer may have more than one food source;b. organisms eaten may be at different trophic levels;c. may change their trophic level over time;d. different stages in life cycle might exist in different trophic level (eg frog);e. example of organism (presenting such a difficulty);

 **30b.** *[4 marks]*

Explain the cause and consequences of biomagnification, using a **named** example.

## Markscheme

a. a process in which chemical substances become more concentrated at each trophic level;b. valid named example (for example mercury, organophosphorous pesticides, DDT, TBT);c. these substances cannot be broken down / are broken down slowly by metabolism;d. are often stored in (adipose) tissues;e. each organism consumes large quantities of the trophic level below it;f. so substance accumulates/increases to reach toxic levels; *If no example is given award* ***[3 max]****.*

 **31.** *[1 mark]*

State **one** soil condition that favours denitrification.

## Markscheme

a. lack of oxygen / anaerobic conditions;b. excess water / bog/marsh conditions;

 **32a.** *[1 mark]*

Identify the primary food for all grasshoppers without predators.

## Markscheme

grasses

 **32b.** *[1 mark]*

Deduce, using the data, how the feeding behaviour of instar larvae changes if without predators, conditions change from cool to warm.

## Markscheme

feeding time on grasses (slightly) reduces / feeding time on bushes increases

 **32c.** *[1 mark]*

Deduce, using the data, how the feeding behaviour of instar larvae changes if in warm conditions, predators are introduced.

## Markscheme

feeding time on grasses (greatly) reduces / feeding time on bushes increases

 **32d.** *[2 marks]*

Compare adult feeding to instar larval feeding.

## Markscheme

feeding is similar without predators;more feeding on grass by adults with predators;

 **32e.** *[1 mark]*

Suggest why adult feeding differs from instar larval feeding when predators are present.

## Markscheme

a. instars are more protected from predators/camouflaged when feeding in bushes;b. adults can escape predator attacks more easily/camouflaged when feeding in grasses;c. adults are bigger and less easily captured; *Accept other reasonable responses.*

 **33a.** *[3 marks]*

Explain the niche concept.

## Markscheme

a. niche is an organism’s ecological role/mode of existence;b. niche is how organism uses abiotic and biotic resources;c. depends on where organism lives/habitat;d. depends on organism’s nutrition/feeding activities;e. depends on interactions (competition/herbivory/predation/mutualism) with other organisms;

 **33b.** *[1 mark]*

Outline **one** reason for the extinction of a **named** animal species

## Markscheme

name of species and what caused it to become extinct (*both needed*)*The named species must be extinct and not endangered.*eg:passenger pigeon (became extinct when) hunted as a source of food*Note: dinosaur is not a named species.*

 **34.** *[2 marks]*

Discuss how an understanding of biomagnification could help these human populations reduce their risk of mercury poisoning while maintaining their traditional diet.

## Markscheme

a. (recognize that) some fish are more contaminated than others;b. identify and eat fish that are close to the start of a food chain;c. avoid eating piscivores/omnivores/highly polluted species;d. eat only piscivores that feed close to the start of a food chain;

 **35a.** *[1 mark]*

Calculate the decrease in mass of food foraged by fed sand gobies when a predator was introduced, giving the units.

## Markscheme

2.6 mg (*units required*) (*accept answers in the range of 2.5 mg to 2.7 mg*) *No working required*.

 **35b.** *[2 marks]*

Compare the effect that starvation had on both species of goby when no predator was present.

## Markscheme

both foraged more after starvation;black goby increased the amount of food foraged more than the sand goby;

 **35c.** *[2 marks]*

Describe the effect the predator had on the foraging of the gobies.

## Markscheme

a. predator present causes both to forage for less food;b. fed black gobies showed little change in foraging (with predator present);c. starved gobies foraged more than fed gobies (with predator present);d. relative foraging remains similar between the two species / black goby always forages less than sand goby;

 **35d.** *[1 mark]*

Suggest a reason for the effect of the predator.

## Markscheme

a. gobies may feed on smaller mud shrimps when predator present;b. gobies may hide rather than forage when predator present / gobies may feed less efficiently if they are watching out for predators;c. predator may also eat shrimp so less for gobies;d. if predator eats gobies the total mass of food foraged is less / *OWTTE*;

 **36a.** *[2 marks]*

Explain the principal of competitive exclusion.

