SL Paper 3

a. Define the terms fundamental *niche* and *realized niche*. [2]

Fundamental niche: ....

Realized niche: ....

b. Explain why the carnivores in an ecosystem tend to be fewer in number and have a smaller biomass than the herbivores in the same ecosystem. [2]

c. Explain why carnivores tend to be more affected by biomagnification than organisms lower down the food chain. [3]

Markscheme

a. *Fundamental niche*:

the potential niche / the niche the organism could occupy under ideal conditions / the full mode of existence given the adaptations of the species / *OWTTE*;

Realized niche:
the actual niche / the niche restricted by competition and environmental variables / the niche resulting from the limits placed on the species / *OWTTE*;
Responses must distinguish between the two types to gain credit.

b. energy transfer along the food chain is less than 100 % efficient;

10 % energy transfer between trophic levels;

nutrient transfer is less than 100 % efficient;

each carnivore needs to consume many prey organisms;

tendency for size of organisms to increase as trophic level increases;

c. mercury / DDT / other named example;

biomagnification is the accumulation of chemicals through the food chain;

chemicals that undergo biomagnification are stored/not broken down (in the bodies of the organisms that consume them);

chemicals are passed (unaltered) from one trophic level to the next;

chemicals become more concentrated in the bodies of each (subsequent) trophic level;

organisms higher up the food chain consume larger amounts of the chemical;

Examiners report

a. Few could give accurate definitions of the two niches.

b. This proved to be another weak area, as not many candidates could link the decrease in numbers to the loss of energy between trophic levels in an ecosystem.

c. Most candidates did not seem to understand that the term biomagnification refers to the passing of chemicals along the food chain, or that the chemicals are stored in the bodies of the organisms that consume them. Consequently, there were few good answers to this question.

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b. Outline the role of saprotrophic bacteria in the treatment of sewage. [2]

c. Explain the formation of methane from biomass. [3]

Markscheme

b. sewage trickled over bed of rocks with (biofilm of) saprotrophs and oxygen added;

saprotrophic bacteria feed on/break down organic matter (found in sewage);
transforming it into harmless/re-usable products/ $\mathrm{CO_2}$, $\mathrm{H_2O}$, ammonia;

c. bioreactor with anaerobic conditions;

bacteria convert organic matter into organic acids/alcohol/acetate/ $\mathrm{CO_2}$ and $\mathrm{H_2}$;
methanogenic bacteria produce methane from breakdown of acetate/ $\mathrm{CO_2}$ and $\mathrm{H_2}$;
(Accept correct word or chemical equations)

Examiners report

b. As was stated in the N12 Examiners' Report, candidates did not do well in this question on the treatment of sewage. One mark for saprotrophic bacteria feed on/break down organic matter (found in sewage) was common but seldom was a second mark awarded.

c. This proved to be a discriminating question as 1 mark may have been given but seldom 2 marks and not 3.

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b. Explain the principles involved in the generation of methane from biomass. [3]

c (i) State the role of *Rhizobium* in the nitrogen cycle. [1]

Markscheme

b. 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

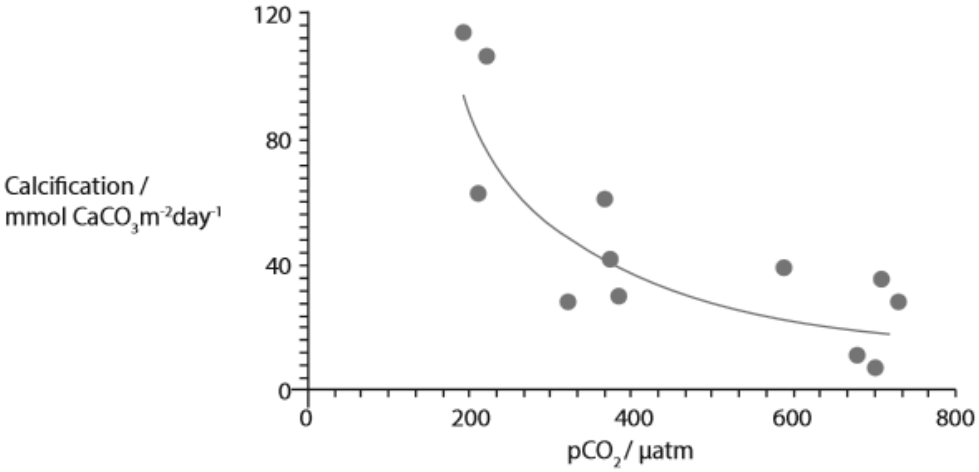
c (i) nitrogen fixation / changes (free) nitrogen to ammonia

Examiners report

b. Most candidates only scored one or two marks in this question as they only explained that bacteria are used to transform organic matter. No further detail of the process was provided.

c (i) (c) (i) and (ii) almost all scored full marks.

