May 2014 subject reports

Environmental systems and societies

Overall grade boundaries

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 13	14 - 27	28 - 38	39 - 48	49 - 60	61 - 70	71 - 100

Standard level internal assessment

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 7	8 - 14	15 - 19	20 - 24	25 - 29	30 - 34	35 - 42

The May 2014 moderation session has come to a close and it is amazing to see how many new examiners we need, to stay ahead of the new schools offering the course. With new schools come learning curves, especially for teachers that are coming to the course from more geographical backgrounds and who may have less experience in working with students on science practicals.

Much of what is said in each subject report is a repeat, with new details, of what has been said before. It is a really useful investment of time to read past Subject Reports. There are a lot of valuable tips and suggestions in these, as well as some red flags regarding how some teachers interpret the marking rubrics in Internal Assessment (IA).

Teachers are encouraged to read the rubrics carefully when awarding marks. The bands for a “complete” and a “not at all” are quite narrow, and the band for a “partial” quite broad. For example many teachers use the approach that one mistake means a partial and two a not at all. This is not correct. For example, a data table may have units in the individual cells and data reported to an inconsistent number of decimal places and still score a partial.

This session saw the usual variety of programs in terms of their strengths and weaknesses. Some schools have students engaging in practical work that is almost publishable, and other schools have programs that are not at the sophistication necessary for this students of this age. As has been said before, a good rule of thumb for judging if the level of difficulty is high enough is to ask oneself if much younger students could do the practical in question. Many of the Lincoln Index practicals fall into this category. Introducing marked beans into a jar of beans, to take one sample in order to estimate the

"population" of beans is too simple to earn any marks for the IA. Moderators can find themselves struggling to find a place where a mark can be awarded in practicals like these.

The problems that moderators encountered are varied both in scope and in depth. Some schools need to polish details, other need to revamp their entire program. The most common problems in summary (details provided below) stem from lack of sufficient data in planning, lack of attention to detail in Data Collection and Processing (DCP) and/or graphing of raw data and in Discussion, Evaluation and Conclusion (DEC) lack of context and lack of inclusion of specific data in support of conclusions.

Candidate performance against each criterion

Planning

Some schools are marking Aspect 1 of this criterion too severely requiring that students include units for all variables and indicate how control variables will be controlled for a complete. This is incorrect, the course guide and clarifications on applying the rubric, nowhere indicate that units or uncertainties need to be provided with each variable for full marks. What is required is that students be able to identify the independent and dependant variable, as well as those which are to be controlled. Students should understand the distinction between these three. A useful way of phrasing a research question such that the independent variable (IV) and dependent variable (DV) are clearly outlined is:

"To determine how [the independent variable] affects [the dependent variable] in [the context of your experiment]."

Aspect 2 of PI refers to controls. Students often miss a mark (and teachers incorrectly award one!) for not specifying **how** samples were collected (i.e. what technique was used) and for not justifying their choice of study site. This is important because often it is the single most relevant aspect of the investigation to ensure that the students carry out an unbiased practical. If samples are to be collected randomly, how will the student ensure that every part of the sampling site has an equal chance of being sampled? The fact that a method indicates that sampling is to be random, does not make it so. Often methods go on at length regarding methods that are largely prescriptive and make little or no mention of the student's contribution to the experimental design. For example for sampling of a river to measure dissolved oxygen, it is not necessary to give all the details of the Winkler Method but it **is** necessary to provide a detailed account of how and where the samples were collected.

Aspect 3 of Planning requires that students be able to show that they can determine how much data is sufficient and what make data relevant. As straight forward as this may seem to some teachers, it is the single most important reason that students lose marks in Planning. Five treatments and five repeats per treatment are required. The reasons are quite simple and are described in Data Collection and Processing (DCP) below.

Data Collection and Processing

Practice and good instruction should allow all candidates to score full marks for Aspect 1 of DCP. The requirements are straight forward. Data tables **must** have a good descriptive title. Raw Data will not suffice and usually results in the loss of a mark. This is because without the context of a title the table may not be interpretable. All column and/or row headings require proper units. The placement of units in individual cell will result in the loss of a mark. Data must be reported to a consistent number of decimal places. Excel normally truncates trailing zeroes and students should be reminded to use

editing features to ensure that this does not happen. Teachers should ensure that students appreciate what are inappropriate combinations of decimal places within data collection and processing, e.g. if students include a tolerance of ±0.05 grams but report their data to three decimal places.

