Name: _____

Date: _____

Class: _____

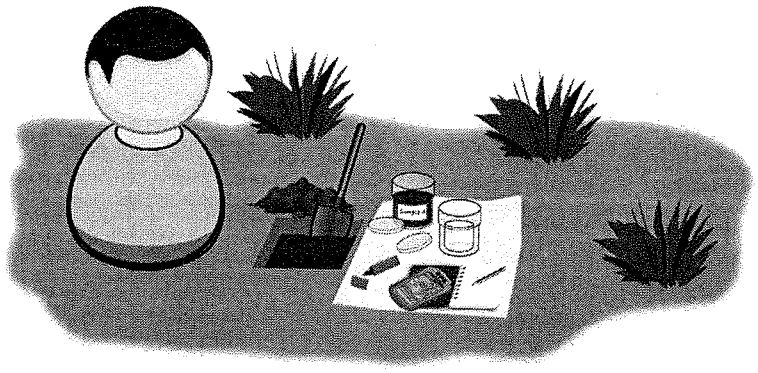
IB ESS

2.5 Investigating Ecosystems

Significant Ideas

The description and investigation of ecosystems allows for comparisons to be made between different ecosystems and for them to be monitored, modeled and evaluated over time, measuring both natural change and human impacts.

Ecosystems can be better understood through the investigation and quantification of their components.



Measuring Abiotic Factors in Water Ecosystems

1. List the abiotic components of a marine ecosystem that might be measured.

Salinity, pH, temperature, dissolved oxygen, wave action

2. Outline what the following abiotic variables are and summarise the methods used to measure them in freshwater ecosystems.

Turbidity

Details	Brief summary of process
is the cloudiness of a body of water high turbidity = cloudy water low turbidity = clear water Limits the penetration of sunlight and thereby the depth at which photosynthesis can occur.	• A secchi disc is lowered into the water until it disappears from view • Read the depth from graduated rope slowly raise the disc until it is just visible again and read depth • Calculate the average depth (known as the Secchi depth)

Flow Velocity

Details	Brief summary of process
Speed at which the water is moving and determines which species can live in a certain area. Flow velocity varies with: Time - melt water in spring → high flow Depth - surface waters flow more slowly Position in river - inside bend has shallow slower moving water than outside	• Impeller mounted on a graduated stick and base placed on river bed • The impeller is held at the end of the side arm and lowered into the water facing upstream • The impeller is released and the time it takes to travel the distance of the side arm • Repeat 3-5 times

pH

Details	Brief summary of process
Values in freshwater range from slightly basic to slightly acidic depending on surrounding soil rock and vegetation. Freshwater organisms, eg fish are sensitive to changes in pH.	Can be measured using a pH meter or data logging pH probe. The meter or probe must be cleaned between readings and readings should be taken at the same depth.

Temperature

Details	Brief summary of process
Temperature affects the metabolic rate of aquatic organisms (many are ecothermic). Low temperature = low metabolic rate	An electronic thermometer with probes (datalogger) is used. Temperature needs to be recorded at a standard depth. Digital thermometers can be used for shorter time periods

Dissolved Oxygen

Details	Brief summary of process
Amount of oxygen dissolved in the water. Higher temperature = lower oxygen concentration. Water pollution can reduce oxygen concentrations. Organisms rely on dissolved oxygen for respiration.	Oxygen sensitive probe on a data-logger or Winkler titration. Data loggers can be affected by oxygen in the air. Winkler method is more labourious - oxygen reacts with iodide ions, acid can be added to release iodine that can then be quantitatively measured.

3. State and evaluate <u>two</u> methods of measuring oxygen concentrations in water.

Data loggers / oxygen probes give quick results but need to be well maintained and calibrated in order to give accurate results.
The winkler method is more labour intensive as it requires several steps and chemicals.

Measuring Abiotic Components in Terrestrial Ecosystems

1. Outline what the following abiotic variables are and summarise the methods used to measure them in terrestrial ecosystems.

