MARINE SCIENCE

Paper 9693/11
AS Structured Questions

Key message

Candidates need to develop the skills in interpreting information from graphs.

General comments

Candidates need to develop their understanding of key scientific language and should use this language effectively and accurately. They need to ensure they carefully read all the information provided to them in order to answer the questions correctly, and use precise language in their answers, not giving generalisations, such as “suitable”, “amount” or “changes”. At this level, candidates should be able to express how something changes, give detail of how something is suitable, and state what the amount is, e.g. number, mass or volume.

Many candidates also gave no response to at least one question. Candidates should be encouraged to attempt every question.

Comments on specific questions

Question 1

(a) (i) This question required candidates to consider reasons for an increased tidal height in a set location. Many candidates talked about the Moon or Sun not being where they would be expected, showing a misunderstanding of the predictable movement pattern of the Moon and Sun relative to Earth. Few candidates were able to state an environmental condition that would lead to a change in the tide heights. Some candidates gave wind as a factor but the concept of onshore wind i.e. directionality, was required. Few candidates mentioned that decreasing air pressure would have this effect, so few scored full credit.

(ii) Many candidates were able to give one or two suitable responses, usually flooding or infrastructure damage, but some focused on the impacts to tourism or people visiting the beach.

(b) (i) This question required accuracy. Candidates needed to look carefully at the diagram and interpret the tide heights. Weaker candidates did not ensure that the peaks matched the time of the high tides, with some showing more than 2 high tides. Many candidates were able to identify low tides were at midnight, midday and midnight again.

(ii) Many candidates stated that the curve would be lower, which implied the entire curve would be moved down, so low tides would also be lower which was incorrect. Some candidates only talked about tidal range and did not indicate how that would change the curve.

Question 2

(a) (i) Few candidates scored full credit here. Many candidates stated that waste material sank, or was excreted, which was already in the diagram, or that it went to a consumer or was harvested, but again these were in the original diagram. Stronger candidates gained credit for talking about movement, respiration, or heat loss.

(ii) Some candidates discussed the waste material being consumed as it passed through the water column. However, consumption was included in the initial diagram, so waste material that was consumed was still part of the energy passing to consumers. Some candidates discussed the

decomposition of the waste material by bacteria at the seabed, or that the material would remain on the sea floor until upwelling raised them to the surface to be taken back into the food chain.

(iii) Candidates often had difficulty in finding the amount of energy that passed to the consumer, with some simply choosing one of the numbers in the diagram. Candidates needed to consider the information and work out the difference between the energy coming into the system and the energy stated passing out and then undertake their percentage efficiency calculation. Candidates should always be encouraged to have a calculator with them for their exam as some candidates calculated this without one. Weaker candidates simply calculated 10 per cent of 3300, showing no understanding that these are approximate figures, and that change depended on energy expenditure at each trophic level. Many candidates failed to show their working and so could not be awarded partial credit for any correct working.

(b) (i) Most candidates stated that they were in the fourth trophic level but quite a few weaker candidates said that they are a predator or a carnivore and showed they had either not understood the question did not understand the term “trophic level”.

(ii) Some candidates did not recognise nematodes as being a parasite of tuna and so talked about nematodes praying on other large species within the ecosystem, or simply talked about energy flow rather than numbers. Candidates rarely considered the relative size of organisms going through the food chain, which is important when considering a pyramid of numbers. Stronger candidates were able to state that there are many nematodes in each tuna or that the nematodes were very small and so many lived on a single fish. Relatively few candidates stated that there were more algae because of the small size of the algae.

(iii) Many candidates said that nematodes are smaller than tuna, which they are in size, but in order to answer the question they needed to state that the nematode bar would be smaller than the tuna bar. Other candidates stated that the tuna bar would be larger without indicating that it would be larger than the nematodes bar or that it would still be smaller than the sea bream bar.

(c) (i) Many candidates gave two uses of phosphorus in sea bream. Weaker candidates often suggested respiration, energy, or growth.

(ii) Many candidates suggested that sea bream absorbed the phosphorus directly from the water, implying that this was through skin or stated that it was through gills. Those who talked about it coming from food rarely mentioned the small crustaceans and some stated the sea bream ate the algae which had absorbed the phosphorous. As almost all the information needed to answer this question was provided, candidates needed to read the question more carefully and to make better use the information given in their answers.

(iii) Weaker candidates misunderstood the question, often responding with the idea that most of the energy in the calcium was used by the sea bream. Stronger candidates recognised the use of calcium within the sea bream and stated that bones, teeth, or scales were indigestible by the tuna or were not eaten by them.

Question 3

(a) The majority of candidates answered this correctly.

(b) Many candidates struggled to give the required level of accuracy in this answer. Many gave an answer of eight without examining the graph carefully enough to determine the correct answer with a greater degree of accuracy.

(c) Some candidates gave responses not related to the information provided in the graph, as requested in the question, such as photosynthetic activity. Some candidates read the graph as if depth was the y-axis and so stated that increasing depth decreased temperature and salinity, so oxygen concentration increased with depth. Credit was most frequently awarded for recognising that temperature decreased with depth, with fewer candidates knowing that salinity increased with depth. Only stronger candidates correctly made the link to the oxygen concentration changing as a consequence of that.

Question 4

(a) (i) Few candidates recognised that Coriolis forces would be minimal in the region where there are few tropical cyclones. Some did mention Coriolis forces, but did not make the link to them it being too weak. The most common error was that the water temperature would be too high for them to form.

(ii) Several candidates stated that this was because it was on the equator, but South America stretches a long way. A few candidates were able to correctly state that the water temperature would be too low, with a few of those mentioning upwelling too. Very few made any mention of wind shear.

(b) (i) This question focused on just the energy changes within the formation of a cyclone, which many candidates found challenging. The most common answers provided were evaporation of water and then condensation of the water. Stronger candidates also were aware of the release of latent heat as the water condensed. Some candidates also mentioned that the energy for the cyclone was coming primarily from the heat of the ocean water.

