MARINE SCIENCE

Paper 9693/01
AS Structured Questions

Key messages

Candidates should be encouraged to be specific in their responses using suitable scientific language in order to describe and explain phenomena accurately and in suitable depth.

It is important for candidates to read all the stimulus material carefully and complete all the instructions contained within the question. This was particularly evident in **Questions 1(b)** and **(c)** which were missed by a number of candidates. In **Question 6(a)** many candidates did not refer to the graph.

Candidates should also be reminded on what each of the commonly used command words mean. The command words *describe* and *explain* were two of the most commonly confused.

General comments

Some areas of the syllabus were better known than others. Candidates should be reminded to revise all the material detailed in the syllabus. A useful tool is to use the syllabus as a revision tool and to encourage candidates to go through the syllabus ensuring that they have covered each learning objective in their revision.

There were many examples of vague responses which prevented some candidates from accessing the available marks. The number of marks available for each question and the number of answer lines provided is a good indicator of level of response required by the candidate. Extended prose questions often require a detailed explanation. Candidates should be encouraged to make at least one relevant point for every mark available.

Comments on specific questions

Question 1

(a) Some candidates were unclear about the different conditions that would be experienced in the eye of a tropical cyclone. Common misunderstandings including statements such as the eye would experience stronger winds and rainfall. Some candidates were too vague in their responses and describe the conditions experienced in the eye as calm. Candidates should be encouraged to be more specific in their responses and refer to a lack of wind or rainfall rather than the conditions being still or calm.

(b) It was clear that few candidates were confident in answering this part and many candidates did not appear to notice the instruction to annotate the figure. A wide variety of responses were seen with some candidates placing their **X** in the clouds rather than near the sea.

(c) Many candidates correctly identified the initial movement of water into the cyclone did not continue their arrow to show the direction of movement through the cyclone.

(d) Many vague responses were seen. Many candidates referred to warm temperature, which was not enough to gain credit. Candidates should be encouraged to be more specific in their answers. Here a reference to warm sea surface temperature or stating the temperature was required.

(e) The correct answer of evaporation was frequently seen. However, a common error was to give the process of precipitation rather than condensation for the second arrow.

Question 2

(a) (i) Candidates found this part very challenging. Candidates should be prepared to accept that on occasion, data does not provide any significant findings. Evaluating data is an important skill for candidates to master. One of the important aspects of this data was that there was a large overlap in length between fish with and without parasites. This was a point that only a minority of candidates were able to identify. A few candidates tried to explain why longer fish were more likely to have parasites attached to their bodies.

(ii) This question was answered well with many candidates providing valid suggestions of the impact of parasitism on a fish causing it to be more likely to be caught by predators. A minority of candidates tried to explain this in terms of longer length fish having more parasites.

(b) The relationship between coral and zooxanthellae was well know by many candidates with several excellent responses seen.

(c) (i) Many candidates were able to identify a correct year. The most common incorrect response seen was 1990, a result of misreading the graph.

(ii) It is important that candidates know the difference between the command words *describe* and *explain*. Some candidates tried to provide explanations for the fluctuations seen in the data rather than describe what the data shows. Many candidates needed to be more specific in their responses. Many identified the regular fluctuations in sea surface temperature, but fewer described the overall increase or tried to manipulate the data.

(iii) Many candidates identified two factors that result in erosion of coral reefs. The most common correct answers included predation, ocean acidification and storm damage. Occasionally vague references to human activity were seen. Stronger candidates were more specific in stating which human activity, and anchorage of boats or blast fishing were examples of these answers.

(d) Many candidates misinterpreted this question and gave methods of reconstructing a coral reef rather than its history. This statement and methods of reconstruction of the history of a coral reef are taken directly from the syllabus. The most common answer seen was carbon dating.

Question 3

(a) This part was very well answered with the vast majority of candidates gaining credit.

(b) This part was very well answered with the vast majority of candidates gaining credit. A minority of candidates incorrectly stated large fish as a prey organism.

(c) This part proved more problematic with many candidates giving the description of a primary consumer rather than stating the trophic level of 2.

(b) (i) This part was very well answered with the vast majority of candidates gaining credit. Occasionally candidates tried to make this question more complicated than it was by attempting to calculate the energy loss as a percentage.

(ii) There were many correct responses seen. It was clear that many candidates had a good understanding of the ways that energy is transferred between trophic levels.

