MARINE SCIENCE

Paper 9693/01
AS Structured Questions

Key Messages

As indicated in last year's report, candidates should take notice of the number of marks allocated to each question and the amount of space available for the answer. This gives a good indication of the length of response required and the number of salient points that should be made.

In those questions which involve a calculation the working must always be shown. The reason for this is that there is usually a mark available for the correct working even if the answer is incorrect. Candidates should also be encouraged to quote units in any numerical answer. In most questions which require a numerical answer no credit will be given if the units are omitted.

The command words used in the questions should be understood by candidates so that they are aware of the type of answer required. This is particular so in the case of the command words, 'Describe' and 'Explain' which are frequently mixed up by candidates.

Describe, in the case of a process, for example, requires the candidate to give a step by step written statement of what happens during the process.

Explain may imply reasoning or some reference to theory, depending on the context. It is one way of asking candidates to give reasons for. Candidates need to leave the Examiner in no doubt **why** something happens.

General Comments

This year's examination generated a wide range of marks and a corresponding wide range of performance.

As is usually the case, some candidates gave vague and imprecise responses which sometimes contained a lot of information irrelevant to the question and did not gain credit for this.

On the other hand, there were many responses which had the opposite characteristics, being clear, precise and to the point.

Some aspects of the syllabus knowledge and understanding were much better known than others. In this respect, candidates, by and large, had a much better knowledge and understanding of food webs and interrelationships of organisms (**Question 3**) than of productivity (**Question 5**).

The quality of responses to questions requiring the application of knowledge to new situations or interpretation of data were varied with many excellent answers to **Question 3 (c)** contrasting with many weak responses to **Question 6 (b).**

Comments on Specific Questions

Question 1

(a) (i) Most candidates were able to explain the term 'habitat'.

(ii) The meaning of the term 'community' was usually only partially correct with many candidates not stipulating that **different** species make up a community. A simple reference to 'many organisms make up a community' does not make it clear that these were from different species.

(b) (i) Most candidates were able to appreciate from the data the overall difference in size of the particles from the sandy shore and those from the muddy shore. Many others also appreciated the difference in the range of size of the particles and were able to give a correct numerical comparison. Some did attempt to explain the difference in the sizes of the particles in percentage terms and this was invariably incorrect. Few candidates appreciated that there was an overlap in the range of particle size.

(ii) This question elicited responses which were usually centred on the correct ideas of particles being deposited and then accumulating to form the muddy shore.

There were generally few references to organic materials which are a major component of muddy shores or to the correct role of water in transporting particles. Quite a number of candidates included in their answers, references to how sediments were formed, which although often correct, was not part of the answer to the question posed.

(iii) This section of the question proved to be rather difficult for many candidates and often the only valid explanation for the difference in biodiversity was an appreciation that rocky shores are more stable. More able candidates were able to extend their answers and explain the difference in stability as well as referring to other salient points such as rocky shores providing a firm surface for the attachment of marine organisms, references to the ideas of protection or shelter provided by a rocky shore and an appreciation that sandy shores are mostly only suitable for burrowing organisms.

Question 2

(a) (i) This was generally answered well although many candidates omitted the units from their answer. Other incorrect responses did not indicate the decrease in the oxygen concentration.

(ii) This question required candidates to extrapolate the curve to estimate the oxygen concentration at 45 ^{0}C. A small allowance was made for the responses to this question but it appeared that many candidates were simply guessing, as indicated by responses such as ‘about 6’. Other candidates attempted to extrapolate by drawing a free hand line or simply plotting points.

(iii) The drawing of the graph was generally inadequate. The following points are worthy of note –

- The actual plots themselves were often inaccurate despite a relatively easy scale.
- The majority of candidates did not use neat crosses to plot the points and often used circular blobs, often larger than a grid square which lacks the accuracy required.
- In many cases, the line drawn was somewhere mid-way between joining points and a line of best fit, and did not score; the line often curved going close to points but not as a line of best fit. There were a few correct lines of best fit, and similarly few who actually joined all the points neatly with straight lines using a ruler.

Centres should aim to impress upon their candidates the importance of accurate graph drawing and its neat presentation.

