MARINE SCIENCE

Paper 9693/01
AS Structured Questions

Key Messages

Candidates should always

- read and consider the question carefully before attempting to answer.
- take note of the mark allocation for the question and the number of lines given for the answer. This indicates the length of the response expected.
- give only one answer where a question requires a short response e.g. a letter or a number.
- clearly cross out the original response when changing an answer. Do not write over an existing answer. Very often the result is something that cannot be read clearly.
- state the units in questions requiring a numerical response unless these are printed on the answer line.
- include references as required by a question. For example, where a question includes a phrase such as 'with reference to Fig. 3.1', then the response given should refer to the contents of the figure referenced.

General Comments

Many candidates had a reasonable grasp of particular parts of the subject matter of the syllabus and were able to demonstrate their knowledge and understanding in questions relating to these syllabus areas. In this respect, topics such as photosynthesis (**Question 3 (b)(i)**) and the biological use of ions in seawater (**Question 8 (b)(i)**)were generally well known. Of particular note was the excellent standard of response to **Question 2 (b)(ii)** where the majority of candidates showed a high level of knowledge of this part of the syllabus. By contrast, there were many candidates whose knowledge of the formation of muddy shores (**Question 5 (b)(ii)**) was minimal.

Comments on Specific Questions

Question 1

(a) (i) In this question and in **(b)(i)** candidates usually gained partial credit for describing the benefits or lack of benefits of parasitism or symbiosis. However, in both instances, candidates failed to indicate that the respective relationships operate between organisms of different species. This is a common omission that has been seen in previous examinations and candidates should be aware of this fundamental aspect of parasitic and symbiotic relationships.

(ii) Most candidates were able to name an example of a parasitic relationship in a marine environment. This was usually the relationship between nematodes and tuna although other examples were acceptable. However, most candidates failed to state which organism was the parasite and which the host.

(b) (i) The same comments as in **(a)(i)** apply here.

(ii) Candidates very often gained full credit in this part of the question. In many instances the descriptions of the symbiotic relationship between coral and zooxanthellae were excellent with the role of each organism clearly stated.

Question 2

(a) (i) Most candidates read the graph correctly and also quoted the units in their answers.

(ii) Most candidates gained partial credit for specifying the relationship between the depth of water and the growth rate of Montastraea annularis. In addition, many were also able to use data from the graph to back up their description of the relationship. No candidate referred to the relationship being a linear one.

(iii) In the explanations for the relationship described in **(a)(ii)** few candidates made a reference to the growth rate being faster at the surface of the sea. However, there were many excellent suggested explanations in terms of the photosynthesis of zooxanthellae and the increased light available at the surface.

(b) (i) Of the three parts of the atoll shown in the aerial photograph most candidates recognised A as a reef and B as the ocean. Part C (lagoon) was least often recognised.

(ii) As indicated in the general comments section of this report, this topic was very well known and the question elicited a large number of excellent responses throughout the ability range. These were characterised by accurate descriptions of the formation of an atoll. Candidates included in their description 'the formation of a volcanic island which becomes colonised by coral. Fringing reefs develop, the island sinks and barrier reefs form. Further sinking of the island leaves the atoll'.

Question 3

(a) (i) The majority of candidates were able to select the correct food chain from the food web shown in Fig. 3.1.

(ii) Many candidates gave excellent reasoned explanations of the effect of overfishing of lobsters on the mussel population. These largely centred on the decrease in the mussel population due to the increase in the crab and whelk populations eating more mussels. Other valid explanations were possible and some candidates argued correctly that a decrease in lobsters could lead to an increase in the mussel population as a consequence of the removal one of their predators. A common mistake was for candidates to start their explanation with the incorrect premise of the lobsters being the prey of the mussels.

(b) (i) Most candidates appreciated that the process taking place at point A was photosynthesis and they were able to give very good descriptions of the process which included references to light, chlorophyll and the raw materials and end products of the process. Candidates should be aware that the energy needed for photosynthesis is light and not the sun. 'Sunlight' was acceptable.

(ii) Correct calculations of the heat energy lost by the zooplankton were relatively uncommon. It was often difficult to ascertain how candidates had arrived at their incorrect answers.