(e) A few candidates suggested that longer daylight hours would lead to more predation. These responses were generally unsuccessful. Some candidates correctly linked increased daylight hours to an increase in photosynthesis and productivity.

(f) (i) The role of chemosynthesis was not well known. Many candidates could state that it involved chemicals, but few were specific enough to gain full credit. The strongest responses linked the transfer of chemical energy from dissolved minerals to the rest of the food chain.

(ii) Candidates commonly gave the incorrect responses of Riftia or Tevnia or tube worms for this part.

Question 4

(a) (i) Candidates should be encouraged to read command words with care. Candidates needed to calculate the range rather than state the range. Some errors were seen due to lack of care with their calculations.

(ii) Most candidates were able to state the correct day.

(iii) Most candidates were able to state the correct number of tidal cycles. Occasionally candidates doubled the number of tidal cycles.

(b) (i) Candidates found this question more challenging as they had to interpret a diagram. The most common misconception was that the positions of the Earth, Moon and Sun would result in a high tide. Candidates should have described the result as the least difference between low and high tide. The term neap tide was also an acceptable answer.

(ii) The factors that affect the tidal range were not well known. Common correct responses included references to the size of the body of water and morphology of the coastline. Occasionally vague responses were seen with reference to wind rather than wind direction and wind speed.

Question 5

(a) Only the strongest candidates were able to successfully answer this question. Many candidates simply described the meaning of the terms erosion and sedimentation and were unable to link these to formation of rocky shores. Candidates frequently referred to rocky shore formation in terms of high levels of sedimentation.

(b) Candidates were more successful in describing how the processes of erosion and sedimentation lead to the formation of deltas. This question was generally well answered with many candidates displaying a good understanding of the processes involved in the formation of a delta.

(c) Many candidates gained at least some credit in explaining how factors would affect ecological communities, commonly referring to desiccation and the need to attach to a hard substrate. Candidates should use the number of marks allocated to a question as an indication to how many points they need to make.

Question 6

(a) (i) This question was generally well answered with many candidates linking oxygen production to availability of sunlight and depth in the water column. Occasionally candidates misread the question and attempted to explain the effect of photosynthesis on concentration of dissolved oxygen beyond 250 m. Candidates should be encouraged to read questions carefully as sometimes they only need to describe or explain a small section of the data presented to them.

(ii) Again, only a small part of the water column required explanation. Candidates should read all stimulus material carefully and reference to the axes titles on graph will help them interpret the information contained within the graph. Candidates should have identified that between 2 000 m and 3000 m, dissolved oxygen concentration increased. Many candidates reported the opposite.

(b) (i) Some candidates only referred to salinity at the surface of the water rather than salinity gradients through the depth of the ocean. The strongest responses linked salinity with density of water and that denser water sinks.

(ii) There were several suitable suggestions with many candidates gaining at least partial credit. Some candidates tried to explain differences in salinity in terms of pollution or runoff. However, the position of the area of high salinity was a large distance from any land mass. Candidates should engage with stimulus material critically to formulate their suggestions.

Question 7

(a) (i) Many candidates were able to answer this question successfully. Questions should be read carefully as the question asked for how phosphorus enters the ocean. Some candidates gave the source of phosphorus as being sewage or pollution.

(ii) Many candidates were able to identify the process occurring at **C**.

(iii) Most candidates were able to link the lack of phosphorus with its necessity for the formation of DNA and consequent reduction of fish populations. Fewer were able to link these ideas to earlier on in the food chain with the uptake by producers.

(b) This question was well answered with most candidates correctly describing many processes including the death and sinking of organisms and their decomposition. Only the strongest candidates described processes occurring after this point such as incorporation into coral reefs or rocks.

MARINE SCIENCE

Paper 9693/02
AS Data-Handling and Free-Response

Key messages

- Centres need to ensure candidates are well prepared for exams with a calculator, ruler and pencil to allow them to complete the paper when required to draw a graph and to undertake calculations.
- Candidates need to become more critical in their evaluation of data, considering the experimental method provided to evaluate if it has met basic scientific method. This was particularly required in **Question 2(b)**.
- Candidates should aim to use scientific vocabulary rather than trying to use descriptive terms.

