MARINE SCIENCE

Paper 9693/01
AS Structured Questions

Key Message

It is worth noting that on occasions the bar charts drawn in **Question 2 (c) (ii)** were untidy. Some candidates did not use a ruler and scribbled inside the bars to produce charts which were not fully clear. In the case of a bar chart it is the top of the bar which must be accurate to gain marks for plotting. However, when the lines are drawn without a ruler or other form of straight edge the accuracy of the lines can be difficult to determine.

General comments

It is pleasing to be able to report an increase in entry and an improvement in the performance of candidates in this year's examination. The mean mark was over 50%, a very satisfactory performance overall and one on which teachers should be congratulated.

The majority of candidates were able to make creditable attempts at most questions and there was little evidence of misinterpretation of the questions. There were only a few instances of questions being left blank and unanswered.

Very few candidates were unable to complete the paper in the allocated time.

One general point that needs to be made is that where candidates need to change an answer they should do this by neatly crossing out the original and writing the new answer clearly. Some candidates attempted to overwrite an answer and sometimes leaving responses which were difficult to read.

Comments on specific questions

Question 1

(a) (i) This part of the question was very well answered and nearly all candidates gained both marks.

(ii) Many candidates were aware that the arrows in the food web represent the transfer of energy and there were many good descriptions of this. Fewer candidates were aware that the arrows also represent the transfer of biomass.

(iii) Almost all candidates were able to name two prey organisms of the giant clam.

(iv) This section of the question was very well answered and it is pleasing to note how many candidates understood the concept of pyramids of energy.

(b) (i) Many candidates understood the idea of symbiotic relationships and were able to describe it and give an example. Examples given most often were coral with zooxanthellae and clown fish with anemones. There were a significant number of candidates who quoted non marine examples despite the stem of the question specifying a marine example.

(ii) The concept of parasitism was generally well understood and examples given were mainly those from the syllabus i.e. tuna and nematodes.

Question 2

(a) This part of the question was not particularly well answered and often the only mark gained was for a correct reference to subsidence. Some candidates correctly named changes in sea levels as a factor involved in the formation of atolls. Other factors such as erosion and sedimentation were rarely mentioned.

(b) This was quite well answered and most candidates named carbon dating and drilling as two methods used to date coral reefs.

(c) (i) Most candidates were able to calculate the percentage of reef islands that were less than 2 metres higher than mean sea level.

(ii) Most candidates gained four marks for the graph drawing. Candidates did not always label the x-axis. As mentioned earlier many of the graphs seen were very untidy and candidates should be aware that if a plot cannot be easily seen it is unlikely to gain the mark.

(d) There were some very clear and precise statements of the differences between the two reefs. However, many candidates did not make the comparison between the two reefs clear. Where a question requires a comparison of differences, as in this question, it is not enough to state that one reef, for example, has a maximum height of 3.5 metres. It is necessary to give the opposing statement for the other reef.

(e) This part of the question was, in general, well answered with most candidates able to give the correct sequence in the formation of an atoll.

Question 3

(a) This was generally well answered with most candidates able to give a correct definition of salinity.

(b) Just over half of the candidates were able to carry out this calculation correctly.

(c) (i) The majority of candidates read the graph as 20 rather than 21 or 22 cm.

(ii) This part of the question was reasonably well answered.

(iii) Many candidates gave clear and precise descriptions of the changes in salinity between 40^{o} North and 40^{o} South. These were characterised by succinct references to the increase and decrease of salinity over the appropriate degrees of latitude. They also included a clear reference to relevant figures from the graph to illustrate their answer.

(iv) This section of the question was very well answered and most candidates were able to link the changes in salinity and rainfall and state the relationship between the two factors.

(v) Most candidates gained 1 mark here usually for stating correctly that ‘evaporation’ is an important factor affecting salinity. Incorrect responses seen most frequently were references to ‘pressure’ and to ‘‘rainfall’ despite the instruction in the stem of the question. References to ‘runoff’ were quite common but without more detail it was unclear what the candidates were referring to in terms of this.

(d) This was reasonably well answered with many candidates putting together a well reasoned and comprehensive argument why global warming may affect salinity of the oceans. The argument usually followed the lines of ‘an increase in temperature will cause melting of icebergs and glaciers with a consequent release of freshwater and therefore a fall in salinity’ Other candidates put forward a valid argument for a rise in salinity. This was along the lines of ‘the rise in temperature will cause an increase in evaporation of water leaving salt behind and consequently a rise in salinity’.