Aspect 2 of DCP requires some numerical processing, and **one** sample calculation of all processing carried out. This is to ascertain that students understand what they are doing. It is **not** necessary for students to include the method employed to calculate all fifty averages (for example) for a data set. However the absence of sample calculations results in the loss of a mark. Processed data should be calculated to a consistent and appropriate number of decimal places. A rule of thumb is that the result should not be more precise than the components from which it was calculated. However teachers must be careful when assessing this. For example when calculating the average number of children per family, it is customary and indeed necessary to include one decimal, although clearly families have integer numbers of children. However, it is **not** the same to have an average family size of 2,1 or 2,4 children. Reporting both groups as 2 would be a loss of very valuable information.

In data processing the need for five repeats established in the planning section, becomes apparent. Clearly when students use only two treatments, their data will always generate a perfect linear relationship (two points define a line). However, with five we can start to determine how linear or curvilinear the relationship really is. In this regard many schools are using Excel functions to calculate regression formulas. There is nothing wrong with this but if this tool is to be used, students need instruction on the interpretation of R or R^2. Excel will draw the line of best fit, but it may be meaningless and if students use a line with positive slope to indicate that there is a relationship where the R^2 value is 0.04, they will lose marks. The five repeats for each treatment allow the calculation of standard deviations (with less than five it becomes a relatively pointless exercise – statisticians concerns aside). A rule of thumb is that if the error bars (plus and minus one standard deviation) of two different means, overlap significantly, the difference between them is perfectly attributable to random chance). It is not necessary for students to calculate t-tests or ANOVAs but they should be able to ascribe a greater or lesser significance to the difference of two means.

Too many students are losing marks for graphing raw data. Aspect 3 requires processed data and there is no “error carried forward” approach here. If a student fails to process data and graphs raw data, they will receive zero marks for both aspects 2 and 3 of DCP. There are still some problems in the choice of graphs, and teachers need to spot this and point it out to students. Using a line graph to join categories is a mistake and will normally result in zero marks for Aspect 3. Using a bar graph when students have not ordered the bars according to size will normally result in the loss of one mark. A graph requires a good title and obviously the inclusion of units on both axes. This session saw a few schools awarding marks for graphs drawn on unruled paper or without the use of rulers. This is not acceptable and will normally result in zero marks for the graph.

Discussion, Evaluation and Conclusion (DEC)

Aspect 1 of DEC, is perhaps for some the most challenging in the IA model and certainly the most challenging to mark and moderate. Students should give a thorough, detailed account of their data. This does not mean a blow by blow account but rather the analytical account. What trends were spotted, to what extent are these trends spurious or significant, and this of course requires an analysis measure of central tendency and of spread. Just as importantly students should make links to theory, real-life situations, published and/or secondary data. The idea is that students should be able to determine to what extent their results “fit” the general body of knowledge. The practicals in which they are engaging, do not exist in a vacuum.

Aspect 2 evaluates the methods used and the errors inherent to them. In this sense, teachers must not send DEC write-ups for moderation without including the planning (student designed or provided by the teacher) or the data. It is impossible for the moderator to determine if the method has been adequately critiqued if there is no method to look at. The same is true for the data produced by the student. If the moderators have no data to examine, they cannot determine to what extent the student has done an adequate job of analyzing it. The improvements suggested by the student have to be realistic and relatively detailed. It is not sufficient to include “more data” in a chart.

Finally, students are losing marks in their conclusions for not including references to specific findings from their data. For example is the conclusion is that site A is more diverse than site B the student should include the diversity index values in the statement. This has been mentioned before and it is such a simple thing to do that it is sad and frustrating to see candidates lose marks for this.

In general, too many schools are being marked down in moderation for easily remedied shortcomings in their students’ write-ups. Clearly some teachers are not aware of these issues, and it becomes the role of the IB Coordinator to point them out. Also, many students are only assessed twice against the criteria during the two years of the course, and so are not getting the feedback to correct these problems.

Recommendations for the teaching of future candidates

Many reports continue to show no evidence of feedback to students, comments, cover sheets with summary statements, or anythng to indicate that the student has received corrective advice.

