La-Net

BIO 307

FIELD COURSE I

Course code: BIO 307

Course title: Field Course I

Course credit load: 1 Unit

Series 1: Field Sampling Techniques

Introduction

Field biology is the practice of studying living organisms in their natural environment rather than in the laboratory, and the quality of any field study depends entirely on how carefully samples are collected, recorded, and managed. Sound sampling techniques allow biologists to make reliable estimates of species composition, abundance, and distribution from a limited number of observations, and to draw valid conclusions that extend beyond the specific locations and times sampled.

This Series introduces the principles of field sampling as applied within local habitats up to 20 km from the university, covering the purpose and planning of field studies, the major quantitative sampling methods used in biological fieldwork, and the equipment, data recording, and sample-handling procedures that ensure data quality from the field to the laboratory. These skills underpin all the habitat-specific and collection work covered in the remaining Series of this course.

Series Learning Outcomes

Upon completing this Series, you should be able to:

- **SLO 1.1** explain the purpose of field sampling, describe study design principles, and apply field safety and ethical guidelines,
- **SLO 1.2** describe and apply quadrat, transect, mark-recapture, point count, pitfall trap, and sweep net sampling methods, and
- **SLO 1.3** demonstrate correct field data recording, equipment use, and sample handling procedures.

1.1 Principles and Planning of Field Sampling

1.1.1 Purpose and importance of field sampling

Field sampling allows biologists to characterise the organisms present in a habitat (species composition), estimate how many individuals of each species occur (abundance), map where they occur (distribution), and monitor changes in these parameters over time; because it is impossible to count or record every individual in most natural habitats, sampling provides a practical means of obtaining representative data from which inferences about the whole population or community can be drawn, provided the sampling is well-designed and unbiased.

Field data collected through systematic sampling have applications across ecology, conservation, environmental impact assessment, pest management, and basic biological research; in the local context, field sampling within habitats near the university provides the raw data for understanding the diversity and structure of Nigerian terrestrial, aquatic, and forest-edge communities, and gives students direct practical experience of the organisms and environments studied in lecture courses.

Fill in the blank: Field sampling provides a practical means of obtaining ________ data from which inferences about the whole population or community can be drawn, provided the sampling is well-designed and unbiased.

1.1.2 Study design and sampling strategy

A sound study design specifies the question to be answered, the variables to be measured, the spatial scale and location of sampling, the number of sampling units, and the method of allocating sampling units across the study area; the three main sampling strategies are random sampling (sampling units placed at randomly chosen locations, minimising bias but potentially missing important habitat patches), systematic sampling (sampling units placed at regular intervals across the study area, ensuring even coverage), and stratified sampling (the study area divided into strata reflecting known habitat differences, with sampling units allocated proportionally within each stratum to ensure representative coverage of all habitat types).

The number of sampling units (replicates) required depends on the degree of natural variability in the system and the precision required from the study; pilot sampling (a small preliminary survey to estimate variability) is useful for determining the appropriate sample size before the main study; for most field biology assessments, a minimum of five to ten replicate sampling units per habitat or treatment is a practical guideline, though more may be needed in highly variable habitats.

Fill in the blank: ________ sampling divides the study area into strata reflecting habitat differences and allocates sampling units within each stratum, ensuring representative coverage of all habitat types.

1.1.3 Field safety and ethical conduct

Field safety requires that all participants are briefed on hazards specific to the study site before the visit (including dangerous animals such as snakes and stinging insects, unstable terrain, deep water, and traffic near roadsides), that appropriate personal protective equipment (sturdy footwear, long trousers, sun protection, and in some habitats, anti-malaria precautions) is worn, and that participants work in groups of at least two, never alone; a field first-aid kit should always be carried, and the location and contact details of the nearest medical facility known before departure.

Ethical conduct in field biology requires that collecting and sampling activities cause the minimum necessary disturbance to the habitats and organisms studied; protected species should not be collected without the appropriate permits; collecting permits are required for many animal groups even in non-protected areas; invertebrates and small vertebrates captured for identification should be released after recording unless voucher specimens are specifically required; field sites on private land or protected areas require written permission from landowners or site managers before entry.

Fill in the blank: Field ethical conduct requires that sampling causes the ________ necessary disturbance to habitats and organisms, and that protected species are not collected without the appropriate permits.

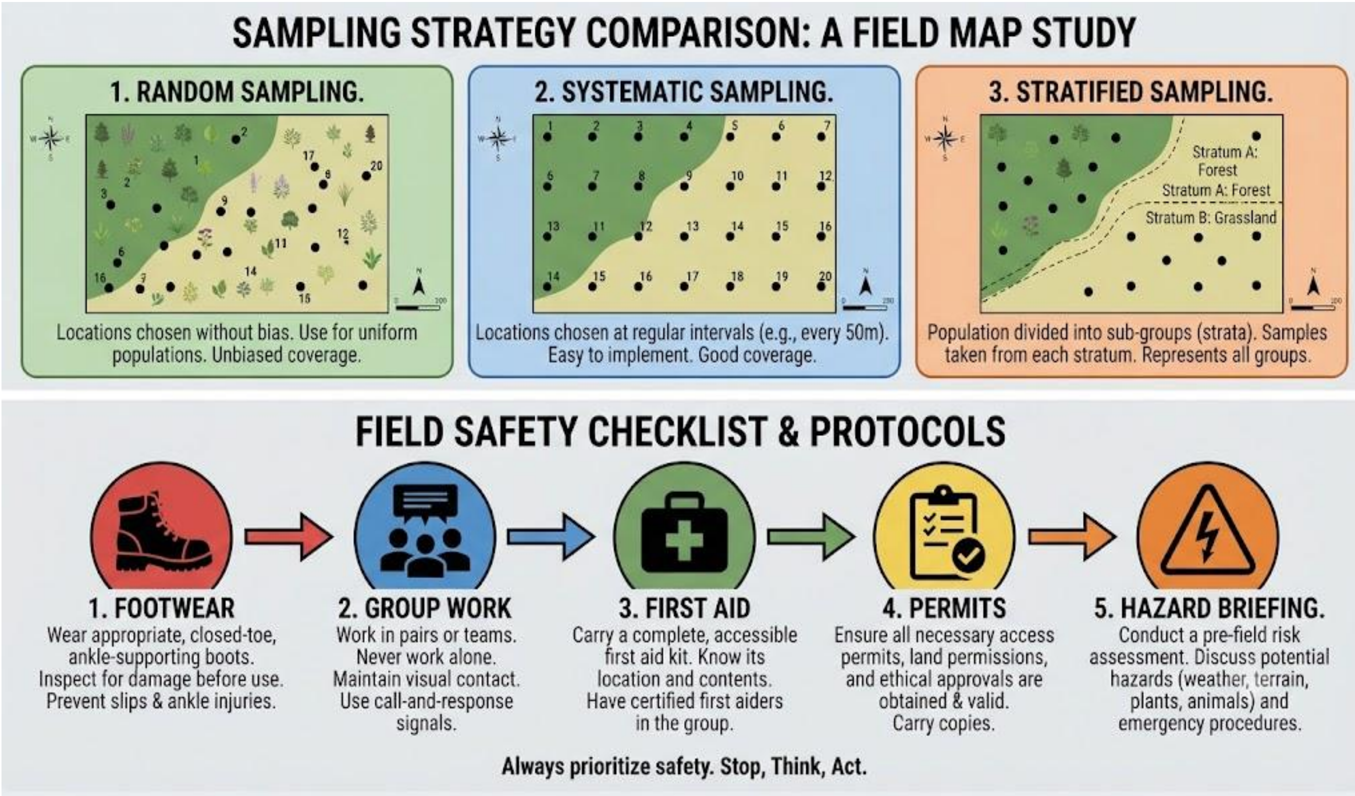

Figure 1.1: Field sampling principles and safety

Pilot questions 1.1

1. State three types of information that field sampling can provide about organisms in a habitat.
2. Distinguish between random, systematic, and stratified sampling strategies.
3. Explain why pilot sampling is useful before a main field study.
4. Name three field safety precautions that should be taken before a field visit.
5. Explain what is meant by ethical conduct in field biology.

1.2 Quantitative Sampling Methods

1.2.1 Quadrat and transect methods

A quadrat is a defined area (typically a square of fixed dimensions such as 1 m x 1 m for herbaceous vegetation or 10 m x 10 m for trees) within which all organisms of the target group are counted, measured, or identified; quadrats may be placed randomly, systematically, or stratified across the study area; plant percentage cover, species frequency (the proportion of quadrats in which a species occurs), and species density (number of individuals per unit area) are the most commonly recorded quadrat variables in vegetation surveys.

A transect is a line along which observations or measurements are made at regular intervals, or within defined plots placed along the line; belt transects (a strip of defined width along the transect line, within which all target organisms are recorded) and line transects (along which point observations are made at regular intervals) are the most common types; transects are particularly useful for recording changes in species composition across environmental gradients such as from water edge to dry land, or from forest to grassland.

Fill in the blank: A ________ transect is a strip of defined width along a line within which all target organisms are recorded, useful for mapping changes across environmental gradients.

1.2.2 Mark-recapture and point count methods

Mark-recapture is a method for estimating the size of animal populations that are difficult to count directly; a sample of individuals is captured, individually marked (with paint, tags, rings, or fin-clips depending on the animal), and released; after sufficient time for the marked individuals to mix randomly with the population, a second sample is captured; the proportion of marked individuals in the second sample relative to the total sample is used to estimate total population size using the Lincoln-Petersen formula: $N = (M \times C) / R$, where N is population size, M is the number marked and released, C is the total second sample, and R is the number recaptured.

Point count (or point census) methods are widely used for sampling birds and, in some contexts, other conspicuous animals or plants; an observer stands at a fixed point for a defined period (typically 5 to 10 minutes) and records all individuals seen or heard within a defined radius or without a distance limit; multiple point count stations distributed across the study area provide an index of relative abundance and species richness; the method is rapid, non-invasive, and well-suited to detecting species that would be missed or disturbed by physical sampling methods.

Fill in the blank: In mark-recapture, the Lincoln-Petersen formula estimates population size as N = (M x C) / ________ , where R is the number of marked individuals recaptured in the second sample.

1.2.3 Pitfall traps and sweep nets

Pitfall traps are open-topped containers (plastic cups or tin cans) sunk flush with the soil surface so that ground-active invertebrates (beetles, spiders, ants, centipedes, and other arthropods) walking across the surface fall in and cannot escape; they are typically left for 24 to 48 hours and checked daily, with specimens preserved in ethanol or identified and released; arrays of pitfall traps (10 to 20 traps at regular intervals along a transect) provide standardised samples of ground-active invertebrate communities that can be compared between habitats or sites.

Sweep nets are large, robust nets swept rapidly through low vegetation (grass, shrub, or crop canopy) to collect aerial and vegetation-dwelling invertebrates including grasshoppers, beetles, bugs, flies, and spiders; a standard sweep is a defined number of sweeps (typically 10 or 20) in a defined vegetation type, after which the contents of the net are emptied into a bag and the collected invertebrates identified and counted; both pitfall trapping and sweep netting provide rapid, standardised samples of invertebrate diversity that are repeatable across sites and seasons.

Fill in the blank: ________ traps are open-topped containers sunk flush with the soil surface, collecting ground-active invertebrates that walk across the surface and fall in.

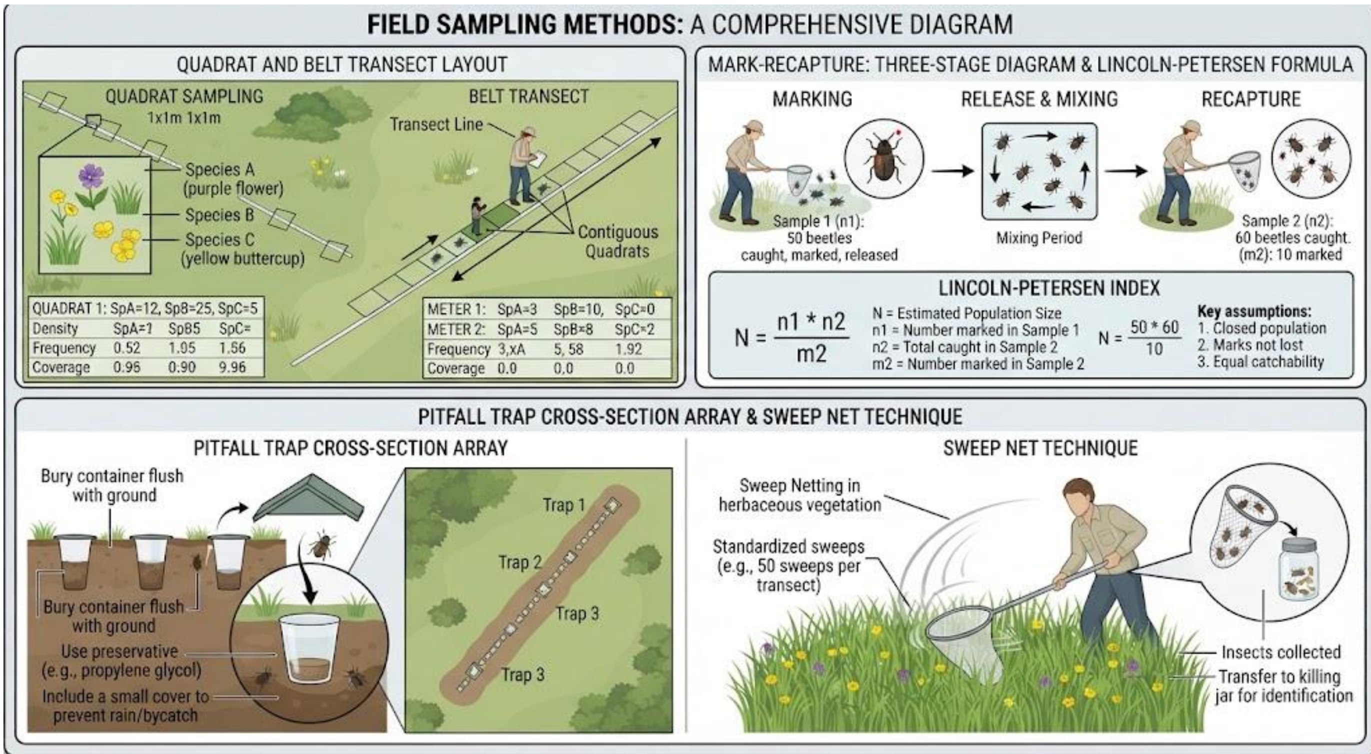

Figure 1.2: Quantitative field sampling methods

Pilot questions 1.2

1. Define a quadrat and name two variables commonly recorded within a quadrat.
2. Distinguish between a belt transect and a line transect.
3. Describe the mark-recapture method and state the Lincoln-Petersen formula.
4. Describe the point count method and state one advantage it has over physical trapping.
5. Explain how pitfall traps are set up and what types of organisms they capture.

1.3 Recording, Data Management, and Equipment

1.3.1 Field recording and data sheets

All field data should be recorded on prepared data sheets at the time of collection rather than from memory later; a well-designed field data sheet includes the date, time, site name and GPS coordinates, weather conditions, names of observers, the sampling method used, and a systematic table for recording the target data (species names, counts, measurements, or presence/absence); field notes should also include qualitative observations about habitat conditions, unusual species, or any deviations from the planned sampling protocol.