Question 4

(a) More than half of the candidates were able to state two factors required for the formation of a tropical cyclone and gained both marks in this section of the question. The most frequent correct responses referred to 'warm water (above 26 ^{o}C)' and 'low pressure'. It was unusual to see references to 'humid air', 'rising air' or 'low wind shear'.

(b) (i) The majority of candidates were able to interpret the data in the table and state clearly the relationship between the distance from the centre of the cyclone and rainfall. Few candidates gained the second of the two marks by using the figures to substantiate their answer.

(ii) Because of the nature of the data in the question it was necessary to allow a large range for the answer and consequently very few candidates failed to gain the mark.

(c) Most candidates were able to state at least one feature of tropical cyclones and this was usually a reference to high or strong winds or a suitable description of these.

(d) (i) There were a large number of possible valid answers to this question and many candidates were able to state at least two destructive effects of cyclones. However, candidates did tend to repeat themselves by stating an effect and then stating the same in a slightly different form of words. The most frequent correct responses seen were references to damage to buildings or property or part of the infrastructure. References to erosion and habitat damage were also seen quite frequently.

(ii) This part of the question generated some excellent and concise responses as well as an equal number of vague ones. Good answers argued that a beneficial effect of a cyclone could be the supply of water to arid or desert land and thus make it suitable for growing crops. Vague responses were exemplified by answers such as 'it supplies nutrients' without any reference to the source or usefulness of these nutrients.

Question 5

(a) (i) Some candidates were able to state two biological reasons for the variation in oxygen concentration in seawater.

Often single words such as 'respiration' or 'photosynthesis' were given. These were not reasons and what the Examiners required was an appreciation that respiration of organisms in the sea reduce the concentration of oxygen and that photosynthesis by aquatic plants increase the oxygen concentration.

(ii) This was slightly better answered than **(i)** and more candidates were able to state one or two physical reasons for the variation in oxygen concentration in seawater. Very few candidates were able to give three reasons. The most common correct answers were usually one or two of the following reasons, 'temperature', salinity', pressure', 'depth of water' or 'water turbulence'.

(b) (i) The majority of candidates calculated the mean oxygen concentration as 6.13.

(ii) This question proved to be challenging. Most candidates were under the impression that repeating the measurements at each depth was to increase accuracy. Accuracy is a function of the instruments used not repetition of the readings. What was required was an appreciation that the process of repetition would increase reliability or mitigate the effects of anomalous results or errors in reading the measurements.

Question 6

(a) This question, which required candidates to give a description of the theory of plate tectonics, elicited a wide range of responses. Generally, most candidates gained two marks for quoting relevant and valid facts which were clearly distinguishable in the answer. Usually candidates made a valid reference to the Earth's crust being made up of tectonic plates and to these plates being in constant motion. Less precise responses such as 'the Earth is made up of plates' did not gain credit and often the incorrect or no reason for the movement was given.

References to plate boundaries or a specific named type of boundary were also credited.

(b) (i) Relatively few candidates described mid-ocean ridges as 'underwater mountains'. Many candidates appeared to be under the impression that they were ocean trenches and the explanation as to their formation was often vague and imprecise. What was required was an appreciation that the uplifted seafloor or ridge results from magma at a divergent plate boundary emerging as lava and building up to form new crust as it cools.

(ii) While the explanation for the formation of tsunamis was often correct quite a number did not give an adequate description of one. For example, quite a number of candidates did not refer to them as a 'wave', an essential fact in any description of a tsunami.

(iii) Description of abyssal plains was often quite vague and typically simply referred to them as parts of the sea floor. A good response would have indicated that they are relatively flat ocean floors formed when the lower oceanic crust is melted and forced upwards. As this material reaches the surface of the ocean floor it solidifies and forms new oceanic crust. The abyssal plain results from the carpeting of this crust oceanic crust by sediments falling from above.

(c) (i) Many candidates appreciated that water at an hydrothermal vent is heated by the magma.

(ii) The reasons given as to why the water is rich in minerals was often rather vague and did not always convey the essential point that the water picks up minerals as it passes through the ocean crust.

MARINE SCIENCE

Paper 9693/02
AS Data-Handling and Free Response

Key messages

There are a number of points arising from this paper, as indicated below, which would help to raise the achievement of candidates in the future.

