MARINE SCIENCE

Paper 9693/01
AS Structured Questions

Key messages

Candidates should ensure they read questions carefully so that they answer the question that has been asked. Candidates need to give focused answers. For example, stating how a factor would change or explaining reasons for the change. A general comments such as "it would change" is not usually sufficient.

Candidates should be familiar with command words such as *describe*, *explain* and *outline*.

Candidates should be aware that accuracy is important when drawing graph lines, label lines or diagrams.

Candidates should be encouraged to give named examples of organisms in their answers where appropriate.

General comments

Candidates answered short answer factually based questions such as **3(b)ii**, **4(a)i**, **4(a)ii**, **4(a)iii**, **6(a)** and **7(a)** well. Answers requiring analysis and descriptions of interlinked ideas, for example **2(b)**, **2(c)i**, **5(c)i** and **5(d)** were more challenging.

Most candidates performed well on the questions with a mathematical content.

Comments on specific questions

Question 1

(a) (i) The majority of candidates were able to identify the structures correctly. Label lines needed to be drawn more accurately by some candidates, especially for the mid-ocean ridge.

(ii) A significant number of candidates were not aware that this was a divergent boundary and not all candidates answered this question.

(b) This part of the question was generally answered well, but a few used terms such as *transform* and *abduction* as their plate type examples, which were not accepted. Some candidates wrote descriptions and these were not accepted as the question asked for the plate boundary type.

(c) (i) Many candidates knew and explained the effects of a tsunami. However, answers needed to emphasise the tectonic processes leading up to the formation of such a wave. This needed to include pressure build-up, causing a sudden plate slippage which then releases energy and causes a massive displacement of water.

(ii) Most candidates understood where volcanoes appeared but few knew how the volcano would subsequently be formed. Candidates needed to be able to distinguish between magma and lava, which is important in explaining the build-up of a volcano. Many candidates described the magma as seeping out and spreading, which was not sufficient for credit as the idea of magma rising or erupting was required.

Question 2

(a) (i) Most candidates correctly identified the alga in the figure.

(ii) Many candidates explained or defined mutualism instead of describing the relationship between algae and coral. Many referred to the algae providing food or nutrients to the coral, whereas providing carbohydrates or oxygen was a more precise answer.

(b) Candidates needed to realise that sediment and deep water would lead to reduced light reaching the zooxanthellae. Often, answers simply indicated that the algae needed light and more detailed responses were needed. For example, explaining that more light could reach the algae when in shallow water with less sediment.

(c) (i) Many candidates described and repeated the figures already given in the table. They needed to analyse and compare the data provided, which would then reveal the trends in the three coral reef areas. Some stronger candidates were able to manipulate the data to help describe these trends and patterns.

(ii) Some candidates misread this question and gave reasons for reef erosion by humans or stated the benefits of reefs such as reduction of wave action or slowing down waves. Stronger candidates used their knowledge and applied it to the context of the question suggesting that a reef decrease would cause more erosion at the coast and a probable loss of tourism.

Question 3

(a) This question was generally well answered, but some candidates did not mention ions or refer to salts dissolving in the water. Many correctly referred to the convention of parts per thousand as a unit of salinity.

(b) (i) Most candidates were able to identify the correct number from the figure and gave the relevant correct unit.

(ii) This was well understood with many accurate and detailed responses.

(c) Many candidates understood that increasing evaporation would cause an increase in salinity. Some quoted run-off without mentioning the salts that this would bring to the ocean. A few responses correctly mentioned the idea of ice formation in the ocean, but others described glacier formation, which was not accepted as it would be land based.

Question 4

(a) (i) Most candidates gained full credit but a few quoted depth instead of height and some gave unrealistic units such as centimetres or inches.

(ii) Most candidates correctly selected 12 hours as the length of time between low tides.

(iii) Most candidates correctly chose **C** as representing the tidal range.

(iv) Often graph lines were untidy and difficult to follow. Many candidates drew their line above the original tide cycle line and some lines were drawn out of phase so the peaks did not coincide. Clear and precise lines were required in this part of the question.

(b) Many candidates understood the influence of the Sun and Moon's gravity on tidal range. There were many well explained answers, but some candidates needed to explain the result of the Sun and Moon being in line or at right angles to each other. Some answers were too generalised and discussed high and low tides instead of considering tidal range.