Field data sheets should be written in pencil (which does not run when wet, unlike ink) and carried in waterproof bags or clipboards with waterproof paper where weather conditions may be a problem; all data should be transferred to a digital spreadsheet as soon as possible after the fieldwork, with the original paper data sheets retained as the primary record; any errors or uncertainties on the data sheet should be annotated rather than erased, so that the original observation is preserved.

Fill in the blank: Field data should be recorded on prepared ________ sheets at the time of collection, including site name, GPS coordinates, date, observer names, and sampling method used.

1.3.2 Equipment for field sampling

Basic field sampling equipment includes: measuring tapes and ranging poles (for laying out quadrats and transects), a GPS receiver or compass and map (for navigation and recording locations), hand lenses (for identifying small organisms in the field), forceps, specimen jars, and collection bags (for handling and temporarily holding specimens), field identification guides appropriate to the target organism groups, a camera (for photographing organisms that cannot be collected), and notebooks or prepared data sheets on clipboards.

Additional equipment for specific methods includes: quadrat frames (folding metal or plastic squares of defined size), sweep nets (sturdy nets on a long handle for invertebrate collection), pitfall trap containers and preservative fluid, binoculars (for bird and large mammal observation), and first-aid kit (essential for any field party); all equipment should be checked and packed the day before the field trip, and a spare supply of pencils, bags, and labels carried in case of breakage or loss during fieldwork.

Fill in the blank: A ________ receiver or compass and map is essential field equipment for navigation and for recording the precise locations of sampling sites.

1.3.3 Handling and storing samples in the field

Live specimens that are to be identified and released should be kept in ventilated containers out of direct sunlight and processed as quickly as possible to minimise stress and mortality; invertebrates requiring preservation for later identification in the laboratory should be placed in small tubes or vials of 70 to 95 percent ethanol immediately after collection, with a paper label written in pencil placed inside the tube recording the site, date, collector, and sampling method; vials should be tightly stoppered and stored upright in a padded container to prevent breakage and evaporation during transport.

Plant material collected for pressing should be placed immediately in a plant press between sheets of newspaper and blotting paper and kept in a cool, shaded location; pressed specimens begin to deteriorate rapidly if left without pressing or refrigeration; soil samples should be collected in sealed plastic bags labelled on the outside with a permanent marker and kept cool until laboratory analysis; photographic records taken in the field should be backed up to a second device before leaving the field site wherever possible, as photographic data are easily lost through camera failure or theft.

Fill in the blank: Invertebrates for laboratory identification should be preserved in 70 to 95 percent ________ immediately after collection, with a pencil-written label inside the tube recording site, date, and collector.

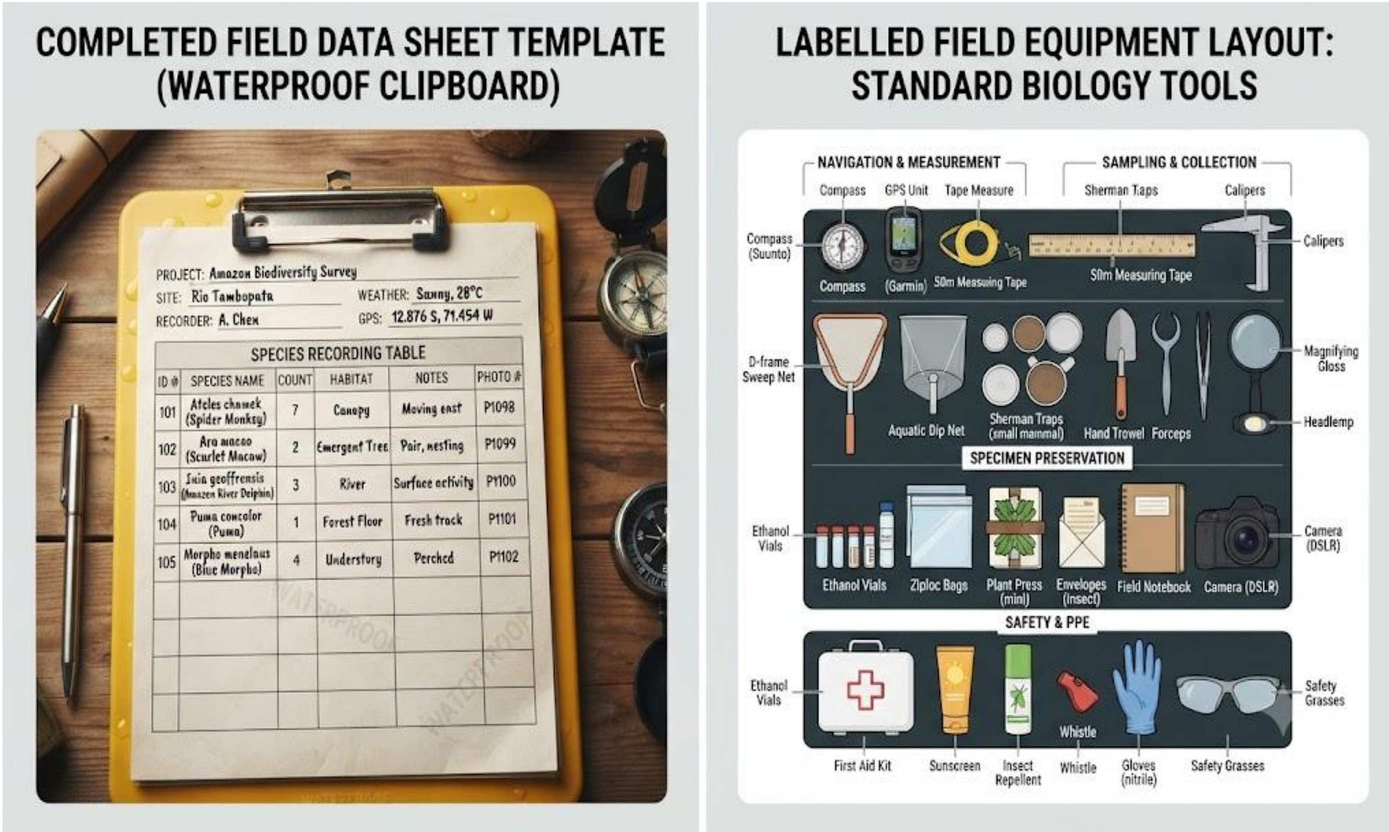

Figure 1.3: Field recording and equipment

Pilot questions 1.3

1. State five items that should be included in the header of a field data sheet.
2. Explain why field data should be recorded in pencil rather than ink.
3. Name five pieces of basic equipment needed for a general field sampling exercise.
4. Explain how invertebrate specimens should be preserved for laboratory identification.
5. Describe how plant material collected for pressing should be handled immediately after collection.

Series Summary

This Series established the foundational skills needed for any biological field study. Effective field sampling begins with careful planning: defining the research question, selecting an appropriate sampling strategy (random, systematic, or stratified), and determining the number of replicates needed. Field safety and ethical conduct, including pre-visit hazard briefing, group working, and minimum-disturbance collection, are non-negotiable requirements that must be planned before any site visit.

The major quantitative sampling methods covered, including quadrats, transects, mark-recapture, point counts, pitfall traps, and sweep nets, each have specific strengths suited to different organism groups and habitat types. Underpinning all of them is rigorous field data recording on prepared data sheets, correct use and maintenance of equipment, and careful handling and labelling of specimens from the moment of collection. These skills form the practical toolkit applied throughout the remainder of this course.

Glossary of Terms

- **Belt transect:** a strip of defined width along a line within which all target organisms are recorded, used to capture changes across environmental gradients.
- **Mark-recapture:** a population estimation method in which individuals are captured, marked, released, and later recaptured to estimate total population size.
- **Pitfall trap:** an open-topped container sunk flush with the soil surface to passively capture ground-active invertebrates.
- **Point count:** a sampling method in which an observer at a fixed point records all organisms seen or heard within a defined period and radius.
- **Quadrat:** a defined sampling area of fixed dimensions within which all target organisms are counted, measured, or identified.
- **Stratified sampling:** a sampling strategy in which the study area is divided into strata reflecting habitat differences, with sampling units allocated within each stratum.

- **Sweep net:** a robust net on a long handle swept through vegetation to collect aerial and vegetation-dwelling invertebrates.
- **Voucher specimen:** a preserved specimen deposited in a museum or herbarium as a permanent reference record of an organism collected at a given place and time.

Concept Check Questions [Series 1]

Objective Questions

1. ________ sampling divides the study area into strata reflecting habitat differences and allocates sampling units within each. (Linked to SLO 1.1)
2. A ________ transect records all organisms within a strip of defined width along a line across the study area. (Linked to SLO 1.2)
3. In mark-recapture, the Lincoln-Petersen formula estimates N as (M x C) divided by ________ . (Linked to SLO 1.2)
4. Pitfall traps are sunk ________ with the soil surface so that ground-active invertebrates fall in. (Linked to SLO 1.2)
5. Invertebrates for laboratory identification should be preserved in 70 to 95 percent ________ immediately after collection. (Linked to SLO 1.3)

Short-Answer Questions

6. Distinguish between random and stratified sampling. (Linked to SLO 1.1)
7. Describe the mark-recapture method and state the Lincoln-Petersen formula. (Linked to SLO 1.2)
8. Name three field safety precautions. (Linked to SLO 1.1)
9. State five items of equipment needed for a general field sampling exercise. (Linked to SLO 1.3)
10. Explain how plant material collected in the field should be handled. (Linked to SLO 1.3)

Long-Answer Questions

11. Describe the principles of field sampling, study design strategies, and field safety and ethical requirements. (Linked to SLO 1.1)
12. Describe the main quantitative sampling methods used in field biology and explain when each is most appropriate. (Linked to SLO 1.2)

Answers to Concept Check Questions [Series 1]

Objective Questions

1. Stratified.
2. Belt.
3. R.
4. Flush.
5. Ethanol.

Short-Answer Questions

6. Random sampling places units at randomly chosen locations, minimising bias but potentially missing habitat types; stratified sampling divides the area into strata and allocates units within each, ensuring all habitat types are represented.
7. A sample is captured, marked, and released; a second sample is taken later; N = (M x C) / R, where M is number marked, C is total second sample, and R is the number recaptured.
8. Never work alone, carry a first-aid kit, and wear appropriate personal protective equipment (or pre-briefing on site hazards, anti-malaria precautions).
9. Measuring tape, GPS receiver, hand lens, forceps, specimen jars, and field identification guide (any five).
10. Plant material should immediately be placed in a plant press between newspaper and blotting paper and kept in a cool, shaded location to prevent deterioration.

Long-Answer Questions

11. Field sampling characterises species composition, abundance, and distribution, and monitors change over time. Study design involves defining the question, choosing a strategy (random, systematic, or stratified), and determining replicates. Field safety requires group working, PPE, first-aid kit, hazard briefing, and collecting permits. Ethical conduct requires minimum disturbance, proper permits, and release of organisms after recording.

12. Quadrats sample defined areas for plants and sedentary organisms; belt transects record organisms in a strip across gradients; mark-recapture estimates mobile animal population sizes; point counts sample conspicuous species such as birds non-invasively; pitfall traps collect ground-active invertebrates passively; sweep nets collect vegetation-dwelling and aerial invertebrates actively. Choice depends on organism mobility, habitat, and study objective.

Answers to Pilot Questions [Series 1]

Part 1.1

1. Species composition (which species are present), abundance (how many individuals per species), and distribution (where in the habitat they occur).
2. Random: units at random locations, minimises bias. Systematic: units at regular intervals, ensures even coverage. Stratified: area divided into habitat strata, units allocated within each stratum.
3. Pilot sampling estimates variability in the system, allowing the appropriate number of main study replicates to be calculated before investing in full-scale sampling.
4. Pre-briefing on site-specific hazards, wearing appropriate PPE (footwear, long trousers), and carrying a first-aid kit.
5. Ethical conduct means causing the minimum necessary disturbance to habitats and organisms, obtaining all required collecting permits, and releasing organisms alive after recording unless voucher specimens are essential.

Part 1.2

1. A quadrat is a defined area of fixed dimensions; commonly recorded variables include species density (individuals per unit area) and percentage cover.
2. A belt transect records all organisms within a strip of defined width along a line; a line transect makes point observations at regular intervals along the line without a fixed-width strip.
3. First capture: capture, mark, and release M individuals. Second capture: recapture C individuals, of whom R are marked. Population size N = (M x C) / R.
4. An observer at a fixed point records all organisms seen or heard within a defined period; it is non-invasive and does not disturb the target organisms.

5. An open-topped container (plastic cup) is sunk flush with the soil surface; ground-active invertebrates walking across the surface fall in and are collected; beetles, spiders, ants, and centipedes are typical captures.

Part 1.3

1. Date, time, site name, GPS coordinates, and observer names (or weather conditions, habitat type, sampling method).
2. Pencil does not run when the data sheet gets wet, unlike ink, ensuring data remain legible in all weather conditions.
3. Measuring tape, GPS receiver, hand lens, forceps, and specimen jars with ethanol (or field guide, camera, quadrat frame, sweep net, binoculars).
4. Place them immediately in vials of 70 to 95 percent ethanol with a pencil-written paper label inside recording site, date, collector, and method; stopper tightly and store upright in a padded container.
5. Place immediately in a plant press between sheets of newspaper and blotting paper and keep in a cool, shaded location until pressed specimens can be properly processed.

References and Attribution

Textual References (Books and External Sources)

- Sutherland, W. J. (Ed.). (2006). Ecological census techniques: A handbook (2nd ed.). Cambridge University Press.
- Krebs, C. J. (2014). Ecology: The experimental analysis of distribution and abundance (6th ed.). Pearson.
- Henderson, P. A., & Southwood, T. R. E. (2016). Ecological methods (4th ed.). Wiley-Blackwell.
- National Open University of Nigeria (NOUN). (2023). Field course I course material. NOUN Press.

Figures, Plates, Tables, and Boxes

- Figure 1.1: Field sampling principles and safety Attribution: AI generated. Suggested OER search string: "field sampling study design random systematic stratified sampling field safety ethics biology OER".
- Figure 1.2: Quantitative field sampling methods Attribution: AI generated. Suggested OER search string: "quadrat transect mark recapture Lincoln Petersen pitfall trap sweep net field sampling methods biology OER".
- Figure 1.3: Field recording and equipment Attribution: AI generated. Suggested OER search string: "field data sheet recording GPS equipment quadrat sweep net pitfall trap specimen preservation field biology OER".