Increasing carbon dioxide concentration in the atmosphere leads to acidification of the ocean. This in turn reduces the amount of dissolved calcium carbonate. A study was undertaken to investigate the effect of increasing the concentration of atmospheric carbon dioxide on the calcification rate of marine organisms. Calcification is the uptake of calcium into the bodies and shells of marine organisms. The study was undertaken inside Biosphere-2, a large-scale closed mesocosm. The graph shows the results of the data collection.



[Source: © International Baccalaureate Organization 2016]

a. State the relationship between atmospheric carbon dioxide and calcification rates. [1]

b. Distinguish between the exchange of matter and energy with the surroundings in a closed mesocosm. [1]

Markscheme

a. Negative correlation (*Do not accept "negative" alone*)

OR

inverse relationship

Decrease in calcification as atmospheric CO_2/pCO_2 rises

b. Matter does not exchange/enter/leave but energy exchanges/enters/leaves

Examiners report

a. N/A

b. Generally well answered though many referred to exchange within the mesocosm rather than with the surroundings.

Discuss the definition of the term species.

Markscheme

a. meaning of species has changed over time / no longer just based on morphological features/phenotype;

b. species members also resemble each other in physiology/biochemistry/DNA sequences/use of habitat/behaviour;

c. but species can evolve and features change/species gradually split up;

d. definition now based on ability to interbreed/produce viable, fertile offspring;

e. gene flow among populations of the species maintains the species' uniqueness;

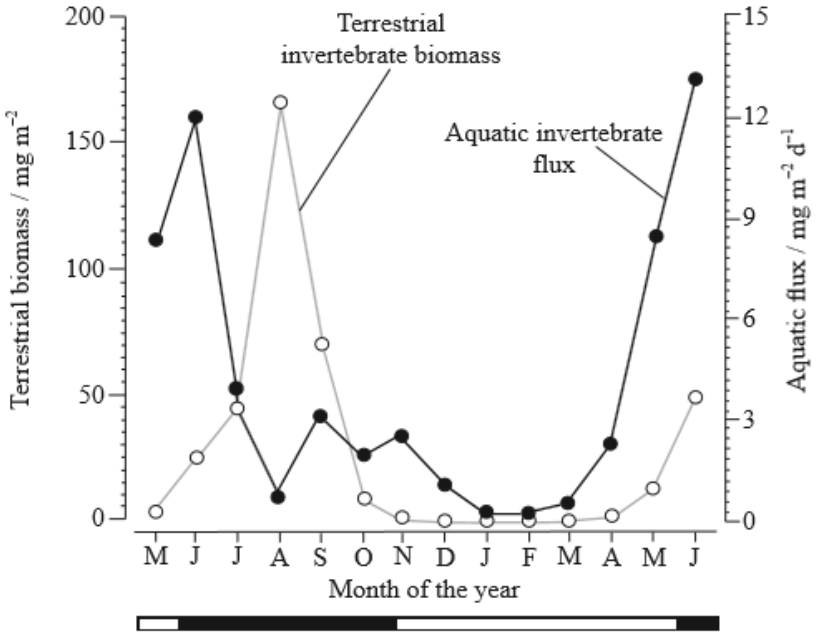
f. some interspecific hybrids are fertile making categorization difficult;

g. further accurate discussion point about species definition;

Examiners report

The discussions of the definition of 'species' were very varied, with very few gaining all three points.

The graph below shows the monthly mean values of terrestrial invertebrates from May 1997 to June 1998 in the northern hemisphere. The light line shows the biomass of invertebrates which are prey to forest birds (terrestrial invertebrate biomass). The darker line shows the invertebrates which lived in the stream and have moved to the forest (aquatic invertebrate flux or movement). The black bars on the horizontal line at the bottom show periods when trees have leaves and the white bars show periods of defoliation.



