Centre Number						Candidate Number				
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Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
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7	
TOTAL	

General Certificate of Education
Advanced Level Examination
June 2012

Environmental Studies ENVS4

Unit 4 Biological Resources and Sustainability

Friday 1 June 2012 1.30 pm to 3.30 pm

You will need no other materials.
You may use a calculator.

Time allowed
- 2 hours

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.
  Two of these marks are for the Quality of Written Communication.
- You will be marked on your ability to:
  - use good English
  - organise information clearly
  - use specialist vocabulary where appropriate.
- Question 7 should be answered in continuous prose.
  Quality of Written Communication will be assessed in this answer.

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ANSWER IN THE SPACES PROVIDED

Answer **all** questions in the spaces provided.

1 The table lists some terms associated with agroecosystems.

Complete the table by selecting the appropriate letter from the list below.

A the increase in body mass per unit time
B physical environmental condition
C the amount produced per unit area
D the increase in body mass per unit of food eaten
E spreading inputs over a large area produces a low yield per unit area, but increases total yield
F a variable whose shortage of availability prevents a process occurring more rapidly
G the range of conditions in which a species can survive, eg temperature range
H high yields are achieved by using large inputs on a small area
I a measure of an output compared with the level of input

Term	Letter
Limiting factor	
Gross Growth Efficiency	
Growth Rate	**A**
Productivity	**C**
Abiotic factor	
Intensive agriculture	
Extensive agriculture	
Efficiency	**I**

(5 marks)

5

2 The formation and natural erosion of soil often create a dynamic equilibrium where the amount of soil present is constant. If human actions reduce the rate of formation or increase the rate of erosion then the amount of soil present will go down.

The rate of erosion is affected by many factors, and can be estimated using the Universal Soil Loss Equation (USLE).

Erosion rate = **R** × **K** × **L** × **S** × **C** × **P**

Where:
R = Rainfall erosivity factor
K = Soil erodibility factor
L = Slope length factor
S = Slope gradient factor
C = Cropping management factor
P = Erosion prevention factor

The tables show data that can be used to estimate erosion rates.

Farm name	R factor
St John's	90
Tacoma	110
Richmond	120

Soil texture type	K factor
Clay	0.22
Loam	0.30
Fine sand	0.38

Slope length	Slope (%)	L x S factor
30 m	10	1.4
	5	0.5
	1	0.1
250 m	10	3.9
	5	1.5
	1	0.2
1000 m	10	7.8
	5	3.0
	1	0.4

Crop management	C factor
Wheat	0.35
Fruit trees	0.10
Permanent grassland	0.02

Erosion prevention factor	P factor
Ploughing down the slope	1.00
Contour ploughing	0.75
Strip cropping and contour ploughing	0.25

The soil formation rate in this area is 3 t ha^{-1} yr^{-1}, so erosion rates less than this are sustainable.

2 (a) Complete the table **and** calculate the erosion rate for a field with the following features.

Field feature	Erosion factors
Richmond farm	**R** =
Clay soil	**K** =
250 m slope at 5%	**L** × **S** = 1.50
Wheat	**C** = 0.35
Strip cropping and contour ploughing	**P** =

Space for calculation

Erosion rate = ……. t ha^{-1} yr^{-1}

(2 marks)

2 (b) A field of loam soil on St John's farm, used to grow wheat, was ploughed down the slope. The USLE formula was completed using information from the tables.

The erosion rate was estimated to be 4.73 t ha^{-1} yr^{-1}

To make the erosion rate sustainable, changes in the farming methods were suggested.

Estimate what the erosion rate would be if:

2 (b) (i) contour ploughing was used instead of ploughing down the slope

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(1 mark)

2 (b) (ii) fruit was grown instead of wheat.

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(1 mark)

Turn over ▸

2 (c) Suggest **two** reasons why growing fruit trees instead of wheat would affect the erosion rate.

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(2 marks)

2 (d) Outline how the management of livestock can be used to reduce soil erosion.

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(4 marks)

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3 The photograph shows a variety of wheat that has been selectively bred to improve its desirable characteristics.

3 (a) Outline the advantages and disadvantages of growing a genetically uniform crop.

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(4 marks)

3 (b) Describe how embryo transfer can be used to reduce the time it takes to produce large numbers of young from a single breeding female.