Candidates should:

- read the questions carefully, considering the 'command words' used and noting the mark allocation;
- select appropriate information to answer the questions;
- use scientific terms and vocabulary.

General comments

This paper includes questions requiring data handling and free-response questions. The questions test candidates' knowledge and understanding of the syllabus content, and their ability to apply their knowledge in new and possibly unfamiliar situations. There was a wide range of responses to this paper, from candidates with only a superficial recall of the factual content, to those with an impressive knowledge of the content and an ability to apply their knowledge in the context of these questions.

Comments on specific questions

Section A

Question 1

In general, candidates answered **(a)** and **(c)** more successfully than **(b)**.

(a) There were some very good answers which correctly included references to both the presence of zooxanthellae in corals and their requirement for light for photosynthesis. Some candidates recognised that light is required for photosynthesis, but without referring to the algae within the corals. It was clear that there appeared to be some confusion between light and temperature, as a number of candidates suggested that the lights provided heat. Several answers were too imprecise to gain credit, such as references to illumination providing light for growth, or reproducing the same conditions as in the sea.

(b) This part proved to be difficult for many candidates. One common reason was that candidates tended to give general accounts of how to carry out the experiment, with references to controls and details of measurements of coral growth. The question specifically referred to the stated hypothesis and therefore references to the measurement of light were expected. There were some good answers in which candidates referred to the need for a device (such as a photocell) for recording light intensity and duration in both the sunken ship and in the laboratory. There were some descriptions of measuring the 'amount' of light, where more precise terms, such as intensity, or duration, would have been appropriate.

(c) Part **(c)** gave opportunities for the majority of candidates to gain credit, usually for suggesting three appropriate factors which may affect the growth of this coral. Many candidates correctly suggested factors including turbidity, sedimentation, salinity or predation. Whilst many candidates also qualified each factor with its predicted effect on growth; some others stated simply that the factor would 'affect' growth, without indicating whether it might increase or decrease growth. Some of the factors suggested by candidates, for example, 'weather' or 'humans', were considered to be too

imprecise. However, candidates sometimes qualified these factors with an acceptable statement such as 'bad weather could include strong wave action which might break corals and reduce their growth' and were given credit accordingly.

Question 2

This question related to knowledge and understanding of syllabus **Section 3** (Energetics of marine ecosystems). Candidates are expected to be able to explain the meaning of terms included in the syllabus, such as *productivity*, and to be able to carry out calculations relating to the efficiency of energy transfer between trophic levels. Overall, this proved to be a discriminating question and full credit was rarely awarded, particularly in **(a)**, **(b)(i)** and **(b)(ii)**. Part **(b)(iii)** was usually answered more successfully.

(a) There were a number of accurate explanations of the term productivity, which included references to both the rate of accumulation of biomass (or energy) and to a unit area or volume. However, this proved to be a difficult term for many candidates to explain and there were many inaccurate references to, for example, reproductive success, use of energy by organisms, or growth. Candidates could improve their performance on this type of question by noting carefully the terms which appear in italics in the syllabus, such as *ecosystem*, *biodiversity*, *succession* and *productivity*.

(b)

(i) This proved to be a difficult calculation and consequently there were relatively few correct answers. Candidates are advised that this paper may include questions involving a calculation and Skill B includes manipulation of numerical data. It may also be helpful to candidates if reference is made to the Mathematical Requirements, which are included in the syllabus.

(ii) Candidates who read the question carefully were generally able to give good answers, usually with references to reflection of light, inappropriate wavelengths of light, inefficiencies of photosynthesis, or losses in respiration. There were a number of answers which digressed into general accounts of energy losses in food chains and included references to losses in faeces of the inefficiency of energy transfer between trophic levels. In this instance, it was important for candidates to note the allocation of marks for this part; to be awarded full credit, three distinct points were expected.

(iii) This part was generally answered quite well and the majority of candidates gained at least partial credit. There were many appropriate references to energy loss in a food chain and this was often qualified with an explanation of how energy is lost, for example, as heat from respiration. Many candidates also recognised that there is insufficient energy to support more than five trophic levels. Relatively few candidates referred specifically to Fig. 2.1, but this was not essential to gain full credit.

