Environmental systems and societies SL

Contents

Grade boundaries

This DP/CP subject report contains overall subject boundaries only, unlike previous reports where component boundaries were also published; component boundaries for this session are available in IBIS. The IB advises schools not to use component boundaries for this session as direct indicators of academic standards for future exam preparation because they have been set in response to the particular needs of the cohort. Two significant conditions which do not normally feature in grade boundary setting have had to be satisfied during the boundary setting for the M22 session: the need to apply reasonable standards to adjusted assessment models for students who have restricted access to learning during the COVID pandemic and the need to maintain parity with students who undertook the non-examination route.

Standard level overall

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 9	10 - 17	18 - 29	30 - 39	40 - 51	52 - 61	62 - 100

Standard level internal assessment

The range and suitability of the work submitted

The range of work was wider than expected. There was still less fieldwork away from school or home. Mostly campus-based fieldwork or home based fieldwork was done. There are still a few essay style pieces, these are inappropriate for the criteria. Many secondary data IAs were seen ranging from excellent to very short, superficial ones. Surveys were popular again this year, mostly average to poor in quality. More lab/wet work done at home or school was done this session, similar to pre-Covid times. There were some interesting RQs linked to the pandemic and/or COVID. Most looked at air pollution in some way. One unique idea was on NFTs and carbon emissions in 2021. Still popular are the seed germination or growth with acids, fertilisers or a pollutant of some type (salinity being the most common). EVS with another factor - age, gender, GDP etc. are very common for the survey, followed by EF. Air pollution and disease/mortality as a secondary data report is often done poorly. Hands-on primary data reports tended to be stronger than secondary or surveys. Secondary and survey reports tend to lack enough data and/or analysis.

Candidate performance against each criterion

Context

The context is generally well-done. Many Research Questions were relevant but not focused, being too broad. Constructing a coherent RQ was still a problem in many of the IAs. Phrasing the RQ as a yes/no question indicates it is not focused. Environmental issues with local connections were more successful. The majority of the candidates were able to clearly identify a global or a local issue. However, too many of the 2250 words available are used in descriptions of well-known processes such as global warming, eutrophication, acid rain. The connection between the RQ and EI were mostly outlined or described rather than being justified, this is the weakest aspect of context. Many students stated a personal engagement; this is a Biology requirement not an ESS one.

Planning

Very few students had no planning section. Overall ,most students address all the aspects of planning. The justification of the sampling strategy is often overlooked or is poorly done. Some methods are unrepeatable due to a lack of information/detail on what procedure to follow. Surveys: information on how the respondents are selected, and how the survey will be sent/distributed is often too vague or missing. Indicating the survey will go out on social media like Facebook, WhatsApp etc is not sufficient - which groups/only personal friends must be considered as part of the plan. Surveys/Questionnaires are still being put into an Appendix - this is not looked at. Secondary data: the name of the website without any further justification is not sufficient for planning. How the data is selected/collected needs to be very clear. Candidates are also reminded that sufficient relevant data varies depending on the type of investigation. 5 treatments and 5 trials each is typical for a lab based investigation, one of these should be a control group. Comparative area fieldwork should be at least one transect in each area + eight 0.25m^2 quadrats or equivalent. Secondary data and surveys should have the minimum data points for the statistical test the student wants to perform for the RQ. 30 data points for each variation is usually a good basis. Risks & ethics vary widely. Some excellent, some poor. All investigations need this section completed. Most often missing is secondary data. The reliability of the database should be mentioned.

RAC

Raw data is required in the main body of the IA report. Only having the processed data or raw data in an appendix will mean only a maximum of a 4 can be obtained. Most students were able to construct graphs

and tables appropriately, but many still graphed raw data as well . A wide range of data analyses was done: from t-tests & ANOVA to simply calculating averages. Standard deviation is also commonly done and most students correctly interpret error bars. A reminder that not all Spreadsheets have the correct placement of error bars. Care should be taken that statistics are applied correctly and using enough data. For example, on sample sizes that are too small, or using a correlation that requires ranking and the student never explained how things were ranked. Correlation analysis must mention that correlation does not imply causation. Generally, the reports had conclusions that were drawn from the collected data. The conclusion aspect of RAC is often folded in with DEV. In the conclusion students would make an assumption, making statements that could not be supported by the data. If the data and analysis are poor, students are often able to make a reasonable conclusion for the third aspect. There is a pattern of describing pie charts from the IAs that involved surveys, rather than having an analytical approach. Often survey pie charts alone do not address the RQ as they show answers for individual questions.