General comments

The majority of candidates attempted all questions and demonstrated their level of understanding and synthesis of specification material. Candidates need to ensure they read the questions carefully to understand what is being asked of them and to consider all the data and information provided. A few candidates used bullet point for their answers, which sometimes meant they did not make adequate links between points and so may not have accessed the full mark range.

Comments on specific questions

Section A

Question 1

(a) (i) The majority of candidates could state a reason for the presence of algae in the tank. Those who did not suggested it made the tank look nice or to affect the crab or periwinkle. Weaker candidates needed to consider what the effect on the periwinkle was, i.e. provides food or protection.

(ii) Some candidates suggested the periwinkles should be the same size, which was considered to be too vague at this level. A more precise answer, such as mass, shell length or height, was required. Some candidates misread the question and gave a control variable for the experimental set-up, such as that the temperature of water should be the same.

(iii) While many candidates correctly stated that several replicates were required for improved reliability of the investigation, others stated both accuracy and reliability, or just accuracy. A few candidates stated it was to make it a fair test. At this level it is expected that candidates understand the difference between these terms and can apply them with certainty.

(iv) A range of acceptable answers was seen, including the death of a named organism, that the periwinkle may have reached its maximum size and so no more data could be collected or that waste products had built up. Some candidates stated, “it affects the organisms too much” and provided no details of what the effects may have been. Stronger candidates provided a scientifically reasoned answer, e.g. “it affects the algae as they have used all the nutrients in the water and can’t grow any more”.

(b) (i) Many candidates correctly calculated the percentage change in shell thickness. Some candidates may have achieved credit if they had shown their workings as although they gave an incorrect answer, they had made an error in their working, but this was not shown.

(ii) Many candidates stated that the thicker shell provided greater protection for the periwinkle, while some just stated "more protection" which was not quite sufficient. Some candidates just stated that the shell was thicker, without commenting on the advantage to the periwinkle.

(iii) The majority of candidates correctly calculated the ratio of mean shell length to mean shell thickness.

(iv) Some candidates restated their answer to **(ii)** rather than recognising that the resources are utilised to increase thickness of the shell rather than growth in the length of the shell. Some candidates gave answers such as "the shell became shorter with a crab present" rather than showing that the shell did not grow in length but increased in thickness instead.

Question 2

(a) Having two sets of data to plot was challenging for weaker candidates. While the data could be plotted on a single *Y*-axis, several candidates chose to draw two *Y*-axes to different scales and labelled them appropriately. Some candidates did not seem adequately prepared to draw a graph and attempted to draw bars freehand with little attention to detail or accuracy of plotting. This usually meant there was no consistency in the width of all bars, and often the top bar was drawn in such a way that it covered more than 1 small square.

Weaker candidates were more likely to get the scales and axes the incorrect way around, which was acceptable if they then plotted the bars in a horizontal orientation. However, most candidates who did this then attempted to plot the bars in the vertical orientation, so data could not be read from the graph. Some candidates found choosing an appropriate scale difficult and used inappropriate increments which made plotting accurately very difficult, or meant they used a small proportion of the graph paper.

Candidates should be reminded to draw graphs with a pencil so they can erase errors and redraw without having to start again. Stronger candidates were able to construct a suitable graph although a small number drew a line graph with the data.

(b) Candidates needed to consider the data and state if the hypothesis was supported or not, and how it was supported or not. Some candidates described the data, e.g. "At zero nitrogen input *Z. marina* had 48 g per m^2 and macroalgae had 53 g per m^2" without actually stating if the hypothesis was supported. Stronger candidates looked at the quality of data presented to see if it met criteria for accuracy and reliability, and critically considered the spread of data and control of variables.

(c) Many candidates answered this question well. Some candidates did not use information provided in the question, and suggested that the macroalgae used all the nutrients, leaving none for the *Z. marina*, rather than recognising that at low nitrogen levels *Z. marina* can grow but macroalgal growth is compromised.

Section B

Question 3

(a) Stronger candidates had a clear understanding of the causes and effects of El-Nino and provided structured, coherent answers. Other candidates could sometimes express the changes that cause an El-Nino event, describe some of the effects along the west coast of South America, state the effect on upwelling, or the effects the loss of upwelling has in the area. Sometimes they identified the incorrect area that these effects were occurring in or suggested more upwelling occurred. The weakest candidates often provided brief answers, and often seemed unsure of what an El-Nino event is.