Section B

Question 3

(a) The answers to this part were rather varied. A number of candidates readily gained maximum, or near maximum credit for detailed descriptions of the roles of magnesium, calcium and phosphorus, but some answers included few accurate details rather than inaccurate generalisations about all three of these ions in marine ecosystems. As an example, some candidates stated that 'these ions are involved in the formation of bone', but without specifying which. The roles of calcium ions were possibly better known than the other two and there were many suitable references to the formation of shells, bone, corals and calcium carbonate. The roles of phosphorus were less well known and magnesium was sometimes linked with photosynthesis, where a specific reference to chlorophyll was expected.

(b) There were some very good answers to this part, frequently receiving full credit. These answers usually included references to the death of organisms and the sinking of these, together with faeces or detritus, to the ocean floor. References to harvesting, as a means of nutrient loss, were also seen quite commonly. Some candidates also included appropriate references to slow decomposition; relatively few commented on incorporation of ions into reefs.

Some of the weaker answers digressed into rather general accounts of nutrient cycling, often including material which was relevant to **(c)**. A number of candidates did not notice that this question related to the subsequent loss of nutrients after they have been taken up by organisms living in the surface layer of an ocean. As examples, some answers included irrelevant details of downwelling, or stated incorrectly that nutrients 'evaporated'. This illustrates the importance of reading the question carefully and selecting appropriate information for the answer.

(c) There were some very good answers to this part, including references to decomposition, upwellings, leaching or run-off and dissolving of atmospheric carbon dioxide, as processes by which nutrients are replenished. Upwellings were frequently described in detail. These answers showed candidates' accurate knowledge of syllabus **Section 4**. Some candidates described run-off, but did not name a nutrient, such as nitrate or phosphate, in this context.

Question 4

(a)

(i) The majority of candidates were able to explain what is meant by the term *producer* and to give an acceptable example. References to photosynthesis and phytoplankton were seen frequently. Some candidates gave inaccurate definitions, such as 'an organism which produces energy' or 'an organism which converts light into energy', but may nevertheless have named a suitable example.

(ii) The term *succession* proved to be more difficult for candidates to explain accurately and relatively few gave a concise definition which conveyed the process of changes in communities over a period of time. There were references to, for example, predator-prey relationships and food chains. Many candidates were, however, able to give a suitable example and references to succession at a hydrothermal vent were seen quite often. Many candidates cited 'whale fall' as an example of succession. Whilst this, in itself, is not an example of succession, candidates who described the subsequent sequence of events were given credit.

(b) This question proved to be difficult for candidates, mainly because there was a tendency to describe, or list, the environmental factors on a rocky shore, but not to explain how these factors influence the communities. There were many references to, for example, wave action, exposure, temperature and the nature of the substrate. However, these were rarely linked to their effect on the organisms present on a rocky shore. On the other hand, there were some good accounts which correctly linked the environmental factors to their effect. For example, 'rocky shores are often exposed to strong wave action; therefore organisms need a means of attachment to the substrate. Barnacles and limpets are firmly attached to rocks which prevents them from being washed away'.

(c) This also proved to be a difficult question for candidates to answer accurately and many attempted to describe an environment which was both extreme and unstable, rather than treating each one separately. Many candidates also attempted to explain the term *biodiversity*, although some of the definitions were rather vague or ambiguous, such as references to 'the number of organisms present', where it would have been more accurate to refer to the number of different species present. In general, candidates were familiar with hydrothermal vents as an example of an extreme environment and gained credit for references to the high temperature, or high pressure, and organisms such as tube worms or chemosynthetic bacteria. There was a tendency for candidates to suggest that the extreme conditions 'cause organisms to adapt' or that organisms 'adapt themselves' to the conditions. It would be preferable to state that only those organisms with specific adaptations are able to tolerate the extreme conditions. Previous Principal Examiner Reports have commented on examples of non-marine habitats being given by candidates. There were a number of references to, for example, the Sahara desert and rain forests in answers to this paper. Candidates should always use examples of marine environments or habitats, where appropriate, in Marine Science.

MARINE SCIENCE

Paper 9693/3
A2 Structured Questions

Key message

There are a number of points which would help to raise the achievement of candidates in future. Some of the points include;

- the use of precise technical terms,
- practise analysing both graphs and tables.