Question 5

(a) Many candidates understood the implication of kelp loss and could explain how it would cause a decrease in the populations of sea urchins, small fish and sea snails, and the subsequent decrease in the crab population. Some referred to the crabs feeding on kelp, but overall there were some impressive descriptions and reasoning of the effect of kelp loss on the food web.

(b) The majority of candidates gained credit for the correct labelling of the pyramid. The answer required neat stepped boxes of energy but many drew a triangle. Many answers were drawn freehand and were imprecise.

(c) (i) The idea of light being reflected from the water was the most frequently seen correct answer. This part of the question was challenging for many candidates. There were few references to photosynthetic inefficiency or some light wavelengths not being suitable.

(ii) Most candidates worked this out correctly and showed their working to arrive at 25%.

(d) There were many precise descriptions of upwelling which described how the increase in nutrients would affect the producers and the rest of the food web. Candidates needed to be aware that this nutrient increase would cause increased photosynthesis and growth in the algae, which would supply the rest of the food chain with more energy. Many answers focused on productivity in a generalised way, when more detail and reference to named organisms (e.g. phytoplankton) was required.

Question 6

(a) (i-iv) The biological uses of nitrogen, phosphorus and magnesium were well known by most candidates. There was more uncertainty over the use of carbon and many gave vague answers, for example “essential for life”.

(b) (i) There were many excellent explanations of weathering, erosion and run-off. Most candidates gained full credit.

(ii) Most candidates were able to identify that process **B** represented death, decomposition and the sinking of detritus to the sea bed.

(iii) This part of the question was only answered well by stronger candidates. There were many generalised answers which referred to calcium being needed in the ocean as an essential nutrient. Stronger candidates realised that the calcium present in the organisms would be removed permanently by over-harvesting and thus less calcium would be available for recycling. Some correctly understood that the calcium present in organisms was needed for the skeleton.

Question 7

(a) There were many accurate and detailed definitions and most candidates answered correctly.

(b) (i) The trends on the graph were interpreted correctly by most candidates.

(ii) Many candidates understood that the predators increased and subsequently decreased, but few linked this idea to the amount of prey available.

(c) Many lines were drawn poorly and lacked neatness. Some candidates drew large increases for both populations before recording a decrease. Candidates needed to show the peak of the predator population lagging behind the prey population peak. Often, the predator line was correctly drawn decreasing, but it needed to be lower than the population line at time **F** to gain credit.

(d) (i) Many candidates gave clear reasons for the lag phase and appreciated that adjustment, and time to reproduce, would be required. Adaptation on its own was insufficient for credit.

(ii) Most candidates drew this line correctly and showed a significant decrease.

(iii) Many candidates gave unqualified answers such as referring to food, weather or competition. These answers needed to be qualified, for example loss of food, change of temperature or increased competition, all of which would have an effect on the population of the prey.

MARINE SCIENCE

Paper 9693/02
AS Data-Handling and Free Response

Key messages

Candidates should read the questions carefully and consider what the focus of the question is before starting their answers. 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 to support a trend in the data, rather than quoting figures directly.

The quality of graph drawing was generally very high. However, candidates should be reminded that axes should be labelled correctly and that they should not use non-linear scales when working out the size of the graph axes.

General comment

A very high standard of scientific knowledge and understanding was displayed by many candidates.

Most candidates attempted every question. Weaker candidates occasionally did not answer some questions or attempted a vague answer with very little scientific detail.

Overall candidates tended to answer better in **Section A** than in **Section B**, showing that many candidates were able to apply their knowledge of principles and concepts in a logical, deductive manner.

Comments on specific questions

Section A

Question 1

(a) (i) Many candidates answered fully correctly. Common errors included forgetting units, non-linear scales and extending the line to zero.

(ii) Most candidates correctly read the value from the graph. A few candidates estimated the value from the data in the table.

(b) (i) Many candidates gained partial credit here. Better candidates manipulated the data but many others just quoted the data from the table. The majority of candidates described the rate of uptake as decreasing at high nitrate concentrations rather than a small increase or levelling off.

(ii) Nearly all candidates were able to describe how to work out the mean. A few candidates described averaging the six different concentrations in the table rather than the seven replicates for a concentration of 1.2.

(iii) Many candidates were too general in their answers to this question. Many wrote that nitrates are essential in photosynthesis or growth. Better candidates stated that nitrates are used to synthesise amino acids and proteins.

Question 2

(a) Nearly all the candidates correctly stated that periwinkles are primary consumers. However "secondary consumer" was seen several times.