## Markscheme

no two species can occupy the same niche/role in an ecosystem;too much competition occurs until one is eliminated / one out-competes the other;competition is for habitat/nutrition/relationships/space/limited resources;

 **36b.** *[2 marks]*

Using a **named** example, explain a consequence of biomagnification.

## Markscheme

name of chemical and top consumer affected; (*both needed*)consequence;eg:DDT, affecting bird of prey;fragile egg shells which did not hatch affecting population size;

 **37.** *[3 marks]*

Water is one factor that affects the distribution of plant species. Outline **three** other factors that can also affect plant distribution.

## Markscheme

temperature affects metabolism/enzyme activity/transpiration rate/germination / each plant species has an optimum temperature range;light affects rate of photosynthesis/(time of) flowering;soil pH affects absorption of minerals/enzyme activity / each plant has an optimum pH range / some plants require acid soil / some plants require alkaline;salinity affects the osmotic potential / most plants function in narrow range of salinity / salts affect the water uptake by the plants;mineral nutrients required for synthesis of organic molecules;presence of (suitable) pollinator/dispersal organisms to aid reproduction;distribution (number and type) of predators/herbivores/diseases/pathogenic organisms which harm plants;competition from other plants (for resources);other valid factor with brief outline; *Accept examples for each factor eg nitrates are necessary for protein synthesis.Award* ***[0]*** *for a list of factors.*

 **38a.** *[1 mark]*

Define the term *biomagnification*.

## Markscheme

Process by which chemical substances become more concentrated at each trophic level.

 **38b.** *[1 mark]*

Define the term *biomass*.

## Markscheme

total dry mass of organic matter in organisms/trophic level

 **39a.** *[3 marks]*

Explain the principles involved in the generation of methane from biomass.

## Markscheme

organic matter/manure/waste/agricultural material/seaweed used;bacteria in digester transform biomass/raw material;anaerobic conditions / constant temperature / neutral pH in the digester;bacteria convert organic material to organic acids/alcohol;other bacteria convert organic acids/alcohols into acetate;methanogenic bacteria convert acetate to methane

 **39b.** *[1 mark]*

State the role of *Rhizobium* in the nitrogen cycle.

## Markscheme

nitrogen fixation / changes (free) nitrogen to ammonia

 **40a.** *[2 marks]*

Biotic factors involve the other organisms in the environment of an animal species. List **two** biotic factors that could affect the distribution of an animal species.

1. ..................................................................

2. ..................................................................

## Markscheme

predation;competition;disease;food supply;

 **40b.** *[2 marks]*

Research into a river ecosystem produced these approximate values: 25, 300, 6000 and 36 000 kJ m yr. Using this data, construct a pyramid of energy showing **four named** trophic levels, each with their corresponding energy value.

## Markscheme



bars of decreasing size going upwards at least a third of the bar below; the trophic level on each bar labelled correctly;

 **41a.** *[3 marks]*

Explain how living organisms can affect the abiotic environment during primary succession.

## Markscheme

remains/debris/litter from growth/death of plants can increase soil depth;remains/debris/litter from growth/death of plants can increase soil mineral content;remains/debris/litter from growth/death of plants can alter soil pH;remains/debris/litter from growth/death of plants can improve soil water retention and reduce drainage;growth of (larger) plants can reduce erosion though binding action of roots;

 **41b.** *[1 mark]*

State **one** example of biological control of an invasive species.

Invasive species: ......................................................

Biological control: ......................................................

## Markscheme

example of invasive species and an example of its biological controle.g.:prickly pear cactus is controlled by moth (*Cactoblastis cactorum*)*Accept other suitable example.*

 **41c.** *[1 mark]*

Define *biomagnification.*

## Markscheme

a process when chemical substances become more concentrated at each trophic level

 **42a.** *[2 marks]*

Outline changes in species diversity during primary succession.

## Markscheme

few colonizing species establish themselves in harsh conditions/volcanic ash/ sand/areas devoided of life/bare rock;*e.g.* moss/lichens/marram grass/bacteria;more organic material accumulates/soil develops;increasing species diversity;

 **42b.** *[2 marks]*

(i) Describe the environmental impact of a **named** invasive alien species.

(ii) State an example of biological control of the invasive alien species named above.

## Markscheme

(i) name of invasive alien species and impact *e.g.*:water hyacinth is an invasive plant with explosive growth that blocks waterways/kills other aquatic organisms

(ii) example of biological control organism *e.g.*: weevils/moths/fungus/mites have been used to control the water hyacinth growth *Do not award the mark if the example of the control does not correspond to the species named.*

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