General Comments

Overall answers were often imprecise and the questions rephrased as answers. Candidates should be familiar with the standard data presentation of the changes with depth in the ocean of light penetration, temperature and productivity. Candidates should be aware that data processing using mathematical formulae may also be required. **Questions 3**, **4**, **6** and **7** were answered well. **Questions 1**, **2** and **5** were low scoring, in particular **2(a)** and **5(b)**

Comments on specific questions

Question 1

This question was about the effects of light and temperature on marine productivity. Information about gross and net primary productivity was provided as the syllabus does not distinguish between them.

(a) Candidates often restated the information in the question or wrote an equation showing the same information. Better answers showed an understanding that net primary productivity is a way of estimating the carbon or food availability for the rest of the marine food web and is thus an indication of total productivity.

(b)

(i) Candidates were expected to use their knowledge of photosynthesis and the information in the question about gross and net productivity to answer this question. Better answers showed an understanding that photosynthesis produces oxygen, some of which might be consumed by respiration, so the oxygen released is an indirect measure of net primary productivity. Weaker answers referred only to oxygen production by photosynthesis.

(ii) There were some good answers to this part of the question. Most candidates recognised the general trend shown in Fig. 1.1 and related this to the effect of reduced light penetration on photosynthesis. Better answers referred to light being a limiting factor for photosynthesis but not for respiration.

(c)

(i) Most candidates gave a correct answer.

(ii) Most candidates gave a correct answer.

(iii) There were very few good answers to this question. Candidates who realised that enzymes were involved were able to explain the effect of temperature on the rate of reaction. Few candidates showed an understanding that temperature has a greater influence on respiration than it does on photosynthesis. Consequently, candidates were not able to explain that more light would be needed at higher temperatures for sufficient photosynthesis to

compensate for the increased respiration, thus accounting for difference in depth of the compensation point at higher temperature. Many candidates tried to explain the difference in compensation point in terms of the solubility of gases at different temperatures, which does not take into account the metabolic processes concerned.

(iv) More candidates stated that warm seas were more productive than cold seas. This indicates that candidates had not linked the significance of the greater depth at which compensation point occurs in temperate seas to greater net primary productivity in these seas, which in turn results in higher overall productivity

Question 2

This question was about oxygen consumption in relation to activity and the adaptations of respiratory systems to maintain oxygen supply.

(a)

(i) The *y*-axis of the graph in Fig. 2.1 was misinterpreted by a great many candidates as a direct measurement of oxygen consumption per individual, rather than oxygen consumption per gram of tissue. Some candidates commented that they would expect larger crabs to consume more, but did not follow this up by revisiting the graph data. It is important that candidates read the axis labels carefully and understand how to manipulate the data as well as making direct readings from a graph. For this question, the figures show that the heaviest crab (**C**), is over six times heavier than the lightest crab (**A**), but the oxygen consumption is only about double.

(ii) Candidates commonly recognised that oxygen was no longer a limiting factor. Better answers showed an understanding that uptake of oxygen must be related to respiration, although few stated that respiration rate must be constant. Adaptations to maintain constant supply of oxygen, such as adjusting the gas exchange surface or the circulation, were rarely addressed. Many candidates left this section blank.

(b) There were some good answers to this question, referring to increased respiration to supply additional energy for increased activity. Better answers also related increased oxygen consumption to the use of oxygen by respiration.

Question 3

This question was about reproduction in different types of fish and some of the possible effects of their life cycles on fishing.

(a)

(i) Candidates were able to find the relevant data in the table. It was common for all the information about the selected species to be copied, rather than selecting the most relevant information. Better answers identified the Southern Bluefin tuna because it releases greatest number of eggs per breeding cycle. Yellow fin tuna was also a possible answer as it has a large number of eggs and several breeding cycles in a year. It was not possible from the data give to comment on lifetime fecundity of these species as the total life span and breeding age range were not supplied.

(ii) Most candidates gained full credit here. The most common answers were that tuna spawn in the sea and salmon in fresh water or rivers and that tuna eggs are free floating and salmon eggs are in nests. Weaker answers did not make a complete comparison, for example, salmon only spawn once. Candidates should be aware that a comparison requires a statement about the same feature for each of the organisms being compared.

(b) Most candidates identified the Southern Bluefin tuna because it has only one breeding area. Better answers also explained that a closed area would restrict the number of spawning fish caught and thus allow the population to be maintained. As in **(a)(i)** candidates tended to write all the given information, some of which was not relevant to the question, for example the age at which the fish reach sexual maturity and the frequency of breeding.