DEV Most of what was written in the last four reports applies.

Some candidates combined the discussion section with the conclusion and/or analysis. This year, many candidates wrote a very brief discussion (1-2 sentences) and spent more of the word count available on the evaluation aspect of this criterion. Generally, candidates failed to address the EI and consider the conclusion in this section. Most candidates state some strengths, weaknesses of methodology and improvements, although most do not include enough on the potential impacts on the investigation. Further areas of research are often missed or only have very superficial suggestions.

APP

Most candidates included some form of application or solution, but generally, evaluation of it was superficial or not completed. Many applications are not described in sufficient detail. There were more reports than normal with no application section. Some candidates list a variety of solutions rather than focusing on one. The evaluation is mostly described not evaluated.

COM

Most reports are properly structured and well-presented. The overall quality of the reports is good. The clarity of the data presented still needs improvement - titles, units or headings in tables and graphs. An APPENDIX means the maximum mark is two. A word count beyond the 2250 limit will also cause a candidate to lose marks for not being "concise." Teachers should encourage students to be vigilant about word-count, reports that look long do have the words counted..

Recommendations and guidance for the teaching of future candidates

- When teaching the use of statistics, teachers need to get students to consider why they would use each statistical method and what the results mean to their work. Where appropriate, candidates should be encouraged to go further than simply calculating averages. Ensure that students have access to a range of statistical analysis tools (at least standard deviation).
- Ensure that no school or candidate data appears on the IA report.
- Students and teachers need to use the IB's experimentation policies and consistently use an academic referencing system.
- Teachers must give students support in how to develop a fully focused research question that will be able to provide sufficient data.
- Students need instruction on how to construct repeatable methods when using websites databases and questionnaires/surveys.
- Fieldwork plans must include site choice information for repeatability.

- Have students practice writing out methodologies to ensure that the plans are complete and repeatable to the reader.
- Sampling strategy is not just about 'stratified or convenience.....' but about every part of the methodology.
- All plans should have a risks and ethics section.
- The use of google forms and other online survey platforms needs to be supported to allow students to process the data generated themselves. Candidates should be advised to generate their own graphs and not include only those generated by the survey.
- Students should include a graph that responds directly to their RQ. This graph is frequently missing.
- Students should be aware that they cannot use data directly from databases as their own, processed data.
- Remind the students that the use of an appendix is not appropriate, this is not marked.
- Students need support in how to write an evaluation of the conclusion in the discussion.
- In APP more specific solutions should be stated - 'education of the population ... but how? Not just 'post things on social media' but a justification of how the social media platform will be used.
- The evaluation of the solution needs to be detailed.
- The report should be written formally, addressing each aspect of the criteria.
- Students should be aware of how the command terms are different in each of the markbands.
- Students need to give an accurate word count for all words in the report. Data, citations/bibliography and figure titles do not count.
- Many of the teacher comments were very brief and did not allow the moderator to see how or why a mark was or was not awarded for a criterion.
- Teachers should revisit the FAQs for ESS, as ESS is an interdisciplinary subject.

Standard level paper one

General comments

The majority of G2 respondents considered the difficulty of the paper to be appropriate. Compared to the paper from last year, approximately 63% considered it to be of a similar standard, 23% believed it was more difficult and 13% thought it was easier. The quality of the paper in terms of clarity of wording, presentation, readability, suitability and inclusivity was considered by most respondents to be either acceptable, good or very good.