(ii) Many candidates stated that it acted as a barrier, which was imprecise use of language. A barrier would stop something completely whereas reefs reduce the impact or the energy of the waves.

(c) Many candidates scored at least partial credit here recognising that sand is likely to be very easily moved during a cyclone, with many understanding the consequences of erosion.

Question 5

(a) (i) Many candidates knew that biodiversity was to do with the number of organisms but that was often all they stated, without recognising that it is to do with the number of different species as well as the number of individuals of each species. A significant number of candidates named an area that had high biodiversity, such as a coral reef.

(ii) Many candidates showed a good understanding here, scoring at least partial credit, often for stating that organisms need to burrow in the sand for protection, or that sandy shore substrates are unstable compared to rocky shores.

(iii) A significant number of candidates stated that a predator-prey relationship was one in which both organisms benefit. Some went on to discuss the predators keeping the prey species under control. Many candidates gave suitable named examples of both relationships but many others used non-marine examples. A few candidates were able to explain that parasites do not necessarily kill their prey, just harm them, or stated that it was a long-term feeding relationship. Very few recognised that a predator feeds on many prey throughout its life, while a parasite will usually remain with a single host, unless it requires a secondary or tertiary host to complete its life cycle.

(b) This was well understood and was answered well by most candidates with many achieving full credit and most at least partial credit.

Question 6

(a) The majority of candidates recognised the feature as an ocean trench or subduction zone. Weaker candidates often just stated subduction, which was insufficient for credit as they needed to name a feature not a process.

(b) Few candidates recognised that as the crust subducted it would be heated and would melt as it moved towards the mantle. Many candidates gained credit by stating that the magma is forced out through cracks or holes in the crust, but many gave the impression there was no force causing this, or that the magma leaked out slowly.

(c) The majority of candidates correctly stated tsunami.

Question 7

(a) Many candidates stated three abiotic factors rather than what those factors needed to be to create the conditions required for coral growth. Simply stating “temperature”, “substrate” or “salinity” was insufficient to gain credit as candidates were asked for the conditions that are suitable. Many

candidates stated “suitable temperature”, without stating what that suitable temperature would be. Candidates needed to provide more precision in their answers.

(b) This question required candidates to consider why a particular part of the Great Barrier Reef had suffered dramatic coral death in a given year. Many candidates simply stated that this was due to human activities, without recognising that these occur every year, or predation, without stating that it must be an increase, as predation happens all the time. Candidates needed to give an explanation as to why such a high loss occurred in one year. Candidates needed to recognise this occurred at the northern end of the reef, which was closer to the equator and therefore warmer to start with. This is another example where candidates needed to look carefully at the information provided to help them develop an answer.

(c) Many candidates perhaps did not recognise the meaning of “historical rate of loss”. A number of candidates looked at that as simply being within the last few years, and discussed the use of quadrant sampling, rather than going back for hundreds of years. Candidates who understood the term often answered well and were able to suggest core sampling, drilling, carbon-14 analysis or looking at the bands within the corals.

Question 8

(a) Few candidates were fully aware of how dry monsoons are formed. Many described the formation of a hurricane, and some described how a wet monsoon was formed. Credit was most often awarded for recognising that the wind came from the land to the ocean. Some candidates talked about the lack of evaporation from the ocean causing the winds to be dry.

(b) (i) Most candidates demonstrated a good understanding of this impact and gained at least partial credit. Many recognised that salinity would decrease and that nutrients would be added. Some candidates went on to discuss the impact of these changes on the organisms living in the ocean here, which was not required.

(ii) Most candidates achieved credit for suggesting a nutrient but many did not link this to photosynthesis, often simply stating that it will increase productivity.

MARINE SCIENCE

Paper 9693/12
AS Structured Questions

Key messages

- Candidates should read the instructions for each question with care. When asked to circle or select an answer, instructions must be followed, for example, do not circle two words if only one is asked for. Where candidates change their mind, it must be clear which answer has been crossed out.
- The command word for each question should be considered carefully. If candidates are asked to explain, or suggest reasons for an observation, just stating or describing the observation or data will not gain credit.

General comments

In this paper, some questions were answered well by all candidates. Others were more challenging and required descriptions or explanations. Most candidates attempted most questions and had no difficulty with the space and time allowed.

Comments on specific questions

Question 1

(a) Candidates were expected to have a detailed understanding of relevant terminology. Confusions between the terms ecosystem, community, population and habitat were seen.

(b) (i) Candidates could generally set out the food web in a logical format. It was not appropriate to list octopus in two separate locations in the food web. The arrows needed to be in the correct direction to show the flow of energy through the food web.

(ii) The pyramid of energy had to include four bars with the widest bar at the base for chemosynthetic bacteria. Candidates needed to read the question carefully, ensuring that only the food chain with four tropic levels was shown in the pyramid. Candidates who tried to include all six organisms from the food web could not allocate them to a correct trophic level and therefore could not gain full credit.

(ii) Candidates could state two ways in which energy is lost between tube worms and fish. Care needed to be taken not to refer to losses at other stages of the food chain, such as respiration of the fish, as that did not answer the question.

(c) Mutualism between chemosynthetic bacteria and tube worms could generally be described. It is important that candidates understand the difference between photosynthesis and chemosynthesis and that neither process produces energy. Some confusion was seen where responses referred to tube worms as hydrothermal vents.

(d) Candidates must not imply that succession is when one species of tube worm evolves into another species.

(e) Candidates showed a good understanding of why algae and plants are not found at hydrothermal vents. References to simply “extreme temperature” or “extreme environment” were insufficient.

(f) The strongest responses referred to the movement of plates closing the fissure or minerals in the water precipitating out of sea water and blocking the fissure.

Question 2

(a) (i) Candidates were asked to describe the data in this question. Therefore, they needed to consider what the data showed, not just read values from the graph. Many candidates wasted time and space referring to parts of the graph that were not asked for in the question, such as using the data from 1986 to 2005.