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(2 marks)

Turn over ▸

3 (c) Outline how the use of genetic engineering may be used to produce Genetically Modified (GM) crop varieties that could not be produced using natural pollination.

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(2 marks)

3 (d) **Table 1** shows the yields of two different wheat varieties.

Table 1

Wheat variety	Number of fields sampled	Mean yield / t ha^{-1}
Paragon	25	99
Tybalt	20	106

A Mann Whitney U test was carried out to see whether the differences in yield were statistically significant.

The U values were calculated and the smallest was found to be 105.

3 (d) (i) Use **Table 2** to find the Critical Value with which this U value should be compared.

Table 2

		Number of fields of Paragon				
		10	**15**	**20**	**25**	**30**
Number of fields of Tybalt	**10**	23	39	55	71	87
	15	39	64	90	117	143
	20	55	90	127	163	200
	25	71	117	163	211	258
	30	87	143	200	258	317

Critical Value …… *(1 mark)*

3 (d) (ii) It was concluded that the difference was statistically significant at the 5% level. Explain what is meant by '*significant at the 5% level*'.

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(1 mark)

10

4 Plantation forestry in the mid twentieth century often involved large-scale monocultures of non-indigenous, conifer species that were planted close together. The simple age structure of the plantations meant large areas were felled at the same time.

4 (a) Suggest why foresters used:

4 (a) (i) non-indigenous tree species

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(2 marks)

4 (a) (ii) close planting.

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(2 marks)

Question 4 continues on the next page

4 (b) The picture shows a clearing created by harvesting trees.

4 (b) (i) The abiotic factors of a forest affect the survival of many wildlife species.

Outline a study that could be carried out to investigate how wind velocity changes with increasing distance from the clearing into the remaining plantation.

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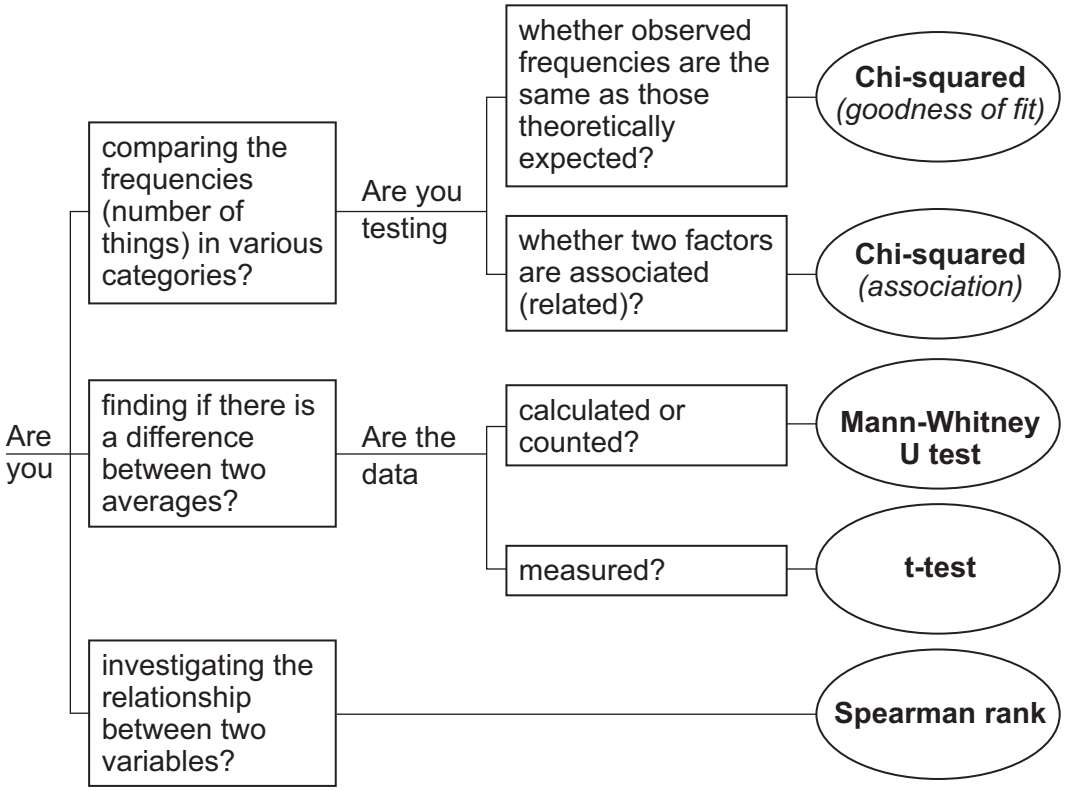
(5 marks)

4 (b) (ii) Use the flow diagram to choose a suitable statistical test to assess the significance of the results.