(b) Most candidates were able to make some relevant statements on this question, usually regarding the effects on human coastal communities. Some candidates listed human infrastructure that was destroyed and needed to think more broadly. Responses from weaker candidates were often quite vague in relation to the effect on coral reefs, such as "it gets damaged" or "organisms get swept away" rather than considering the effects of increased sediment in the water or the impact of the wave action on the biology of the coral polyps. To achieve full credit candidates had to consider both the coral reef and human communities. A few candidates only provided answers on human communities.

Question 4

(a) This question was generally answered well, with most candidates stating that magma comes to the surface at divergent boundaries. Many candidates could also explain what happens at transform boundaries and why volcanoes do not occur there.

(b) Many candidates found this a challenging question, as it required some synthesis of information from different specification areas. Many candidates mentioned some of the physical effects on the sea water, such as temperature changes, but did not state how that affected the chemical composition, such as reduced gas (or named gas) solubility. Stronger candidates were often able to make these connections and discussed the effects of volcanic activity on the chemical composition of sea water with clarity. They often named one or more gases that are released from volcanic activity, and their consequent effect either directly into sea water or through atmospheric dissolution.

(c) Only the strongest candidates recognised that hydrothermal vents are areas of primary productivity, so the biodiversity around them is higher than generally found at the seafloor in depths where the vents are found. A few candidates made the link that the primary productivity of photosynthesis in the oceans photic zone is much greater, and so the biodiversity was lower than in areas where photosynthesis occurs. Many candidates could give some of the conditions found at the hydrothermal vent that affects the ability of organisms to live at such sites, but only stronger candidates linked this to organisms that live there.

MARINE SCIENCE

Paper 9693/03
A2 Structured Questions

Key messages

The command word (or words) needs to be identified so that answers match what is being asked.

Candidates should be reminded to use the correct scientific vocabulary in their answers.

Candidates should select appropriate information to answer the questions and try to avoid including irrelevant details or vague descriptions.

Answers for questions that require observation and interpretation of graphs should describe what is actually visible and candidates should be able to interpret the trends or features shown, linked to their subject knowledge.

General comments

There were some excellent answers, with candidates demonstrating a strong knowledge of the syllabus. Generally, candidates answered **Question 1** on seagrass and oyster culture in an estuary and **Question 2** on the life cycles of tuna and salmon very well. Questions requiring more application of knowledge e.g. **Question 3** on illegal fishing and vessel monitoring and parts of **Question 5** on plastic pollution were more challenging for many candidates.

Comments on specific questions

Question 1

(a) (i) Most candidates could define an estuary, but poor wording meant that some candidates missed out on any credit. Examples included “a swamp or bay surrounded by land” or “where a river flows into a bay”. Answers that stated that an estuary “provided a home for marine life” were incorrect.

(ii) Partial credit was common, usually for more light penetration in shallow and clear water. Light needed to be linked to photosynthesis, not growth or productivity. If warm temperature was mentioned at all, it was rarely linked to increased enzyme activity. There were few references to the range of available wavelengths decreasing with depth or to chlorophyll absorbing red light in shallow water.

(iii) Very few candidates gained any credit as they misread the question and answered in terms of how seagrass had adapted to living in estuaries rather than how it modified its surrounding to improve survival. Incorrect answers therefore focused on roots anchoring the plant and flexible leaves which would not be damaged in the current.

(b) (i) Answers needed to be precise and to state how dredging damaged the seagrass beds. Stating that it damaged the environment was too vague.

(ii) Stronger candidates were able to process all the information provided and gained full credit. Candidates should have noticed that seagrass was still being damaged by oyster farming, resulting in a loss of habitat for commercially fished species and consequently less areas to fish and subsequent loss of income for fishermen. Some candidates confused the commercial fishermen with the oyster fishermen.

Question 2

(a) (i) Most candidates gained at least partial credit, usually for giving the answer “sperm”. Some candidates confused tuna with salmon and gave answers such as alevin and smolt, while others used vague terms such as adolescent or young fish.

(ii) Again, the lack of precise wording meant that credit often could not be awarded. Examples included an advantage that more fertilisation would occur, but more cross fertilisation would have been a much clearer answer. Disadvantages included that the eggs were harmed or that eggs die.

(iii) Partial credit was common, usually for the idea that the fish were larger. Fewer references were made to the fish having more energy reserves or the ability to store more eggs.