(ii) The strongest responses clearly showed their working. Care should be taken to position decimal places correctly and to give appropriate units.

(b) Candidates could generally give two or more environmental factors needed for the formation of mangrove forest. Vague responses that did not gain credit referred to “correct temperature” or “correct salinity”.

(c) (i) Candidates needed to suggest two reasons for the changes in salinity that linked to data in the figure. Some did not answer the question, and instead discussed the changes in oxygen concentration.

(ii) Most candidates linked lower temperatures in autumn and winter to increasing solubility of oxygen. Others correctly referred to increased turbulence or wave action causing increased surface mixing or dissolution.

Question 3

(a) Common correct answers were DNA, bone and ATP. Incorrect answers were often too vague, such as “for growth”.

(b) (i) The majority of candidates could name the processes in the phosphorus cycle. Credit could not be given for descriptions of the processes without naming the process.

(ii) Many candidates could give one advantage but could not elaborate on their idea or give another advantage.

(c) (i) Some confusion was seen between the meaning of the terms “productivity” and “efficiency”. Candidates needed to be able to explain what is meant by both terms and to understand the concept of rate.

(ii) Candidates could generally suggest why harvesting algae could decrease the productivity of a marine food web.

Question 4

(a) A minority of candidates answered the incorrect way round, referring the strongest winds in the eye of the tropical cyclone. The question asked for differences in weather, therefore the strongest responses were clearly comparative such as “lower wind speed at A”, rather than just “no wind”.

(b) (i) Some candidates listed factors that cause a tropical cyclone, which did not always apply to the question that was asked about factors that can affect the maximum wind speed.

(ii) Credit could not be given for repeating “wind speed” which was given in the question, but this was frequently seen. The question asked for other pieces of information that are needed to predict the extent of storm damage.

(c) Candidates often gave detailed suggestions of how the impact of a tropical cyclone could be reduced. Candidates should be reminded to consider the marks available for each question and to use this as a guide as to the length of responses required. “Building a barrier around the community” was a typical answer that was too vague to demonstrate understanding.

Question 5

(a) (i) This question was very well answered. Most candidates could give three advantages of shoaling, Occasionally, candidates mistakenly expressed the same idea twice.

(ii) Most candidates gained credit here.

(b) The strongest responses outlined what an El Niño event is and then the effect on decreasing upwelling, decreasing nutrient concentration in sea water, and then explained the effect on phytoplankton, anchovies and the shark population. Some responses were too vague, such as "the sharks are affected". The effect on the shark population was essential to get full credit here.

(c) (i) Clear definitions of parasitism were seen. The best responses also gave examples such as endoparasitism and exoparasitism or described specific examples.

(ii) Most candidates could describe the way parasites on fish that shoal could more easily pass to a different host. Fewer could specify that this was because fish in a shoal are closer together.

Question 6

(a) (i) Candidates should be able to use correct vocabulary such as crust, plates, mantle accurately. Many candidates did not use terms precisely or correctly. Stronger responses described the Earth's crust made up of plates, described the plates as floating on the mantle or asthenosphere and moving. Candidates were also able to gain credit for describing the convection currents in magma or mantle below plate and how these movements are driven by heat or density. Weaker responses tended to list the types of movements at plate boundary, rather than answering the question.

(ii) Descriptions of the types of evidence to support the theory of plate tectonics were generally clear. Occasionally, they lacked enough detail to make sense as an answer to the question, therefore responses such as simply "magnetic rocks" were insufficient.

(b) (i) Most candidates could interpret the figure to identify the features.

(ii) The type of plate boundary was generally named accurately. Either divergent, diverging or constructive were acceptable.

(c) This was a challenging question to explain how isostasy produces shallow seas at the edge of continents. Only stronger candidates gained full credit. Many responses lacked detail or showed no understanding of the relevance of isostasy.

MARINE SCIENCE

Paper 9693/13
AS Structured Questions

Key messages

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(c) (i) Some confusion was seen between the meaning of the terms “productivity” and “efficiency”. Candidates needed to be able to explain what is meant by both terms and to understand the concept of rate.

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MARINE SCIENCE

Paper 9693/21
AS Data-Handling and Free-Response

Key messages

Candidates should read the questions carefully and consider what the question is about. They should select appropriate information to answer the questions and try to avoid including irrelevant or vague descriptions.

Candidates should manipulate data presented in tables or graphically, rather than quoting figures. These figures need to be exact and not approximations.

Calculations require working out to be completed and shown. Even if the final answer is incorrect, credit can be awarded for the process of working it out.

When candidates are directed to draw a bar on a bar chart, they should be encouraged to use a ruler.

General comments

A good standard of scientific knowledge and understanding was displayed by many candidates. Most candidates attempted every question. Weaker candidates sometimes did not answer the question or attempted a vague answer with very little scientific detail.

Comments on specific questions

Section A

Question 1

(a) This question was answered well by most candidates. However, a few candidates stated “cleaned” or that mutualism meant that neither benefitted, or that the parasite benefitted.

(b) Many candidates provided good answers. However, data was often quoted but not manipulated. For example, in 2010, “there were 44 species on the reef, which increased to 67 species in 2017”, did not gain credit. If the candidate had continued to say that 67 – 44 = 23, showing an increase in species, this would have gained partial credit.

Despite the question specifying “number of fish species”, a significant number of candidates referred to “number cleaned” and some candidates thought the bar graph referred to the number of shark nose gobies.

(c) (i) Many candidates found it difficult to read an accurate value from the graph, the figure 77 for the total number in 2016. A significant number of candidates were unable to complete the calculation. Some candidates with incorrect final answers were awarded partial credit for showing some correct working. However, several candidates with the wrong answer did not show any working out and could not be awarded any credit. A small, but significant number of candidates showed incorrect rounding.