(iii) Many of the more able candidates were able to calculate the percentage of the energy in the phytoplankton transferred to the fish as 0.091%. Answers rounded to 0.09% were allowed. However these candidates were in the minority.

(iv) Answers to this part of the question were very varied in quality. Few candidates were able to suggest more than two reasons why the efficiency of energy transfer between the phytoplankton and the fish was very low. Some gained a mark for suggesting that that some of the energy loss is due to loss of energy as heat from respiration or from excretory processes. Often answers simply stated that the energy passed between trophic levels was 10% without any attempt to explain why.

(v) This part of the question was poorly answered. Weaker answers did not indicate that the activity of decomposers would release nutrients for use by producers thus leading to increased growth or productivity.

Question 4

(a) This part of the question was reasonably well answered. Units were often quoted although these were unnecessary to gain the mark.

(b) (i) This part of the question was also well answered and most candidates were able to state a biological use for magnesium, calcium and nitrate.

(ii) The two sources of the ions in sea water most often quoted were runoff and atmospheric dissolution.

(iii) This part of the question was poorly answered and very few candidates were able to give two valid responses. Incorrect answers such as 'evaporation', 'respiration' or 'chemosynthesis' were not uncommon.

(c) (i) Some candidates appreciated that the higher salinity of the sea water in summer was due to higher temperatures leading to increased evaporation and the subsequent increase in salinity. Many candidates omitted a reference to the reason for the lower salinity in the winter i.e. increased rainfall.

(ii) Few candidates made the link between melting ice, fresh water inflow and the low the salinity in the Arctic Ocean.

Question 5

(a) (i) Generally, most of the descriptions of 'estuary' were at least partially correct. Responses involving descriptions of the properties of the water present in an estuary did not answer the question.

(ii) This was a poorly answered part of the question and only a minority of candidates were able to name two conditions to which organisms living in an estuary would need to be adapted. Good responses made reference to 'changes in salinity', 'tidal flow', 'changes in sea level' and 'a high degree of sedimentation'. Weaker answers such as 'wind', 'a stable environment' or 'shallow water' were fairly typical.

(b) (i) Most candidates recognised two of the types of littoral zones shown in the diagram i.e. B a rocky shore and C a sandy shore. However, few candidates recognised type A as a delta. Rather it was often named incorrectly as a 'muddy shore'.

(ii) The explanations of the formation of a muddy shore were extremely varied and ranged from clear and accurate answers gaining full marks to very poor one with nothing to credit. Many candidates refered to the terms 'sediment', 'silt' and 'erosion' but often these were not linked together to give a meaningful answer to the question.

(iii) Only a minority of candidates gained any marks on this question and answers were generally vague and imprecise. Good answers made reference to the type or function of the root system, to pneumatophores and the control of salts.

Question 6

(a) (i) This section of the question was not well answered. The most common error seen in candidate's responses was an inadequate and vague description of the basic description of an abyssal plain as 'a relatively flat area of the ocean floor'. Responses such as 'a flat area of the sea', 'the lowest part of the ocean' were fairly typical. Very few candidates stated the approximate depth at which abyssal plains are located. Some candidates gave descriptions of how abyssal plains are formed which, of course, was the next question.

(ii) Generally, answers to this question were slightly better than the previous one and many candidates were able to give at least one or two valid points relating to the formation of abyssal plains. References to upward movement of magma which solidifies to form new ocean floor were seen quite often. Some candidates also refered to the abyssal plain being covered with sediment.

(b) Generally, this was a well answered question. 'Mid-Ocean Ridge' and 'tsunami' were the two features best known with 'volcanos' often confused with 'hydrothermal vents'.

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

Key Messages

Candidates should read the questions carefully, noting the "command words" used and the mark allocation for each part. They should select appropriate information to answer the questions and try to avoid including irrelevant details, try to write free response answers in a logical, coherent sequence and use scientific terms and vocabulary.

Candidates should manipulate data presented in tables, rather than quoting figures directly, when describing results. They should include units with numerical answers and, where appropriate, should choose suitable axes and label them fully when plotting a graph.