Air Temperature

Details	Brief summary of process
Air temperature varies temporally and spatially. Organisms have a range of temperatures they can tolerate. Ectotherms' metabolic rate varies with temperature	Can be measured using a simple liquid thermometer or more complex digital probes. A probe can be used for longer term monitoring should be held in consistent position.

Light intensity

Details	Brief summary of process
Amount of light that falls on an area. Will affect primary productivity as affects rate of photosynthesis	Light meter - should be held at a fixed height and direction. Varies throughout the day and due to cloud cover so repeat readings are needed.

Wind Speed

Details	Brief summary of process
Wind speed is a fundamental atmospheric quantity caused by air moving from high to low pressure, mainly due to changes in temperature	Anemometer - small hand held digital version can be held in the path of the wind. The wind blows through the fan at the top and gives reading in m/s.

Rainfall

Details	Brief summary of process
Rainfall will affect the amount of water available for plants for photosynthesis which will affect primary productivity. Some animals are limited by water availability	Can be measured using a rain gauge. Should be placed away from interference from building, trees or other obstacles. Can be checked every 24 hours.

Soil Texture	
Details	Brief summary of process
Soil is made up of different sized particles - the ratio of these size will determine important soil characteristics size as fertility, porosity, ease of working.	In the field a hand identification chart can be used In the lab the soil can be placed in a bottle filled with water + shaken. Allow to settle + measure depth of layers

Measuring Biotic Components in Terrestrial Ecosystems

4. Design an investigation to compare the NPP and GPP of 2 different lakes.

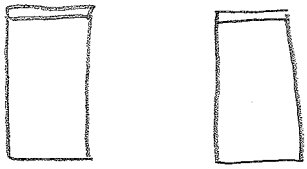
Use the bottles method and include a diagram, as well as the calculations you would use.

Method Zimmer.csufresno.edu/~sblumens/AquatEcol/LakePP_Met.pdf

1. Using the VanDorn sampler collect water samples from a depth of 1 metres.
2. Remove the water from the sampler immediately upon retrieval. Transfer the water to a 'dark' bottle. Allow the water to flow continuously through the bottle to prevent splashing and bubble formation, until at least 3 times the capacity of the bottle has overflowed (count the seconds needed to fill the bottle initially, then repeat twice)
3. Insert the BOD probe and take an initial DO measurement. Record
4. Cap the bottle and make sure no light enters the bottle
5. Repeat steps 1-4 for the 'light' bottle
6. Repeat steps 1-5 for 4 sites on lake A
7. Repeat steps 1-6 for 5 sites at lake B.
8. Allow the bottles to incubate for a minimum of 2 hours.
9. Retrieve bottles. Wrap 'light' bottle in tin foil. Use the BOD probe

Diagram

Van Dorn Sampler



'Light' bottle

'Dark' bottle covered in tin foil

Calculations

The light bottle gives a reading of GPP as both photosynthesis and respiration are occuring

The dark bottle gives a reading of respiration only (R)

In both light and dark bottles the change in oxygen is measured

To calculate NPP = GPP - R

5. Briefly summarise a method to measure productivity of plant material.

Terrestrial ecosystem: 3 quadrats of equal size placed on vegetation
A - harvested immediately and biomass measured
B - covered with black plastic (respiration only)
C - left as is (respiration + photosynthesis)
After suitable time period B+C are harvested + biomass measured
Aquatic ecosystems: light and dark bottles

6. Briefly summarise a method for measuring net <u>secondary</u> productivity.

A herbivore is fed with a known amount of food - both food and herbivore are weighed. After a suitable time remaining food, herbivore and feces are weighed.

7. Briefly explain the use and procedure for the following:

Sweep nets

Nets of various sizes can be swept through grasses at various heights. The insects that are caught can be emptied into a large, clear container and the species and numbers recorded.

Pooters

Plastic straws are attached to a glass jar or pot. One tube is put in the mouth; suction draws the small animals into the jar through the other straw. Gauze prevents sucking in the insect

Tree beating

Used to find insects in tree branches. A catching tray is placed beneath a tree branch and the branch gently tapped. The tray will catch anything that falls.