Course code: BIO 307

Course title: Field Course I

Course credit load: 1 Unit

Series 2: Terrestrial, Aquatic and Aerial Studies

- ## Part 2.1: Terrestrial Field Studies
  - Sub Part 2.1.1: Sampling terrestrial vegetation
  - Sub Part 2.1.2: Sampling terrestrial fauna
  - Sub Part 2.1.3: Recording environmental variables in terrestrial habitats
- ## Part 2.2: Aquatic Field Studies
  - Sub Part 2.2.1: Sampling freshwater habitats
  - Sub Part 2.2.2: Sampling aquatic organisms
  - Sub Part 2.2.3: Water quality measurement
- ## Part 2.3: Aerial Studies
  - Sub Part 2.3.1: Observing and recording aerial fauna
  - Sub Part 2.3.2: Methods for aerial fauna sampling
  - Sub Part 2.3.3: Linking aerial, terrestrial, and aquatic observations

Introduction

Organisms are distributed across three main environmental media: the terrestrial surface and its vegetation layers, freshwater and other aquatic habitats, and the aerial environment above the ground; each of these environments presents distinct challenges for field sampling, requires different equipment and methods, and supports characteristic communities that can only be properly studied using techniques adapted to those conditions. A competent field biologist must be able to work effectively in all three environments.

This Series covers the practical methods for conducting biological surveys in terrestrial, aquatic, and aerial environments within the local study area. It addresses vegetation and fauna sampling in terrestrial habitats, the collection of organisms and measurement of water quality in freshwater habitats, and the observation and recording of aerial fauna including birds, bats, and flying insects. Throughout, the importance of recording associated environmental variables alongside the biological data is emphasised.

Series Learning Outcomes

Upon completing this Series, you should be able to:

- **SLO 2.1** describe and apply methods for sampling terrestrial vegetation and fauna and recording environmental variables,
- **SLO 2.2** describe and apply methods for sampling freshwater habitats and organisms and measuring water quality, and
- **SLO 2.3** describe methods for observing and recording aerial fauna and explain how aerial, terrestrial, and aquatic observations are linked.

2.1 Terrestrial Field Studies

2.1.1 Sampling terrestrial vegetation

Terrestrial vegetation is most commonly sampled using quadrats and transects as described in the sampling methods Series; for grassland and herbaceous communities, 1 m x 1 m or 0.5 m x 0.5 m quadrats are standard, recording species presence or percentage cover by the point-quadrat method (a grid of pins lowered through the vegetation, with contact species recorded at each pin) or by visual estimation using Braun-Blanquet cover scales; for woodland and forest, 10 m x 10 m or 20 m x 20 m plots are used, recording tree species, diameter at breast height (DBH), and canopy height for each individual.

Vegetation structural parameters such as canopy height, canopy cover, and understorey density can be measured using a clinometer or rangefinder (for height), a densiometer (a mirrored instrument for canopy cover estimation), or by photographing the canopy and analysing the photographs; leaf area index (a measure of the total leaf surface per unit ground area) can be estimated using a LAI-2000 instrument or hemispherical photographs; recording these structural variables alongside species composition allows the physical structure of the vegetation to be characterised as well as its species content.

Fill in the blank: For forest vegetation sampling, ________ at breast height (DBH) of each tree is measured within the plot alongside species identification and canopy height.

2.1.2 Sampling terrestrial fauna

Different terrestrial animal groups require different sampling methods: small mammals are typically sampled with live traps (Sherman traps baited with peanut butter or grain, set along trap lines and checked at dawn) or snap traps for kill-trapping; reptiles and amphibians are recorded by active searching under rocks, logs, and vegetation during appropriate weather conditions, supplemented by drift fences with pitfall traps at intervals; large mammals are recorded by track and sign surveys, camera traps, or distance sampling along transects.

Soil invertebrates are extracted using Berlese-Tullgren funnels from soil cores, or by hand-sorting soil monoliths; leaf litter fauna are sampled by collecting litter into bags and extracting invertebrates by heat or flotation; dung beetles and carrion beetles are attracted to baited pitfall traps (using dung or carrion as bait) and provide useful indicators of ecosystem health; recording the habitat characteristics (vegetation type, canopy cover, soil moisture) at each trapping point allows the relationship between habitat and fauna composition to be analysed.

Fill in the blank: Small mammals are typically sampled using live ________ traps baited with peanut butter or grain, set in trap lines and checked at dawn to minimise stress and mortality.

2.1.3 Recording environmental variables in terrestrial habitats

Biological data from terrestrial field surveys is most informative when accompanied by measurements of the relevant environmental variables that influence the distribution and abundance of organisms; standard variables to record at each sampling site include air temperature (using a thermometer or data logger), relative humidity (using a hygrometer), light intensity at ground level and canopy level (using a light meter or lux meter), soil temperature (using a soil thermometer inserted to 5 cm depth), and soil moisture (using a soil moisture meter or by gravimetric sampling).

Habitat characteristics such as vegetation type, percentage bare ground, percentage rock cover, aspect (compass direction of the slope face), and slope angle should be recorded at each sampling site and used to stratify or classify sites for analysis; GPS coordinates and elevation should always be recorded for every sampling point using a GPS receiver, allowing sites to be mapped and relocated for repeat surveys; photographs of each sampling site from a standardised direction and distance provide a permanent visual record of habitat conditions at the time of sampling.

Fill in the blank: ________ coordinates and elevation should always be recorded at every sampling point using a GPS receiver, allowing sites to be mapped and relocated for repeat surveys.

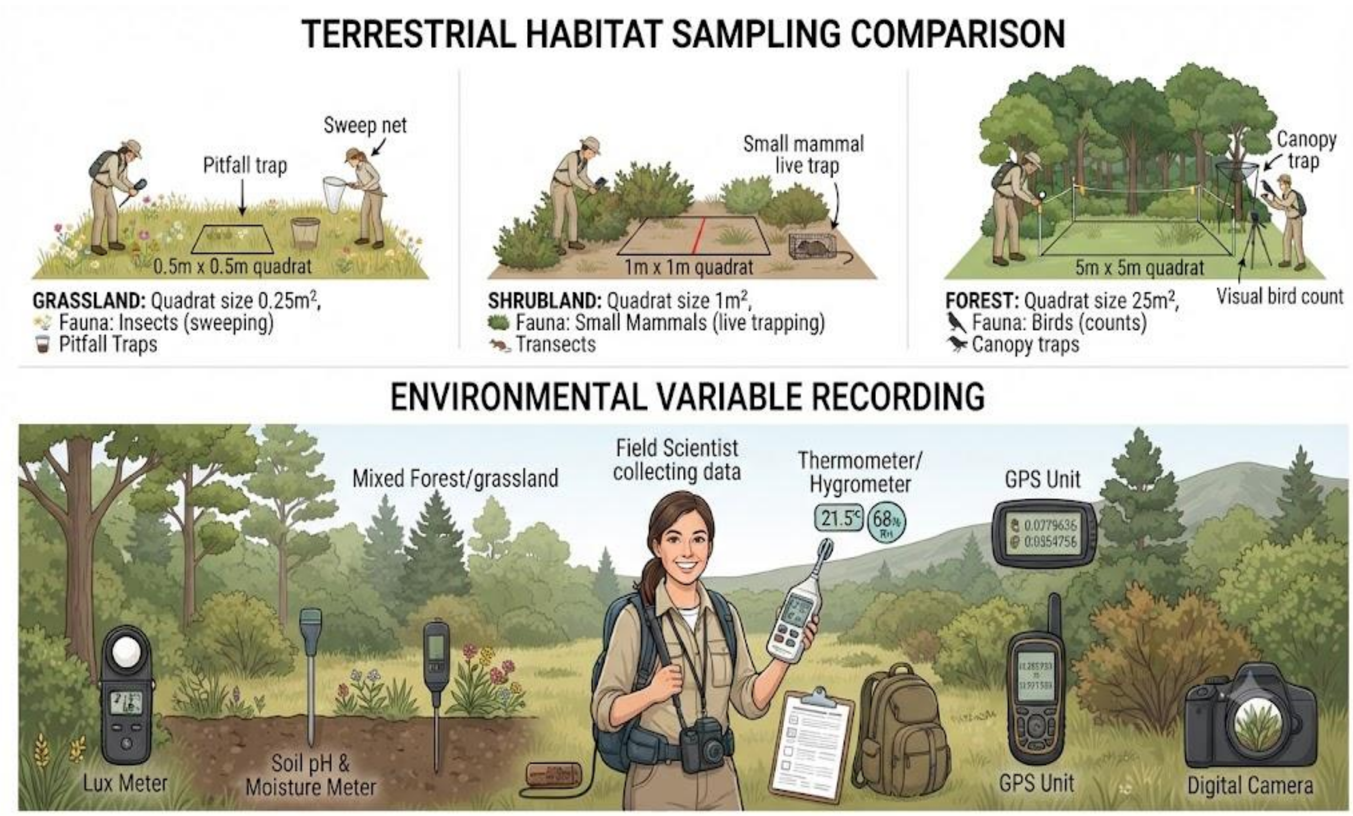

Figure 2.1: Terrestrial field study methods

Pilot questions 2.1

1. State the standard quadrat size used for herbaceous vegetation and for forest tree surveys.
2. Name two methods for estimating canopy cover in a forest.
3. Describe how small mammals are typically sampled in terrestrial field surveys.
4. Name four environmental variables that should be recorded at each terrestrial sampling site.
5. Explain why GPS coordinates should always be recorded at sampling points.

2.2 Aquatic Field Studies

2.2.1 Sampling freshwater habitats

Freshwater habitats sampled in field courses commonly include streams and rivers, ponds, lakes, swamps, and irrigation canals; before sampling, the habitat should be characterised by measuring channel width and depth (for streams), water surface area (for ponds), habitat heterogeneity (noting the presence of riffles, pools, and runs in streams, or open water, emergent vegetation, and bank zones in ponds), substrate type (sand, gravel, rock, mud, or leaf litter), and the degree of shading by riparian or overhanging vegetation.

Sampling points in streams should be selected to represent all major microhabitat types (riffles with fast, shallow, aerated water over gravel are the richest for invertebrates; pools with slow, deep water support different communities); in ponds and lakes, sampling along a transect from the bank into open water captures the gradient from emergent macrophyte zones through submerged vegetation to open water, each supporting distinct communities; the time of day and season of sampling should be recorded as these strongly affect the activity and detectability of many aquatic organisms.

Fill in the blank: In stream surveys, ________ are the habitat zones with fast, shallow, aerated water over gravel that typically support the richest invertebrate communities.

2.2.2 Sampling aquatic organisms

Aquatic macroinvertebrates (the most widely used biological indicators of water quality) are sampled using a kick net (a 500 micron mesh net held downstream while the sampler disturbs the substrate upstream with their feet for 30 seconds, dislodging invertebrates that are swept into the net) in streams, or a pond net (a fine mesh net swept through vegetation or dipped from the bank) in standing water; the contents of the net are emptied into a white tray of water for sorting and identification; macroinvertebrates are identified to order or family level and counted.

Fish are sampled by electrofishing (passing an electric current through the water that stuns fish temporarily, allowing them to be netted, identified, measured, and released), seine netting (dragging a fine-mesh net between two operators along a stream reach), or cast netting in larger water bodies; aquatic plants (macrophytes) are recorded by direct observation along belt transects from the bank or by swimming transects; phytoplankton and zooplankton are sampled by collecting water in bottles or with fine plankton nets towed through open water.

Fill in the blank: A ________ net is used to sample stream macroinvertebrates by disturbing the substrate upstream while the net is held downstream to collect dislodged organisms.

2.2.3 Water quality measurement

Physical and chemical water quality parameters measured at aquatic sampling sites include temperature (using a thermometer or temperature probe), dissolved oxygen (DO, measured using a DO meter or Winkler titration method, critical for aquatic life as values below 5 mg/L stress most organisms), pH (measured with a pH meter or test strips), turbidity (water clarity, measured with a Secchi disc in deeper water or a turbidity meter), conductivity (a measure of dissolved salts, using a conductivity meter), and flow velocity (in streams, measured with a flow meter or float method).

Biological water quality assessment using macroinvertebrate biotic indices (such as the Biological Monitoring Working Party score, BMWP, which assigns score values to macroinvertebrate families based on their sensitivity to organic pollution) allows the overall ecological status of a water body to be assessed without expensive chemical analysis; polluted streams typically have low-diversity communities dominated by pollution-tolerant taxa such as tubificid worms and chironomid midge larvae, while clean streams have high-diversity communities including pollution-sensitive taxa such as stonefly, mayfly, and caddisfly larvae.

Fill in the blank: The BMWP score is a ________ water quality index that assigns scores to macroinvertebrate families based on their sensitivity to organic pollution, used to assess stream ecological status.

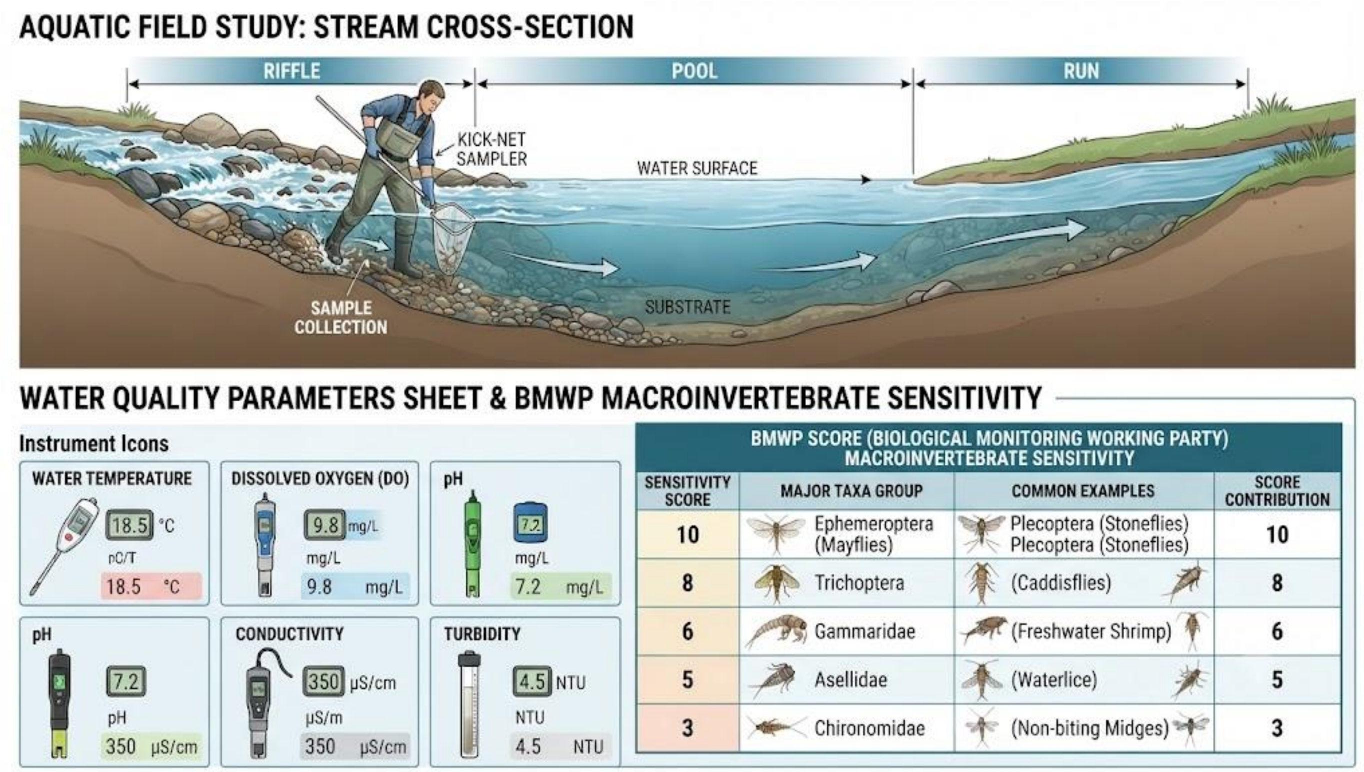

Figure 2.2: Aquatic field study methods

Pilot questions 2.2

1. Name four features of a freshwater habitat that should be characterised before biological sampling.
2. Explain why riffles in streams are particularly important sampling sites for macroinvertebrates.
3. Describe the kick net method for sampling stream macroinvertebrates.
4. Name four physical or chemical water quality parameters that can be measured in the field.
5. Explain what the BMWP score measures and how it is used.