(c)

(i) Answers to this part of the question tended to be related to salmon being euryhaline and having to adjust to the change in salinity. The question is about different temperatures at which salmon develop. Candidates were expected to realise that salmon must reach an optimum size both for migrating and for reaching sexual maturity, which takes longer at lower temperatures as enzyme activity and thus growth rate is slower.

(ii) Candidates mostly realised that migrating salmon travel in large numbers and are thus easy spawning.

Question 4

This question was about sustainable fishing, how it might be developed and the consequences to fishing communities of sustainable fishing.

(a) Candidates were familiar with the principles of sustainable fishing in terms of maintaining a viable fish stock. Better answers also referred to reducing the impact of fishing on the environment.

(b)

(i) The most common answers were related to marketing the supermarket chain as a 'caring concern' to attract more customers or to 'self-interest' in keeping a supply of saleable fish.

(ii) The most common answer in this section was related to environmental concerns. Very few considered the impact on employment prospects in fishing.

(iii) Most candidates assumed that the fishermen would receive more wages for catching fewer fish. Candidates need to be aware that although sustainable fishing may allow fish stocks to recover, the catch size will remain lower than before the introduction of sustainable fishing. The benefit is that there are long term employment prospects and a guaranteed market for the fish caught. As the fish stocks recover there is an added benefit of larger, more saleable fish.

(c)

(i) Candidates realised that there would be a loss of employment and reduced income. Either answers were acceptable, often both were given. A common misconception was that the population of the fishery would have less fish to eat.

(ii) Candidates often answered in terms of the long term effects on the fishery rather than the community. It is true that the fishing stock will recover and the fish caught will be larger, but this does not answer the question. Some better answers showed an understanding that employment in other fishing related trades, such as boat building and market trading would be supported. The wider community amenities such as shops, schools, entertainment venues were not considered.

Question 5

This question was about some of the features of oxygen and food supply in intensive aquaculture systems. In general candidates showed limited understanding of how to process the data either in Fig. 5.1 or Table 5.1.

(a)

(i) Candidates were able to read the correct figures from the graph in Fig. 5.1, although some did not gain full credit, either because the units were omitted or the graph scale was misread. Candidates should be aware that for graph readings or graph plotting there is usually a tolerance of ± half mm square on the grid and that correct units are expected for data extracted from either graphs or tables.

(ii) This question was about the effect of the number of fish on the oxygen content of water at various temperatures. Better answers recognised that the higher the temperature the greater the metabolic rate resulting in a higher oxygen consumption due to higher respiration rate. Most candidates answered in terms of oxygen solubility in fresh water and sea water, rather than the effect of temperature on the oxygen consumption of the fish. Credit was given for realising from Fig. 5.1 that the sea water started from a lower oxygen saturation

than the fresh water. However, the oxygen saturation of fresh water at 15 °C is approximately 3 mg dm^{-3} greater than sea water at 3 °C, which is not sufficient to account for the difference in the stocking densities supported.

(iii) Candidates were expected to answer in terms of a commercial aquaculture system, such as pumped oxygen or gravity feed water systems. Many of the answers were more suited to an aquarium, for example air stones and pond weed. Credit was given for answers that explained the use of oxygenating plants in terms of photosynthesis. There was some confusion about the terminology used to describe aeration systems, for example filters were described as providing oxygen. Another common answer was to reduce the stocking density, which does not maintain the oxygen content.

(b) To answer this section candidates needed to understand how the composition of the food supplied was used by fish to gain in mass. Any food source should contain protein to promote new tissue formation and an energy source. The relative proportions of these determine how effective they are in promoting growth.

(i) The higher the protein content of the diet the greater the proportional contribution to tissue formation, so to achieve the same growth using a low protein diet, fish must eat more. Most candidates did not get any further than stating that high protein food was better than low protein diet, which is not an explanation.

(ii) As an energy source is also needed for growth, high protein diets may be less efficient overall as some of the protein is used for energy rather than tissue formation. Low protein diets contain other substances such as carbohydrate or fat that supply energy so all the protein can be used for tissue formation, so their overall efficiency is greater. Most candidates simply stated that low protein diets were more efficient.

(c) The most common answer was a diet that would give the best growth. Very few candidates considered availability or the storage properties of a food, both of which are important for large scale aquaculture.

Question 6

This question was about use of TBT and the potential environmental consequences of this use. Candidates were well informed about the hazards of TBT and imposex in molluscs.