(ii) Most candidates correctly plotted this bar. The most common error was not drawing the bar the correct width (three squares). A significant number of candidates did not plot the bar onto **Fig. 1.1** but attempted to redraw the bar chart in a space on the examination paper. Another common issue with the drawing of this bar was that it was often drawn free hand without the use of a ruler.

(d) (i) Most candidates managed to gain partial credit. Candidates were not critical enough and simply stated the relationship was that as one increased the other decreased, when this was not always the case. Many candidates often repeated their trend in reverse to try to gain further credit. If data was used it was sometimes inaccurate or an approximation when exact figures were required.

(ii) Most candidates obtained at least partial credit with all the marking points seen. The most common error was referring to just the numbers of fish rather than specifically the number of species present or the number of gobies. Stronger candidates recognised that changes in the parasite population would have an impact or that there maybe species preferences for the cleaner fish.

Question 2

(a) Only a minority of candidates were able to draw a line of best fit. Some candidates drew a zig zag line joining each plotting point. Lines which were vertical and horizontal were also seen.

Some candidates may have treated the bottom right two points as anomalies and a significant number of candidates did not draw the line long enough through all the data points.

(b) Only stronger candidates answered this correctly. A common misconception was that more data points meant more penguins. Some candidates also repeated their trend in reverse.

(c) Many candidates gave a precise answer and achieved credit here. However, others gave an imprecise value or a range of percentages as their answer which could not be credited. A small number of candidates just stated that the temperature will be lower without giving figures and a few omitted the minus sign.

(d) Many candidates understood that the decrease in penguin populations was linked to the lack of upwelling and the resulting lack of nutrients due to El Nino. However, a significant number of candidates thought the penguin population decreased because they did not like warm water. One misconception was that candidates thought El Nino was a collection of storms.

Question 3

(a) (i) Stronger candidates answered this very well. Many candidates stated that it was not possible for organisms that were not adapted to live in such conditions.

Stating only extreme pressure or extreme temperature without qualifying the way in which it was extreme could not be credited and nor could stating use of low light instead of no light. Some weaker candidates suggested a high pH and an increase in acidity.

(ii) Many candidates did not understand the term succession. It was often confused with success (survival of the fittest), food chains, describing trophic levels and evolution.

Some candidates described the differences between primary and secondary succession, which could not be credited. Candidates who stated that succession was the idea of a community changing overtime answered well. Many candidates correctly named two organisms, usually chemosynthetic bacteria, Tevnia and Riftia.

Only the strongest candidates understood that each species changes the conditions allowing other species to colonise and the idea of a climax community.

(b) Many candidates gave good answers, but a significant number of candidates described the movement (convergent/divergent), instead of describing how this movement is driven.

The evidence part of the question was often answered well but vague answers such as countries instead of continents, mountain ranges on continents and fossils found in different countries were not credited. These points required the idea that the rocks in the mountain ranges and the fossils were similar.

A lot of candidates stated that plate tectonics were under the Earth, below the crust or beneath continents. Many candidates referred to plates as plate tectonics, not really understanding the word tectonics. The structure of the Earth was not well known by a significant number of candidates and there was confusion between the theories of plate tectonics, evolution and the formation of atolls.

Question 4

(a) Most candidates did not understand the term “morphology”. They explained how mangrove roots act as nurseries for juvenile fish or create habitats. They did not explain how mangroves help to form and shape deltas. A number of candidates made some reference to only biological factors, for example, providing food, oxygen and removing salt instead of how mangroves affect the morphology of a delta by being a buffer to erosion, trapping sediment and allowing it to accumulate.

The idea of reducing erosion was commonly seen, but sometimes in the wrong context. There were descriptions of reducing erosion by the sea or incoming tides, rather than the river water leaving the delta. Many candidates mentioned a reduction in wave action instead of a reduction in the flow of water currents.

(b) (i) Most candidates gained at least partial credit on this question. However, many candidates were not specific enough in the kind of environmental changes bought about by long periods of rain. These included the idea of increased erosion, increased turbidity, decreased salinity and increased current flow. Many candidates just referring to “change”. For example, “a change in salinity” did not gain credit, but “decreased salinity” did.

Factors were often listed without linking them to an impact.

(ii) Many candidates produced good responses to this question, compared to **(i)**. Candidates mentioned increased nutrients and algal blooms and the consequences of these on coral productivity. Stronger candidates gave well linked points and often gained full credit. However, some candidates produced vague answers for example, that the salinity will change rather than decrease or that photosynthesis would be affected, rather than the rate being reduced.

MARINE SCIENCE

Paper 9693/22
AS Data-Handling and Free-Response

Key messages

- Candidates should be familiar with what is required by different command words used on the paper, such as the difference between “describe”, “explain” and “suggest”.
- They should also always look at the number of marks available for each question part to help them decide how much detail to include in their answer.

General comments

Overall candidates demonstrated an excellent knowledge of the syllabus and were able to apply this very well to the contexts presented. The standard of answers from many candidates was high.

Questions about patterns/trends in data may ask candidates to use the data to support their answer, (e.g. see **Question 1a** below). Candidates should ensure they read the question carefully to correctly identify which part(s) of the data set they need to comment on. This includes looking carefully at any key present if there are multiple lines or bars on a graph or reading the correct axis.

In questions asking for a scientific method, it is helpful for candidates to think in terms of variables:
Independent variable – what am I changing and what range will I use?
Dependent variable – what am I measuring/recording and using which measuring device/equipment?
Control variables – which factors must be controlled to ensure reliable results are obtained.

Stating that the investigation should be repeated at least 3 times and mean results calculated is also important in gathering reliable results.

Comments on specific questions

Section A

Question 1

This question was well understood and answered well by most candidates.

(a) Weaker candidates did not attempt to use the data to support the answer. Candidates must ensure they carefully extract data from the information provided to support their answer, e.g. “with one red grouper present the percentage change in juvenile fish increased from 50 per cent in week 2 to 110 per cent in week 6”. Stronger candidates were able to manipulate the data in some way. For example, here by stating that the percentage change increased by 60 per cent between week 2 and week 6.