2.3 Aerial Studies

2.3.1 Observing and recording aerial fauna

Aerial fauna, organisms that spend all or part of their lives in the air, include birds, bats, flying insects (butterflies, dragonflies, beetles, flies), and some spiders that balloon on silk threads; birds are the most practically accessible aerial fauna group for daytime field surveys, recorded by the point count method (observing all individuals seen or heard at a fixed point for a defined period) or along transect walks; all bird records should include species, number of individuals, behaviour (perched, flying, feeding, calling), distance from observer, and habitat at the point of observation.

Bats are active at dusk and dawn, and can be detected by their ultrasonic echolocation calls using a bat detector (an electronic device that converts ultrasonic calls to audible frequencies); bat activity surveys are conducted along fixed transects at dusk, recording bat passes per minute as an index of bat activity; butterflies are most effectively surveyed using the Pollard walk transect method (walking at a slow, steady pace along a fixed route and counting all butterflies seen within 5 m to either side and 5 m ahead, on days with suitable weather conditions of sunshine and low wind).

Fill in the blank: A bat ________ converts the ultrasonic echolocation calls of bats to audible frequencies, allowing bat activity to be detected and recorded during dusk transect surveys.

2.3.2 Methods for aerial fauna sampling

Butterflies and other diurnal flying insects can also be sampled using a sweep net swept through vegetation in the flight zone; Malaise traps (tent-like structures that intercept flying insects and direct them upward into a collection chamber containing preservative) provide standardised passive samples of flying insects over extended periods; light traps (ultraviolet or mercury vapour lamps attracting nocturnal insects, which fall into a funnel and collecting vessel below) are highly effective for sampling moth diversity and abundance and can be operated overnight at a fixed location.

Mist nets (very fine nylon mesh nets strung between poles in the flight path of birds or bats) can be used to catch, ring, measure, and release birds and bats for detailed study, but require specialist training and government permits and must not be left unattended; dragonflies and damselflies (odonates) are surveyed by walking slowly along water margins and recording all individuals seen, with capture in a fine net for close identification of difficult species followed by release; aerial insects can also be sampled by sticky traps (flat surfaces coated with a non-drying adhesive suspended at the appropriate height in the flight zone).

Fill in the blank: ________ traps are tent-like structures that intercept flying insects and direct them into a collection chamber, providing standardised passive samples of flying insect diversity.

2.3.3 Linking aerial, terrestrial, and aquatic observations

Many species exploit more than one environmental medium during their life cycle or daily activity, making integrated surveys across aerial, terrestrial, and aquatic environments necessary for a complete picture of community composition; dragonflies and damselflies breed in aquatic habitats but hunt aerial insects as adults; herons and kingfishers are aerial predators that feed in aquatic habitats and nest in terrestrial vegetation; bats roost in trees and buildings (terrestrial) but feed on aerial insects that in many cases are aquatic insects that have emerged as winged adults from streams and ponds.

Recording the habitat context of all aerial observations (noting whether birds are over water, over grass, or in forest canopy, for example) and linking aerial species records to the terrestrial and aquatic habitats from which they are feeding or emerging allows the functional connections between habitat types to be mapped; this integrated approach is particularly valuable in the local field study area, where fragmented habitats create complex mosaics of terrestrial, aquatic, and aerial environments that many species move between on a daily basis.

Fill in the blank: Many species exploit more than one environmental medium: dragonflies breed in ________ habitats but hunt aerial insects as adults, illustrating the importance of integrated multi-habitat surveys.

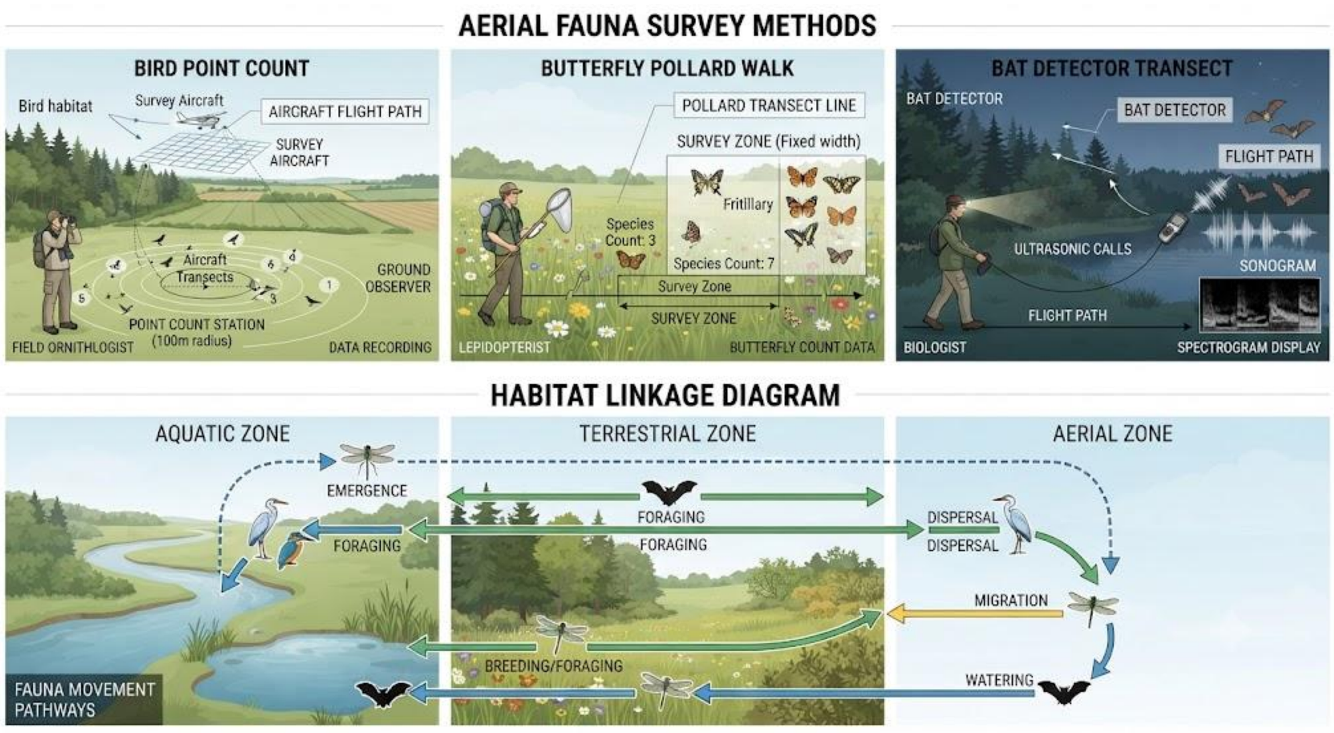

Figure 2.3: Aerial fauna observation and sampling

Pilot questions 2.3

1. Name three groups of aerial fauna commonly recorded in field surveys.
2. Describe the Pollard walk method for butterfly surveying.
3. Explain what a bat detector is and how it is used.
4. Describe two passive methods for sampling aerial insects.
5. Give two examples of species that link aerial and aquatic habitats and explain how.

Series Summary

This Series examined the practical approaches to biological fieldwork in terrestrial, aquatic, and aerial environments. In terrestrial habitats, vegetation is sampled using appropriately sized quadrats and transects alongside measurements of structural variables such as canopy height and cover, while fauna are targeted with methods matched to each group, from Sherman traps for small mammals to pitfall arrays for soil invertebrates. Environmental variables including temperature, humidity, light intensity, and GPS location must accompany all biological records.

In freshwater habitats, the kick net is the workhorse tool for macroinvertebrate sampling, and the biological community data it produces, combined with physical water quality measurements, enables assessment of ecological status through biotic indices such as the BMWP. Aerial surveys rely on point counts and transect walks for birds and butterflies, bat detectors for bats, and passive traps for flying insects. The Series closed by emphasising that many species cross between environments during their lives, making integrated multi-habitat surveys the most informative approach to understanding local biodiversity.

Glossary of Terms

- **BMWP score:** the Biological Monitoring Working Party biotic index that assigns scores to macroinvertebrate families based on their sensitivity to organic pollution, used to assess stream water quality.
- **Bat detector:** an electronic device that converts ultrasonic bat echolocation calls to audible frequencies, enabling bat activity monitoring.
- **Canopy cover:** the proportion of the ground surface covered by the vertical projection of tree or shrub crowns above, estimated using a densiometer or hemispherical photographs.
- **DBH (diameter at breast height):** the standard measure of tree trunk diameter recorded at 1.3 m above ground level.
- **Dissolved oxygen (DO):** the concentration of oxygen dissolved in water, a critical indicator of aquatic habitat quality.

- **Kick net:** a net held downstream while the substrate is disturbed upstream by foot, used to collect stream macroinvertebrates.
- **Malaise trap:** a tent-like structure that intercepts flying insects and channels them into a collection chamber.
- **Pollard walk:** a standardised butterfly transect method in which an observer counts all butterflies within a defined zone while walking a fixed route at a steady pace.
- **Riffle:** a section of a stream with fast, shallow, turbulent water over a coarse substrate, typically the richest zone for macroinvertebrate diversity.
- **Sherman trap:** a foldable live trap for small mammals, baited and checked at dawn to minimise stress.

Concept Check Questions [Series 2]

Objective Questions

1. For forest tree surveys, ________ at breast height (DBH) is measured for each individual within the plot. (Linked to SLO 2.1)
2. Small mammals in terrestrial surveys are commonly sampled using live ________ traps baited with peanut butter or grain. (Linked to SLO 2.1)
3. In streams, ________ are fast, shallow, gravel zones that support the richest macroinvertebrate communities. (Linked to SLO 2.2)
4. The BMWP score is a ________ water quality index using macroinvertebrate family sensitivity scores. (Linked to SLO 2.2)
5. A bat ________ converts ultrasonic echolocation calls to audible frequencies for field monitoring. (Linked to SLO 2.3)

Short-Answer Questions

1. Name two methods for estimating canopy cover in forest surveys. (Linked to SLO 2.1)
2. Describe the kick net method for sampling stream macroinvertebrates. (Linked to SLO 2.2)
3. Name four physical or chemical water quality parameters measurable in the field. (Linked to SLO 2.2)
4. Describe the Pollard walk method for butterfly surveys. (Linked to SLO 2.3)
5. Give one example of a species that links aquatic and aerial habitats. (Linked to SLO 2.3)

Long-Answer Questions

1. Describe the methods used for terrestrial vegetation and fauna sampling and the environmental variables that should be recorded. (Linked to SLO 2.1)
2. Describe aquatic habitat characterisation, organism sampling, and water quality measurement, and explain how aerial surveys are conducted and linked to other habitat types. (Linked to SLOs 2.2, 2.3)

Answers to Concept Check Questions [Series 2]

Objective Questions

1. Diameter.
2. Sherman.
3. Riffles.
4. Biotic.
5. Detector.

Short-Answer Questions

1. Densiometer (spherical or flat mirrored instrument) and hemispherical photographs of the canopy analysed by image software.
2. A 500 micron mesh kick net is held downstream while the sampler disturbs the substrate upstream for 30 seconds; dislodged invertebrates are swept into the net, emptied into a white sorting tray, and identified and counted.
3. Temperature, dissolved oxygen, pH, and turbidity (or conductivity, flow velocity).
4. An observer walks a fixed route at a slow, steady pace, counting all butterflies within 5 m to each side and 5 m ahead, on days with sunshine and low wind.
5. Dragonflies: larvae live in aquatic habitats and emerge as winged adults that hunt aerial insects; or bats that roost on land and hunt aerial insects emerging from water.

Long-Answer Questions

1. Terrestrial vegetation: quadrats (1 m x 1 m for grass, 10-20 m x 10-20 m for forest) recording cover, DBH, and canopy height; densiometer or hemispherical photos for canopy cover. Fauna: Sherman traps (small mammals), drift fences and pitfall traps (reptiles), camera traps (large mammals), Berlese funnels (soil invertebrates). Environmental variables: temperature, humidity, light, soil temperature, soil moisture, GPS coordinates, habitat photographs.
2. Aquatic: characterise width, depth, substrate, shading, microhabitat types (riffles, pools). Sampling: kick net for macroinvertebrates, electrofishing/seine net for fish. Water quality: temperature, DO, pH, turbidity, conductivity, flow velocity; BMWP biotic index from macroinvertebrates. Aerial: point counts for birds, Pollard walks for butterflies, bat detectors

for bats, Malaise/light traps for insects. Integrated surveys link species across habitats (dragonflies, herons, bats, kingfishers).

Answers to Pilot Questions [Series 2]

Part 2.1

1. 1 m x 1 m or 0.5 m x 0.5 m for herbaceous vegetation; 10 m x 10 m or 20 m x 20 m for forest trees.
2. Densiometer and hemispherical photographs (or LAI-2000 instrument).
3. Sherman live traps are baited with peanut butter or grain, set along trap lines at dusk, and checked at dawn to minimise stress and mortality.
4. Air temperature, relative humidity, light intensity, soil temperature (or soil moisture, GPS coordinates, slope, aspect).
5. GPS coordinates allow sites to be mapped and precisely relocated for repeat surveys, enabling long-term monitoring of changes in species composition and abundance.

Part 2.2

1. Channel width, water depth, substrate type, degree of riparian shading, and microhabitat types such as riffles and pools.
2. Riffles have fast, aerated, shallow water over coarse gravel, providing high oxygen levels and diverse physical microhabitats that support high invertebrate diversity and abundance.
3. A 500 micron net is held downstream while the sampler disturbs the gravel substrate upstream with their feet for 30 seconds; dislodged invertebrates are swept into the net, emptied into a white tray of water, and sorted and identified.
4. Temperature, dissolved oxygen, pH, and turbidity (or conductivity, flow velocity).
5. The BMWP score sums the sensitivity scores of all macroinvertebrate families present; high scores indicate clean water with sensitive taxa; low scores indicate pollution-tolerant communities; used as a biological measure of stream ecological status.