General Comments

This paper includes questions requiring both data handling and answers written in continuous prose. The questions are intended to test candidates' knowledge and understanding of the syllabus content, and their ability to apply their knowledge in new and possibly unfamiliar contexts. In ***Section A***, questions may relate to Scientific Method (Syllabus ***Section 1***) and candidates are expected to be able to understand the relationship between hypothesis, experiment and theory in science and to recognise uncertainty in experimental results. Questions may also relate to practical activities, including the design of an investigation to test a hypothesis, with references to the control of variables.

Many candidates were well-prepared for this paper and coped well with the different skills being tested, including accurate recall of information and an ability to apply their knowledge and understanding of the subject content in a new situation.

The majority of candidates were awarded higher credit on **Question 1**; the answers to the other questions were more variable, although candidates generally performed comparably on **Questions 3** and **4**.

Comments on Specific Questions

Section A

Question 1

(a) The majority of candidates correctly identified the trophic level occupied by limpets, although not all used the information given to support their answer, with reference to feeding on producers, or feeding on algae growing on the rocks.

(b) (i) This part was answered well by the majority of candidates, giving detailed comparisons of the distribution of these two species of mollusc. It is worth noting that the command word "compare" requires both similarities and differences between the distributions and it is appropriate, therefore to recognise that neither species is present at 0, 26, 28 nor 30 m from the low water mark. Some of the answers were more general descriptions of the distribution of each species, rather than giving comparative points. Candidates may find it helpful to think of comparative points linked with a words such as "but". For example, "limpets were found at 14 to 24 metres from the low water mark, but periwinkles had a wider distribution and were found at 2 to 16 metres from the low water mark".

(ii) This part was also answered well and many candidates gave appropriate environmental factors, such as temperature and competition that could influence the distribution of these two species. Some factors, such as "human activities" were considered to be too general to be awarded credit,

when candidates were expected to be able to give specific biotic or abiotic factors relating to a rocky shore.

(c) (i) The majority of candidates correctly calculated the mean height of each sample.

(ii) Candidates found it challenging to propose a suitable hypothesis based on the data; limpets growing on an exposed shore have higher shells than those growing on a sheltered shore, or a converse statement. However, some of the hypotheses referred to the growth rate (for example, "limpets grow better on an exposed shore") or survival of limpets, for which there is no evidence. The terms "exposed" and "'sheltered" relate to the shores, rather than to the limpets.

Question 2

(a) This was a relatively straightforward graph to plot with the depth as the independent variable and the concentration of phosphorus as the dependent variable. One common error in plotting the data was to omit the units on the axis label. Graph plotting is a skill and candidates should choose a suitable linear scale, orientate the axes correctly and label them fully, including the units, plot the points accurately, using either encircled dots or crosses and join the points carefully, using a ruler if straight lines are required. In this instance, candidates were instructed to join the points with straight lines, but some attempted to draw a line of best fit or to draw a freehand curve through the points.

(b) The majority of candidates gained partial credit for a general description of the relationship between depth and the concentration of phosphorus, by recognising that the concentration decreased as depth increased, but relatively few went on to quantify this, or to refer to the non-linear relationship.

When describing data, either from a graph or from a table, candidates were given credit for suitable manipulated quantitative references, rather than quoting figures directly. In this instance, a comment such as "there is an overall decrease in the concentration of phosphorus of 1.8 micrograms per dm^3, as the depth increases from 250 to 2500 metres" gained credit, whereas "the concentration changes from 3.0 to 1.2 micrograms per dm^3" was insufficient. Some of the answers attempted to explain the changes, for which no additional credit was given. It is important to distinguish between the command words *describe* and *explain*.

(c) The majority of candidates suggested, correctly, that the upwelling would increase the productivity of producers, but the explanations were often rather general, referring to, for example, food chains in general, rather than to the effect on producers specifically. To explain the increase in productivity of producers, candidates were expected to refer to a biological use of phosphorus in producers, such as the synthesis of DNA or another appropriate phosphorus-containing compound.

Section B

Question 3

(a) Many gained credit for appropriate descriptions of tectonic processes and the formation of hydrothermal vents. There was a tendency here to discuss the properties of a hydrothermal vent, rather than its formation, for which no additional credit was awarded.