Kick sampling

Used to sample river organisms. Involves agitating the riverbed with a boot and collecting disturbed animals downstream in a net. A fixed time is set for sampling, catch in sorted in shallow tray of water

8. Create a paired statement key to identify 6 aquatic invertebrates.

Use your textbook or do research to find pictures of the organisms

mayfly nymph, damselfly nymph, dragonfly nymph, water scorpion, water beetle, saucer bug

Aquatic Invertebrates with 6 legs

1 a 'Tail' present 2

b No obvious 'tail'

2 a 'Tail' split into 2 or more 'prongs' 3

b 'Tail' single point ..... water scorpion

3 a 'Tail' made up of 3 prongs 4

b 'Tail' made up of 2 prongs ..... Dragonfly nymph

4 a Spines on side of thorax/body ..... mayfly nymph

b No spines on side of thorax/body ..... Damselfly nymph

5 a Antennae present on head ..... water beetle

b No antennae present ..... saucer bug

Answers will vary

Measuring Abundance

9. Summarise the capture, mark, release, recapture method.

Used to measure total population size of a motile animal.
Establish a study area and capture a sample of the population.
Mark each organism caught and record number marked.
Release the captured + marked individuals, give time to remix.
Take a second sample, count number of organisms (marked + unmarked)

10. Write the formula for the Lincoln index.

Include what each symbol stands for (e.g. "n1=...")

$$N = \frac{n_1 \times n_2}{m_2}$$

N = total population
n_1 = number of animals first marked and released
m_2 = number of marked animals in second sample
n_2 = number of animals in second sample

11. Use the following information to calculate an estimated population size of using the Lincoln index.

A class of 10 students collected data on snails from a small forest area. They captured 25 snails and marked them, then released them. They returned 1 day later to find they had captured 31 snails, 4 of which were marked.

$$N = \frac{n_1 \times n_2}{m_2}$$

$$= \frac{25 \times 31}{4}$$

$$= 193.75$$

Estimated population of snails = 194

(Nearest whole number, avoid using decimals)

12. Evaluate this method of estimating the snail population size.

(Hints: What assumptions must we make for the Lincoln Index to be reliable and how likely is it those assumptions are true? Are there any reasons why this method is inaccurate or not reliable?

Assumptions made:

- mixing is complete - marked individuals have spread throughout the population. With sufficient time and careful marking this is likely
- Marks do not disappear, are not harmful, do not increase predation with careful, subtle marked this is likely but challenging.
- It is equally easy to capture all individuals and trapping the organism does not affect their chances of being trapped a second time - this depends on the size and distribution of organisms.
- no emigration, immigration, births or deaths - difficult to measure if the population size is not known

Measuring Species Diversity

13. Describe what is meant by "species diversity". see Booklet 3.1

a function of the number of species and their relative abundance i.e. species richness and species evenness.

14. Write the equation used for Simpson's Reciprocal Index. Include what each component stands for (e.g. "N = ...")

$$D = \frac{N(N-1)}{\sum n(n-1)}$$

D = Simpson Diversity index

N = total number of organisms of all species found

n = number of individuals of one particular species

15. Students collected data on the plant species present in an area using a quadrat. The numbers below are an estimate of the total amount of each plant within that area.

	2008	2016
Species A	*78*	*95*
Species B	*45*	*17*
Species C	*61*	*21*
Species D	*38*	*0*
Species Richness (question a)	4	4
Species diversity (question b)		

a) Complete the table to show the species richness.

b) Calculate the species diversity for each year using the Simpson's Reciprocal Index. Show your working below, and add your answers in the table

2008

$$D = \frac{222(221)}{78(77) + 45(44) + 61(60) + 38(37)}$$

$$= \frac{49062}{6006 + 1980 + 3660 + 1406}$$

$$= \frac{49062}{13052}$$

$$= 3.76$$

2016

$$D = \frac{133(132)}{96(95) + 17(16) + 21(20)}$$

$$= \frac{17556}{9812}$$

$$= 1.79$$

c) In which year is the species diversity of the ecosystem higher?

Year : 2008