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

- Calculation of doubling time of human population (topic 8.1)
- Explicitly linking reasons to the changes that occur within the age-gender pyramids overtime (topic 8.1)
- Providing reasons for why it is difficult to determine the exact number of species which exist in Costa Rica (topic 3.3)
- Understanding the role of a protected area and the value of expanding and increasing the number of protected areas (topic 3.4)
- Understanding the different roles of a keystone species and a flagship species (topic 3.4)
- Understanding the role of a wildlife corridor and difficulties associated with establishing and maintaining them (topic 3.4)
- Providing a reason for why use of wind power has increased in Costa Rica (topic 7.1)
- Understanding the relationship between ecological footprint and biocapacity (from data provided) in determining sustainability (topic 1.4)

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

- Most candidates were able to correctly interpret data presented in the Resource Booklet (e.g. Q1 and Q6b).
- The majority of students had an appropriate knowledge and understanding of:
- the criteria used to determine IUCN Red List status.
- impact of growing cash crops on nearby water systems
- strategies to reduce the use of crude oil

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

Q1 The majority of candidates identified the correct climatic conditions from the figures. A common error was to give generic statements e.g. the area has high temperatures and low rainfall, without any reference to specific numerical values.

Q2(a) A significant number of candidates struggled with this question with some giving no response at all. Common errors included calculating the natural increase rate (NIR) from the data provided instead of doubling time, incorrect rounding of the final answer and incorrect placing of the decimal point.

Q2(b) There were some very good responses to this question. However, common errors included not explaining the reasons for decrease in birth rates or increase in life expectancy or the converse, not explaining the impact of greater availability of contraception or improved health care.

Q3(a) A number of responses were too vague for credit. Some responses confused determining the number of species present with population size or incorrectly referred to the amount of diversity or number of protected areas in Costa Rica.

Q3(b) Most candidates obtained some marks for this question, although few achieved the maximum of 3 marks. Most candidates were able to correctly identify that designation of protected areas could limit human activities which damaged habitats or threated the species living there. However this marking point was frequently repeated within the same response. A few candidates appear to incorrectly view protected areas as a type of zoo.

Q4(a) The majority of candidates appear to be familiar with the IUCN Red List criteria and gave an appropriate response.

Q4(b) There were some very good responses to this question, although a significant number of candidates did not attempt this question. A common error was to only describe keystone species as a predator or refer to its role in a food chain rather than in a food web or ecosystem.

Q4(c) Responses varied widely for this question. A common error was to give vague responses e.g. corridors are near the capital city without linking this to what specific difficulties this might pose.

Q5(a) There were some good responses for this question and many candidates were able to correctly identify a reason that led to deforestation between 1940-1987 and a reason for forestation after 1987. The most common error was to simply state that deforestation occurred without providing a reason for why.

Q5(b) Many responses correctly linked the increase in trees to an increase in carbon dioxide absorption or increase in the carbon sink. Although some students incorrectly deduced that there had been a loss of trees/forest in Costa Rica since 1987 which resulted in more carbon dioxide in the atmosphere. In addition, a significant number of students inappropriately focused on trees producing oxygen rather than the importance of trees absorbing carbon dioxide in order to mitigate climate change.

Q6(a)(i) Responses were highly variable for this question. A common error was not to link the cause to the effect on the soil or give very generic responses e.g. stating that soil is eroded without an explanation of the cause.

Q6(a)(ii) Most candidates answered this question well. A popular correct response was to link use of fertilizers to the problem of eutrophication in lakes and rivers.

Q6(b) Most candidates correctly identified pasture land.

Q7 Many candidates answered this question well with many understanding that some of the income from tourism can be invested into conservation. Some answers lacked the necessary detail for credit e.g. tourism causes pollution that is harmful to species, where neither the specific pollution or the reason it is harmful was given.

Q8(a) Responses varied widely for this question. A common error was suggesting that wind currents had changed or suggesting there was more investment in wind power without giving a reason for this.

Q8(b) Many candidates achieved at least one mark for partially workings. Most candidates correctly calculated the total sources of energy but incorrectly calculated the amount of energy from fossil fuels often omitting oil and coal.

Q8(c) Most candidates obtained some marks for this question. Common errors included giving generalised responses e.g. switch to alternative energy sources or not linking the use of public transport, car-pooling or bikes to a reduction in individual car use.

Q9 A significant number of candidates struggled with this question. Many were able to correctly link the changes in ecological footprint (EF) and biocapacity to sustainability. A common error was to describe the trends in EF and biocapacity but not link this to sustainability. Only a small proportion of students were able to correctly explain why Costa Rica was sustainable prior to 1990/1 but not sustainable thereafter when EF became greater than the biocapacity.