(a) There were some good answers to this question that referred to the attachment of barnacles and the consequent effects on ship efficiency. A common error was to confuse anti-fouling treatment with anti-corrosion treatment.

(b)

(i) Candidates were familiar with the idea that a chemical with a broad spectrum effect was one that would impact on a large variety of different species. Only better answers also explained that toxicity mean that the chemical was poisonous and likely to kill organisms.

(ii) There were some well-expressed descriptions of both biomagnification and bioaccumulation, both of which were acceptable answers. Weaker answers said only that the TBT passes through food chains.

(c) For this section, candidates were expected to use the information in the question and their own knowledge. A wide variety of suggestions were accepted.

(i) The most common answers were related to the use of TBT on nets and pots used for inshore aquaculture or shell fisheries and to the greater frequency of shipping in coastal areas. Candidates also related the higher coastal concentration to higher sedimentation. This was a more appropriate answer to **(ii)**.

(ii) Common acceptable answers included reference to the large number of older ships still in service and an increase in the number of cargo or cruise ships that were larger than 25 metres. Weaker answers showed some misinterpretation of the information given as answers referred to more small ships being treated with TBT.

(d)

(i) Better answers described the relationship between increased TBT and the growth rate of oysters. Weaker answers described a relationship between growth rate and time of exposure to TBT for individual TBT concentrations.

(ii) Good answers showed an understanding that increasing the concentration of TBT would reduce the maximum size of oysters and reduce the number reaching maturity. As a consequence the oyster population would decrease, so that it may become uneconomic or impossible to culture oysters. Weaker answers tended to write extensively about imposex without relating this to the culture of oysters.

Question 7

This question was about marine conservation and some of the management strategies used in a conservation area.

(a) There were some excellent, clearly set out answers to this question. Weaker answers missed out stages in the processing of data, commonly the actual measurements made of the marine conservation area. Candidates should be aware that if a question states 'Show you working', there will be credit allocated to the expected stages of a calculation. To gain full credit for this question, candidates were expected to show three main stages in their working. One of these was measurements in mm or cm of the rectangular area of the conservation area. Better answers had lines drawn on the diagram to show where the measurements had been made. Weaker answers used inches or fractions for measurements. The syllabus mathematical requirements indicate that decimal and standard form should be used. Another expected step was to show the actual conversion of these measurements to km. The other expected step was to show the use of the scale to find the actual size. A number of candidates omitted this question.

(b)

(i) Most answers were imprecise, for example 'to keep the environment safe' or 'to protect the species that live there'. Candidates were expected to consider more specific reasons, such as breeding grounds for endangered species or areas with fragile ecosystems or great biodiversity. The growing popularity of ecotourism was allowed, although this is not a reason for creating a reserve.

(ii) The expected answer was the inshore region. A variety of answers were acceptable, although many as in **(i)**, were too vague, for example 'because a certain species lives there'. Acceptable answers referred to specific examples of endangered species, such as turtles, nesting sites of sea birds, and nursery grounds of juvenile fish.

(c)

(i) Candidates were familiar with the effects of trawling on the sea bed. Better answers also included reference to the effect of sediment on light penetration and the gills of sea animals, together with the consequential effect on the benthic ecosystem. Candidates who described the likely effect of the by-catch on the ecosystem were also given credit.

(ii) Better answers showed an understanding that netting, which was the only form of commercial fishing allowed, is more sustainable as it limits the catch size. Some of the better answers also took into account social and economic considerations for the local people. Answers that reversed the arguments given for trawling in **(c)(i)** were not accepted.

(d) Candidates were expected to apply their knowledge of marine ecosystems to specific examples of potentially damaging human activities. Some answers achieved this successfully; others did not make a connection to the examples and gave very general statements.

(i) Most candidates were familiar with wrecks as habitats or artificial reefs. Candidates who approached this question from the point of view of the possible disturbance to the marine environment of wreck removal were also given credit.

(ii) Candidates approached this question in two ways, both of which were acceptable. The most common answer was related to the limited catch of angling and the possibility of releasing the fish. Other answers were related to the economic benefit of attracting sport fishermen.

(iii) Most answers to this question were about pollution from oil or petrol spills. Other acceptable answers were the danger of killing or injuring slow moving large animals, damage to sea grass from propellers, the erosion of shoreline from the wave action of the wake from boats and disturbance of birds and fish by engine noise.