Choice of test .....

(1 mark)

10

Turn over for the next question

5 Modern organic farming aims to provide good yields of quality products by using natural ecological processes and cycles rather than replacing these with the use of synthetic chemicals. Sceptics claim that organic farming cannot produce enough food to feed a growing world population, while supporters claim that organic farming is the only sustainable system which can maintain production indefinitely.

As the demand for food has grown, so has the trend towards large-scale, mechanised methods that often need to be planned far in advance. Natural processes, such as the biological control of pest populations, often develop slowly and there may be a delay before the benefits are seen. Before this happens, farmers may feel it is necessary to use synthetic chemicals that may damage the natural processes that have not yet worked fully. Organic methods may also require the careful choice of crop and cultivation methods, such as crop rotation.

Synthetic fertilisers release nutrients and stimulate growth rapidly, while organic fertilisers release nutrients slowly. Crop rotation and crop choice may also help to raise nutrient levels and to balance demands on the soil.

For commercial agriculture to make the maximum profit, a quick return on financial investment is required. This is often achieved by the use of rapidly released fertilisers and pesticides rather than by the methods used by organic farmers. The long-term sustainability of food production may be seen as less important than high short-term profits.

The sustainability of farming systems may also depend on the sustainability of associated industries, such as the manufacture of pesticides, which may rely on energy from fossil fuel. Organic nutrient supply and pest control require a much lower energy subsidy.

Use the information in the passage and your own knowledge to answer the questions.

5 (a) Explain why the public demand for organic food is increasing.

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(4 marks)

5 (b) Explain how methods used by organic farmers:

5 (b) (i) maintain soil nutrient supplies

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(3 marks)

5 (b) (ii) control pest populations.

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(3 marks)

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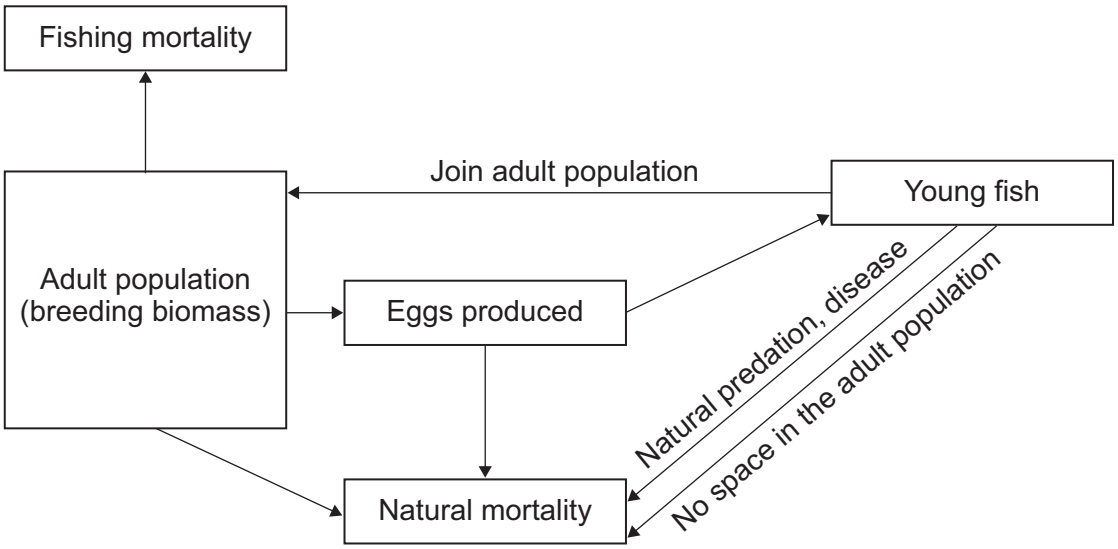
6 The diagram shows the factors that control the biomass of a fish population.



6 (a) Use the diagram to explain why limited fishing would not cause a reduction in the biomass of the adult population.