With words like “fracking” and “tipping point” becoming more and more common, this course is a wonderful opportunity for students to engage in critical thinking about data that is really quite relevant to their lives. It is hard to imagine a career today that does not engage with environmental issues on some level. Certainly as voters in any country these issues are becoming more and more relevant. IA work in environmental systems, for many students, may be their last opportunity for hands-on experience with scientific methodology, and so we owe to them to provide them with significant experiences within this context, and to give them much needed feedback to hone their thinking.

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 7	8 - 15	16 - 21	22 - 25	26 - 30	31 - 34	35 - 45

Paper 1 was wide ranging in its coverage of the syllabus. Out of the 9697 candidates, marks ranged from 0 to 43 out of the maximum achievable 45 marks. The mean for May 2014 was 22.59 compared to 23.76 for the May 2013 session.

Overall G2 comments received from teachers were positive. They confirmed that the level of difficulty was appropriate for an Standard Level (SL) paper and there were no significant difference in difficulty compared to the May 2013 paper. Most G2 respondents considered the clarity and presentation of the

paper to be good or better. The majority of respondents also agreed that questions were accessible to all candidates with learning support and irrespective of religion/belief system, gender or ethnicity.

The areas of the programme and examination which appeared difficult for the candidates

- Management of pollution (i.e. fertilizers and pesticides) (Q1).
- Aspects which limit food and water supply (Q2).
- Relative strengths and weaknesses of the Convention on International Trade in Endangered Species (CITES) (Q3).
- Criteria required for successful conservation area (Q3).
- Nitrogen cycle including processes, storages and flows (Q4).
- Definition of positive feedback and example associated with global warming (Q5).
- Human perceptions on global warming supported with evidence (Q5).

The areas of the programme and examination in which candidates appeared well prepared

- Flow of energy, ecosystem structure and interactions (Q1).
- Interpretation and calculation of data using figures (Q2).
- Awareness of factors that affect human population dynamics (Q2).
- Methods for estimating abundance of organisms and factors that can lead to them becoming endangered (Q3).
- Methods used to conserve species (Q3).
- Restoration of soils (Q4).
- Movement of pesticides within human food chain (processes of bioaccumulation and biomagnification) (Q4).
- Reasons for how global warming may affect agricultural productivity (Q5).

The strengths and weaknesses of the candidates in the treatment of individual questions

1ai) Most candidates correctly identified sunlight as the source of energy. A common mistake was to state producers/plants/phytoplankton.

1aii) Most candidates answered this question well. Common answers included ‘heat loss from respiration’ or ‘migration of kingfishers/birds’. Some answers were considered too vague such as just ‘respiration’ or ‘death of species’.

1aiii) The majority of candidates were able to draw a food chain correctly. Common errors included incorrect direction for the flow of energy/arrows or drawings of foodwebs or pyramid of numbers.

1aiv) This question was generally well answered. In some cases answers were too vague e.g. ‘changes would occur in food chain/some species would increase/decrease’ or ‘change in biodiversity’.

1av) This question was slightly less well answered than 1aiv). Common errors included generalized statements e.g. ‘would disrupt the foodchain’ and ‘causes an imbalance in the food chain’.

1b) The majority of candidates achieved at least one mark (out of 2). A common mistake was ‘use organic fertilizer’ or ‘use organic pesticides’ or impact of pesticide was ‘acidification of the lake’.

2ai) & 2aii) Most candidates correctly answered these two questions based on Figure 2.

2b) Responses varied widely and the marks were spread from 0 to 3. There were some very clearly focused and succinct answers. Sometimes statements given were too generalised to be credited marks e.g. ‘lack of education’, ‘due to technology’ or irrelevant aspects such as pollution were discussed.

2ci) & 2cii) There were a wide distribution of marks for both these questions. Errors included giving only one reason or stating ‘increase in population leading to increase in demand’ which is not a reason that limits food supply.

2d) The majority of students achieved some marks for this question. Common errors included providing generalized statements (e.g. ‘policy causes problems’ or ‘there is no need for change’) or only describing how population had changed in a specific country without reasons.

3ai) The majority of candidates correctly responded to this question. A common error was to state ‘Simpson Index’.