(b) The majority of candidates understood that the data supported the conclusion, but as the command word asked them to explain, they needed to say why, and some candidates did not support their answer with an explanation.

(c) (i) Most bar graphs seen were drawn well with bars of equal width, evenly spaced and graphs which filled most of the area provided. The most common error was not labelling the bars correctly. Different styles of bar chart were accepted, for example some candidates drew 4 bars, one for each number. Others drew 2 bars, one for absent and one for present and correctly subdivided the

bar. Candidates should be aware that the tolerance for the correct height of their bars is usually 1 mm (half a small square on the grid) so care must be taken to draw them accurately.

(ii) Many candidates correctly stated the generalist niche, with some incorrectly stating a specialist niche. However, some candidates suggested more general terms such as "predator".

(d) Only stronger candidates answered this question fully correctly. Many candidates were able to describe the ways in which the data helped to support the idea, but only a minority were able to describe the limitations of the investigation, such as only 4 hollows per treatment, no distinction of the variety of species of juvenile reef fish, a lack of data on other species in the ecosystem, and only one area of sea bed investigated.

Question 2

(a) Most candidates were able to gain at least partial credit for their described method. Candidates are advised to follow the guidance in the General comments above regarding the description of the variables. Candidates should take care to suggest suitable timeframes for investigations involving marine organisms. Some suggestions seen were inappropriate, such as leaving the dinoflagellates for weeks or months.

(b) The majority of candidates understood the link between depth, light, and photosynthesis. However, care should be taken to describe the available light in scientific terms, for example "light intensity" rather than "the amount of light". The weakest answers simply referred to the amount of Sun. Similarly, photosynthesis is best described in terms of the rate of photosynthesis rather than the amount of or more photosynthesis.

Section B

Question 3

(a) Many good answers were seen, and most candidates were able to score at least partial credit. Some answers were too vague with candidates referring to "suitable" depth/temperature/pH rather than specific figures. Again "amount" should be avoided e.g. "a suitable amount of light" or "plenty of light" should be replaced with "high light intensity" or "high penetration of light".

(b) Some excellent answers were seen, and in particular there were some detailed descriptions of how carbon 14 dating can be used. Many candidates described the methods, but few candidates mentioned that analysis should be carried out at different depths on the reef.

A minority of candidates were confused by what the question was asking, and described how reefs can be regenerated following reef destruction/erosion e.g. by using artificial reefs.

(c) Most candidates were able to gain at least partial credit on this question with many comprehensive responses seen. The question asked for the impact on human communities, but a common error was for candidates to discuss the impact on ecosystems/coastlines without then elaborating on how the changes would affect the human population.

Question 4

(a) Only a minority of candidates described both the tectonic process and the subsequent settling of sediments on the uneven rock surface created. Some described the tectonic process involved at a mid-ocean ridge well, but not the subsequent settling, and vice versa.

Also, only a few candidates mentioned the depth or location of the abyssal plain, so full credit was rarely awarded.

(b) (i) Most candidates were able to gain partial credit, but only stronger candidates gained full credit. A number of candidates used incorrect language around the availability of light energy, such as there being very little, or very low light levels, rather than stating that no light is available at this depth. Not all candidates then linked this to there being no photosynthesis to support food chains. Some candidates incorrectly discussed the marine snow being used to facilitate chemosynthesis.

Candidates need to be careful with their use of language in answers relating to energy. Accurate responses referred to energy becoming “available” to food chains. References to “producing” or “making” energy were incorrect.

(ii) Many candidates were able to gain credit on this question with comprehensive responses often seen. The syllabus lists nutrients as elements, such as nitrogen and phosphorus, but some candidates named the appropriate ions they are found in, such as nitrate and phosphate.

MARINE SCIENCE

Paper 9693/23
AS Data-Handling and Free-Response

Key messages

- Candidates should be familiar with what is required by different command words used on the paper, such as the difference between “describe”, “explain” and “suggest”.
- They should also always look at the number of marks available for each question part to help them decide how much detail to include in their answer.

General comments

Overall candidates demonstrated an excellent knowledge of the syllabus and were able to apply this very well to the contexts presented. The standard of answers from many candidates was high.

Questions about patterns/trends in data may ask candidates to use the data to support their answer, (e.g. see **Question 1a** below). Candidates should ensure they read the question carefully to correctly identify which part(s) of the data set they need to comment on. This includes looking carefully at any key present if there are multiple lines or bars on a graph or reading the correct axis.

In questions asking for a scientific method, it is helpful for candidates to think in terms of variables:
Independent variable – what am I changing and what range will I use?
Dependent variable – what am I measuring/recording and using which measuring device/equipment?
Control variables – which factors must be controlled to ensure reliable results are obtained.

Stating that the investigation should be repeated at least 3 times and mean results calculated is also important in gathering reliable results.

Comments on specific questions

Section A

Question 1

This question was well understood and answered well by most candidates.

(a) Weaker candidates did not attempt to use the data to support the answer. Candidates must ensure they carefully extract data from the information provided to support their answer, e.g. “with one red grouper present the percentage change in juvenile fish increased from 50 per cent in week 2 to 110 per cent in week 6”. Stronger candidates were able to manipulate the data in some way. For example, here by stating that the percentage change increased by 60 per cent between week 2 and week 6.

(b) The majority of candidates understood that the data supported the conclusion, but as the command word asked them to explain, they needed to say why, and some candidates did not support their answer with an explanation.

(c) (i) Most bar graphs seen were drawn well with bars of equal width, evenly spaced and graphs which filled most of the area provided. The most common error was not labelling the bars correctly. Different styles of bar chart were accepted, for example some candidates drew 4 bars, one for each number. Others drew 2 bars, one for absent and one for present and correctly subdivided the

bar. Candidates should be aware that the tolerance for the correct height of their bars is usually 1 mm (half a small square on the grid) so care must be taken to draw them accurately.