(b) Many candidates gained credit for their descriptions of hydrothermal vents as extreme environments, with references to the physical and chemical factors associated with the vent. Many candidates also gained credit for citing an example of an organism associated with a hydrothermal vent, such as a tube worm or chemosynthetic bacteria. Some candidates suggested, inaccurately, that many organisms are "unable to adapt" to the extreme conditions, where it would be better to state that few organisms "are adapted" to survive.

(c) This part was well answered, as many candidates were able to give an outline account of chemosynthesis, with reference to chemosynthetic bacteria and the oxidation of hydrogen sulfide. The link between this and the fixation of carbon dioxide to produce organic materials was less often described, although there were many references to the symbiotic, or mutualistic, relationship between the bacteria and other organisms including tube worms and clams. Candidates were also given credit for reference to detritus as a way in which energy is made available to food chains.

Question 4

(a) (i) The majority of candidates gave an acceptable explanation of the term *habitat*, usually with reference to the place where an organism lives, or an equivalent statement.

(ii) The answers to this part were sometimes less accurate than those of part **(a)(i)**, as there were some that were unclear about the difference between *community* and *population*. When giving a definition of these terms, accurate terminology is important and there is a difference between "different organisms" and "different species of organisms". Therefore, whilst many candidates gained partial credit for a reference to the same habitat, the first point about the number of different species was more discriminating.

(b) Candidates who correctly interpreted the information given and referred specifically to populations of striped bass and herrings often gained most of available credit on this part, with appropriate descriptions of a predator-prey relationship and the cyclic changes in numbers of each population. Some answers essentially repeated information in the introduction to the question, but did not really explain the reasons for changes in the populations, for example, by referring to food availability. Some answers also did clearly identify which species is the predator and which the prey. A number of candidates illustrated their answer by sketching a graph showing the changes in populations and were given credit for this. Few suggested that there may be no relationship if striped bass have an alternative food source or if striped bass are not a major predator of herrings.

(c) Most candidates were able to give some features of shoals, such as shoals consisting of large numbers of fish of the same species, but the features were not always accurately qualified with an explanation of the advantages. As an example, a number of candidates referred correctly to shoaling giving a reproductive advantage to fish such as tuna, although this was rarely explained in terms of proximity of males and females within the shoal, increasing the chances of fertilisation. Similarly, many candidates recognised that shoaling increases hydrodynamic efficiency; additional credit was given for references to increasing swimming speed and saving energy. References to foraging efficiency and predator avoidance were seen quite frequently and these were given credit.

MARINE SCIENCE

Paper 9693/03
A2 Structured Questions

Key Messages

Candidates should ensure that they read questions carefully so that their responses are relevant. They need to know how to interpret graphs and process data from both graphs and tables. Appropriate units must be included with numerical answers. Candidates should try to include the detailed knowledge and specific vocabulary required at A Level in all appropriate answers.

General Comments

Candidates gained more credit on factually based questions than on questions requiring interpretation and analysis. The importance of mangroves and sea grass to the marine ecosystem was well understood. Candidates could improve on understanding the relationship between pigments found in algae and wavelength at which maximum absorption of light occurs in these pigments. Data interpretation from graphs and tables also requires improvement and this was particularly evident in **Questions 5**, **6** and **7**.

Comments on Specific Questions

Question 1

(a) Many candidates were able to gain full credit. Most candidates were able to state that primary producers carry out photosynthesis or chemosynthesis to gain partial credit. A response that was not credited was "primary producers are at the base of the food chain". Better answers expanded on this by stating that primary producers formed the basis of all food chains by providing other organisms/consumers with food. Carbon dioxide was often quoted as being required for photosynthesis; stronger candidates gained credit for stating that carbon dioxide was fixed or used in photosynthesis.

(b) (i) Candidates were required to identify two features of sea grass that allowed them to live in moving water. Good answers were seen for the role of roots in anchoring the plant to the sea bed.Some candidates repeated the information given in the question instead of identifying that the leaves were "long or thin to offer little resistance to water movement".

(ii) Most candidates gained a mark for the idea that the sea grass required light for photosynthesis. Stronger candidates stated that "more light was present" or "red light was present" in shallow water.

(iii) Answers needed to make reference to the information given in the question that corals require clear water. Stronger candidates were able to link the leaves or roots trapping sediment to the provision of clear water. No credit was given for answers stating that sea grass "slowed down water movement" or that it "provided oxygen for the zooxanthellae in coral".