S. Nakano and M. Murakami, 'Reciprocal subsidies: Dynamic interdependence between terrestrial and aquatic food webs'. *PNAS*, 98 (1) pp. 166-170. Figure 1C. Copyright (2001) National Academy of Sciences, U.S.A.

a. State the mean terrestrial invertebrate biomass measured in August. [1]

b. Describe the trend in the aquatic invertebrate flux. [2]

c. Suggest the relationship between defoliation and the amount of terrestrial invertebrates in the forest. [2]

d. Suggest a possible explanation for the pattern in aquatic invertebrate flux to the forest seen between the months of June and December. [2]

Markscheme

a. 166 mg m^{-2} (*Allow answers in the range of 162–168 mg m^{-2}*)

b. rapid rise and fall between April and August;

peak in May/June;

fluctuates between August/September and December;

low December/January until February/March;

cyclical;

c. negative relationship / during period of defoliation, biomass (of terrestrial invertebrates) is at its lowest;

less leaves means less food/habitats / easier for predators to see invertebrates;

defoliation occurs in winter/autumn and the cold may kill invertebrates;

d. (aquatic invertebrate flux) decreases because movement to the forest has occurred (by adult forms) / fewer aquatic invertebrates left in the stream so fewer are moving;

fluctuation due to movement of different species/different life cycles/second generation;

decreases because invertebrates left at the beginning of winter/cold season;

(adult forms) move to utilize (changes in) food supply in forest;

Examiners report

a. Most answered correctly within the range of 162-168 mg m^{-2}.

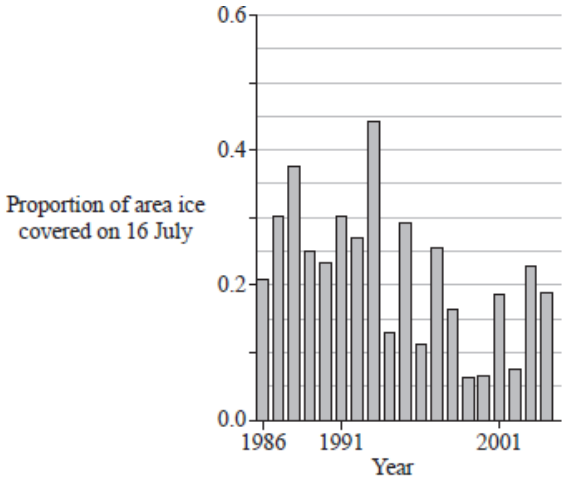
b. This part of the question required some reference to the months of the year given in the graph, and many answers simply mentioned seasons, ie spring, summer etc, and so did not gain any marks.

c. The majority answered correctly.

d. It seems that many students did not fully understand the question, and so were unable to suggest any explanation for the movement of aquatic invertebrates. Perhaps this is due to a lack of knowledge of invertebrate life cycles,which would help to interpret the data.

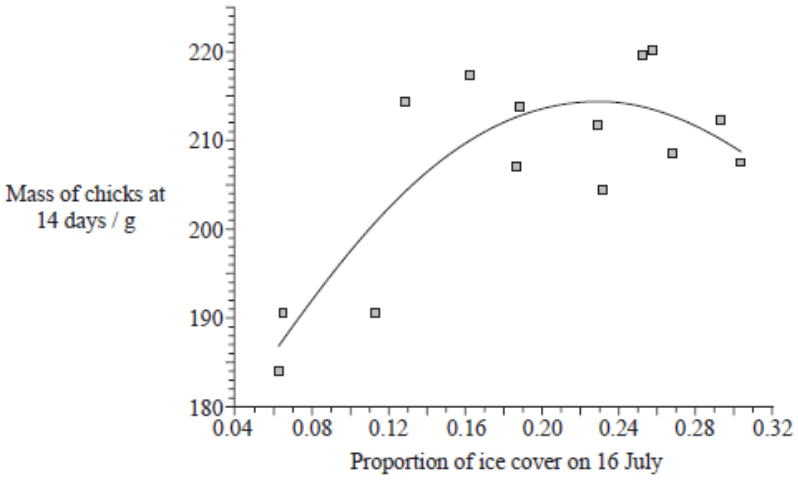
A colony of a marine diving bird, Brunnich's guillemot (*Uria lomvia*), lives on the southern limits of the Arctic on Coats Island. Brunnich's guillemots feed principally on Arctic cod (*Arctogadus glacialis*) which are characteristic of Arctic waters.