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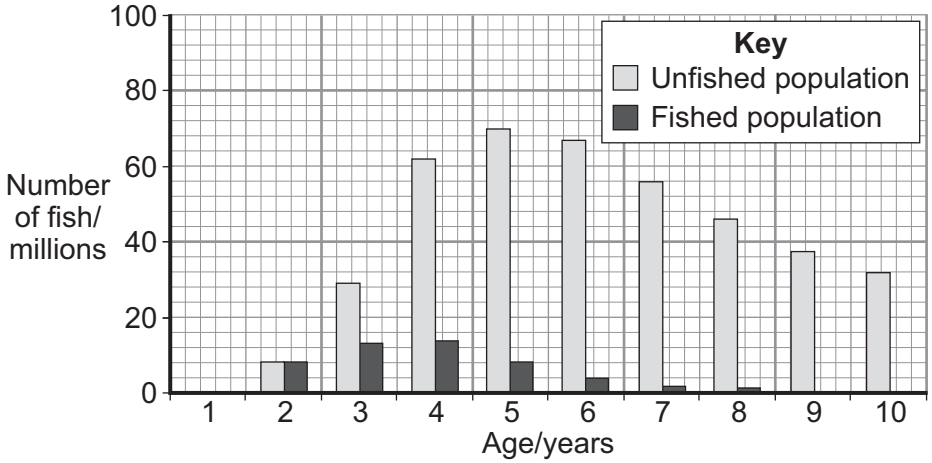
(2 marks)

Question 6 continues on the next page

6 (b) **Graph 1** shows information for two populations of Atlantic cod, *Gadus morhua,* of similar original size and population structure. One population has never been fished, the other has been fished for 10 years.

Graph 1



Source: www.cefas.defra.gov.uk

6 (b) (i) Use the information in **Graph 1** to suggest how fishing affects fish populations.

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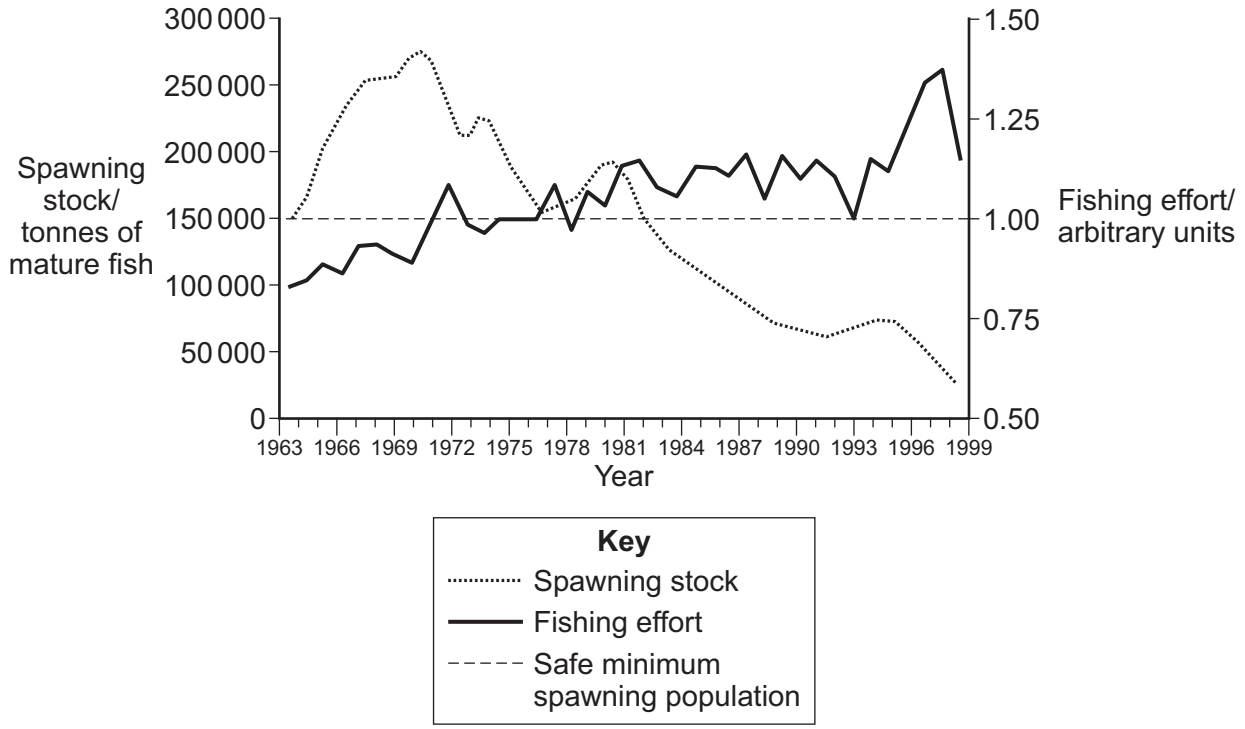
(4 marks)

Graph 2 shows changes in spawning stock and fishing effort for a population of Atlantic Cod.