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(d) Only stronger candidates answered this question fully correctly. Many candidates were able to describe the ways in which the data helped to support the idea, but only a minority were able to describe the limitations of the investigation, such as only 4 hollows per treatment, no distinction of the variety of species of juvenile reef fish, a lack of data on other species in the ecosystem, and only one area of sea bed investigated.

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Section B

Question 3

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A minority of candidates were confused by what the question was asking, and described how reefs can be regenerated following reef destruction/erosion e.g. by using artificial reefs.

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Question 4

(a) Only a minority of candidates described both the tectonic process and the subsequent settling of sediments on the uneven rock surface created. Some described the tectonic process involved at a mid-ocean ridge well, but not the subsequent settling, and vice versa.

Also, only a few candidates mentioned the depth or location of the abyssal plain, so full credit was rarely awarded.

(b) (i) Most candidates were able to gain partial credit, but only stronger candidates gained full credit. A number of candidates used incorrect language around the availability of light energy, such as there being very little, or very low light levels, rather than stating that no light is available at this depth. Not all candidates then linked this to there being no photosynthesis to support food chains. Some candidates incorrectly discussed the marine snow being used to facilitate chemosynthesis.

Candidates need to be careful with their use of language in answers relating to energy. Accurate responses referred to energy becoming “available” to food chains. References to “producing” or “making” energy were incorrect.

(ii) Many candidates were able to gain credit on this question with comprehensive responses often seen. The syllabus lists nutrients as elements, such as nitrogen and phosphorus, but some candidates named the appropriate ions they are found in, such as nitrate and phosphate.

MARINE SCIENCE

Paper 9693/03
A2 Structured Questions

Key messages

- Candidates need to spend time reading the questions carefully, analysing stimulus material e.g. a graph or a table, before starting on their answers.
- It is important to identify the command word or words so that answers match what is being asked. Too few candidates answered 'describe and explain' or 'suggest and explain' questions correctly.
- Candidates should ensure their responses are clearly written and legible.

General comments

Strong candidates performed very well. They had a good knowledge of the syllabus and were able to demonstrate excellent analytical skills when presented with unfamiliar material. This was particularly evident in **Question 3** on mackerel fishing and in **Question 4** on grouper aquaculture. However, many candidates performed very poorly on these questions and gave answers which showed that they had not referred to the information provided and had very limited scientific knowledge. Some candidates used bullet points for their answers, which often meant that they did not make adequate links between points, so could not access the full mark range.

Comments on specific questions

Question 1

(a) (i) Most candidates were able to obtain partial credit, usually for suggesting that producers providing food for consumers. Fewer answers referred to energy and in many cases credit could not be awarded as energy was said to be produced rather than provided for consumers. Oxygen production was a common answer, but this was rarely linked to consumer respiration. Few references were made to providing shelter or providing a habitat or to fixing carbon to form glucose.

(ii) Answers were usually too imprecise to gain credit e.g. the manure "contains waste", or "contains nutrients", to help algae grow. Stronger candidates were able to name the nutrient in manure (usually nitrates or phosphates) and provided a more specific reason as to how it was used by the producer, e.g. nitrates used to make proteins, or phosphates used to make DNA.

(b) (i) The majority of candidates gained partial credit, usually for suggesting run-off of fertilizers or agricultural waste which contained nitrogen, so increasing algal growth. Very few candidates related warm temperatures or bright light to the water being shallow. Few references were made to upwelling or to aquaculture. References to run-off of pesticides were incorrect.

(ii) This question was about eutrophication. Many answers incorrectly focused on less photosynthesis by producers, so less food for consumers, or algae blocking light for other producers. Other incorrect answers stated that the phytoplankton used up oxygen. Stronger candidates were able to describe decomposition by bacteria and the effects of decomposition on consumers. Many candidates gained credit for stating that the algae would release toxins.

(c) To gain credit, candidates were required to read the information provided and to discuss any advantages that the new monitoring methods provided. Some candidates did not refer to the information provided, while others gave answers that were too confused to gain any credit. candidates needed to be clear that only satellites can predict where algal blooms are likely to

occur, and that no method can prevent algal blooms forming. A common incorrect answer was that these new methods were “more accurate”.

Question 2

(a) (i) This question asked candidates to complete a word equation for respiration. Few candidates gained full credit and the most common errors were to confuse glucose with either water or with carbon dioxide. Some candidates had the correct idea but replaced water with ATP, while others stated water on both sides of the equation. The question asked for a word equation, so providing a formula was not required.

(ii) There were a few excellent answers, with stronger candidates gaining full credit. However, naming the process provided a variety of incorrect answers, including ram ventilation, pump ventilation, respiration and even photosynthesis. Many weaker candidates described the pathway for oxygen rather than the process. There was much confusion over the terms breathing, ventilation, gas exchange and cellular respiration. Sea anemones having a large surface area to volume ratio was the most common correct answer. Many candidates missed out on full credit as they identified a thin body rather than a thin body wall.

(iii) Only the strongest candidates were able to state that the moving tentacles maintained a diffusion or concentration gradient.

(b) (i) Partial credit was common, usually for stating that the gills provide a large surface area so that more oxygen could be absorbed. Few references were made to external gills being in constant contact with the water or to short diffusion paths. Complex incorrect answers involving oxygen being transported to the mouth were common. The question was about gas exchange, but some candidates stated that the feathery gills were important for camouflage and protection from predators.

(ii) To gain credit for this question, candidates were required to compare the labelled diagram of a sea anemone with one for the sea slug. Most candidates stated that the sea slug had a multi-layered body or had to move to obtain food, so required more oxygen or energy. However, there were a few very confused answers, with some candidates suggesting that sea anemones carried out photosynthesis.