(b) (i) Many candidates correctly picked the numbers to put into the formula but unfortunately some did not calculate the correct answer.

(ii) A significant number of candidates were unable to calculate area in this question. The answer in **(i)** was often divided by 20 or 40.

(iii) Most candidates were able to achieve at least partial credit for a correct reason why the mark-release-recapture technique may not have been accurate. There were references made to predation but these were rarely qualified by stating that marking might increase the predation rate. There were many good answers but a lot of candidates concentrated on human experimental error.

Section B

Question 3

(a) Many candidates were familiar with the term succession. However many candidates referred to two specific species which changed from one to another rather than references to the ecosystem/community changing over time.

If *Tevnia* and *Riftia* were mentioned, they were usually in the correct sequence. It was not always clear from some candidates that they understood that the *Riftia* outcompetes *Tevnia* and that therefore *Tevnia* disappears from the ecosystem. There were a number of vague answers including stating that recolonization occurs in the aftermath of natural disasters. Although the question specified "marine environment", a small number of candidates wrote about woodland and other non-marine habitats.

(b) Many candidates did not separate erosion and sedimentation in their responses, often stating that rocky/muddy shores were produced by both, without being specific about the relevant involvement of each. Many candidates understood erosion as being the weathering of rocks, rather than the removal of sediments. Other misconceptions included, sedimentation building up rocky shores by the sediment being compacted into rocks on the shore or that muddy shores formed because erosion had taken everything else away. There were very few references to particle size.

(c) This was often very well answered with clear understanding from many candidates. Most candidates appreciated that predation, exposure to air, climate change and storm damage were significant factors on reef erosion.

Some candidates made vague references to the effect of human activity. Stronger candidates provided suitable examples, such as boat anchorage. Errors were seen with incorrect reasons for coral bleaching given.

Question 4

(a) Many responses were vague about the changes in the composition of seawater, without any specific detail of substances. There was also confusion between pH and acidity, for example "material increased the pH and made the water more acidic".

Many candidates simply stated that the material changed or affected the pH/acidity or composition of seawater but did not attempt to clarify the change or effect.

Magma was a common response instead of the required ions or minerals having an effect.

A significant number of candidates stated that carbon was coming out of the volcano and dissolving to lower the pH, rather than carbon dioxide. Volcanic gases were often incorrectly named as nitrogen, phosphorus and sulfur. Even if the gases were correctly identified, there was little understanding of how the gases got into the water. The effect of volcanic ash on the pH of seawater was generally only given by stronger candidates.

(b) This was answered well by stronger candidates. Some candidates gave vague answers with little detail or linked changing temperatures to changes in salinity. However, there were some very good descriptions as to how temperature gradients form in water to produce ocean layers. Many candidates mentioned the term “thermocline” and also that the temperature of the water decreased with increasing depth.

Most candidates knew that mixing of layers could take place due to upwellings or surface winds. Mixing due to convection currents was less well known.

(c) Most candidates failed to make a direct comparison between the two bodies of water. They answered in general terms without describing which area would be most affected or why. There was sometimes a lack of comparative language used, for example, “warm” was often given rather than “warmer”.

While some candidates understood that an increase in wave action would help in atmospheric dissolution of oxygen in the open ocean, only stronger candidates referred to the reduced solubility of oxygen in either warm or more saline water.

Some good candidates commented that there would be more producers in the ocean and so more photosynthesis would take place, oxygenating the water. They often went on to comment on the effect of respiration of marine organisms in decreasing dissolved oxygen concentration. A number of candidates made incorrect references to photosynthesis taking in and depleting oxygen rather than producing it.

MARINE SCIENCE

Paper 9693/03
A2 Structured Questions

Key messages

Candidates are advised to read and process information in the questions carefully before starting their answers.

Candidates need to take into account the command word, the number of answer lines and mark allocation for each question.

Candidates should be advised to use terminology carefully and precisely to ensure their answers are clear.

General comments

There were some very strong scripts and the overall standard was good with few very weak candidates. Stronger candidates showed a sound understanding of the syllabus and were able to process the information provided, while weaker candidates gave generalised answers that gained partial or no credit.

Comments on specific questions

Question 1

(a) (i) Most candidates correctly stated the function of the holdfast. However a common misconception was that it acted as a root and absorbed water and/or nutrients.