Q10 Most candidates achieved 2 or 3 marks for this question. There were some excellent responses that achieved the full 6 marks but also a number of poor responses achieving no marks. Some responses inappropriately repeated material from the resource booklet without connecting the facts provided to the question being asked. Few candidates were able to provide a well-balanced conclusion. Many conclusions were either one sided or vague.

Recommendations and guidance for the teaching of future candidates

- Students should be encouraged to read the question carefully and thoroughly. Students should practice reading exam style questions to try and understand what is being asked and then how to answer the question directly.
- Ensure the meaning of each command term is fully understood. It may be useful to practice answering the same question using a different command term to really understand the difference between describe, explain, evaluate etc. Students should also know which command term requires them to include counter arguments and a clear conclusion/appraisal.
- Students should be encouraged to plan and practice 6-mark questions with for and against arguments together with how to write a balanced conclusion. The conclusion requires a value judgement supported by evidence from both sides of the argument.
- Students should be encouraged to consider the number of marks that are awarded to a question and ensure that enough information has been included to earn full marks (e.g. reasons, impacts, limitations, or examples).
- Students should be encouraged to avoid repetitive points in the same response.
- Students should be encouraged to give focused answers to questions using appropriate ESS terminology. They should avoid using generalised words or phrases such as "pollution/emissions", "impacts/affects" as these are too vague for credit. Responses need to be specific, for example, if pollution is being emitted, what kind of pollution and what is its impact.
- Students should practice past papers, answering different command terms and extracting information from data tables, charts and graphs.
- Students should be encouraged to take care with their handwriting during the exam to ensure that it is clearly legible. Only dark ink should be used as scripts will be scanned and marked on-screen.
- Candidates should be encouraged to keep their answers within the answer box. If extra space is required, then they should continue the response on additional pages.
- Students should be discouraged from leaving blank responses.

Ensure the whole syllabus is covered in sufficient detail. This includes ensuring students:

- Are able to calculate doubling time of the human population and know how to round numbers correctly to two decimal places.
- Understand the factors that influence changes in the age-gender pyramid over time and explicitly articulate the link between cause and effect.
- Understand the factors that make it difficult to determine how many species exist.

- Understand the role of protected areas and the impact of their size and number on conservation of species.
- Understand the role of keystone species and flagship species.
- Understand the role of wildlife corridors and difficulties in establishing and maintaining these areas.
- Understand the factors that contribute to changes being made to energy sources used, including reasons for the increase in the use of renewable energy sources e.g. wind power.
- Understand the relationship between ecological footprint, biocapacity and sustainability.

Standard level paper two

General comments

The great majority of G2 feedback forms indicated a broad satisfaction with the quality and fairness of the paper. There was some feeling that Section B was a little more difficult than previous sessions and the cohort's scores may support this, but only to the extent of a couple of marks. The suggestion was also made that question 1, being set in the context of England may require specialised knowledge of English culture but the required responses were of such a generic nature that candidates familiar with such a background were at no advantage.

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

Interpreting stacked histograms and multiple axes; details of natural selection; defining a primary pollutant; explaining diurnal changes in tropospheric ozone; the nature and function of a biotic index; the role of atmospheric circulation in the distribution of biomes; major atmospheric pollution issues; detailed processes of the hydrological cycle; large scale strategies of water conservation.

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

Issues surrounding SDW choices; the impact of geographical isolation in speciation; impacts of tropospheric ozone; the nature and function of Simpson's diversity index, the role of diversity in sustainable food production; the multifarious values of tropical biomes; small scale strategies of water conservation; processes of soil formation; principles of negative and positive feedback; limits to human population growth.

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

Section A:

1a. Most were able to read the recycling rate from the graph but a significant number used the wrong axis.

1b. Most were able to recognise the curve was reaching a plateau and explained how the rate was being limited although some simply explained why recycling had increased which was not required.

1c. Most were able to calculate the reduction in landfill waste although, again, there was some confusion over which axis to use, and how to interpret the stacked histograms.