MARINE SCIENCE

Paper 9693/04
A2 Data-Handling and Free Response

Key messages

Interpretation of data was generally good although many candidates did not have particularly strong mathematical skills.

There were, however, many candidates who had underestimated the level of detailed knowledge that is required at A Level and gave answers that were superficial.

Many candidates were reluctant to use key scientific terminology and tended to use language that was too vague and imprecise.

General comments

The quality of candidates' scripts was very variable. There were several excellent scripts where candidates had an excellent factual knowledge of all areas of the specification that was compatible with A Level standards. Some very strong candidates gave information from far beyond the specification – particularly in **Question 4**.

Comments on specific questions

Section A

Question 1

(a) The majority of candidates were able to correctly use the formula given in order to calculate CPUE. The only apparent errors were due to general mathematical mistakes.

(b) Most candidates were able to label linear axes and plot the points accurately. A minority of candidates were unable to draw a correct line or curve of best fit, simply joining the points.

(c)

(i) The majority of candidates were able to identify an overall decreasing trend. Only about half of these then went on to give a little more detail in terms of oscillation or levelling off of the curve.

(ii) Only about half the candidates were able to suggest reasons for a decrease in CPUE, the most common suggestion being over fishing. Many simply gave another description of how the CPUE varied over the time. Only the strongest candidates recognised that at times the CPUE increased and then went on to give an appropriate reason.

(d) This question generated a very good set of responses. The majority of candidates were able to give an appropriate suggestion, typically illegal catches.

(e) Only stronger candidates were able to gain full credit here. Many weaker candidates seemed unaware of the section of the specification listing information that might be needed to ensure sustainable fishing. Of those who were awarded credit here, there were some excellent answers giving very good detailed explanations of how fishing could be sustainable.

Question 2

(a) The majority of candidates were able to complete this simple calculation.

(b) Only stronger candidates were able to calculate a percentage increase. Many candidates were unaware that they had to determine a difference between the juvenile and adult tuna, simply dividing the juvenile ratio by the adult ratio.

(c) Only stronger candidates gained any credit here. Very few answers were seen that received full credit. Very few candidates were able to make a link between oxygen consumption and respiration and activity levels. Many simply wrote about diffusion of oxygen and why fish have gills. Only a handful noticed the difference between the juvenile and adult and went on to give a good explanation for it.

(d) Approximately half of the candidates were able to recognise the reason for using ratios and described the difference in body mass of different fish. Many candidates wrote answers that focused on fair tests or accuracy.

Section B

Question 3

(a) Many candidates gave excellent definitions and clearly had an excellent knowledge of all areas of the specification. There were, unfortunately, many other candidates who had no knowledge of any of the terms, with only a few vague references to choosing breeding partners being given. Some answers were over simplistic for A Level standard and lacked precision of language.

(b) Many excellent, detailed accounts were given where candidates had carefully studied the section of the specification concerning genetic engineering. The use of promoters and growth enhancing genes was explained and the value of this to fish farmers. Unfortunately, many candidates had only a very rudimentary knowledge of this topic and made a guess at why a fish could be engineered, e.g. “tuna can be made to be bigger” was an answer typically seen.

(c) The majority of candidates, except for the weakest, were able to gain some form of credit for the idea of reducing risk exposure. Few could then go on to explain how this related to GM fish in any significant detail. Weaker candidates were often able to recognise that the fish could escape or there may be a risk to the consumer but then did not give any further detail. Stronger candidates often gave excellent answers giving details of food chain disruption, extinctions and competition between native species.

Question 4

(a) The majority of candidates were able to gain at least partial credit but few gained full credit. Weaker candidates gave overly simplistic answers, e.g. “ice caps melting” and failed to elaborate any further. There were some very detailed descriptions giving data from well beyond A Level standards.

(b) Most candidates were able to gain some credit for this question although weaker candidates limited themselves to one or two superficial suggestions. A very good range of suggested effects was seen overall with some particularly good detailed descriptions and explanations of coral bleaching.

(c) Only stronger candidates were able to attain good scores here. This question is one that is addressed in the specification and many candidates had clearly not considered it. Weaker candidates often did not go beyond a limited description of how CO_2 was increasing and linked it to industry. Many candidates did not discuss both sides, instead only discussing the idea of human impact. However, some very high quality discussions were seen giving both sides of the argument and just as was the case in **4(a)** gave evidence from beyond the bounds of the specification.