(b) Several candidates were confused and incorrectly stated that salmon changed sex during development or that fertilisation in salmon was internal and external in tuna. Stronger answers made correct reference to salmon being euryhaline, or that they laid eggs in a nest in rivers, while tuna were stenohaline and laid eggs in surface waters of the open ocean.

(c) (i) The majority of candidates gained credit for stating that food provided energy for continuous swimming, but only stronger candidates were able to state that food provided a substrate for respiration.

(ii) Most candidates gained partial credit, usually for stating that tuna swims with its mouth open. There were few references to ram ventilation or to maintaining a diffusion gradient. Some candidates were confused, stating that water entered through the gills or that gills opened and closed to get oxygen. Several answers focused on gas exchange rather than on ventilation.

Question 3

(a) Almost all candidate could name a method of enforcement to combat illegal fishing. However, a few candidates gave examples of restrictions on fishing e.g. imposing quotas, which did not gain credit.

(b) The dishonesty of logbooks was a common correct answer, but there were fewer correct answers for patrol aircraft. Common errors included being able to see what is being caught or the ability to look for illegal fishing or answers such as that the area could be covered quickly.

(c) (i) That AIS has gaps in data was a common correct answer. Fewer candidates mentioned that the signal was continuously visible. Vague answers included that both VMS and AIS showed more information or that they provided more accurate results. Only stronger candidates could state that using VMS and AIS proved that no fishing occurred in the marine conservation area.

(ii) Only the strongest candidates answered this question correctly, usually for the idea that Indonesia could prove that they were not involved in illegal fishing. Most answers focused on the idea that the information could be used to share the best fishing locations or to spot illegal fishing, neither of which gained any credit.

(d) (i) The benefits of fishing using factory vessels were well understood, with most candidates gaining at least partial credit.

(ii) Many candidates described the map instead of discussing the evidence for illegal fishing. The command word here was *discuss* and most candidates only described strong evidence for illegal fishing and did not make reference to features that only provided little evidence.

Question 4

(a) Only stronger candidates gained full credit. Many candidates focused their answers on new technology, which would be true for both aquaculture and commercial fishing. Few references were made to the increasing market demand for fish being met by aquaculture or that world population is increasing.

(b) (i) To gain any credit, answers needed to be linked to clean water, efficiency of food use and disease management. Some excellent answers described how the biological filters removed toxic ammonia by converting it to nitrates, then filters converting this to nitrogen gas, so providing clean water. Many answers were too imprecise to gain credit e.g. “UV light is used to keep the water clean”, “automatic feeders are efficient”.

(ii) There were many general answers e.g. “clean tanks”, “room for fish”, “oxygen”. Many answers did not focus on the word sustainable, so were unable to gain any credit. Answers should have been based on ***Section 12(c)*** of the syllabus.

(iii) To gain credit, candidates were required to study the recirculating system in **Fig. 4.1** and identify two disadvantages of this system, rather than stating two disadvantages of aquaculture in general. Common correct answers were that it would be expensive to set up or maintain and that it would have a high energy consumption.

(iv) Some candidates misread the question and gave answers which did not relate to the environmental benefits of a recirculating system. Others just repeated their answer for **(iii)**. Some candidates mentioned disease control but did not add that this prevented the spread of disease to wild populations. Weaker answers mentioned preventing pollution or not harming the environment, which were not worthy of credit.

(c) Most candidates gained at least partial credit, usually for the idea that fish raised in aquaculture were poor competitors for food or that they were easily predated. Some candidates incorrectly stated that the fish raised in aquaculture would outcompete the wild fish or that they would spread disease to wild fish. References to the idea that fish raised in aquaculture might not have the same genetic profile as wild fish were rare.

Question 5

(a) (i) The majority of candidates could name the Coriolis effect, though spelling varied considerably. Incorrect answers included gravity, plastic, El Niño and tides.

(ii) Few candidates were able to name two correct factors. The most common incorrect answers included the moon and gravitational pull.

(iii) Most candidates could state that the plastic would collect in the centre of the gyre as there were no currents there, or that rotational currents brought the plastic to the centre. Some answers lacked precision and did not make it clear that the plastic was in the centre.

(b) (i) Most candidates could calculate the correct number of years as 603. A few candidates gave an incorrect formula. Candidates should always show their workings so that partial credit can be awarded if there is a mathematical error.