Question 3

(a) (i) The majority of candidates gained partial credit, but a few incorrectly stated that sonar could detect eggs or fish larvae/fry. Others just described what sonar did.

(ii) This question was based on ***Section 11(d)*** of the syllabus and only stronger candidates provided answers that were worthy of any credit. These candidates were able to describe the types of data which could be obtained e.g. the number of adult/juveniles, size of catch, but were often unable to state how this data could be used.

(iii) Most candidates stated that returning juveniles would allow them to mature and breed, so increasing stocks in future. However, some candidates thought that catching juveniles and releasing larger fish so that they could reproduce was an acceptable answer. Fewer candidates correctly stated that mackerel were a migratory fish, so placing a restriction in area would be unsuitable.

(b) (i) Only stronger candidates gained full credit but many candidates were awarded partial credit. Some candidates made an error reading from the graph, others added up all the values for each year from 2002 to 2011 and then divided by 2 or by 10. Error carried forward was allowed, but for marking point 3, the correct units were required and the vast majority of candidates stated, “million tonnes” instead of “million tonnes per year”.

(ii) Some candidates did not read the question carefully enough to understand it and made no reference at all to the figures. A few candidates misunderstood the map and thought that the feeding areas had decreased each time, and others gave answers related to overfishing. However, there were also some very good answers where candidates applied knowledge to the information provided.

Question 4

(a) Partial credit was common, usually for stating that the salinity remained the same as no freshwater was being added to the ponds, or for stating that temperature remained constant as cooler water did not enter from the river. Some answers were too vague e.g. river water would "change" the conditions in the ponds. Few references were made to silt blocking gills or to river water flow removing phytoplankton. References to pollution, run-off or fish escape were not credited.

(b) (i) This question produced some very good answers and many candidates gained full credit. A common error was to identify waste products or toxins, but there was no indication that these were being removed. References were made to nutrients entering the pond, but there was no link to phytoplankton. Stronger candidates stated that oxygen entered the ponds and was used for grouper respiration.

(ii) Paddles used for water exchange, keeping predators away and as a means of generating electricity were common incorrect answers. Some candidates thought that the paddles contributed to upwelling of nutrients, rather than providing an even distribution of phytoplankton.

(ii) Candidates who did not make the connection between paddle wheels providing oxygen, could not gain any credit. Few candidates referred to the information provided, that the paddle wheels operated from late afternoon until the following morning. Stronger candidates realised that it was something to do with photosynthesis but often forgot to state that this occurred during the day.

(c) (i) Common incorrect answers included "cleans the pond" or "removing faeces", "toxins", "waste food" or "disease" rather than pathogens. For the second element of the question, it needed to be clear that the disease-causing organisms did not infect the new stock of grouper fingerlings.

(ii) There were some good answers to this question and stronger candidates were able to process the information provided in the table and combine this with their knowledge of hatcheries. Common errors included simply repeating the information in the table or misinterpreting the information and giving answers that involved releasing hatchery fish into the wild.

Question 5

(a) To gain credit, candidates had to state that there was an <u>increase</u> in demand for water e.g. for irrigation or for aquaculture.

(b) (i) Most candidates had the idea that the inflow pipe should be placed deeper, but it needed to be clear that the pipe was deeper in the water and not just in deeper water as it could still be on the surface. A common error was to state that the phytoplankton and fish eggs were in shallow water rather than in surface waters.

(ii) Stronger candidates gave excellent answers using the correct scientific terms and had a thorough knowledge of water potential. Some candidates stated that the mussels dried out or were harmed or killed or that the salt made conditions unsuitable. A few candidates thought that mussels were osmoregulators instead of osmoconformers, while others confused the terms stenohaline and euryhaline. Some candidates incorrectly stated that the high salt concentration from brine reduced oxygen availability or eroded shells.

(iii) Some answers to this question were not precise enough. e.g. "damage" instead of remove, "affecting" or "harming" coral instead of bleaching coral. A common correct answer included high pressure disturbing sediment, which blocked light for producers, so decreasing photosynthesis. Fewer references were made to toxins or to disruption of food chains.

(c) (i) Only stronger candidates answered this correctly but most other candidates realised that the bulge would be to the right of the existing line. Most lines started at the top instead of starting at 250m, which was where the outflow was released.

(ii) A description of why the shape had changed was usually correct, even if the graph was incorrect. However, the increased salinity needed to be linked to the brine or outflow to gain credit. Just stating that the brine changed the salinity was not enough.

(d) The command word here was 'explain', but most candidates just stated the effect of brine on marine organisms. Answers therefore were incomplete e.g. "high temperature denatures enzymes" or "organisms die". Only stronger candidates gained full credit.

Question 6

(a) Many candidates had little idea of the stages in a salmon life cycle. Common errors were to state incorrect terms such as larvae for alevin and juvenile for parr.

(b) A few candidates did not read the question carefully and gave answers on the benefits of hatcheries, so no credit could be awarded. Most candidates gained at least partial credit, but their answers often did not include one of the activities in the question. Examples included, that migration was prevented, but there was no reference to a dam, or that nests/redds were destroyed, but there was no reference to excavation.

(c) This question had two command words, 'suggest' and 'explain' and only stronger candidates stated an advantage linked to an explanation. Common answers included stating that more fish would survive, but not why, or that conditions were controlled, but they did not name the condition or why there was an advantage. In a few cases candidates thought that the question was about fish farming rather than about the benefits of hatcheries.

(d) (i) Stronger candidates correctly stated a reason for preventing breeding between the wild salmon and hatchery produced salmon and knew that the risk was connected to different gene pools and genetic diversity. Some candidates did not focus on the word breeding, so incorrect answers referred to introducing diseases or competition for food, which were correct answers for **(ii)**.

(ii) This was generally answered well by most candidates, with "competition for food", "spreading disease" and "more easily predated" common correct answers. Incorrect answers included referring to breeding again or not stating what the fish were competing for.