3aii) Most students attained a mark for this question.

3aiii) Most candidates answered this question well. Marks were sometimes lost for lack of detail.

3b) The role of CITES was generally poorly understood and few students attained more than 1 out of 4 marks.

3c) A significant number of responses were too vague or covered the same criteria twice.

4a) Few candidates achieved both marks for this question. Most achieved either 0 or 1 mark with a number of students not attempting the question. Popular correct responses included (1) consumers and (4) decomposition and few were able to correctly identify (2) as nitrates/nitrites or (3) as nitrogen fixation.

4bi) & 4bii) Many candidates struggled with these two questions. For b(i) responses often focused on nitrogen store instead of impact on flow and for b(ii) often stated ‘an increase in nitrogen within soils’ instead of the converse or ‘nitrogen in plants’ which was too vague.

4c) The majority of candidates gained some marks for this question.

4d) Most candidates performed well on this question with many achieving full marks.

5ai) This question was well answered by most candidates.

5aii) A significant number of candidates did not answer this question appropriately, with many losing marks by not identifying the direction of change ie increase or decrease of productivity in specific areas.

5bi) & 5bii) Many candidates struggled to provide a clear definition of positive feedback for bi) and then given an appropriate example associated with global warming for bii). Some students also confused global warming with the ozone layer and UV radiation.

5c) Many responses lacked evidence to support contrasting human perceptions and few gained more than 1 mark.

Recommendations and guidance for the teaching of future candidates

Students should be encouraged to:

- Read the exam question carefully and ensure they address the specific command term and actual question being asked.
- Provide a more detailed response when more than a mark is allocated for ONE reason.
- Attempt all components of the exam questions and not leave any blank responses.
- Make and appreciate the inter-connections between each ESS topic.
- Practice past question papers and other questions that involve application of knowledge and understanding to different situations, including mathematical calculations.
- In addition, students should ensure they are familiar with the key terms and concepts listed within the glossary of the ESS Guide.
- Write legibly.

In terms of curriculum content, students need to be able to:

- Differentiate between the causes and effects of global warming and the role of stratospheric ozone.
- Evaluate the scientific evidence that supports different perspectives regarding global warming/climate change.
- Understand the nitrogen cycle including associated processes, storages and flows.
- Evaluate the role of CITES in species conservation.

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 6	7 - 13	14 - 19	20 - 26	27 - 34	35 - 41	42 - 65

Paper 2 included the case study and extended response questions. The case study enables candidates to apply a wide range of concepts and principles in a holistic analysis of a particular environmental issue or system. In this paper, the issue of focus was the mining of tar sands in North America. The extended response questions enabled candidates to demonstrate a more in-depth analysis and evaluation in a range of syllabus topics.

Amongst the 9697 candidates, marks ranged from 0 to 63 out of the maximum available 65 marks. The mean mark for May 2014 Paper 2 was 25.23, noticeably lower than the 32.42 for May 2013 session, but more similar to the previous May 2012 session. The majority of G2 perceptions identified the overall difficulty of the paper as similar to last year, with a significant minority suggesting it was a ‘little more difficult’. In the event, slightly lower grade boundaries certainly reflected a small increase in difficulty, and the component grades for this paper were consequently very much in line with recent years.

Overall the G2 comments were positive. Over 85% confirmed that the level of difficulty was appropriate for an Standard Level (SL) paper, that the clarity of wording and presentation were good to excellent, and also agreed that questions were accessible to all candidates with learning support and irrespective of religion/belief system, gender or ethnicity.

As in most previous sessions, there were contradictory G2 comments criticising the case-study for asking either too many, or too few, questions whose answers were available in the resource booklet itself. The fact is that the case-study is specifically designed to do both – to test candidates' ability to identify relevant data within a variety of verbal, visual, graphical contexts, and also their ability to apply their existing knowledge of concepts and principles to a fresh set of data.

The areas of the programme and examination which appeared difficult for the candidates

- Calculating % (1a ii).
- Outlining components of EIA (1b i).
- Dynamic nature of resources (1c ii).
- Secondary productivity (2a i + ii).
- Application of second law of thermodynamics (2b).
- Concepts of natural capital and income (4b).
- Photochemical smog (5a).
- Evaluating indirect/direct methods of pollution monitoring (5b).
- Identifying and evaluating strategies for addressing acid deposition (5c).