(ii) Full credit was often awarded, but some answers were not precise enough to gain full credit e.g. “the animal gets tangled in fishing line and dies” or was “unable to survive” instead of giving a reason why it did not survive.

(c) Partial credit was often awarded, but many answers lacked the detail required for further credit. Most candidates could state that shellfish eat phytoplankton and would therefore consume microplastic at the same time. Few references were made to microplastics increasing along the food chain as consumers eat many shellfish. There were some correct references to bioaccumulation and to microplastics being toxic.

(d) Some candidates did not read the question and information provided carefully enough and thought that waste prawn shells were being dumped at sea, instead of being made into an alternative plastic, so reducing prawn waste. Few references were made to the alternative plastic being biodegradable; that it would release useful minerals back into the sea; or that it was non-toxic to marine organisms as it was a natural product. More precise language was required and references to it not harming the environment and that it causes pollution were too vague to gain credit.

Question 6

(a) Most candidates gained partial credit for the idea of local people caring more about their own environment or the idea that local people were more likely to be involved in conservation issues arising in their immediate environment. Few references were made to the expertise that conservation organisations offered, or that there were likely to be fewer conflicts over resources. Some answers were too vague for credit, for example that there is less conflict or that there is more preservation of the environment.

(b) Almost all candidates could state why it was important to conserve coral reefs, with providing a suitable habitat and providing a nursery area the most common correct answers. Fewer candidates made reference to their importance for coastal protection or that coral reefs were important carbon sinks. Again, some vague answers, e.g. that the coral reef was a home for marine organisms or that it was important for tourism, were not quite enough.

(c) (i) Many answers did not address the question and merely stated that bleaching and the number of organisms showed if the reefs were healthy or not. Stronger answers linked less bleaching to coral recovery and that the number of species and population was an indication of biodiversity. Where there was an increase in species and populations, it was rarely linked to more habitats becoming available.

(ii) Many answers were too simplistic for credit e.g. “tourists want to see the reef, but LMMA managers want to stop them”. To gain credit, answers needed to state why tourists would visit the reef and how LMMA managers would limit tourist numbers.

MARINE SCIENCE

Paper 9693/04
A2 Data-Handling and Free-Response

Key messages

- Candidates should be reminded to give detail that is of an A-Level standard, particularly in ***Section B*** extended answers.
- It is important for candidates to use specific vocabulary in answers.
- Developing a clear understanding of the requirements shown by command words will ensure candidates give full relevant responses.
- Candidates should be encouraged to select sensible, linear scales when drawing graphs.

General comments

Some outstanding answers to questions were seen and many candidates had clearly prepared very thoroughly for the examination. Stronger candidates looked carefully at data analysis questions and used their knowledge to explain trends in the data. They also wrote extended answers of great depth and detail and used scientific vocabulary confidently and accurately. Most candidates demonstrated very good graph skills and were prepared to tackle mathematical questions and analyse data. Some candidates did not give great depth in their answers. A few candidates also found data analysis difficult and confused command words such as *explain* and *describe*. When giving descriptions of data patterns and trends, it is not necessary to try to make conclusions. If a question requires an explanation, candidates should always give a reason.

Comments on specific questions

Section A

Question 1

(a) (i) This question tested candidates' knowledge of the scientific method and required them to state that the sampling of organisms is carried out randomly to avoid bias. Many candidates correctly stated this, although others gave vague answers such as "make a fair test" or "ensure accuracy". It is important that candidates understand terms such as accurate, representative and valid.

(ii) This graph question was well answered, and most candidates approached graph questions well. Most candidates correctly selected linear scales and made good use of the space provided. The majority of candidates plotted points accurately and were able to label the axes. A few candidates did not label the lines drawn and others did not use a rule to join the points.

(ii) Many candidates showed an excellent knowledge and understanding of the bioaccumulation of toxins along food chains. Excellent, accurate terminology was used by many candidates and most recognised that mercury is passed on when organisms from lower trophic levels are consumed. The strongest answers also explained that mercury is not broken down or excreted from tissues. A few candidates incorrectly stated that the mercury was absorbed from the water.