(ii) Many candidates gained full credit for the idea that the air bladders held the plant upright to receive maximum light for photosynthesis. Some candidates incorrectly thought that the air bladders were involved in gas exchange and stored gases for photosynthesis.

(iii) Almost all candidates answered fully correctly but few candidates showed their working. A minority of candidates forgot to multiply their measurement by 10, while very weak candidates found difficulty in measuring the seaweed correctly.

(iv) Good responses gave clear statements describing how light penetration decreases with increasing depth. The majority of candidates had some idea of this, but few succeeded in explaining adequately. There were few references to the importance of pigments in light absorption.

(b) The majority of candidates gained partial credit, usually for *Sargassum* providing food and shelter from predators. Relatively few referred to “producer” or “fixing carbon”. Common errors were stating “nutrients” instead of food and “oxygen”, but no mention of its use in respiration. Vague wording such as “helps animals survive” could not be credited.

(c) Strong candidates gained full credit, usually for outcompeting the local species and introducing disease. Some answers referred to molluscs instead of *Sargassum*, while others gave vague responses e.g. “disturbing the ecosystem” or “upsetting food chains”.

Question 2

(a) A common correct answer was that water entered through the mouth and left via the operculum. Weaker candidates suggested that water entered and left via the operculum. Strong candidates

included correct references to pressure and volume changes, though these were rarely seen. A minority of candidates described ram ventilation instead of pumped.

(b) (i) Most candidates could complete the word equation for respiration. Common errors were giving "ATP", "nitrogen" or "chloride" in the second box.

(ii) There were many references to operculum movement representing respiration rate instead of ventilation rate. References to respiration using oxygen was often implied rather than stated. Cause and effect were often confused and a common answer was that increased oxygen caused more respiration.

(iii) The calculation was usually correct.

(iv) Most candidates were able to state the relationship between temperature and operculum movements, though a minority misinterpreted the graph so had cooler water with faster operculum movements.

(v) The idea that the oxygen content of water decreased with increasing temperature was well known, but answers often referred to ventilation movements as respiration. Some candidates thought that the issue was about temperature and salinity and greater need to osmoregulate.

Question 3

(a) There were a number of vague responses seen, e.g. "open ocean", "estuary". Specific locations were required for each stage. Few candidates gained full credit.

(b) This questions was generally well answered. The most common error was a reference to producing eggs rather than storing them.

(c) Strong candidates made the link between external fertilization and increasing genetic diversity. Many answers lacked sufficient detail. For example "lower survival rate" was frequently given as a disadvantage, but without explaining why, or, "risk of predation" instead of "higher risk of predation".

(d) (i) Many answers to this question were not precise enough. Answers stating "more competition" were considered too vague as "more competition for food/resources" was required. There were only a few references to cannibalism in shrimp. Some candidates seemed to equate internal fertilization with increased parental care and protection and did not appreciate that when fertilized eggs are laid, they are also vulnerable to predation.

(ii) The majority of candidates gained full credit. However, answers needed to be qualified, so "shelter", or "protection" could not be credited.

Question 4

(a) (i) Most candidates gained credit for juveniles not reaching breeding age or juveniles being caught by trawling. Few references were made to the sustainability of stocks or the fact that the ban coincided with the spawning season. Weaker candidates suggested that overfishing caused sea bass to mature faster.

(ii) Full credit was common for size, location or seasonal restrictions on fishing. References to enforcement were not credited.

(b) (i) The vast majority of candidates could identify the correct overall trend. Several candidates tried to explain why the catch was going up, showing a need to read the question more carefully and to look at the mark allocation.

(ii) Even strong candidates struggled to read the graph correctly, or could not work out percentage change. When the correct answer of 91% was seen, the negative sign was often missing. There were a few cases where the correct answer was rounded up to 92% or 91.5%.

(iii) In order to gain credit candidates needed to use all of the information provided to state why fish stocks were at a similar low level in 1992 and 2013. Most candidates gave answers about fish

stocks in 1993 and 2015, instead of making reference to the very high recruitment in 1989 and comparing catch in 1992 and 2013. Only a few candidates made reference to sustainability.

Question 5

(a) (i) Many candidates thought that filtration was there to remove toxins or chemicals instead of small particles such as sand or sediment, or microbes in the water.

(ii) Many candidates gained partial credit for adding oxygen as the reason for aeration. Fewer candidates linked this to respiration. Answers were often too vague to gain credit, e.g. “oxygen required to live or survive”. There were only a few references to aeration helping to circulate the water in the tank.