(c) This topic was well understood and generally well answered with almost all candidates gaining partial credit and stronger candidates gaining full credit. Most candidates could state that sea grass beds supplied a "food source" and "shelter from predators". Credit was not awarded for general statements such as "sea grass beds provide a habitat" or "sea grass beds provide shelter".

(d) Most candidates were able to state at least one example of the ways in which humans damage sea grass beds. Better answers showed an awareness of land based sources of pollution from industry and from agriculture and of pollution from boat engine oil. Credit was not awarded for answers such as "pollution" or "oil", where the source of pollution was not mentioned.

Question 2

For the second part of the question, candidates were expected to demonstrate their knowledge and understanding of selective breeding, genetic engineering and the precautionary principle.

(a) (i) Stronger candidates gained full credit for completing the life-cycle diagram correctly. Candidates gained partial credit for identifying that nests were made in gravel. Common misconceptions were that Parr were found in fresh water, Smoults in sea water and naming zooplankton as a source of food for Alevins.

(ii) Almost all candidates were able to state correctly that nests provided protection from predators or provided an increased chance of fertilisation.

(iii) The question asked for development of eggs inside nests, however, most candidates related their answer to fertilisation. Many candidates gave the answer "to escape predators" which did not gain credit.

(b) (i) To gain credit, candidates needed to state the reason for choosing parents for selective breeding and that offspring with the desired characteristics were bred together for many generations. Candidates were able to gain credit for their description of genetic engineering, especially for "removing a gene from one species". Most candidates stated that this gene was then placed into another species but needed to mention that it had to be "placed into the genome/DNA" to gain credit. Partial credit could be gained by quoting "salmon" as a suitable example.

(ii) Most candidates gained credit for stating that the growth gene increased the growth of the salmon. Stronger candidates gained credit for stating the function of the promoter gene. Few answers stated its importance in switching on the growth gene year round. Answers which included information on transcription and translation were not awarded credit.

(iii) Stronger candidates were able to give answers such as "disease resistance" or the idea of "early maturity". Many candidates gave increased growth as their answer; this was not awarded credit.

(c) (i) Candidates were asked to define the term precautionary principle in relation to genetic engineering. Answers which referred to the "precautions required when transferring genes" were not awarded credit. Credit was gained for answers which considered the possible threat to humans or to the environment and that precautionary measures could be taken to prevent harm.

(ii) Credit was given for answers which included keeping the salmon isolated in cages to prevent escape and the idea of the GM salmon being sterile to prevent breeding with the wild population.

Question 3

Candidates were expected to use their knowledge and understanding of mangroves as a habitat for marine organisms and the information provided to answer the questions.

(a) (i) Most candidates gained credit for stating the role of mangrove forests in providing shelter from predators and also acting as a food source for marine animals. Stronger candidates gained full credit for this question. Incomplete answers such as "provide shelter" or "provide a habitat" were not awarded credit.

(ii) Most candidates gained credit for stating that one benefit of restoring the mangrove forest was to supply a greater food resource. Candidates could gain credit for answers such as "providing employment" or "providing income" if a suitable example was also given. There were few references to the role of mangroves in preventing coastal erosion and improving water quality.

(b) Candidates had to use the information provided to suggest ways the three strategies could help restore the mangrove forest. Most candidates gave a correct answer for strategy 1. Stronger candidates were able to gain credit for strategy 2 by stating the importance of preventing human interference. Few candidates gained credit for a correct answer to strategy 3.

(c) Candidates needed to understand the implications of restocking with captive-bred fish to support the wild population. Answers which stated that the captive-bred fish would "out-compete the wild

fish" or that they would be sterile were not awarded credit. There was a misconception held by some candidates that any organism produced by aquaculture must be genetically modified.

Question 4

Candidates were expected to use the information provided to assess a plan for a proposed rural aquaculture development site.

(a) (i) Most candidates gained full credit for the benefits of providing employment and income. Some candidates mentioned that aquaculture would provide a continuous supply of food for the community.

(ii) Few candidates stated a correct negative impact. The answers "loss of income" or "loss of employment" did not gain credit.