1d. This was well-answered with many candidates coming up with three different influences causing the increase in recycling and incineration.

1e. A good number of candidates were able to see that re-use and reduced consumption were most likely to have caused the decline in overall SDW.

2ai. Most were able to identify the lowest point on the species diversity curve. There were some careless responses that failed to acknowledge the figures represented millions of years.

2aii. Most were able to recognise a mass extinction and offer a reasonable cause.

2bi. The great majority could identify the simple positive correlation. Those that missed it got caught up in complex attempts at explanation (required in the next question) and failed to clearly identify the key relationship.

2bii. A good number were able to identify either geographical isolation or climate diversity as a key reason …a few were able to offer both appropriate reasons.

2c. Many candidates struggled to write accurately about natural selection often referring to species mating with other species and similar confusions.

3ai & ii. A surprising number misidentified ozone as a primary pollutant and showed a poor understanding of what is meant by a primary pollutant.

3b. Most were able to link the early rise in nitrogen oxides and hydrocarbons with early use of vehicles and industries burning fossil fuels.

3c. A quite significant proportion of candidates simply described the diurnal changes in ozone rather than offering underlying reasons for them.

3d. Most were able to identify a clear impact of tropospheric ozone.

3e. The majority were able to recognise high intensity of fossil fuel use as a local condition favouring photochemical smog but a smaller number could additionally identify geographical conditions.

3f. The majority of candidates understood the general role of catalytic converters in reducing smog but few could give their detailed role in removing nitrogen oxides.

Section B:

4a. Most candidates had some idea regarding the influence of species diversity and population density on resilience but few were able to gain the full credit available.

4b. Although the majority of candidates had some idea of a 'diversity index', few had sufficient understanding of a 'biotic index' to effectively compare and contrast them.

4c .This was generally well-answered with many relevant examples of terrestrial and aquatic food production systems and particularly the distinction between examples of polyculture v monoculture.

5a. While many had some idea of the tri-cellular model of atmospheric circulation they were often unable to link this closely with the distribution of biomes.

5b. It was this question that revealed the perennial confusion over climatic pollution issues with many candidates identifying UV radiation as the cause of global warming and greenhouse gases as the cause of ozone depletion and many similar mistaken associations.

5c. This question generated many very good responses identifying the many values of tropical biomes and the associated issues of their conservation. Only the better responses, however, considered some counterarguments in favour of other biomes.

6a. The majority of candidates seemed to approach this question with confidence but were often too generalised and failed to specifically identify impacts on 'processes' of the water cycle like percolation, infiltration, run-off, transpiration etc.

6b.The majority of candidates could identify two or three causes of a change in the dynamic value of hydropower but few extended their imagination to gain full credit for this question.

6c.There was a tendency in addressing this question for candidates to prioritise small scale water saving strategies around personal ablutions and laundry rather than more extensive behaviours like those associated with global warming, population growth or food production. While there was generally some

understanding of technological strategies like desalination and drip-irrigation these were often assessed as less significant than turning the tap off while cleaning teeth.

7a. Most were able to identify key processes in the formation of fertile soil apparently from their understanding of early succession which was quite appropriate.

7b.Although candidates appeared to grasp the principles of negative and positive feedback they generally couldn't find the imagination and fresh application to identify examples in the context of decomposers.

7c.This question was often answered very well including references to many potentially limiting factors, Malthusian principles, Boserup's counterarguments, population policies and their limitations.

Recommendations and guidance for the teaching of future candidates

As stated in the last report, it is just as valid this year, to comment on how wonderful it would be to somehow finally stamp out this confusion over ozone depletion being the prime cause of global warming (its contribution is minimal to the point of insignificance) and candidates are losing credit for this in pretty much every examination.

Also true again this year is that candidates are generally following exam instructions very closely, offering multiple answers when required and taking care to address the specific points addressed by the wording of the question. They appear well-prepared for exam performance.

One area in which they may benefit from more experience is in applying their knowledge in new contexts. For example, although they understood the use of a diversity index, they found it hard to apply that knowledge to a contrast with a biotic index. Similarly, while they understood both feedback mechanisms and the nature of decomposers they were unable to freshly apply the principles of one concept to the other.