MARINE SCIENCE

Paper 9693/04
A2 Data-Handling and Free Response

Key messages

Candidates should be reminded:

- to use two y axes on graphs if appropriate
- to look for patterns in data series, describe the patterns and then to think of explanations
- to use key vocabulary in extended answer questions
- to always give both sides of an argument when asked for advantages and disadvantages
- to consider the command word before answering a question.

General comments

There were many very strong performances seen. Most candidates completed the paper and few left questions blank. Extended answers were often detailed and showed good use of scientific vocabulary. Many candidates lacked confidence when answering data analysis questions, but many excellent answers to **Questions 1** and **2** were seen. Candidates should look for patterns in data, describe them and then go on to suggest explanations. Graph skills were generally very good, and most candidates used sensible, linear scales and took the time to label their axes. Some candidates tried to draw scattergrams. Questions on this paper usually require the plotting of two data series with two vertical axes and a shared horizontal axis. Maths skills were good, but many candidates overcomplicated **Question 1(a)(ii)** when asked to calculate a mean rate of change. Sometimes candidates did not recognise the difference between the command words "describe" and "explain".

Comments on specific questions

Section A

Question 1

(a) (i) This question required candidates to calculate the mean, annual rate of change of coral reef area covered with living coral. Many candidates calculated the mean percent coral over the period rather than the mean rate of change. Candidates should remember that to calculate a mean rate of change they need to divide the difference by the time taken.

(ii) Many candidates drew excellent graphs with two linear y axes and took care taken to label axes, give keys and to join plots accurately. Where candidates did not score full credit, it was often for only plotting one data series, or for plotting a scattergram of percentage cover against the mean annual carbon dioxide release. Most candidates selected sensible scales and so generally plotted points accurately.

(b) Most candidates gained at least partial credit for this question, but few went on to further credit. Many correctly described the correlation between reef loss and carbon dioxide concentration, but fewer went on to explain that the loss could be due to other factors. A significant number did not notice that the data was about carbon dioxide while the question referred to global warming. When asked to discuss data, candidates should explore it fully, looking for several ideas rather than focusing on only one aspect.

Question 2

(a) (i) This question required candidates to calculate the percentage increase in dry loss of algae when 90 g of fertiliser was added compared to 0 g. Some candidates did not know how to calculate a percentage change and simply found the ratio of the masses of algae at the two fertiliser masses. Percentage change calculations are common mathematical questions for the paper and candidates should make sure that they are familiar with this skill.

(ii) Most candidates were able to describe the increase, identify the turning point at 60 g, and then describe the subsequent decrease of crude oil reduction. Many candidates understood the difference between the command words, "explain" and "describe".

(b) Most candidates gained at least partial credit but only the strongest gained full credit. The majority of candidates recognised that adding more fertiliser would not result in significant increases in crude oil removal (or even cause a decrease) but would increase the growth of algae. Many also went on to explain the environmental risk of algal blooms in terms of oxygen loss. Only the very strongest made reference to the overlaps of standard deviation. If error bars are given on graphs, they are usually relevant to the question and so candidates should refer to them in their answers.

Question 3

(a) (i) This question required candidates to explain the key features of Sargassum. Most candidates recognised the structure from the diagram, but a few did not explain how features such as the air bladder and holdfast enable Sargassum to survive. Stronger answers referred to each feature and went on to give explanations, such as the large surface area and air bladders linked to light absorption and photosynthesis. Many weaker candidates suggested that the holdfast is like a root that absorbs minerals.

(ii) Many excellent, detailed answers were seen, and most candidates explored the roles of Thalassia in marine ecosystems extremely well. Excellent answers gave detailed descriptions and showed a breadth of issues. Common factors considered included the role of Thalassia in bringing energy into food webs, its role in stabilising the substrate, the production of oxygen and how it acts as a habitat and nursery area for animals. Weaker answers tended to focus on just one or two aspects repetitively.

(b) This question comparing the reproduction of tuna with whales produced an excellent range of answers. Some outstandingly well written, detailed accounts were seen that fully explained the differences in energy, number of offspring produced, fertilisation methods, and parental care. The vocabulary used by many candidates and the structure of their answers was often impressive. Weaker answers tended to focus on one or two features and a few candidates confused the two species, suggesting that whales use external fertilisation.

Question 4

(a) (i) This question focused on how well candidates understood the need to think about the relationships between different organisms when carrying out conservation. Stronger candidates explained that is important to ensure that there is sufficient food to prevent extinction, and the presence of predators to prevent overpopulation. Many also explained that if predators were not present, overpopulation could harm other species due to competition or over-predation. Some candidates did not fully understand what was meant by the term "ecological linkages" and so gave vague answers about different methods of conservation. Some answers also did not fully recognise the aims of conservation in terms of maintaining or preventing the extinction of species.

(ii) This question was answered well by many candidates and there were many well-structured answers that explored aspects such as the impacts on food webs, erosion, and nursery sites. Some candidates did not fully explore disadvantages as well as advantages. If both are asked for, answers need to refer to advantages and disadvantages to gain full credit. When candidates considered the disadvantages, they often referred to the development of invasive species, increased decay, and the costs. When considering broad topics such as mangrove rehabilitation, candidates should focus on both ecological and sociological factors.

(b) This question required candidates to focus on how the negative environmental impacts of an aquaculture venture in coastal waters could be minimised. A significant number of candidates

misread the question and discussed closed, inland systems where fish are kept in tanks. Stronger candidates considered factors such as the removal or reduction of waste by careful feeding regimes or maintaining low stock density. Many excellent answers also discussed the role of multi-trophic level aquaculture. Other excellent points that candidates raised were the minimising of antibiotics and pesticides, the use of strong netting to prevent escape, and placing the venture in an area where water currents wash waste away. Weaker candidates tended to refer to closed systems in tanks, only gave one or two points, or only gave descriptions of methods without going on to explain them. Candidates should be careful not to confuse the command word “explain” with “describe”.