(iv) As outlined in the key messages section this was one question in which candidates displayed a lack of understanding of questions requiring a description and those requiring an explanation. As such many candidates, rather than attempting to describe the differences in the oxygen concentrations in fresh water and sea water, attempted to give an explanation for these differences. While much of this was correct it had no relevance to the question posed.

Candidates often realised that the oxygen concentration in fresh water, as illustrated in the graph, was higher than sea water. However, they did not indicate that this was true at all the temperatures shown in the graph.

Many candidates attempted to compare the shape of the curves but usually did not gain any credit for this.

(b) This section of the question was much better answered and many candidates gained most of the available marks. The relationship was usually stated correctly and a number of valid points were made in the explanation. Most often these referred correctly to the facts that phytoplankton

produce oxygen by photosynthesis and that these are more abundant in the surface waters where most light is available.

Some candidates also indicated correctly that oxygen from the atmosphere dissolved in sea water at the surface due to mixing of air and water by winds and waves.

Question 3

(a) There were many clear, accurate and precise answers to this question which gained full credit. These referred to the producers using the process of photosynthesis to produce carbohydrates utilising light energy, carbon dioxide and water and releasing oxygen. They also quoted the example from the food web i.e. kelp.

Answers which did not gain full credit often referred to producers using the sun's energy rather than light, did not indicate the end product of photosynthesis and did not name the producer.

Of particular note is the idea possessed by a large number of candidates that energy is produced or created rather than released. Centres should emphasise to their candidates the impossibility of energy creation.

(b) Generally, this was not well answered and although many candidates seemed to know the meaning of the terms predator and prey, the question required an explanation of the relationship between the two not just a description of each. In addition, candidates nearly always referred to either predators or prey as organisms rather than animals. In using this language the impression often given was that predators were feeding on plants not animals.

(c) It was pleasing to note the many excellent responses to this question. These gave clear and accurate explanations for the increase in the population of sea otters due to the commercial fishing of the cod and sheephead. Most often, these answers centred correctly on the fact that sea otters, cod and sheephead all feed on lobsters or sea urchins or abalones and that with a reduction in the numbers of two of the predators, the otters would have less competition for food.

However, a common misunderstanding was to mix up the predators and prey in the food web with a result that the argument given led to a fall in the population of sea otters. Some candidates also went to great lengths to describe the effect on the killer whales which in this instance was irrelevant to the question.

Question 4

(a) Answers to this question were generally characterised by vague and generalised comments often about volcanoes, movement of underwater plates, land masses and animals. Consequently they gained little credit. Land masses were often just described as such without reference to continents; the land masses were often said to make a 'jigsaw fit' or were described as part of a puzzle without further comment. References to continents or coastlines were less frequent.

There were frequent correct references to fossils, but these often did not say what this meant in terms of plate tectonic theory.

(b) Many candidates were aware of the process of subduction or were able to describe it accurately. Some answers were often vague and lacking in accurate information concerning the formation of an underwater trench. Many candidates were under the impression that trenches were formed at divergent plate boundaries rather than convergent ones. Plates were often described as being submerged or having subsided although the idea of the plates moving was well appreciated.

(c) Many candidates were able to give a reasonably accurate description of a tsunami although it was sometimes incorrectly described as a tidal wave.

However, explanations of how tsunamis are formed were often only partially correct although the idea of the release of energy displacing large volumes of water was well known.

Question 5

(a) (i) As indicated in the general comments, knowledge and understanding of the concept of productivity was limited although more able candidates gave clear and precise explanations of the term. Again, it was not uncommon for references to be made to the production or creation of energy.

(ii) Many candidates were able to give at least two factors that affect productivity. Correct examples included light, temperature, availability of nutrients and carbon dioxide concentration.

(b) (i) Most candidates were able to read the graph to ascertain the greatest difference between the productivity in winter and that in spring. Some candidates omitted the units which was required.

(ii) Although asked to explain the difference between the productivity in the Northeast Pacific Ocean in winter and spring, a minority of candidates actually specified what the difference was. The most common type of response only stated that in spring there was more light or it was warmer. More able candidates went on to state the consequence such as more photosynthesis or increased growth.

Question 6

(a) (i) Candidates' knowledge of runoff was generally quite good particular with reference to materials carried in the water usually exemplified with a reference to nutrients.