Part 2.3

1. Birds, bats, and flying insects such as butterflies, dragonflies, and moths.

2. An observer walks a fixed route at a slow, steady pace, recording all butterflies seen within 5 m to each side and 5 m ahead, on suitable weather days (sunshine, low wind).
3. A bat detector converts ultrasonic echolocation calls (above human hearing range) to audible frequencies; the observer walks or stands along a transect at dusk and records bat passes per minute as an index of bat activity.
4. Malaise traps (tent-like structures intercepting flying insects) and light traps (UV lamps attracting nocturnal insects overnight).
5. Dragonflies: larvae develop in ponds and streams but adults fly and hunt in aerial zones. Herons: fly aerially between roost trees and aquatic feeding sites. (Or bats, kingfishers, emergent aquatic insects.)

References and Attribution

Textual References (Books and External Sources)

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Figures, Plates, Tables, and Boxes

- Figure 2.1: Terrestrial field study methods Attribution: AI generated. Suggested OER search string: "terrestrial field sampling vegetation quadrat Sherman trap camera trap environmental variables GPS temperature humidity OER".
- Figure 2.2: Aquatic field study methods Attribution: AI generated. Suggested OER search string: "aquatic field sampling kick net macroinvertebrates water quality BMWP stream survey riffle pool OER".
- Figure 2.3: Aerial fauna observation and sampling Attribution: AI generated. Suggested OER search string: "aerial fauna birds bats butterflies point count Pollard walk Malaise trap mist net habitat linkage field survey OER".

Course code: BIO 307

Course title: Field Course I

Course credit load: 1 Unit

Series 3: Plant and Animal Collection

- **Part 3.1: Plant Collection and Herbarium Preparation**
    - Sub Part 3.1.1: Collecting plant specimens in the field
    - Sub Part 3.1.2: Pressing and drying plant specimens
    - Sub Part 3.1.3: Mounting and labelling herbarium specimens
- **Part 3.2: Animal Collection and Museum Preparation**
    - Sub Part 3.2.1: Collecting animal specimens in the field
    - Sub Part 3.2.2: Preserving and preparing animal specimens
    - Sub Part 3.2.3: Labelling and curating museum specimens
- **Part 3.3: Identification and Classification**
    - Sub Part 3.3.1: Using identification keys
    - Sub Part 3.3.2: Morphological characters for plant and animal identification
    - Sub Part 3.3.3: Voucher specimens and their importance

Introduction

The collection, preservation, and curation of biological specimens is one of the oldest and most enduring practices in biology, underpinning the scientific naming and classification of organisms and providing a permanent physical reference that supports ecological research, conservation assessment, and public education. Herbaria and natural history museums hold millions of specimens collected over centuries, forming an irreplaceable archive of biodiversity that continues to yield new knowledge through re-examination with modern techniques.

This Series covers the practical skills of plant and animal collection and preparation for the herbarium and museum respectively, from the correct method of collecting a plant specimen in the field through pressing, drying, mounting, and labelling, to the methods of animal collection and preservation appropriate to the major groups encountered in local field surveys. It also covers the use of identification keys and morphological characters that allow students to name the organisms they have collected.

Series Learning Outcomes

Upon completing this Series, you should be able to:

- **SLO 3.1** describe the correct methods for collecting, pressing, drying, mounting, and labelling plant specimens for the herbarium,
- **SLO 3.2** describe the correct methods for collecting, preserving, and curating animal specimens for the museum, and
- **SLO 3.3** use dichotomous identification keys and describe the morphological characters used in plant and animal identification.

3.1 Plant Collection and Herbarium Preparation

3.1.1 Collecting plant specimens in the field

A good herbarium specimen should represent all the diagnostic parts of the plant needed for identification: for flowering plants (angiosperms) this means including stems, leaves (both upper and lower surfaces visible), flowers or flower buds, and fruits if present; for trees and shrubs, a shoot approximately 30 to 40 cm long bearing leaves and reproductive structures is collected; for grasses and sedges, the complete culm from base to tip with roots, leaves, and the complete inflorescence is required; specimens are collected using sharp pruning shears or a knife, avoiding torn or damaged tissue that deteriorates rapidly.

Each collected specimen is assigned a unique collection number (the collector name and sequential number, such as Adeyemi 001), which is recorded in the field notebook alongside the collection locality, GPS coordinates, date, habitat description, and any notes on characters visible in the living plant but lost on drying (such as flower colour, scent, bark texture, or latex colour and presence); duplicates of the same specimen are typically collected for exchange with other herbaria; the specimens are placed in a polythene bag with a damp cloth or in a vasculum (a rigid metal collecting cylinder) to prevent wilting before pressing.

Fill in the blank: Each herbarium specimen is assigned a unique _________ number (collector name and sequential number) recorded in the field notebook alongside locality, GPS coordinates, and habitat notes.

3.1.2 Pressing and drying plant specimens

Plant specimens are pressed by arranging them between sheets of folded newspaper within a plant press (two wooden boards with a tightening strap or rope, with sheets of corrugated aluminium or cardboard between layers to allow airflow) as soon as possible after collection; leaves should be arranged to show both upper and lower surfaces, flowers opened or split to reveal internal structures, and fleshy fruits sliced in half to allow drying; the press is tightened and placed in the sun or near a heat source, with newspaper changed daily for the first few days as it becomes saturated with moisture from the specimens.

Most specimens dry within one to two weeks under warm, well-ventilated conditions; specimens dried too slowly develop mould and lose colour and diagnostic characters, while those dried too quickly may become brittle; a drying oven or heated drying box (maintained at 40 to 60 degrees Celsius) accelerates the process and is preferred in humid tropical conditions where air drying is slow; once fully dry, specimens are stiff and retain their form permanently, and should be stored in sealed polythene bags or in the press until mounting to protect them from moisture and insects.

Fill in the blank: A plant press consists of two wooden boards with sheets of corrugated aluminium between specimen layers to allow ________ , which is essential for even drying of the pressed specimens.

3.1.3 Mounting and labelling herbarium specimens

Dry herbarium specimens are mounted on standard herbarium sheets (thick, acid-free white card approximately 42 cm x 29 cm) using archival-quality glue or strips of linen tape; the specimen is arranged attractively but scientifically on the sheet, ensuring diagnostic characters are visible and not obscured; small packets of loose material (seeds, small flowers, or detached parts) are attached in a folded paper packet glued to the sheet; any particularly three-dimensional parts such as large fruits are placed in separate boxes labelled with the same collection number.

The herbarium label (typically 10 cm x 7 cm, printed on acid-free paper) is attached to the lower right corner of the sheet and contains: the institutional name, the collection number, the scientific name (genus, species, and author), the common name if known, the family, the locality and GPS coordinates, the habitat description, the date, and the collector name; the herbarium sheet is then filed in a genus folder within the family cabinet of the herbarium, where it forms a permanent, searchable reference specimen accessible to researchers and students.

Fill in the blank: The herbarium ________ is attached to the lower right corner of the sheet and includes the scientific name, locality, GPS coordinates, habitat, date, and collector name.

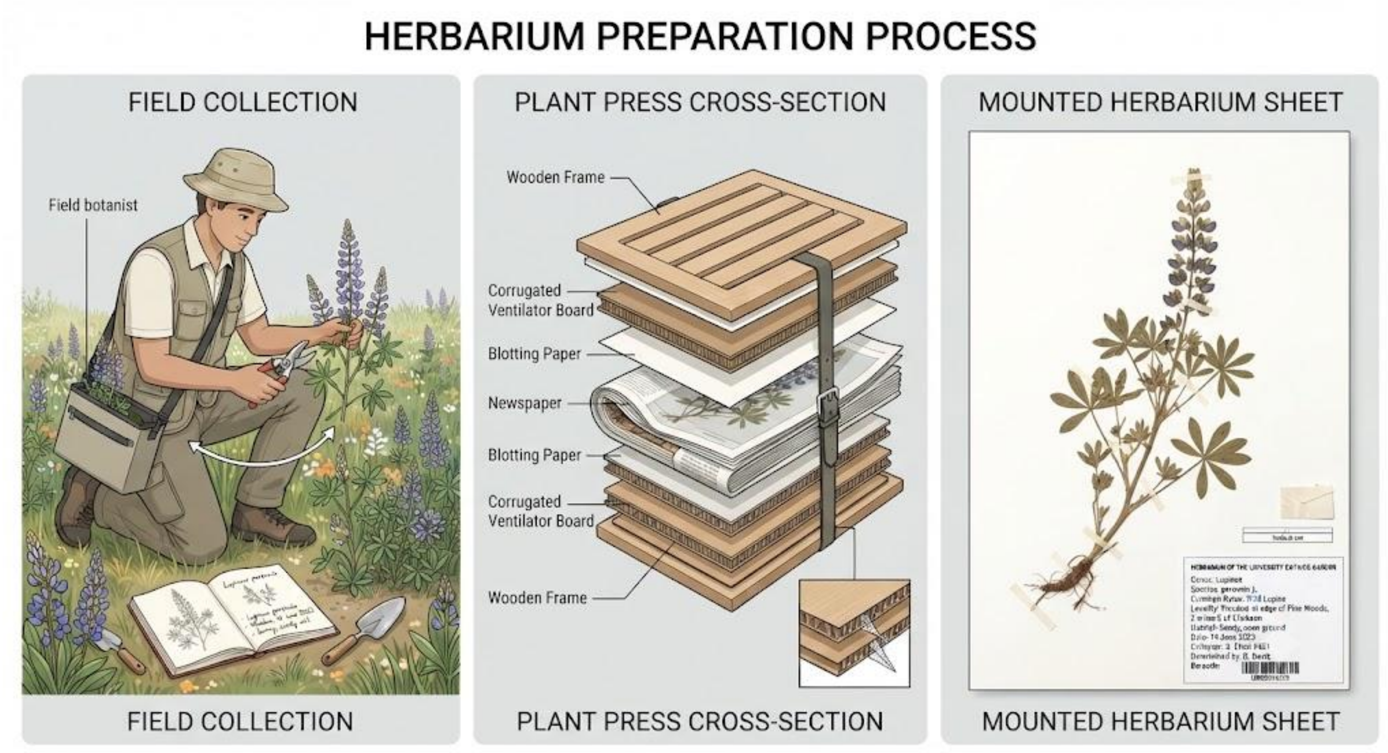

Figure 3.1: Plant collection and herbarium preparation

Pilot questions 3.1

1. Name four plant parts that should be included in a good herbarium specimen of a flowering plant.
2. What is a collection number and what information is recorded alongside it in the field notebook?
3. Describe the components of a plant press and explain the role of the corrugated sheets.
4. Describe how plant specimens are arranged within the press.
5. Name five items of information included on a herbarium label.

3.2 Animal Collection and Museum Preparation

3.2.1 Collecting animal specimens in the field

The method used to collect animal specimens depends on the taxonomic group and the purpose of the collection; invertebrates (insects, spiders, molluscs, and worms) can be collected by hand, with forceps, or using a pooter (an aspirator device that sucks small invertebrates into a collecting tube), a sweep net, or an aquatic net; each specimen is placed in a separate tube of 70 to 95 percent ethanol (for soft-bodied invertebrates) or in a killing jar containing ethyl acetate fumes (for insects to be pinned); reptiles and amphibians are captured by hand or with a noose pole, and specimens requiring preservation are dispatched humanely and fixed in 10 percent formalin.

All collecting must be done in compliance with relevant regulations: endangered and protected species must not be collected; in national parks and forest reserves, special permits are required; the number of specimens collected should be the minimum needed for the scientific purpose, as over-collection can have population-level impacts on rare species; for teaching purposes, where possible, a single representative series of common species should be collected rather than large numbers, and photographic vouchers used in place of physical specimens for any species where physical collection would cause conservation concern.

Fill in the blank: A ________ is an aspirator device that sucks small invertebrates into a collecting tube, useful for collecting small ground-dwelling insects without damaging them.

3.2.2 Preserving and preparing animal specimens

Insects to be pinned as museum specimens are first relaxed (if stiffened after killing) by placing them in a relaxing box (a sealed container with damp sand or wet tissue paper at the bottom and a wire mesh platform above, left for 24 to 48 hours until the specimen is flexible again); the insect is then mounted by passing an entomological pin (sizes 000 to 7, depending on body size) through the thorax at the correct position (through the right side of the mesoscutum for beetles; through the right forewing base for bugs; through the centre of the thorax for flies and wasps) and the wings spread on a spreading board to display them symmetrically before the specimen dries in position.

Vertebrate skins for study skins (small birds and mammals) are prepared by making a ventral incision, removing the body while preserving the skin, skull, and limb bones, stuffing the skin with cotton wool, and sewing it closed in a standardised pose; liquid-preserved specimens (fish, amphibians, reptiles, and invertebrates) are initially fixed in 10 percent formalin for 24 to 48 hours to harden tissues, then transferred to 70 percent ethanol for long-term storage; all specimens must be labelled at the time of collection with a tie-on tag bearing the collection number, date, locality, and collector.

Fill in the blank: Insects to be pinned are first ________ in a sealed box with damp substrate to restore flexibility if they have stiffened after killing, before mounting on an entomological pin.

3.2.3 Labelling and curating museum specimens

Every museum specimen must carry a permanent label bearing the collection number, scientific name (added after identification), locality with GPS coordinates, date of collection, collector name, and collection method; for pinned insects, a small data label (approximately 1.5 cm x 0.5 cm, printed on acid-free card) is pinned below the specimen on the same pin; for liquid-preserved specimens, a label written in pencil (pencil is unaffected by ethanol, unlike ink which fades) is placed inside the jar or vial; study skins carry a tie-on label on one foot bearing the same information.

Museum collections are curated in cabinets or drawers arranged taxonomically by family and genus; pinned insect collections are maintained in insect boxes or glass-fronted drawers with paradichlorobenzene or naphthalene repellent crystals to deter museum pests such as dermestid beetles and psocid booklice, which can destroy pinned collections; liquid collections are stored in sealed jars in cool, dark conditions and checked periodically for ethanol evaporation; a catalogue or database recording all collection data allows specimens to be found, tracked, and cited in publications.

Fill in the blank: Labels inside liquid-preserved specimen jars are written in ________ , which is unaffected by ethanol, unlike ink which fades and becomes illegible over time.