The graph shows the changes in ice cover on Coats Island over a period of 19 years.



[Source: adapted from A Gaston, *et al*., (2005), *Journal of Animal Ecology*, **74**, pages 832–841]

At Coats Island, chick mass at 14 days was measured in most years between 1988 and 2002. The scattergraph below shows the results, plotted against proportion of ice cover.



[Source: adapted from A Gaston, *et al.*, (2005), *Journal of Animal Ecology*, **74**, pages 832–841]

a(i). Outline the changes in ice cover shown in the data above. [2]

a(ii). Suggest **one** reason for the changes in ice cover. [1]

b(i). Outline the relationship between ice cover and the mass of 14-day-old chicks on Coats Island. [2]

b(ii). Suggest reasons for the relationship. [2]

c. Predict, with a reason, the change in the mass of chicks in the years ahead. [1]

Markscheme

a(i). ice cover has decreased (slightly);

the data show much variability/fluctuates;

a(ii). warmer air/atmosphere/water temperatures/global warming (bringing about more ice melt)

b(i). increase in summer ice cover has a positive effect on mass increase;

high proportion of ice cover has little effect / (slightly) negative effect on chick mass/growth;

b(ii). changes in (water) temperature/climate change influence fish populations/ food available for chick growth;

changes in habitat affect chick growth / rearing of chicks;

c. mass may go down as proportion of ice cover has decreased;

mass may increase as most recent data shown in (bar) graph shows increasing proportion of ice area;

Examiners report

a(i). Most candidates were able to detect the fluctuation in data, but few saw an overall decreasing trend.

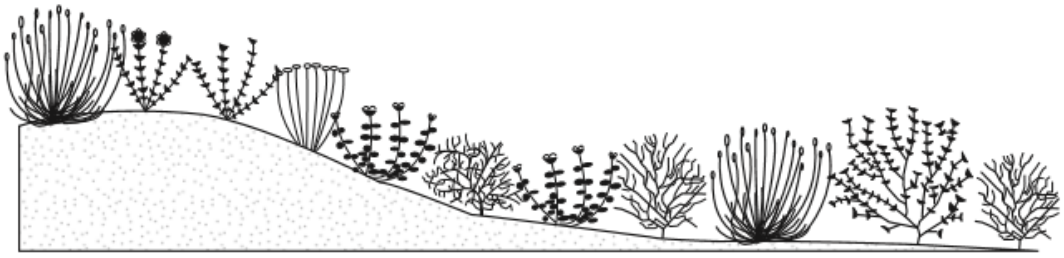
a(ii). Most candidates, if not all, had this answer correct.

b(i). Most candidates answered this question correctly.

b(ii). Most candidates were able to detect one reason for the relationship (mostly change in habitat affecting chick growth). Very few realised that the change in temperature influences the fish populations, thus affecting food availability for chicks.

c. Most candidates answered this question correctly.

The diagram below shows changing vegetation along a slope in a terrestrial ecosystem.



[Source: © International Baccalaureate Organization 2015]

a. Describe how a transect can be used to investigate the distribution of plant species in this ecosystem. [2]

b. The vegetation shown here has developed as a result of primary succession. Outline the changes that take place in the abiotic environment during primary succession. [2]

c. Outline the abiotic factors that affect the distribution of plant species in an ecosystem. [2]

Markscheme

a. a. random positioning of the transect;

b. transect is a line stretched over an area of study;

c. samples taken/species present recorded at regular intervals along the transect;

d. used to investigate effect of an abiotic variable/named example;

b. a. rocks begin to break down;

b. minerals begin to accumulate;

c. soil begins to develop;

d. water retention increases;

e. erosion of soil is reduced (by rhizoids and roots);

c. *The question asks for an outline but most candidates have given a list of factors without a reason. Therefore award **[1]** for every two factors listed or **[1]** for each qualified factor.*

water (distribution) for turgor/biochemical reactions/photosynthesis;
mineral / inorganic content / salinity of soil/water;
temperature (max, min, range, seasonal changes) / altitude;

light (intensity, duration, wavelength) for photosynthesis;
pH (range, average, changes) of soil/water;
wind (direction, strength);