(ii) Most candidates were able suggest at least one way in which runoff can be harmful to marine organisms and this was usually expressed in terms of the materials carried in runoff such as pesticides, excess nutrients, toxins or other materials. References to algal blooms were common but vague responses such as water carrying 'pollution' or 'disease' were not acceptable and did not gain any credit.

(iii) Most candidates appreciated that runoff can be beneficial to marine organisms as it can carry nutrients. Fewer candidates, however, went on to give reasons why these nutrients are of value.

(b) Valid responses to this question included references to calcium being used to form bones and coral, sinking to the sea bed when organisms die, the effect of upwellings and the addition of calcium to sea water by runoff. Very few candidates made more than two of these points or incorporated them into a reasoned argument why the concentration of calcium in sea water shows little variation.

MARINE SCIENCE

Paper 9693/02
AS Data-Handling and Free Response

Key Messages

Candidates should:

- read the questions carefully, consider the 'command words' used and note the mark allocation;
- select appropriate information to answer the questions and avoid including irrelevant details;
- manipulate data in tables, rather than quoting figures directly, when describing results;
- try to write free response answers in a logical and coherent sequence;
- use scientific terms and vocabulary;
- include units with numerical answers.

General Comments

This paper includes questions requiring both data handling and answers written in continuous prose. These questions test candidates' knowledge and understanding of the syllabus content, and their ability to apply their knowledge in new and possibly unfamiliar situations. In ***Section A***, questions may relate to Scientific Method and will expect candidates 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.

A wide range of responses was seen to this question paper, from candidates with little knowledge of the subject content, to those with detailed knowledge and an ability to apply their knowledge and understanding in new contexts. Overall, it seemed that many candidates were well prepared for this paper and were able to include appropriate vocabulary and suitable examples in their answers, indicating an improvement on performance compared with 2012. Almost all candidates attempted every part of the questions, suggesting that the time allocated for this paper was sufficient. It was noticeable that the majority of candidates coped better with **Questions 1** and **3** than **Questions 2** and **4**.

Comments on Specific Questions

Section A

Question 1

The majority of candidates coped well with this question.

(a) In questions requiring candidates to describe tabulated data, it is important that the description does not simply repeat the information, without any attempt to make comparisons and to manipulate the data. In this case, candidates were expected to comment on differences in the percentages of larvae settled on each substrate, without digressing into possible explanations for the differences. The majority of candidates correctly interpreted the data and indicated that the highest percentage of larvae settled on sea grass leaves; many candidates also referred to the lowest percentage settled on sand, or indicated that the percentages settled on crushed coral and a mixture of crushed coral and sand were similar. Relatively few candidates manipulated the data and stated that, for example, 9.4% more larvae settled on sea grass leaves than on a mixture of

crushed coral and sand. Some candidates correctly converted the percentages into an approximate number of larvae, from the initial number released into each container, or pointed out that only 13.2% of the total number of larvae settled on all four substrates.

(b) This part proved to be accessible to almost all candidates and they were able to formulate a suitable hypothesis, based on the data in Table 1.1. Although stated in many different ways, the answers generally suggested that sea grass leaves would be the preferred substrate for settlement of sea cucumber larvae.

(c) This part proved to be more discriminating as many of the answers were considered to be rather vague, for example, stating that the substrate provided ideal conditions for survival of the larvae, without any further qualifications. Many candidates did, however, gain credit here for a reference to sea grass leaves providing nutrients, but relatively few made a specific reference to possible protection from predators.

(d) Many candidates scored well in this part, particularly if they carefully read the introductory part of the question and used information provided in their suggested method. Most candidates correctly suggested setting up separate tanks, with each species of sea grass, and outlined their experimental method. Credit was also given for a description of a choice chamber, where both species of sea grass were included in the same container.

Candidates were expected to include references to the control of variables and the collection of quantitative results. It was important to include specific variables, rather than simply stating that variables would be controlled, and to explain how quantitative results would be obtained. To illustrate this point, a number of candidates stated that results would be observed, or recorded, but did not indicate that the number of larvae settled on each substrate would be counted. Carefully planned experiments included references to the control of specific variables, such as temperature, light intensity, salinity, or pH. Candidates were also given credit for suggesting a suitably large number of larvae to use and an appropriate time scale for the investigation, using information provided in the introduction to this question. Although a number of candidates recognised the importance of repeating the experiment, relatively few also referred to the calculation of means. It was interesting to note that many candidates interpreted the information given as three different species of sea grass, *Thalassia*, *hemiprichii*, and *Euhalus acorides*. This did not, however, adversely affect their ability to gain marks for this part.