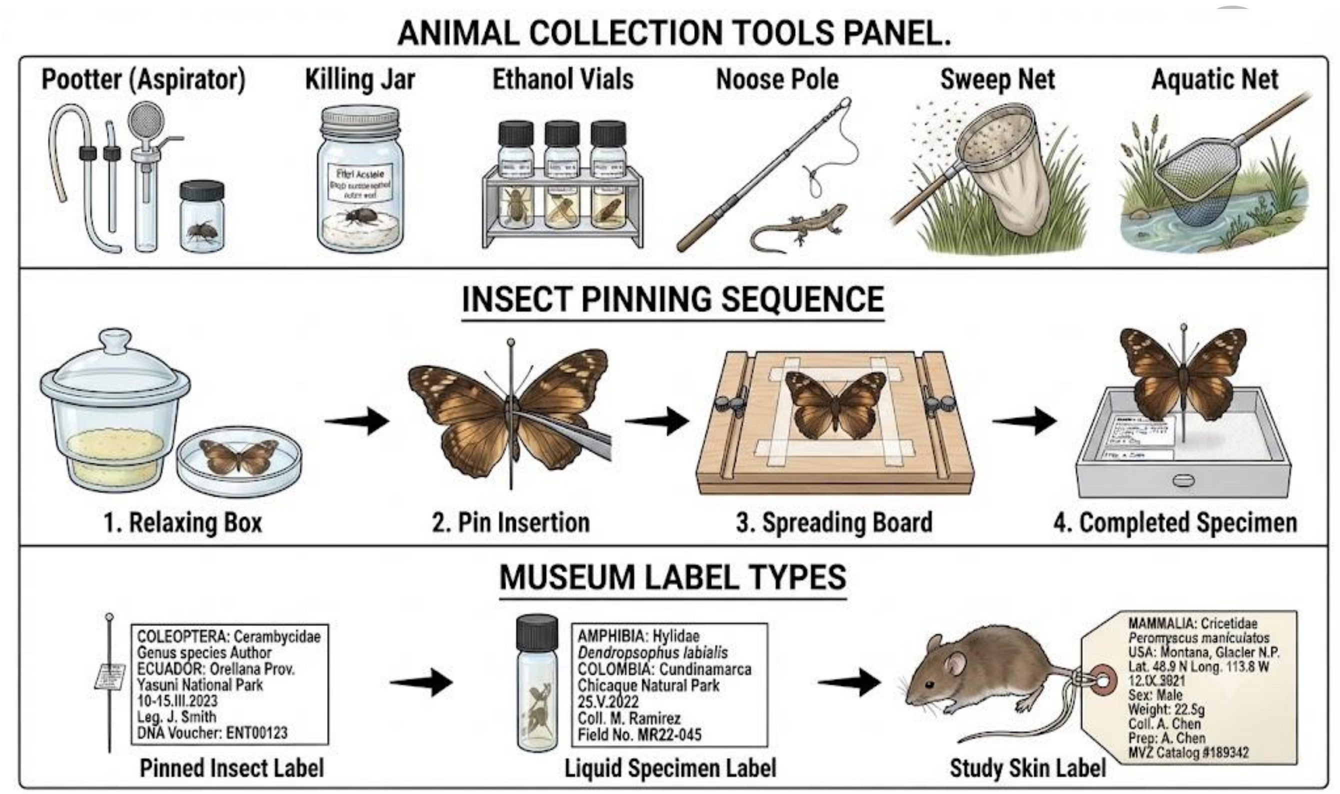

Figure 3.2: Animal collection and museum preparation

Pilot questions 3.2

1. Name three methods used to collect invertebrate specimens in the field.
2. Explain what a relaxing box is and why it is used.
3. Describe how an insect is mounted as a pinned museum specimen.
4. Explain what a study skin is and how it is prepared.
5. Explain why labels inside liquid-preserved jars must be written in pencil.

3.3 Identification and Classification

3.3.1 Using identification keys

A dichotomous identification key is a tool for identifying organisms by presenting a series of paired alternative character statements (a couplet); at each couplet, the user examines the specimen and chooses the statement that matches it, which leads either to a name (if identification is complete) or to the next couplet; the key is worked through sequentially until a name is reached, which should then be verified against a description or illustration to confirm the identification; dichotomous keys exist for most major plant and animal groups in West Africa and Nigeria, though some require specialist literature.

Effective use of identification keys requires careful observation of the specimen, understanding of the technical terms used in the key (which typically describe morphological characters such as leaf arrangement, petal number, wing venation, or antennal structure), and readiness to re-examine earlier couplets if an identification produces an unlikely result; for difficult or unfamiliar groups, working with a reference collection of identified specimens alongside the key greatly accelerates learning and reduces misidentification; photographic field guides can supplement keys for groups where colour and pattern are important diagnostic characters.

Fill in the blank: A ________ identification key presents paired alternative character statements (couplets) at each step, leading the user through a series of choices until a species name is reached.

3.3.2 Morphological characters for plant and animal identification

Plant identification relies primarily on vegetative and reproductive morphological characters: for vegetative characters these include leaf shape (lanceolate, ovate, linear), leaf margin (entire, serrate, lobed), leaf arrangement on the stem (alternate, opposite, whorled), stem cross-section (round, square, triangular), and surface features (glabrous, pubescent, scabrid); for reproductive characters (the most taxonomically reliable), flower structure (petal number and arrangement, sepal number, stamen number, ovary position), inflorescence type (raceme, panicle, umbel, spike), and fruit type (berry, drupe, capsule, legume) are the primary features.

Animal identification uses characters specific to each group: insects are identified by wing number and venation, antennae shape, mouthpart type, leg structure, and body segmentation pattern; birds by plumage colour and pattern, bill shape, leg colour, and wing shape; fish by scale type and arrangement, fin number and position, lateral line structure, and body form; mammals by dentition, body size, pelage colour, and ear and tail characters; accurate identification always requires good magnification (hand lens or dissecting microscope for small invertebrates) and good reference material.

Fill in the blank: Flower structure, inflorescence type, and ________ type (berry, drupe, capsule, legume) are among the most taxonomically reliable characters for plant identification.

3.3.3 Voucher specimens and their importance

A voucher specimen is a preserved specimen deposited in a recognised institutional collection (herbarium or museum) as a permanent, verifiable record of the identification made in a scientific study; when a paper reports on the biology, ecology, or chemistry of a species, a voucher specimen allows any future reader to verify the identification and to re-examine the specimen if the taxonomy is subsequently revised; without voucher specimens, identifications in published literature cannot be verified and may prove unreliable if names have been applied inconsistently.

The collection and deposit of voucher specimens for field study projects is a professional scientific responsibility; students should deposit their collected and identified specimens in the university herbarium or zoological museum with complete label data at the end of the field course, contributing to the institutional reference collection that supports future teaching and research; the voucher number (the institutional accession number assigned when the specimen is deposited) should be cited in any report or paper based on field collections, providing a traceable link between the publication and the physical specimen.

Fill in the blank: A ________ specimen is a preserved specimen deposited in an institutional collection that allows future readers to verify identifications made in scientific studies.

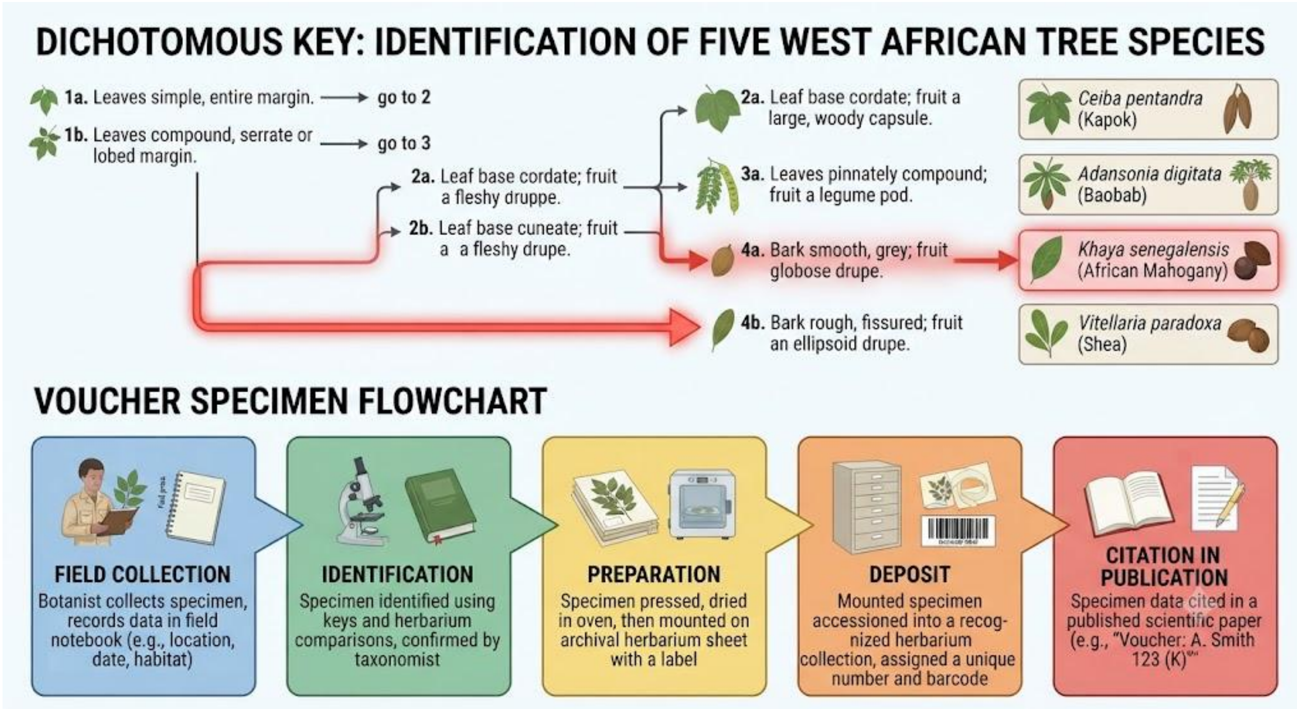

Figure 3.3: Identification keys and voucher specimens

Pilot questions 3.3

1. Explain how a dichotomous identification key works.
2. Name four vegetative morphological characters used in plant identification.
3. Name three morphological characters used to identify insects.
4. Define a voucher specimen and explain why it is important in scientific studies.
5. Explain what information should be cited from a voucher specimen in a scientific report.

Series Summary

This Series covered the complete workflow of biological specimen collection from field to permanent institutional collection. For plants, the process begins with collecting a representative specimen bearing all diagnostic parts, pressing and drying it correctly, and mounting it on an acid-free herbarium sheet with a fully completed label. Each step in the process, from assigning a collection number in the field to filing the finished sheet in the herbarium cabinet, is designed to ensure that the specimen remains informative, verifiable, and accessible for decades or centuries to come.

For animals, collection methods vary by group, from pooters and killing jars for insects through ethanol vials for soft invertebrates to humane dispatch and study skin preparation for vertebrates. Pinning, spreading, and labelling insects, and correctly curating liquid-preserved material, are core practical skills developed during the field course. The ability to use dichotomous keys and recognise the diagnostic morphological characters of plants and animals ties the physical collection work to the identification and classification skills that give specimens their scientific value.

Glossary of Terms

- **Collection number:** a unique identifier (collector name and sequential number) assigned to each specimen collected in the field, linking the specimen to its field notebook record.
- **Dichotomous key:** an identification tool that presents paired alternative character statements at each step, guiding the user to an identification by a series of choices.
- **Herbarium:** an institutional collection of dried, pressed, and mounted plant specimens, arranged systematically and used as a reference for plant identification and research.
- **Killing jar:** a sealed glass jar containing ethyl acetate fumes used to kill insects quickly and without damage before pinning.
- **Pooter (aspirator):** a device used to collect small invertebrates by suction into a collecting tube without handling or damaging them.

- **Relaxing box:** a sealed box with a damp substrate used to restore flexibility to stiffened insect specimens before pinning.
- **Study skin:** a preserved bird or small mammal specimen in which the body has been replaced with cotton wool stuffing while the skin, skull, and bones are retained.
- **Vasculum:** a rigid metal collecting cylinder used to carry fresh plant specimens in the field without wilting.
- **Voucher specimen:** a preserved specimen deposited in a recognised institutional collection to provide a permanent, verifiable reference for an identification used in scientific work.

Concept Check Questions [Series 3]

Objective Questions

1. Each collected plant specimen is assigned a unique ________ number linking it to the field notebook record. (Linked to SLO 3.1)
2. A plant press uses corrugated sheets between specimen layers to allow ________ for even drying. (Linked to SLO 3.1)
3. A ________ is an aspirator device used to collect small invertebrates by suction. (Linked to SLO 3.2)
4. Labels inside liquid-preserved jars must be written in ________ , which is unaffected by ethanol. (Linked to SLO 3.2)
5. A ________ specimen is a preserved institutional deposit that allows future verification of identifications. (Linked to SLO 3.3)

Short-Answer Questions

1. Name four plant parts that should be included in a good herbarium specimen. (Linked to SLO 3.1)
2. Name five items of information on a herbarium label. (Linked to SLO 3.1)
3. Describe how a stiffened insect is prepared for pinning. (Linked to SLO 3.2)
4. Explain how a dichotomous key works. (Linked to SLO 3.3)
5. Define voucher specimen and explain its scientific importance. (Linked to SLO 3.3)

Long-Answer Questions

1. Describe the complete process of collecting, pressing, drying, mounting, and labelling a plant herbarium specimen. (Linked to SLO 3.1)
2. Describe the methods for collecting and preserving animal specimens, and explain the use of identification keys and the importance of voucher specimens. (Linked to SLOs 3.2, 3.3)

Answers to Concept Check Questions [Series 3]

Objective Questions

1. Collection.
2. Airflow.
3. Pooter.
4. Pencil.
5. Voucher.

Short-Answer Questions

1. Stem, leaves (both surfaces), flowers or flower buds, and fruits.
2. Collection number, scientific name, locality and GPS coordinates, date, and collector name (or habitat description, family).
3. Place in a relaxing box (sealed container with damp substrate) for 24 to 48 hours until flexible, then pin through the correct thorax position and spread on a spreading board until dry.
4. The key presents paired alternative character statements at each couplet; the user selects the statement matching the specimen and follows the lead to the next couplet or to a name, repeating until identification is complete.
5. A voucher specimen is a preserved specimen deposited in an institutional collection; it allows future workers to verify identifications and re-examine specimens if taxonomy is revised.

Long-Answer Questions

1. Collect a representative specimen bearing stems, leaves (both surfaces), flowers, and fruits using sharp shears; assign a collection number and record locality, GPS, habitat, and living-plant notes in the field notebook; place in a polythene bag with damp cloth. Press in a plant press between newspaper layers with corrugated sheets for airflow; change newspaper daily; dry for one to two weeks. Mount on acid-free herbarium sheet with archival glue; attach a paper packet for loose parts; complete and attach a herbarium label with all required fields to the lower right corner; file in the herbarium.
2. Invertebrates: collected by pooter, sweep net, or aquatic net; preserved in ethanol (soft-bodied) or killed in killing jar (insects for pinning). Insects: relaxed in damp box, pinned

through correct thorax position, spread on spreading board, data label added. Vertebrates: fixed in formalin then stored in ethanol; study skins stuffed with cotton wool. All labelled at collection with collection number. Identification: dichotomous keys using morphological characters (leaf arrangement, flower structure for plants; wing venation, antennae for insects). Voucher specimens deposited in herbarium or museum with full label data; voucher number cited in reports.

Answers to Pilot Questions [Series 3]

Part 3.1

1. Stems, leaves (showing both upper and lower surfaces), flowers or flower buds, and fruits.
2. A collection number is the collector name and sequential number assigned to each specimen; alongside it in the field notebook are recorded locality, GPS coordinates, date, habitat description, and notes on living characters lost on drying.
3. A plant press has two wooden boards with a tightening strap; sheets of corrugated aluminium are placed between specimen layers to allow airflow for even drying.
4. Leaves are arranged to show both upper and lower surfaces; flowers are opened to show internal structures; fleshy fruits are sliced in half to allow drying.
5. Scientific name, locality with GPS coordinates, date, collector name, and habitat description (or collection number, family, common name, institution name).