(b) (i) Candidates were required to study the plan in **Fig. 4.1** and information provided to describe suitable features. Some candidates did not specifically identify the features which made the proposal a suitable site. Partial credit was awarded to candidates who were able to identify an area of unused land that was available.

(ii) Credit was given for references to the river "supplying oxygen" or to the water flow "removing waste product". Candidates needed to identify features on an extensive system rather than repeating information provided in the question.

(iii) Most candidates could state at least one suggestion as to how the proposed development might affect the water supply to the local village. Stronger candidates gained full credit.

(iv) Most candidates gained at least partial credit for this question. No credit was gained for stating that the river provided enough water for the rice to grow faster.

Question 5

(a) (i) Candidates had to use the graph in **Fig. 5.1** to calculate the mean rate of increase in desalination between 1990 and 2010. The most common errors were identifying incorrect figures from the graph and dividing the difference by 2 instead of by 20. Other common errors were identifying the total global desalination figures for 1990, 1995, 2000, 2005 and 2010 and then dividing the total by 5. To gain full credit, candidates needed to include 10^5 in their answer.

(ii) Stronger candidates were able to link the increase in desalination with a valid reason, usually an increase in population.

(b) (i) This question asked candidates to describe an ecological problem that could occur due to the intake of water. Candidates who gave answers that were related to water intake gained credit; answers which referred to changes to pH and salinity were not awarded credit.

(ii) Stronger candidates were able to state that the brine was more concentrated or more dense than sea water. Many candidates stated correctly that it would sink to the bottom. Stronger candidates were able to link concentrated brine with its effects on osmoregulation in benthic marine organisms. Credit was not given for stating that it was "too salty" or that it "changed the pH of the water".

Question 6

This question required knowledge and understanding of wavelength of light and how different wavelegths penetrate to different depths in water. Candidates were required to use the information provided in **Table 6.1** and **6.2** in their answers.

(a) Stronger candidates gained full credit for this question. A number of candidates mistook wavelength for depth and consequently their answers gained no credit for stating that violet or blue light could only penetrate shallow water while red light was able to penetrate deeper water. Long wavelength and short wavelength were also confused.

(b) (i) Some candidates were able to make the link between chlorophyll a and photosynthesis. The strongest also stated that it was the only pigment able to absorb light energy from both short and long wavelengths.

(ii) Candidates needed to use the information in the tables to link wavelength, pigment and absorption. Few references were made to phycobilin or phycoerythrin in red algae absorbing green light. In general, answers required more detail. Stating that "green algae are found in shallow water and red algae in deeper water" did not gain credit.

Question 7

This question was about how oxygen can enter sea water and the biological processes which can affect the oxygen concentration. Data processing was required and this was linked to ram ventilation in tuna.

(a) (i) Most candidates gained partial credit for stating that oxygen entered the ocean by diffusion or dissolution from the air. Fewer candidates mentioned the importance of wave action.

(ii) To gain credit answers needed to refer to biological processes**.** Answers which only included temperature, upwelling and evaporation as examples were not awarded credit. Stronger candidates gained full credit.

(b) (i) Few candidates calculated percentage difference using figures from the graph and few quoted correct figures for both fresh water and sea water at 10 °C. When candidates did quote the correct figures and subtracted them to give 2.5, this figure was then incorrectly divided by 8.5 instead of by 11.

(ii) Stronger candidates made reference to the graph and quoted the correct figure of 4.9 mg dm^{-3} of dissolved oxygen in sea water. Most candidates were able to gain partial credit by stating that tuna were fast swimming and linked this to having a high oxygen demand. Excellent answers made reference to respiration and the increased efficiency of ram ventilation over pump ventilation.

MARINE SCIENCE

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

Key Messages

- Many candidates are using terminology carefully although some candidates have a tendency to use imprecise language.
- Maths skills are generally good but candidates need to be analyse data carefully.
- Candidates should be careful to identify the focus and requirements of questions.

General Comments

Data handling was again found to be very demanding by many candidates with many not understanding how the data in **Question 2** related to osmoregulation. The free response questions demonstrated that many candidates have a secure grasp of the topics covered but many found it difficult to apply this to the particular context of the questions, particularly in **Question 3(b)**. Here candidates often clearly understood the impacts of the fishing industry and tourism but did not link this to how the two industries affect each other. Similarly, in **Question 4(a)** many candidates showed that they have a full understanding of the factors that may affect climate change but did not discuss the evidence for them.