(iii) Few candidates gained full credit but many gained partial credit for the idea that in the land-based tanks in the hatchery conditions were controlled, whereas those in sea cages were not. The words *intensive* and *extensive* were rarely seen in answers.

(b)(i) This was only answered correctly by stronger candidates. Most candidates could identify temperature as one of the factors but common errors were “salinity”, “males and females present” and “food”. Stronger candidates gave “lunar cycle” or “pH” or “addition of hormones” or were more precise with their answers e.g. “correct diet” instead of food and “ratio of males to females”.

(ii) Identification of the hatching tank as requiring phytoplankton was only given by the strongest candidates, with nursery tank the most common incorrect answer. Most candidates gained partial credit for stating that the phytoplankton provided a food source.

(iii) Credit was awarded for the idea of pellets made from fish waste. Answers such as “using aquaculture to grow food fish” or “feeding grouper on human waste e.g. beef or chicken”, or the idea of feeding less food did not gain credit.

(c) (i) Most gained partial credit for mutualism but a few weaker candidates described the interaction between the goby and the grouper.

(ii) “Spreading disease” was the most frequently seen correct answer. A few candidates gave answers in terms of the goby not being able to adapt to the tanks or becoming prey for the grouper.

Question 6

(a) (i) Most candidates gained partial credit for this question by stating that the blasting caused tuna or prey fish to move away from the blasting area. Fewer answers mentioned that blasting could kill tuna or prey fish outright, or that blasting could kill tuna eggs or fry, or that sediment could increase.

(ii) Partial credit was awarded for stating that seismic surveys should be banned during the fishing season. Few candidates mentioned avoiding migration routes or fishing areas.

(b) Almost all candidates answered correctly, usually for identifying the location or migration route of tuna.

(c) (i) Partial credit was common, usually for stating that toxins in oil kill fish, so there would be less food for birds. More obvious effects of oil on feathers, so reducing flying or reducing buoyancy and drowning, were not frequently given. Many had the idea of bioaccumulation up the food chain, but referred to oil rather than to toxins in the oil.

(ii) The majority of candidates gained full credit. Weaker candidates missed the ‘bio’ remediation and discussed technology and using chemicals.

Question 7

(a) (i) Most candidates gained partial credit, usually for stating that cars cause air pollution. Better candidates gained further credit, usually for using a local hotel or for the idea of more money in the local economy. Many answers were too vague as links to ecotourism were not clear enough.

(ii) Partial credit was common, but links to ecotourism were not usually made. Cruise ships often "caused pollution" but not water pollution. Many candidates answered in terms of cruise ships and that people should not be in a marine protected area at all or that money from these cruises should go into conservation. In many answers there was no value given to simply visiting the reef as a way of raising awareness or learning about the reef ecosystem.

(b) Most candidates gained partial credit for naming an alternative energy source, usually solar panels, but there were few explanations given. In stronger answers explanations included, for example, solar power being a renewable resource or there being a reduction in fossil fuels. Most candidates just repeated the question and stated that they were more sustainable. Some answers mentioned recycling of water, but not from what. A fairly common misconception was that desalination would be acceptable as a sustainable source of fresh water supply.

MARINE SCIENCE

Paper 9693/04
A2 Data-Handling and Free Response

Key messages

Candidates should be reminded to:

- show all working when carrying out calculations.
- take care to label all graph axes and use straight lines that join points.
- use precise scientific vocabulary when answering questions.

General comments

The general standard of answers was good. Some candidates tended to give answers which were too general and lacking in detail, but it was evident that in general most candidates were well prepared. Graph plotting was generally good and most candidates are able to use scientific language. Application of data was challenging for some candidates.

Comments on specific questions

Section A

Question 1

(a) (i) The majority of candidates chose to plot a line graph and correctly used straight lines to join points. Candidates should be reminded that if a bar chart is drawn, the bars should not be touching and that the lines should be ruler drawn. Most candidates were able to devise linear scales and were able to correctly plot points. A few candidates did not add labels or a key but stronger candidates showed precision and care when drawing graphs.

(ii) Around half of the candidates were able to correctly calculate a percentage change. Some candidates found this challenging and tried to divide the catch in 2010 by the catch in 1980 rather than looking at the change in catch.