Part 3.2

1. By hand or forceps, with a pooter (aspirator), or with a sweep net or aquatic net.
2. A relaxing box is a sealed container with a damp substrate (sand or tissue paper) and a wire mesh platform; stiffened insects are placed on the platform for 24 to 48 hours until flexibility is restored for pinning.
3. The pin is inserted through the correct thorax position for the insect group; the specimen is placed on a spreading board and wings are spread symmetrically and pinned in position until the specimen dries completely.

4. A study skin is a preserved bird or small mammal in which the body is replaced by cotton wool stuffing while the skin, skull, and bones are retained; prepared by making a ventral incision, removing the body, stuffing, and sewing closed in a standardised pose.
5. Pencil is unaffected by ethanol; ink dissolves, runs, and becomes illegible when immersed in ethanol over time.

Part 3.3

1. A dichotomous key presents paired alternative character statements at each step; the user selects the statement matching the specimen and follows to the next couplet or to a name, repeating until identification is complete; the result is verified against a description or illustration.
2. Leaf shape, leaf margin, leaf arrangement on the stem, and stem cross-section (or surface features such as glabrous or pubescent).
3. Wing number and venation, antennae shape, and mouthpart type (or leg structure, body segmentation).
4. A voucher specimen is a preserved specimen deposited in a recognised institutional collection; it provides a permanent, verifiable record that allows identifications used in scientific publications to be checked and re-examined.
5. The institutional accession number (voucher number) assigned when the specimen was deposited; this provides a traceable link between the publication and the physical specimen.

References and Attribution

Textual References (Books and External Sources)

- Bridson, D., & Forman, L. (Eds.). (1998). The herbarium handbook (3rd ed.). Royal Botanic Gardens, Kew.
- Stace, C. A. (2010). New flora of the British Isles (3rd ed.). Cambridge University Press.
- Hawksworth, D. L. (Ed.). (1974). The changing flora and fauna of Britain. Academic Press.
- National Open University of Nigeria (NOUN). (2023). Field course I course material. NOUN Press.

Figures, Plates, Tables, and Boxes

- Figure 3.1: Plant collection and herbarium preparation Attribution: AI generated. Suggested OER search string: "herbarium specimen collection plant press mounting label field botany collection number voucher OER".
- Figure 3.2: Animal collection and museum preparation Attribution: AI generated. Suggested OER search string: "insect collection pinning museum preparation study skin liquid preservation herbarium label pooter killing jar OER".
- Figure 3.3: Identification keys and voucher specimens Attribution: AI generated. Suggested OER search string: "dichotomous key plant identification morphological characters voucher specimen herbarium museum taxonomy OER".

Course code: BIO 307

Course title: Field Course I

Course credit load: 1 Unit

Series 4: Institutes and Industry Visits

- **Part 4.1: Research Institutes Relevant to Biology**
  - Sub Part 4.1.1: Types and roles of biological research institutes
  - Sub Part 4.1.2: Preparing for and conducting an institute visit
  - Sub Part 4.1.3: Key observations and information to gather
- **Part 4.2: Industry Visits**
  - Sub Part 4.2.1: Industries relevant to biology
  - Sub Part 4.2.2: Conducting an industry visit
  - Sub Part 4.2.3: Linking industry practice to biological principles
- **Part 4.3: Documenting and Reflecting on Visits**
  - Sub Part 4.3.1: Recording observations during visits
  - Sub Part 4.3.2: Writing a visit report
  - Sub Part 4.3.3: Reflecting on the significance of the visit

Introduction

Biology is not confined to the classroom and the field; it is also practised in research institutes, government agencies, hospitals, agricultural stations, food processing plants, pharmaceutical companies, and many other institutional and industrial settings. Visiting these institutions exposes students to the breadth of career paths open to biology graduates and to the practical applications of the biological principles and field skills developed during this course, demonstrating how science moves from the field and laboratory to societal benefit.

This Series prepares students to gain maximum value from visits to research institutes and industries by covering the range of biological institutions visited, the preparation required before a visit, the observations and information that should be gathered during it, and the documentation and reflection required afterwards. Correct recording during visits and well-structured written reports are assessed components of the field course and form part of the group report submitted at the end of the course.

Series Learning Outcomes

Upon completing this Series, you should be able to:

- **SLO 4.1** describe the types and roles of biological research institutes and explain how to prepare for and conduct an institute visit,
- **SLO 4.2** identify industries relevant to biology, explain how to conduct an industry visit, and link industry practice to biological principles, and
- **SLO 4.3** demonstrate correct observation recording during visits and produce a well-structured visit report with appropriate reflection.

4.1 Research Institutes Relevant to Biology

4.1.1 Types and roles of biological research institutes

Biological research institutes in Nigeria encompass a wide range of specialisations relevant to different areas of biology; examples include the Nigerian Institute for Oceanography and Marine Research (NIOMR, Lagos), focusing on fisheries, marine biology, and aquatic resources; the Forestry Research Institute of Nigeria (FRIN, Ibadan), focusing on forest ecology, wood science, and agroforestry; the Institute for Agricultural Research (IAR, Zaria), working on crop improvement and pest management; the Nigerian Institute for Medical Research (NIMR, Lagos), conducting research on infectious diseases; and various university research centres and botanical gardens that maintain reference collections and conduct ecological and taxonomic research.

The primary roles of biological research institutes include conducting original scientific research relevant to national development priorities, maintaining reference collections (herbaria, museum collections, gene banks), providing technical expertise and advisory services to government and industry, training researchers and technicians, and publishing scientific results that advance knowledge and inform policy; understanding the mandate and work of an institute before a visit allows students to ask informed questions and make the most of the opportunity to see science in action beyond the university campus.

Fill in the blank: The Forestry Research Institute of Nigeria (FRIN), located in ________ , focuses on forest ecology, wood science, and agroforestry, among other specialisations relevant to field biology.

4.1.2 Preparing for and conducting an institute visit

Effective preparation for an institute visit includes: reading about the institute mandate, research programmes, and recent publications before the visit, so that students arrive with background knowledge that enables them to understand what they see and ask relevant questions; preparing a list of specific questions to ask the host scientists about the institute work, the career paths of staff, the methods they use, and the challenges they face; and being briefed by the course coordinator on the specific learning objectives for the visit and the documentation required.

During the visit, students should listen attentively to presentations and guided tours, take organised notes covering the institute mandate, facilities observed, research methods demonstrated, and careers of host scientists, and ask questions from their prepared list as well as spontaneous questions arising from what they see; photographs (where permitted) of facilities, equipment, and collections provide useful documentation for the visit report; students should maintain professional conduct throughout, representing the university appropriately and adhering to any safety or access rules the institute specifies.

Fill in the blank: Before an institute visit, students should prepare a list of specific ________ to ask host scientists about the institute work, career paths, methods used, and research challenges.

4.1.3 Key observations and information to gather

During a research institute visit, the key information to gather includes: the institute mandate and main research areas; the major facilities available (laboratories, greenhouses, field stations, herbarium or museum collections, analytical equipment); the current research projects being conducted and their objectives; the scientific methods routinely used and any specialist equipment or techniques observed; the practical outputs of the institute work (new crop varieties, management guidelines, conservation recommendations, published data); and the career backgrounds and roles of the scientists met.

Students should pay particular attention to connections between what they observe at the institute and topics covered in their biology courses, noting how field sampling methods, specimen collection, identification, and ecological analysis are applied in the context of professional research; the herbarium or museum collections at institutes such as FRIN are particularly informative, allowing students to compare the professional standards of institutional collections with the specimens they have prepared during the field course; these connections strengthen the contextual understanding of both the institute work and the course content.

Fill in the blank: Students should note connections between institute observations and their biology courses, recognising how ________ sampling, specimen collection, and ecological analysis are applied in professional research contexts.

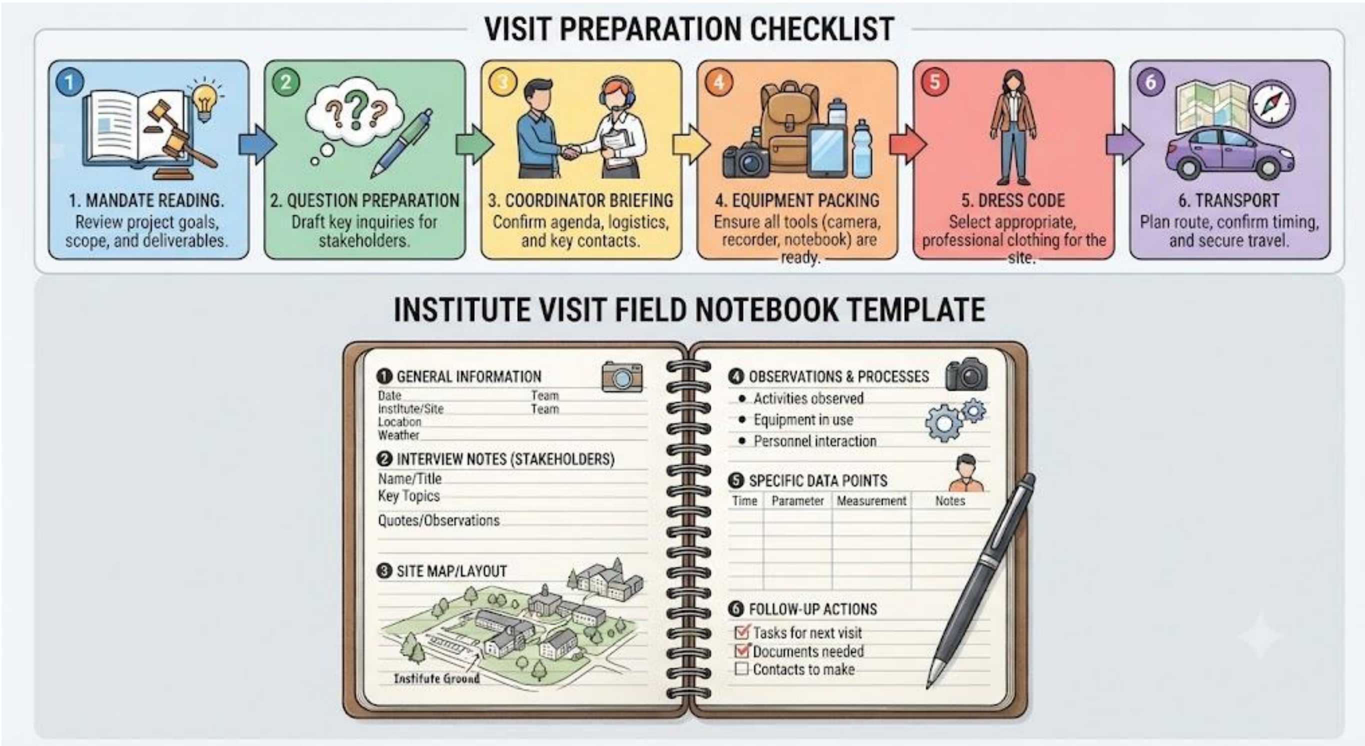

Figure 4.1: Research institute visit preparation and observation

Pilot questions 4.1

1. Name three biological research institutes in Nigeria and state the main focus of each.
2. Name three roles that biological research institutes typically perform.
3. State three things a student should do to prepare for a research institute visit.
4. Name four categories of information a student should gather during an institute visit.
5. Explain why connections between institute observations and course content are important to note.

4.2 Industry Visits

4.2.1 Industries relevant to biology

Many industries depend directly on biological knowledge and employ biology graduates in technical, research, management, and advisory roles; the major industries relevant to biology students in Nigeria include: food processing and beverage industries (applying microbiology, food science, and quality control in the production of processed foods, palm oil, beer, soft drinks, and dairy products); pharmaceutical and healthcare industries (applying biochemistry, microbiology, and pharmacology in drug production, quality testing, and clinical services); agricultural production and agro-processing (applying plant biology, animal science, soil science, and pest management in crop and livestock production and processing).

Additional relevant industries include the timber and wood products industry (applying forest ecology, tree physiology, and wood science); fish farming and aquaculture (applying aquatic biology, fish physiology, and environmental management); environmental consulting and impact assessment (applying ecology, environmental chemistry, and regulatory biology); and conservation organisations and national parks (applying field biology, ecology, and wildlife management); visiting one or more of these industries during the field course exposes students to the breadth of professional contexts in which biological knowledge is applied.

Fill in the blank: Food processing industries apply ________ , food science, and quality control in the production of processed foods, while pharmaceutical industries apply biochemistry and microbiology in drug production.

4.2.2 Conducting an industry visit

The same preparation principles that apply to research institute visits apply to industry visits: students should research the company or industry sector before the visit (understanding what products or services are produced, what biological processes are involved, and the scale of the operation); prepare specific questions relating to how biological knowledge is applied in the industry, what quality control or safety measures are used, what career roles are available to biology graduates, and what challenges or regulatory requirements the industry faces; and receive a pre-visit briefing from the course coordinator on the specific learning objectives for that particular industry.

Industrial facilities often have strict safety and hygiene requirements, particularly in food processing and pharmaceutical manufacturing, so students must comply precisely with all instructions regarding protective clothing, restricted areas, photography restrictions, and behaviour; the visit may include a guided tour of production areas, a presentation by company staff, a demonstration of specific processes or equipment, and an opportunity for questions; students should record all observations in their field notebooks during the visit, noting the biological principles that underlie each process observed.

Fill in the blank: Industrial facilities, particularly food processing and pharmaceutical plants, have strict ________ and hygiene requirements that visiting students must comply with precisely during the tour.

4.2.3 Linking industry practice to biological principles

Every industrial process in biology-related industries is underpinned by specific biological principles; in a brewery or soft drink plant, fermentation by yeast or other microorganisms is the core biological process, applying microbial physiology and biochemistry; in a pharmaceutical facility, the production of antibiotics, vaccines, or diagnostic reagents applies microbiology, cell biology, and biochemical techniques; in a fish farm, water quality management applies aquatic ecology and fish physiology, while feed formulation applies animal nutrition and biochemistry.

Students should actively seek these connections during the visit, asking guide staff which biological principles underlie the processes observed and noting in their field notebooks both the industrial process and the underlying biology; this exercise reinforces that biology is not an academic abstraction but a practical science with direct economic and social applications, and prepares students to communicate biological knowledge effectively in professional contexts; these connections also form the core analytical content expected in the industry visit section of the group field report.

Fill in the blank: In a fish farm, water quality management applies ________ ecology and fish physiology, while feed formulation applies animal nutrition and biochemistry.