Question 2

The majority of candidates found this question to be difficult and the marks were correspondingly quite low. This question was intended to test knowledge and understanding of nutrient cycles in marine ecosystems and the effect of an increase in carbon availability on productivity.

(a) Relatively few candidates referred to either carbon dioxide or dissolution as an explanation of process A in Fig. 2.1 and many did not appreciate, or state, that carbon in the atmosphere is in the form of carbon dioxide. There were, however, some good answers which included references to carbon dioxide dissolving in sea water and the subsequent formation of carbonic acid or hydrogencarbonate ions.

(b) This part also proved to be difficult, as relatively few candidates correctly calculated the overall change in the concentration of carbon in the surface water, taking into account all of the gains and losses. One common error was to subtract 90.0 from 92.5, giving an answer of 2.5. It was relatively unusual to see an answer in which candidates logically considered all the numerical information in Fig. 2.1 and arrived at the correct answer of 0.5. As pointed out in the Key Messages, in questions of this sort, it is important for units to be included with the answer. In this instance, candidates were given credit for stating the correct units (x 10^{12} kg per year), even if their calculation was incorrect.

(c) This part required candidates to use the information in Fig. 2.1 to explain why an increase in carbon in the atmosphere could lead to an increase in the productivity of organisms in the surface water of an ocean. Some candidates logically followed the information given and recognised that if the concentration of carbon dioxide in the atmosphere increases, it is likely that more carbon will be available to producers, or phytoplankton, so more photosynthesis will take place. This increases productivity and makes more biomass available to higher trophic levels. Some of the weaker

answers referred only to carbon being required for photosynthesis, but did not refer to the effects of an increase in the availability of carbon.

Section B

Question 3

This question proved to be accessible to the majority of candidates and the marks were generally high.

(a) (i) The term *symbiosis* was familiar to most candidates and many were able to describe this in terms of a beneficial relationship between two organisms and to exemplify this with reference to a suitable example, usually corals and zooxanthellae. Other suitable examples included sea anemones and clownfish, gobies and snapper shrimps. Relatively few candidates specified that symbiosis is a relationship between two different organisms, or between different species.

Candidates were also given credit if they interpreted this term in a broader sense and included references to commensalism, mutualism and parasitism in their answers.

(ii) The term *parasitism* was also usually well described, in terms of the parasite gaining benefit at the expense of the host organism. Whilst many candidates correctly cited nematodes and tuna as an example of a parasitic relationship, or another appropriate example such as sea lice, there was sometimes confusion between a parasite and a predator.

(b) In this part, candidates were asked to explain why shoaling may be a successful strategy for feeding and reproduction, with reference to tuna. This question illustrates the importance of selecting appropriate information in the answer, as many attempts at this digressed into accounts of shoaling in general, often with details of predator avoidance. These answers may incidentally have included relevant information, usually with references to feeding and the proximity of mates. There were some detailed answers to this part, with references to shoaling providing greater hydrodynamic efficiency with the consequent energy savings and increased swimming speed. Although many candidates referred to the availability of mates within a shoal, relatively few explained the importance of this in terms of reproductive success by increasing the chances of fertilisation.

(c) The majority of candidates were able to gain two marks for this part as they appreciated the interdependence of the populations of tuna and silver sprats. For example, candidates usually explained that if the population of silver sprats increased, then so too would the population of tuna. This was less often explained in terms of the availability of food; many candidates reiterated information in the question that tuna are predators of silver sprats. A minority of candidates suggested that both populations would be in competition for the same food source, or that they would shoal together for protection.

Question 4

This question proved to be less accessible to candidates than **Question 3** and although some good marks were gained in **parts (a)** and **(b)**, **part (c)** proved to be difficult for the majority of candidates.

(a) There were some good explanations of the role of coral reefs in providing protection, usually with references to reefs absorbing wave energy and reducing wave action, thus reducing erosion of the shore. A number of candidates went on to explain that coastal properties, or ecosystems such as mangroves, would be protected and that boats would be able to anchor safely in the calmer water. Almost all candidates indicated that coral reefs would slow down waves, but some were unable to expand on this answer. It was clear too that a number of candidates considered that coral reefs are a suitable place for boats to anchor because anchors are able to grip better on the coral than in sand.