Graph 2



Source: adapted from International Council for the Exploration of the Seas (ICES): North Sea cod - spawning stock biomass (SSB). North Sea cod - Fishing Pressure(F 2-4)

6 (b) (ii) Apart from an increase in the number of survivors, suggest how a reduction in fishing effort may result in an increase in future catches.

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(1 mark)

6 (b) (iii) Suggest what is meant by the term '*safe minimum spawning population*' used in **Graph 2**.

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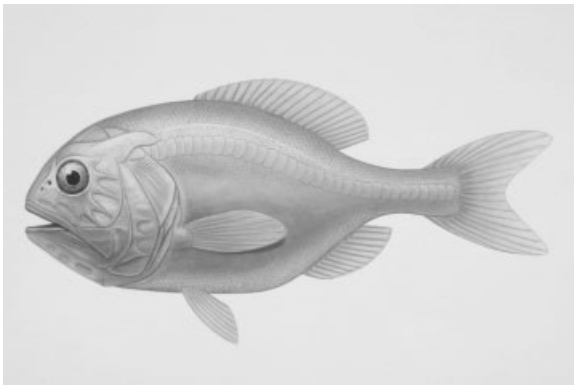
(1 mark)

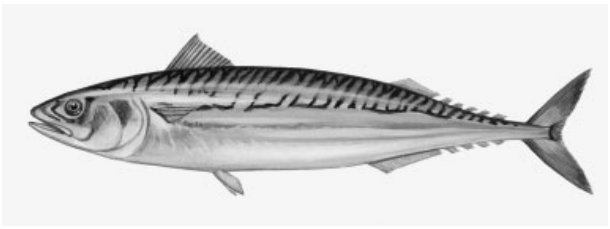
Question 6 continues on the next page

6 (c) Orange Roughy and Atlantic Mackerel are commercially important fish species.

Orange Roughy



Atlantic Mackerel



Source: Getty Images

The table shows information about the breeding biology and fishing methods for Orange Roughy and Atlantic Mackerel.

Feature	Orange Roughy	Atlantic Mackerel
Age of first breeding / years	20	2
Maximum age / years	100+	20
Maximum length / cm	75	45
Length when sexually mature / cm	42	30
Eggs laid per female	20 000 – 200 000	250 000 – 1 000 000
Most common size of caught fish / cm	30 – 40	25 – 35
Time of fishing	During spawning season	During spawning season
Where found	Demersal (seabed)	Pelagic (mid-water and near surface)
Depth / m	500 – 1200	0 – 100
Shoal composition	Mixed population	Single age group shoals
Fishing method	Seabed trawling	Mid-water trawling and seine netting
By-catch rate	High	Low

6 (c) (i) Use the information from the table to explain why the Orange Roughy is much more likely to be overfished than the Atlantic Mackerel.

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(3 marks)

6 (c) (ii) Suggest how the high by-catch rate of Orange Roughy fishing may affect future Orange Roughy populations.

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(2 marks)

6 (d) Suggest how exclusion zones (No Take Zones) can increase the total catches despite the total fishing area being reduced.

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(2 marks)

15

Turn over for the next question

7 Write an essay on **one** of the following topics. Credit will be given for your understanding of the relationship between different areas of the subject, also for the organisation and presentation of the essay and for grammar, punctuation and spelling.

EITHER

7 (a) Discuss how changes in vehicle design and use could increase the environmental sustainability of passenger transport systems. *(20 marks)*

OR

7 (b) Explain how fish production using aquaculture may cause environmental damage. *(20 marks)*

OR

7 (c) Discuss how a high level of affluence can increase the environmental impact of a person's lifestyle, but could also allow them to reduce their impact. *(20 marks)*

Write the number of the question you have chosen in the box below.

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(20 marks)

Extra space for Question 7 .....

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END OF QUESTIONS