The areas of the programme and examination in which candidates appeared well prepared

- Analysing graphical and verbal data (1a i + 1b ii).
- Strategies for managing energy conservation (1a iv).
- Identifying Environmental Value Systems (1c iii).
- Application of first law of thermodynamics (2b).
- Concept of ecological footprint (3b).
- Impacts of global warming (3c).

The strengths and weaknesses of the candidates in the treatment of individual questions

Section A

1ai) Generally good – some responses too vague.

1aii) Responses that did, or did not, include hydroelectricity, were both credited, but many failed to calculate % correctly.

1aiii) The vast majority got this mark.

1aiv) Generally good - responses needed to address strategies rather than individual actions.

1bi) Most candidates included assessing impact on ecosystems/wildlife but few gained any further credit.

1bii) Generally good – some responses too vague to gain full credit.

1biii) Mediocre – responses often addressed general threats to ecosystems, rather than those specific to this ecosystem.

1biv) Most candidates identified 'raising awareness', but few went beyond that to gain further credit.

1ci) Very poor. Only a small minority understood the concept of the 'dynamic' nature (changing value/status) of resources. Those that did had no difficulty applying it to this case.

1cii) Generally OK, although quite a number interpreted 'oil-equivalent' to mean oil exclusively, or gave responses relating to population size that were irrelevant to per capita consumption.

1ciii) Vast majority gained credit for indicating the contrast in the viewpoints, and usually these candidates were able to identify the value systems they represented.

Section B

Question 2

This was not a particularly popular question and was only answered by a minority.

2ai) Generally poor. Candidates were often unable to give a sufficiently precise definition.

2aii) Most were able to identify a couple of factors, but rarely gained the full credit available.

2b) Very good accounts of first law of thermodynamics, but much weaker, vaguer application of second law.

2c) Generally OK. Many candidates were able to address significance of trophic levels used and available insolation in terrestrial v aquatic food production, but few went beyond this. Discussions often lacked valid conclusions derived from balanced argument.

Question 3

This was a very popular question.

3a) Generally good. Most could identify two examples of factors used for Red List status and human impacts on these.

3b) Most had a sound grasp of the concept of ecological footprint and could identify one way in which technology increases, and decreases, this value. Few gained any further credit.

3c) Generally good, but often responses addressed an insufficient variety of potential impacts, or only looked at negative impacts. Discussions often lacked valid conclusions derived from balanced argument.

Question 4

This was a popular question.

4a) Generally good, though a good number struggled with the concept and example of services.

4b) Generally poor. Many candidates had a poor grasp of these concepts of natural capital and income, seeing them in purely monetary terms. While there is an obvious parallel with economic concepts, in this subject, the concepts relate to the resources themselves and their ability to regenerate physical "income", not financial profit.

4c) Generally OK. Most candidates had some grasp of the key characteristics of specific value systems, though this was often a little vague. Candidates often struggled to apply these systems explicitly to the management of fossil fuels. Discussions often lacked valid conclusions derived from balanced argument.

Question 5

This was not a particularly popular question and was only answered by a minority.

5a) Generally mediocre. Most candidates were able to make one or two specific points, but rarely more.

5b) Generally weak. While most candidates gave a thorough description of biotic indices with examples, few addressed the key focus of the question that was a comparative evaluation with direct methods.

5c) Generally OK, but responses were very mixed in quality. Those candidates that clearly referred to a management strategy relevant to acid deposition at each of the required levels usually went on to give clear political/economic advantages. Those that floundered at this first step, however, often gained very little further credit.

Recommendations and guidance for the teaching of future candidates

- More thorough revision of concepts identified in "A" above – especially the dynamic nature of resources, and the concepts of natural capital and income (as defined in Guide).
- Practice in developing balanced arguments, and writing valid conclusions derived from the argument …as opposed to isolated, unjustified statements of opinion.
- Practice in making explicit and specific responses, rather than vague and generalised statements.
- Practice in generating multiple responses to a question, guided by the number of marks available. (Candidates often satisfied themselves with just a single response, losing out on much of the available credit.)
- Practice not only in describing practical methodologies, but in evaluating them compared to alternatives.