(b) There were some good answers to this part, with details of factors which can lead to a transition from reef growth to erosion. There was also a tendency to include irrelevant information in this part, as many answers started with an account of the factors which are important for coral growth, before describing the salient points. Candidates who were aware of the factors which can lead to reef erosion often gained full marks, or nearly full marks, usually by references to human activities, changes in water temperature, ocean acidification, or the presence of predators, such as crown of

thorns starfish or parrotfish. The term *coral bleaching* was known by many candidates, although this was sometimes included in an inappropriate context.

(c) Relatively few candidates seemed to be familiar with the outline principle of carbon dating and how this technique can be used to reconstruct the history of a coral reef. Many of the answers to this part lacked a coherent overall structure, but may incidentally have included references to drilling or sampling and to carbon-14. Some candidates gained one mark only for a reference to sampling of the reef, but then described counting the rings of growth to determine the age of the coral. There were also several answers which suggested that candidates had misinterpreted the term *reconstruct*, with answers including references to rebuilding corals, or the construction of artificial reefs.

Those candidates who scored well on this part explained that living organisms take up carbon during their life and that some of this carbon is in the form of carbon-14. They went on to explain that carbon-14 slowly decays and that measurement of this forms the basis for determining the age of corals. By sampling at different depths, it is possible to find the age of the coral at each depth and to use this information to reconstruct the growth of the reef over a long period of time. Some candidates were also given credit for a reference to the sequence of stages of growth, starting with a fringing reef, in the context of the history of a reef.

MARINE SCIENCE

Paper 9693/03
A2 Structured Questions

Key Messages

- Candidates should make sure that they answer the question that is asked.
- Correct scientific terminology should be used.
- The working for calculations should be presented in a logical sequence with appropriate units shown at each stage.

General Comments

The answers of many candidates indicated that they had worked hard to achieve a good knowledge and understanding of the syllabus content. However, in questions that require the use of data or the application of their knowledge, answers often showed misinterpretation or misunderstanding of what was being asked. This was particularly evident in **Questions 1(a)** and **(c)**, **Questions 2(a)** and **(b)**, **Questions 4(a)** and **(b)**, and **Question 7(c)**. In other questions, candidates did not achieve high marks as they used vague or non-specific language, for example **Question 1(b)(ii)**, **Question 3(a)** and **Questions 6(a) (i)** and **(b) (i)**. There was no evidence of a lack of time as the majority of candidates attempted all the sections of all questions.

Comments on Specific Questions

Question 1

This question was about the effect of light penetration in water on the distribution of algae and the role of cyanobacteria in the productivity of marine ecosystems.

(a) (i) This question required an explanation in terms of the wavelengths of light absorbed by green algae and the depth of water reached by these wavelengths. Most candidates misinterpreted this question and described the distribution of green algae.

(ii) This question also expected an answer in terms of depth reached by different wavelengths of light, linked to the specific pigments found in brown and red algae that absorb these wavelengths. Credit was given if an answer showed an understanding that brown and red algae had specialised pigments that could absorb short wavelengths of light. Candidates needed to refer to the wavelength of light, the majority answered in terms of light intensity. A common incorrect statement was that brown and red algae do not need as much light as green algae to photosynthesise, or in some cases that these algae photosynthesise without light. There was also considerable confusion between the colour of the different wavelengths of light and the colour of the algae, for example, red algae absorb red light and brown algae absorb brown light.

(b) (i) The majority of candidates gave a correct answer. Weaker answers confused cyanobacteria with saprophytic bacteria.

(ii) A few candidates showed an understanding that the availability of nitrogen would increase. Better answers related this additional nitrogen to amino acid or protein synthesis, leading to greater growth of plants. Weaker answers described recycling of nutrients.

(c) (i) Most candidates gave a correct answer. The most common answer was fertiliser run-off.

(ii) A variety of answers were acceptable. The most common correct answers were related to blocking light from producers below the surface and depletion of oxygen due to decomposition of

cyanobacteria. Answers such as eutrophication, red tides and dead zones without any further description were not acceptable.

Question 2

This question was testing the understanding of surface area to volume ratio and the adaptations of gills to maximise oxygen uptake.