(iii) Most candidates were able to give a correct reason for the inaccuracy in the data, typically that the fishermen did not report catches correctly. There was a good understanding of the idea of different areas of sea being unrepresentative of the catch as a whole. Some candidates did not fully understand the question however and thought that it was referring to the ability of the fishermen to catch fish.

(b) (i) Some excellent answers were seen that fully explained the changes in population of sea urchins and cod. Some candidates did not read the command word, 'explain', and instead gave descriptions of how the catches change rather than explaining why, while others just compared the changes in population of each species.

(ii) Whilst proving challenging, there were some excellent answers that fully explained the positive feedback effect of kelp coverage and crab populations. Some candidates gave vague references to overfishing and conservation or suggested methods of conservation rather than using the information provided.

Question 2

(a) This question was well answered by many candidates and most were able to describe the increase in salinity and the area of the graph over which salinity changes little. Some candidates tried to give explanations but weaker candidates were imprecise regarding the salinity concentrations at which there is little change. Stronger answers referred to data points and gave a description of change.

(b) This question was challenging for many candidates and only stronger candidates used precise terminology. There was a great deal of confusion between the terms *osmoregulator* and *osmoconformer*, with many thinking that the salmon was an osmoconformer. Some gave descriptions of the effect of changing salinity or simply described the salmon as a euryhaline species. Even in better answers which explained the process of osmoregulation, there was often imprecision, such as not referring to the gills or active pumping of salt. Some candidates thought that the salmon would need to drink less and pump salt into the gills when in high salinity.

(c) Only the strongest candidates answered this correctly. These candidates understood that the crab was able to osmoregulate within narrow bounds that matched an estuarine salinity. A number of candidates thought that the mussel was an osmoregulator. Very few candidates understood that osmotic damage can occur in different salinities.

Question 3

(a) The majority of candidates gained at least partial credit and had a very good understanding of the ecological effects of dredging. There were many excellent, detailed descriptions of how dredging affects the quality of the water by increasing turbidity, reducing light intensity and the subsequent effects on photosynthesis and productivity. Fewer candidates discussed the release of toxins from the seabed and their effects on ecosystems due to bioaccumulation. There were some excellent, detailed accounts that gained full credit. A few candidates misunderstood the question and discussed oil pollution.

(b) Most candidates showed a good understanding of marine antifouling paints and were able to refer to the use of TBT and mercury in paints. Many gave detailed accounts, describing the condition of imposex and how it would affect mollusc populations. There were a few candidates who were confused about this and considered that sex reversal would happen in other species such as tuna. The effect of reduced breeding on food chains was less well understood and candidates needed to explain the effects on food chains rather than simply saying that they would occur.

(c) (i) The majority of candidates had a full understanding of the terms *genetic engineering* and *selective breeding* although a few gave vague answers to changing organisms rather than making reference to genes and phenotypes/characteristics.

(ii) This question was challenging for many candidates. The question required candidates to think about both the risks and benefits of using genetically engineered fish. Many only referred to risks and were mainly focused on the risk to the genetically engineered fish themselves. Where candidates gained credit, it was typically for the ideas of escape, breeding with native fish and thus passing on the gene and the rapid response to the problem of pollution. Few candidates considered that the method would be much more accessible for less trained people.

Question 4

(a) There were some strong answers that considered the conflicts of the fishing and tourist industries from both sides. A few candidates misunderstood the question and in addition to conflicts also considered how the industries would help each other, or discussed other industries such as aquaculture and agriculture. Most appreciated that there would be effects on fish stocks and fishing zones and that pollution would be an issue. Most candidates had clearly studied this section of the syllabus carefully and were able to apply their knowledge. Stronger answers discussed several aspects of the problem rather than focusing on one area repeatedly.

(b) (i) Many answers gained full credit for comprehensive descriptions of the needs of sustainable aquaculture. Some candidates focused purely on financial sustainability whilst others discussed both financial and ecological sustainability. Many candidates understood the need for sustainable feeding (such as using fish trimmings and plant protein) and limiting antibiotic use to prevent

bacterial resistance. A few candidates misunderstood what the question required and focused on how to set up an aquaculture venture and then discussed pollution effects.

(ii) This question required candidates to give both the advantages and disadvantages of releasing cultivated fish into the wild. Similarly to **3 (c) (ii)**, many candidates focused purely on disadvantages, typically the effects on food chains. Stronger answers considered factors such as the negative effects on the gene pool, poor adaptation of cultivated fish and the positive effects of replenishing the population and stabilising food chains.