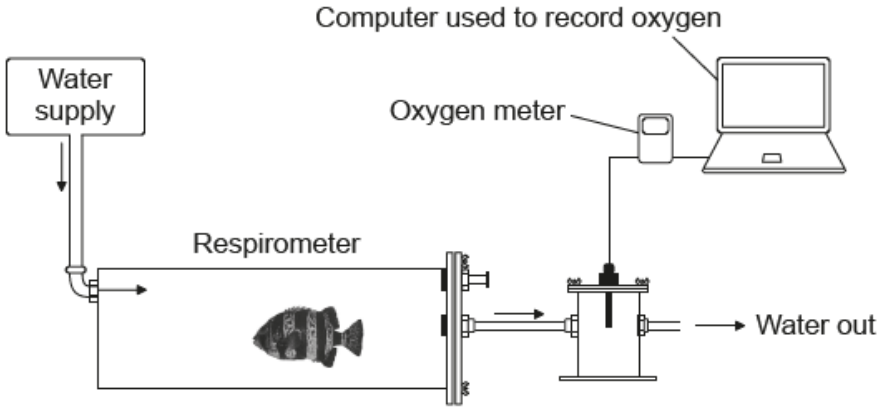
Examiners report

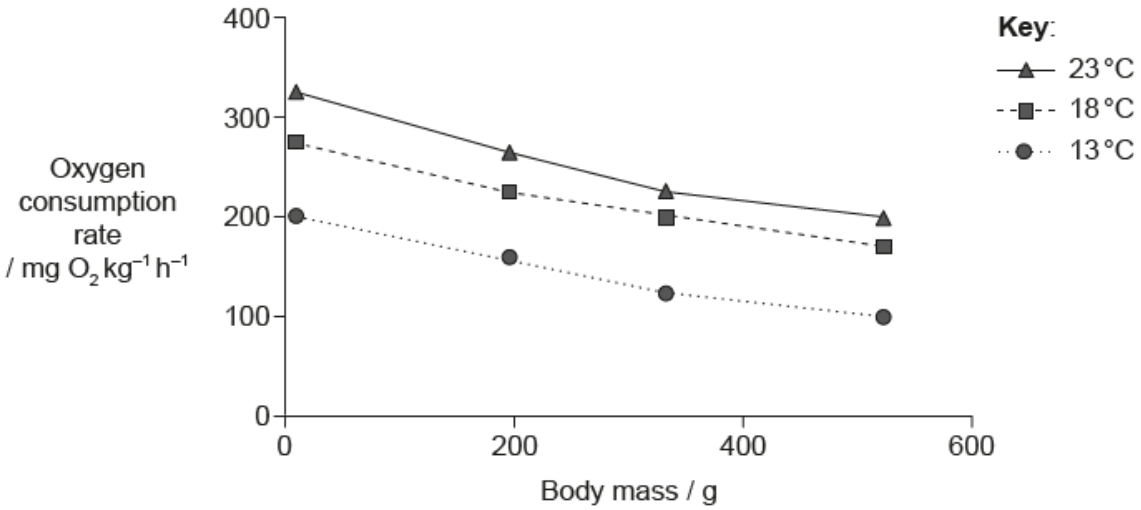
a. As in previous years, many candidates did not know what a transect is or its purpose and some were evidently confused with estimating a population size.

b. In (b) many answers described the vegetative changes in succession rather than the abiotic.

c. The mark scheme in (c) was generous in allowing lists of factors and/or elaborations, otherwise many would not have scored here.

The oxygen consumption rate of the fish *Oplegnathus insignis* was examined in a respirometer at three different water temperatures and at four different body masses.





[Source: adapted from E Segovia, *et al.*, (2012), *Latin American Journal of Aquatic Research*, **40** (3), pages 766–773]

a. Suggest how the oxygen consumption rate is determined using this apparatus. [2]

b. State the relationship between body mass and the oxygen consumption of fish. [1]

c. Predict the effects of global warming on aerobic respiration in fish. [2]

Markscheme

a. a. the data logger measures the differences in oxygen concentration

OR

the oxygen concentration is measured before and after the water passes through the respirometer

b. over time

c. the mass of fish needs to be measured

b. greater body mass, less consumption of oxygen

OR

indirect/negative relationship

c. a. higher temperature, more oxygen consumption

b. «more oxygen consumption» is due to more respiration/metabolism

c. less oxygen can dissolve in warmer water so less «aerobic» respiration
OR
more carbon dioxide dissolved so less oxygen for respiration

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]