(a) (i) Almost all candidates were able to identify organism B. Only better answers were able to explain their choice with reference to the shape of this organism.

(ii) Many candidates identified organism C correctly and related their choice to the small surface area to volume ratio. Only better answers were able to explain why such an organism would need a transport system. A common incorrect answer was organism D because it had the largest surface area. These candidates often stated that a large surface area would be unable to supply sufficient oxygen.

(b) (i) Candidates were expected to answer in terms of increased surface area. The most common answers were either that the filaments filtered oxygen from the water, or that the filaments forced water through the gills.

(ii) Most answers did not go further than stating that the flow of water would supply oxygen. A few better answers referred to counter current flow that moved the oxygen away from the gills, although it was not always clear that these candidates understood the principle of maintaining a diffusion gradient. Few candidates mentioned the removal of carbon dioxide.

(c) (i) Most candidates calculated the area of the gills correctly.

(ii) Most candidates gained credit for reference to the larger body mass of tuna. Only better answers made further connection between the gill size and the faster swimming of tuna. A common misconception was that ram ventilation caused a larger surface area of gills.

(iii) Candidates were expected to answer in terms of greater surface area and increased diffusion. Credit was allowed for answers that related an increase in lamellae to an increase in oxygen supply. Many candidates recognised that the skipjack tuna would obtain more oxygen.

Question 3

This question was testing knowledge of the lifecycle of the giant clam and oysters.

(a) Most answers were imprecise and generalised. For example: Eggs and sperm are released into the water and larvae are formed that live in the plankton for a while. Then they develop a foot and sink to the bottom where they attach to a substrate and grow a shell. When they mature the cycle starts all over again. This type of answer does not gain any credit. Candidates should be able to state when spawning occurs, the types of larvae and the approximate time of each stage in the life cycle. Better answers gained credit for knowing that giant clams are hermaphrodite, have several types of free-swimming planktonic larvae and that the adult takes up to 3 years to mature.

(b) (i) Candidates who knew that giant clams are hermaphrodite gained credit for stating that oysters have separate sexes.

(ii) Most candidates gave at least one correct answer to this section.

(c) Better answers referred to overfishing for food or habitat destruction. Weaker answers were often too vague for credit, for example ‘they are eaten by humans’.

Question 4

This question was testing understanding of the effect of fishing intensity on fish populations and sustainability of fishing.

(a) Better answers were able to explain that increased catch reduces the population so that high intensity fishing will result in low levels of recruitment and fewer fish caught even though a higher

percentage of the population is taken. Poorer answers tended to describe supply and demand and the effect on the value of the catch.

(b) Although most recognised that a catch at 65% of the total stock would not be profitable, few candidates gave a full explanation of the graphs. Only better answers explained that the greatest profit is when the difference between cost of fishing and value of catch is greatest and identified that this is in the range of 25-40% of the total stock. Poorer answers described the two graphs.

(c) Most candidates were able to give two different methods of limiting catch size. The most common were closed seasons, quotas and limitations on the size of the fish caught. Better answers explained how these would improve sustainability.

Question 5

This question was about production of tuna and the methods used to rear bluefin tuna in aquaculture.

(a) (i) Almost all candidates described the change in tuna production on a year by year basis. When asked to describe trends, candidates should look at the overall pattern, not the individual small changes within the total time span.

(ii) Answers to this section were very mixed and a range of answers with different 'rounding' of the totals were accepted. Better answers were able to calculate the price per tonne of each type of tuna and find the difference. These answers did not always gain full credit as the units were omitted from the different stages of the calculation or the 'x1000' was omitted from the figures given in US$.

(iii) Most candidates gave a correct answer.

(b) (i) Only better candidates recognised that both the wild stock of tuna and the stock of food fish would be depleted.

(ii) Most candidates were able to identify two problems. The most common answers were the slow maturation of tuna, poor breeding in captivity and the susceptibility of young tuna to damage from the sea pens.

Question 6

This question tested knowledge about oil spills on the marine environment and the potential value of sinking old ships off the coast of some parts of the world.