(b) Some candidates gave excellent, well-structured answers and looked critically at the two sets of data regarding the use of dredging on the levels of mercury in the water. The figure showed that when dredging was occurring, small amounts of mercury were released into the water each time the estuary was dredged. After stopping dredging, the levels of mercury were very low until flooding occurred releasing a large amount into the water. Stronger answers described the patterns and then went on to explain that the dredging prevented accumulation of mercury in the bed of the

estuary so that less was released when flooding occurred. Some candidates also stated that stopping dredging lowered the amount of mercury in the water as it settled into the sediment, but more was then released after floods occurred. The question asked candidates to discuss the claims that banning dredging has led to an increase and so candidates needed to explore all aspects of the question to gain full credit. The strongest answers pointed out that there was evidence both for and against the claim.

Question 2

(a) This question tested candidates' knowledge of osmoregulators and osmoconformers. The data showed the salinity of the body fluids of a crab when placed in different salinities. Most candidates recognised that the salinity of the body fluids matched the salinity of the water for most water salinities suggesting that the crab is an osmoconformer. Only stronger candidates noticed that when the salinity of the water was below 16 ppt, the body fluids have a higher salinity suggesting that they also osmoregulate when placed in some salinities.

(b) (i) This question required candidates to describe the effect of increasing salinity on the time that crabs spent in particular salinities. Many candidates found this challenging and gave vague answers such as, "the crabs prefer higher salinities". When asked to describe data, candidates should look for patterns and try to identify specific turning points. Explanations are not required if the command word is *describe.*

(ii) Many candidates correctly suggested two other variables that would need to be kept constant, such as temperature and oxygen concentration. Some candidates incorrectly suggested salinity and others gave variables that were already given, such as age, mass, and sex of the crabs.

(iii) Some candidates gave excellent answers that explained that the crabs had adapted to live in the condition with the highest salinity and so spent the longest time there. Only very strong candidates correctly recognised that the crabs were using a form of behavioural osmoregulation, and then went on to state the osmotic effects on the crabs if they were placed in salinities that were too low. Some candidates confused the direction of water movement due to osmosis. A minority of candidates confused the crabs with salmon and gave a detailed explanation of how salmon are able to live in both freshwater and sea water.

Section B

Question 3

(a) Many candidates gave excellent answers to this question. Most candidates organised their answers so that they were clear in showing the long-term and short-term sociological impacts. Some candidates did not recognise that the question was asking about sociological impacts and so gave general answers about fish populations without relating them to humans. Stronger answers referred to the loss of income and jobs in the short-term but then a long-term retention of a fishing industry that could provide food and income for the local population.

(b) This question, asking candidates for the information that can be used to exploit fish stocks sustainably, was often answered well. Stronger answers closely reflected the information listed in the syllabus such as measurement of the MSY, recruitment, growth, natural mortality, fishing mortality, age of reproductive maturity, fecundity and dependency on particular habitats. Other correct information that was credited included breeding seasons and locations and types of fishing method used. As the question asked for a discussion of the information, candidates needed to explore the information rather than just giving a list. Weaker answers tended to give vague answers about fish catch size and the use of quotas and often did not explore many different pieces of information, instead only referring to one or two.

(c) Most candidates were very familiar with the use of artificial reefs and many gave good answers correctly stating that the reefs would act as a habitat and offer protection from predators. The question asked for both advantages and disadvantages, and so to gain full credit, candidates needed to mention both sides.

Question 4

(a) (i) This question asked candidates to outline the genetic engineering of salmon. Stronger candidates often gave excellent answers that had full use of accurate vocabulary. A good level of understanding of genetic engineering techniques and the nature of the promoter and growth hormone genes was often shown. Weaker answers tended to confuse genetic engineering with selective breeding.

(ii) Stronger answers to this question gave many detailed negative aspects such as pollution, loss of species, and conflict over resources and employment. Many candidates also considered that the venture could boost tourism by acting as an attraction and/or providing a cheap source of food for tourists and workers. Weaker answers tended to only consider one aspect rather than looking for several.

(b) This question asked candidates to discuss the evidence that emissions of carbon dioxide and other greenhouse gases from human activity are causing global warming. Many excellent, very detailed answers were seen that discussed both sides of the argument. Stronger answers described the trends in rising carbon dioxide and temperature and also referred to other greenhouse cases such as methane. Many candidates had a full understanding of the use of ice core data and many were aware of the monitoring of glaciers, ice caps and sea levels. The strongest candidates also explored counter evidence such as solar activity. Weaker answers tended to give descriptions of the results of global warming and/or tended to focus on just one idea.