Comments on Specific Questions

Section A

Question 1

(a) Most candidates were able to define the term correctly although many simply rephrased the question stem with answers such as “fishing up to sustainable levels”. The majority understood the idea of fishing without harming future stocks.

(b) (i) Most candidates were able to use the equation to calculate the population correctly.

(ii) This question was found to be very demanding by most candidates with a few gaining no credit. The majority did not appreciate that tagging the fish could potentially affect their behaviour or predation and many thought that the tagging was to track the movements of fish via GPS.

(iii) Few candidates appreciated the need to control the fishing method since different methods could give different catch rates. Many thought that it was to prevent overfishing of the tuna. Candidates needed to be conversant in the need for controls when generating valid, comparable data.

(c) (i) Most candidates were able to calculate the increased recruitment of fish from the population but did not go on to use this to calculate the possible harvest that would maintain the population. Some candidates performed the calculation very well and showed excellent working on the paper.

(ii) The majority of candidates were able to suggest two factors that would affect the tuna population, most commonly predation, and loss of food.

(d) The majority of candidates understood the enforcement methods that can be employed with the majority gaining at least partial credit. Many, unfortunately, focused their answer on fish stock monitoring tools rather than the methods of enforcement.

Question 2

(a) Many candidates found the description of the oxygen levels difficult and did not look at the details in the table. Many thought that the oxygen uptake only reduced and did not notice the increase from 10 ppt upwards. Few referred to the steepness of the decrease or the plateau at 20 ppt.

(b) This question was found to be demanding. Only the stronger candidates explained how active pumping of ions occurs when the fish is undergoing osmoregulation and then made the link between active transport and oxygen usage. Many weaker candidates did not recognise that the question was focused on osmoregulation and referred to general activity levels or swimming speeds of fish.

(c) Most candidates recognised that the oxygen demand linked to respiration and thus to the amount of food metabolised. Many, however, gave only vague answers that stated that different food would be required at the different salinities rather than stating that the higher and lower salinities would require more food.

Section B

Question 3

(a) The majority of candidates understood the concept of ecotourism although many simply rephrased the question and suggested that it was tourism linked to ecology.

(b) Candidates generally had a very good understanding of the effects of both fishing and tourism on the marine environment and the local economy. Some very strong candidates gave excellent explanations of how the two industries come into conflict and then went on to explain how the ecotourism resort could be built utilising renewables and minimising environmental disruption. Some candidates constructed answers around only one aspect such as the effect of tourism while others gave answers that kept repeating the same concept, such as damage to coral reefs, and then did not elaborate on other effects. This limited the credit that could be given. Candidates should try to ensure that they give some degree of diversity in their answers, particularly on extended writing questions.

(c) Most candidates gained partial credit for this question and most understood how wrecked ships can act as a habitat for organisms increasing biodiversity. There was an appreciation that ships may contain toxic substances and fuels and that these may have an effect on the marine environment. Some candidates misread the question and gave long answers that focused upon the economic benefits that artificial reefs would provide or only wrote about benefits, not suggesting the damaging effects.

Section B

Question 4

(a) Most candidates had a good understanding of the possible causes and consequences of global warming and increasing carbon dioxide in the atmosphere. Some excellent answers were seen that gave many pieces of evidence such as satellite images of glaciers, changes in range of organisms and ice core data. Other candidates did not fully appreciate the need for a discussion of the evidence of global warming and restricted their answers to a discussion of all the causes and effects that they knew. Only a few of the strongest candidates discussed the possibility of other factors causing global warming such as solar activity. Some candidates cited incorrect examples of gases such as sulphur dioxide, confusing global warming with acid rain.

b) This question was found to be difficult by many candidates although several excellent, well thought through answers were also seen. Where candidates produced good answers they showed a detailed understanding of how global warming could lead to both increased and reduced productivity by affecting metabolism. Several candidates also explained how salinity could be altered by glacial run off and evaporation of water. Weaker candidates often gave very vague answers suggesting that species would lose their habitat but did not elaborate on this to give a full explanation.