(a) (i) Better answers described some of the ecological impacts of oil on the marine environment. The most common correct answers were related to the toxicity of some components of oil, the effect on zooxanthellae in coral reefs and the blocking of light by the surface oil layer. Many answers were too generalised. Candidates were expected to refer to specific examples, for example the effect of surface oil on plankton, the gills of fish and the feathers of seabirds. Answers such as, 'oil kills all the marine organisms' and 'oil destroys the marine ecosystem', did not gain credit. Many candidates answered a different question about the effect of TBT on molluscs.

(ii) Only better answers used the information in the question that indicated that the microorganisms were used after pumping operations were used to remove oil. Consequently, most answers were given in terms of removing oil from the water, rather than the ship. Credit was given for answers that showed an understanding that the use of microorganisms was less damaging ecologically than dispersants or detergents.

(b) (i) Most candidates gained some credit for describing the formation of artificial reefs. Better answers also described the development of a more diverse ecology around sunken vessels, or the coastal protection provided. Poorer answers tended to be too generalised, for example 'providing homes for marine organisms'

(ii) Almost all candidates gained credit for a reference to tourism or diving sites. Better answers linked this to increased local employment and more money being spent in the area. Other good answers link the increase in fish populations to improved local fishing opportunities and sale of fish bringing in more money.

Question 7

This question expected candidates to evaluate the views of stakeholders about the potential development of a marine reserve

(a) Most candidates were able to identify one reason why the site might be suitable.

(b) (i) There were few good answers to this section as most candidates did not appear to know what is meant by a 'stakeholder'. Candidates need to understand that stakeholders are individuals who have a vested interest in any development of an area. These interests can be very varied, but do not, as many candidates assumed, mean that they must be a land owner.

(ii) The limited understanding of the term 'stakeholder' also meant that the examples given by many candidates were buildings, for example 'the hotel' or 'the fishing complex' or ecological features, such as 'the bird nesting site' or 'the whales'. Limited credit was allowed as error carried forward for this sort of example. Almost all candidates included the fishing complex, but their reasons were often unrelated to the information given, for example, 'because they won't be able fish in the nursery area'. The reasons given rarely related to the impact of the development of a marine reserve on the perceived stakeholder. Candidates were expected to consider specific concerns of stakeholders about decisions that might be made about land use, existing water use or existing access to areas of coast. Most candidates assumed that there would be 'ecotourism' so the hotel and town would have more business.

(c) There were a few good answers to this question as many candidates did not read the question carefully and gave several examples without any explanation. Many answers that did not take account of the practicality of their suggestions, for example 'moving or closing the hotel and fishery'. The majority of candidates included the fishery in their answers. A common answer was 'they would have to change their fishing direction because of the whale migration route'. This was not credited as candidates should be aware that migration is a seasonal event, so the direction taken to fishing grounds was unlikely to be important except at specific times of the year. Few candidates made use of the information given to consider that the fishing practices might have to change to limit damage to the sea bed. Candidates who suggested that water sports would have to be banned rarely related this to coastal erosion or wave damage. Most assumed that the bay would become a nursery area for fish.

MARINE SCIENCE

Paper 9693/04

A2 Data-Handling and Free Response

Key Messages

It was very encouraging to see that the overall standard of entries was better than in previous years. Candidates seemed to have been far better prepared for the examination and had a much better understanding of the standard of answer required at A level. There was still a tendency to write answers that lacked key vocabulary and many struggle to process data effectively.

General Comments

Most candidates were able to attempt all parts of the paper and had a relatively good understanding of the factual knowledge of all areas of the specification that were tested. Use of technical language was good and there was evidence that many had practised past papers and researched all areas of the specification to a level of depth compatible with A level. There was still a tendency for some candidates to write answers that were vague and repetitive rather than looking for specific points.

Comments on Specific Questions

Section A

Question 1

(a) Most candidates were able to draw an appropriate graph and gain at least one mark. Candidates should be encouraged to place the independent variable on the x-axis as a matter of routine, many did not do this. Many lost marks due to carelessness with labelling (units were often missing) and poor drawing of lines – candidates should be encouraged to join points with a ruler and to ensure that the line actually touches the points. Most candidates used sensible scales and were able to plot points accurately.

(b) (i) All but the weakest candidates were able to recognise that the GM salmon grew faster. Fewer candidates gave extra detail to gain further marks and only the strongest used processed data in order to make a comparison. Many did not actually *compare* the growth of the two salmon types. Very few candidates recognised the significance of the overlapping standard deviation ranges (this is a mathematical skill listed in the specification) and often simply described how the standard deviation ranges changed.

(ii) Very few candidates gained full marks here. Only the strongest understood the mechanics of genetic engineering with a surprisingly large number thinking that it referred to the addition of hormones to the waters. Many simply re-described the fact that the GM salmon grow faster.

(c) Candidates often scored highly here with many gaining at least three marks. Most candidates were able to describe an appropriate, valid, well controlled experiment. Many lacked detail with few referring to the calculation of means or the idea of a change in mass (many simply measured mass). Candidates should be encouraged to measure a quantifiable dependent variable such as length or mass rather than simply “growth”.

Question 2

(a) Many candidates gave very detailed descriptions of the data and gained full credit. Many other candidates misunderstood what the question was asking for and gave explanations for the distribution, whilst others did not look closely enough at the data, simply giving an idea of the desalination plant "affecting biodiversity". Candidates should be encouraged to give a "directional change", e.g. reduce biodiversity, rather than just "affect it". Very few actually calculated a difference in number of species or populations and often just quoted the numbers in the table.

(b) This question was found to be the most demanding question by the majority of candidates. Only stronger candidates appreciated that desalination plants actually increase the salinity of water due to putting the concentrated brine back into the water. Many thought it would create a freshwater area. A significant number of candidates thought that the desalination plant was a "green plant" and would thus affect food chains. Few candidates cited a role for osmosis or appreciated that organisms would have a net removal of water. Only the very strongest appreciated that loss of some species could cause an increase in others due to loss of competition.

Section B

Question 3

(a) The majority of candidates were able to gain some credit here with many scoring three or four marks. Most understood the role of photosynthesis in the fixation of carbon and how this is important in food chains. Fewer candidates expanded their answer to the release of oxygen and very few noted that producers provide a useful habitat. There was some confusion amongst weaker candidates of the roles of respiration and photosynthesis.

(b) Most candidates were able to list light intensity as a factor and then go on to suggest at least a second factor. Fewer gave a relevant explanation for the factors listed. Some excellent answers were seen that gave full explanations of the role of light energy in the light dependent reactions, the role of enzymes in the light independent reactions and explanations as to how light wavelength absorption is affected by different pigments. Weaker candidates often simply wrote essays on light intensity and many wrote answers that discussed human impact on photosynthesis.

(c) This question often drew excellent answers and most candidates have an excellent understanding of bioaccumulation and its effects on different levels of the food chain. A few candidates misread the question and wrote about TBT whilst weaker candidates often thought that the mercury in the water acted as a direct pollutant and the loss of species would then affect other organisms in the food chain.

Question 4

(a) Many candidates wrote excellent answers that gave very thorough descriptions of all three factors and their impacts on marine ecosystems. Most understood what purse seine fishing and benthic trawling were but many did not appreciate the significance of factory ships (many candidates simply thought they would break coral reefs). Weaker candidates often gave vague answers such as "all three factors would reduce fish stocks" rather than treating each factor as a separate entity. There was a degree of confusion as to the differences between purse seine fishing and benthic trawl with some candidates thinking that purse seining would break coral reefs. The concept of bycatch was very well understood by most candidates and many specific examples were given.

(b) This question drew a range of responses. Most candidates appreciated that mangroves would provide a nursery for fish (or gave a description of this) but only about 25% went on to give more detail, typically suggesting that the mangroves provide an area of rich food. Many simply referred to mangroves protecting fish rather than the juveniles. Only stronger candidates appreciated the significance of allowing fish to reach breeding age, and again, only a few candidates seemed aware of their role in stabilising the habitat. Weaker candidates often simply kept repeating the same point regarding mangroves acting as a nursery,

(c) Most candidates found this question very accessible and were able to gain at least one or two marks. Most appreciated that conservation prevents extinction and were often able to go on to explain how extinction could cause other effects in an ecosystem. Fewer gave specific examples of how loss of a species affects the trophic levels above and below. Most candidates were able to give some form of counter argument – typically that the grey seal was now reducing common seal and puffin populations and that commercial interest may suffer. Only stronger candidates appreciated the fact that the seals and puffins were competing for the same food source. Candidates should be encouraged to give precise wording in their answers; for example stating "puffin populations have declined due to the increase in the grey seal population" rather than the vague "puffins have been affected by the grey seal".