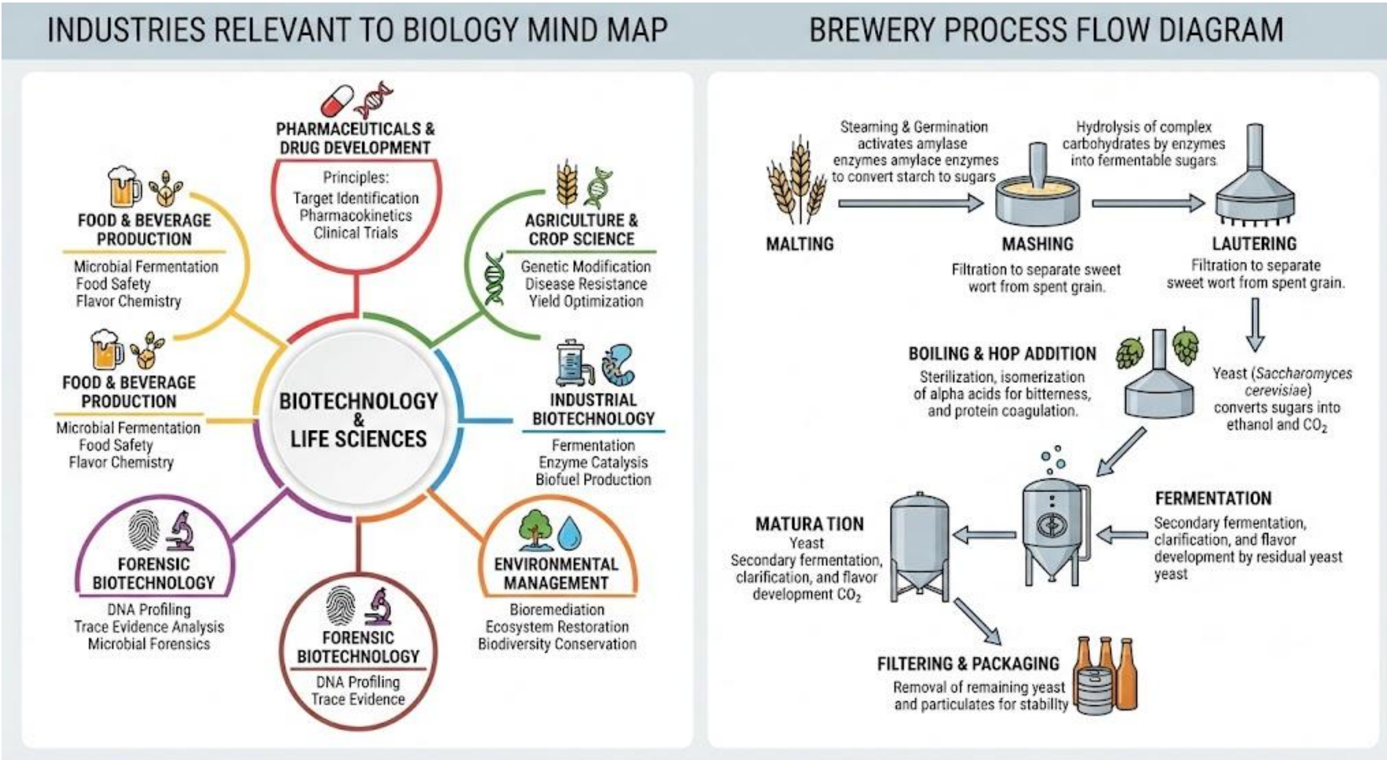

Figure 4.2: Industry visit and biological connections

Pilot questions 4.2

1. Name four industries in Nigeria that are relevant to biology and state one biological principle applied in each.
2. State three things a student should research before an industry visit.
3. Explain why students must comply strictly with safety and hygiene requirements during industrial visits.
4. Give two examples of biological principles that underlie processes in a food processing plant.
5. Explain why linking industry processes to biological principles is important for the field report.

4.3 Documenting and Reflecting on Visits

4.3.1 Recording observations during visits

Effective note-taking during visits requires active listening and organised recording; students should record observations under clear headings in their field notebooks (or on a prepared visit observation template) rather than attempting to transcribe everything said, focusing on key facts, notable features, and observations that connect to course content; useful notes include: the name and mandate of the institution or company, the names and roles of staff who present, specific processes or techniques demonstrated, equipment observed, collections or specimens seen, and career information shared.

Photographs taken during the visit (where permitted) should be organised immediately after the visit by labelling each image with a caption and linking it to the corresponding section of the visit notes; sketches or diagrams drawn during the visit (of equipment layouts, process flows, or specimen structures) are valuable supplements to written notes and photographs; all raw visit notes should be treated as primary data and retained alongside the polished visit report; noting questions that arose during the visit but could not be asked (due to time constraints) provides useful material for follow-up research in preparing the written report.

Fill in the blank: During visits, students should record observations under clear ________ in their field notebooks, focusing on key facts and connections to course content rather than attempting to transcribe everything said.

4.3.2 Writing a visit report

A visit report is a structured written account of what was observed and learned during an institute or industry visit, forming part of the group field report submitted at the end of the course; a well-structured visit report includes: an introduction identifying the institution or company visited, the date, and the purpose of the visit; a background section summarising the mandate and work of the institution or the products and processes of the industry (based on pre-visit research and visit observations); a main body describing what was observed, demonstrated, or explained during the visit in an organised, logical sequence.

The report should also include an analysis section in which biological principles underlying the observed processes are explained and linked explicitly to relevant course content; a section on career relevance noting which career paths in biology are supported by the work of the institution or industry; and a conclusion summarising the key lessons learned from the visit; the report should be written in formal, scientific prose, citing any sources used in the background or analysis sections, and submitted with the field notebook pages covering the visit attached as an appendix.

Fill in the blank: A visit report should include an analysis section that explains the ________ principles underlying observed processes and links them explicitly to relevant biology course content.

4.3.3 Reflecting on the significance of the visit

Reflection is the process of thinking critically about what was experienced and learned during the visit, beyond simply describing what was seen; effective reflection asks: What did the visit reveal about how biological knowledge is applied beyond the university? What connections between the visit and previous study were most surprising or informative? What questions did the visit raise that were not answered? Which aspects of the biology career landscape are better understood now than before? How has the visit changed or reinforced the student understanding of what professional biology looks like?

Reflective statements in the visit report or in a personal journal entry demonstrate that learning has occurred at a deeper level than factual recall, and are increasingly valued in assessment of professional and scientific competence; a good reflective statement is specific (referring to particular observations or conversations from the visit, not vague generalisations), analytical (explaining why the observation is significant rather than just noting that it was interesting), and forward-looking (identifying how the learning will influence the student future study or career thinking); reflection developed during the field course builds a habit of evidence-based self-evaluation that is fundamental to scientific and professional practice.

Fill in the blank: A good reflective statement is ________ (referring to particular observations), analytical (explaining their significance), and forward-looking (identifying their influence on future study or career thinking).

Figure 4.3: Visit documentation and reporting

Pilot questions 4.3

1. State four categories of information to record in field notes during a visit.
2. Explain how photographs taken during a visit should be organised after the visit.
3. Name the main sections of a well-structured visit report.
4. Explain what the analysis section of a visit report should contain.
5. Explain what makes a reflective statement good, using three criteria.

Series Summary

This Series prepared students to gain maximum benefit from visits to research institutes and industry as part of the field course. Research institutes such as FRIN, NIOMR, and NIMR carry out specialised biological research of national importance, maintain reference collections, and offer insights into professional scientific careers. Effective institute visits require advance preparation, including reading the institute mandate and preparing a question list, active and organised note-taking during the visit, and clear documentation of observed facilities, methods, and career paths.

Industry visits reveal the direct economic and social application of biological knowledge across food processing, pharmaceutical production, aquaculture, and environmental management. Understanding which biological principles underlie each industrial process observed, and documenting these connections explicitly, forms the core analytical content of the visit report. Writing well-structured reports with genuine reflection on the significance of what was seen completes the learning cycle, developing the professional communication and self-evaluation skills that are as essential to a career in biology as the field and laboratory techniques covered in the rest of this course.

Glossary of Terms

- **Environmental impact assessment (EIA):** a formal process for evaluating the potential environmental effects of a proposed development or industrial activity, drawing on ecological, biological, and chemical expertise.
- **FRIN (Forestry Research Institute of Nigeria):** a federal research institute in Ibadan focused on forest ecology, wood science, and agroforestry.
- **Group field report:** the collective written report submitted by a student group at the end of the field course, incorporating visit accounts, field data, specimen records, and reflections.
- **NIOMR (Nigerian Institute for Oceanography and Marine Research):** a federal research institute in Lagos focused on fisheries, marine biology, and aquatic resources.

- **NIMR (Nigerian Institute for Medical Research):** a federal research institute in Lagos conducting research on infectious diseases and public health.
- **Reflection:** the process of critically thinking about an experience to identify what was learned, why it matters, and how it influences future thinking or action.
- **Visit report:** a structured written account of observations and learning from an institute or industry visit, submitted as part of the field course assessment.

Concept Check Questions [Series 4]

Objective Questions

1. The Forestry Research Institute of Nigeria (FRIN) is located in ________ . (Linked to SLO 4.1)
2. Before an institute visit, students should prepare a list of specific ________ to ask host scientists. (Linked to SLO 4.1)
3. Food processing industries apply microbiology, food science, and ________ control to their production processes. (Linked to SLO 4.2)
4. During visits, observations should be recorded under clear ________ in the field notebook rather than transcribing everything said. (Linked to SLO 4.3)
5. A good reflective statement is specific, analytical, and ________ -looking, identifying how learning will influence future study or career thinking. (Linked to SLO 4.3)

Short-Answer Questions

1. Name three biological research institutes in Nigeria and state one function of each. (Linked to SLO 4.1)
2. State three things a student should do before an institute or industry visit. (Linked to SLO 4.1)
3. Name four industries relevant to biology and give one example biological principle applied in each. (Linked to SLO 4.2)
4. Name the main sections of a visit report. (Linked to SLO 4.3)
5. Explain what makes a reflective statement effective. (Linked to SLO 4.3)

Long-Answer Questions

1. Describe the types and roles of biological research institutes in Nigeria and explain how to prepare for and conduct an institute visit. (Linked to SLO 4.1)
2. Describe how to conduct an industry visit and how to document and reflect on the experience in a structured visit report. (Linked to SLOs 4.2, 4.3)

Answers to Concept Check Questions [Series 4]

Objective Questions

1. Ibadan.
2. Questions.
3. Quality.
4. Headings.
5. Forward.

Short-Answer Questions

1. FRIN (forest ecology and agroforestry research), NIOMR (fisheries and marine biology), NIMR (infectious disease research).
2. Read the institute mandate and publications, prepare a question list, and receive a pre-visit briefing from the course coordinator.
3. Food processing (fermentation/microbiology), pharmaceutical (biochemistry/drug production), aquaculture (aquatic ecology/fish physiology), environmental consulting (ecology/EIA).
4. Introduction, background, observations, analysis (biological principles), career relevance, conclusion, references, appendix.
5. Specific (refers to particular observations), analytical (explains why the observation is significant), and forward-looking (identifies how learning influences future study or career thinking).

Long-Answer Questions

1. Nigerian biological research institutes include FRIN (forest ecology), NIOMR (marine biology), NIMR (medical research), IAR (crop improvement), and university centres. Their roles include conducting research, maintaining reference collections, providing technical advice, and training researchers. Preparation: read institute mandate, prepare questions, receive coordinator briefing, pack notebook and camera. During visit: take organised notes under headings, ask questions, photograph where permitted, note connections to course content.

2. Industry visits require the same preparation as institute visits: research the company, prepare questions about biological principles applied, comply strictly with safety and hygiene requirements. Link each process observed to its underlying biology (e.g. fermentation in breweries, water quality in fish farms). Document in field notebook with headings, captions, and sketches. Visit report: introduction, background, observations, analysis of biological principles, career relevance, conclusion. Reflection should be specific, analytical, and forward-looking.

Answers to Pilot Questions [Series 4]

Part 4.1

1. FRIN (forest ecology and wood science), NIOMR (fisheries and marine biology), NIMR (infectious disease and public health).
2. Conducting original scientific research, maintaining reference collections (herbaria/museums), and providing technical advisory services to government and industry.
3. Read the institute mandate and recent publications, prepare a question list, and receive a pre-visit briefing from the course coordinator.
4. Institute mandate and research areas, facilities available, current research projects, methods and equipment used (or career profiles of scientists met, practical outputs of research).
5. Noting these connections reinforces understanding of how theoretical knowledge is applied in practice, strengthens contextual learning, and provides the analytical content needed for the visit report.

Part 4.2

1. Food processing (fermentation/microbiology), pharmaceutical (biochemistry/microbiology), aquaculture (aquatic ecology/fish physiology), timber/forestry (forest ecology/wood science).
2. What products or services are produced, what biological processes are involved, and what career roles are available to biology graduates.
3. Failure to comply with safety requirements could endanger students and staff; in food and pharmaceutical plants, hygiene breaches could contaminate products, creating legal and public health consequences.

4. Fermentation by yeast (applying microbial physiology and biochemistry) and quality control microbiological testing (applying microbiology).
5. Linking processes to biological principles demonstrates analytical understanding rather than mere description, which is the core requirement of the analysis section of the group field report.

Part 4.3

1. Institution name and mandate, host staff names and roles, key facilities and processes observed, and biological principles connected to each process (or questions arising and career information).
2. Each photograph should be labelled with a caption and linked to the relevant section of the visit notes immediately after the visit, before details are forgotten.
3. Introduction, background, observations, analysis (biological principles), career relevance, conclusion, references, and appendix (field notebook pages).
4. The analysis section explains the biological principles underlying each observed process and links them explicitly to relevant biology course content studied in lectures or practicals.
5. Specific (refers to a particular observation from the visit), analytical (explains why the observation is significant, not just that it was interesting), and forward-looking (identifies how the learning will influence future study choices or career thinking).

References and Attribution

Textual References (Books and External Sources)

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- National Open University of Nigeria (NOUN). (2023). Field course I course material. NOUN Press.

Figures, Plates, Tables, and Boxes

- Figure 4.1: Research institute visit preparation and observation Attribution: AI generated. Suggested OER search string: "research institute visit biology Nigeria FRIN NIOMR NIMR field course visit preparation observation recording OER".
- Figure 4.2: Industry visit and biological connections Attribution: AI generated. Suggested OER search string: "biology industry visit food processing pharmaceutical aquaculture fermentation biological principles Nigeria field course OER".
- Figure 4.3: Visit documentation and reporting Attribution: AI generated. Suggested OER search string: "institute industry visit report structure field notebook observation recording biology Nigeria field course OER".

Course code: BIO 307

Course title: Field Course I

Course credit load: 1 Unit

Series 5: Assessment and Reporting Methods

- **Part 5.1: Field Course Assessment Structure**
  - Sub Part 5.1.1: Components of field course assessment
  - Sub Part 5.1.2: Continuous assessment during the field course
  - Sub Part 5.1.3: Practical and oral assessment
- **Part 5.2: Group Field Report Writing**
  - Sub Part 5.2.1: Structure of the group field report
  - Sub Part 5.2.2: Presenting field data and specimen records
  - Sub Part 5.2.3: Common weaknesses and how to avoid them
- **Part 5.3: Final Submission and Professional Standards**
  - Sub Part 5.3.1: Referencing and academic integrity
  - Sub Part 5.3.2: Submission requirements and deadlines
  - Sub Part 5.3.3: Professional standards in field biology reporting

Introduction

The skills developed throughout this field course, from sampling techniques to specimen collection to institute visits, culminate in a structured assessment process that evaluates both practical competence and the ability to communicate field findings professionally.

Understanding how the field course is assessed and how to produce a well-structured group field report is essential for translating fieldwork into academic credit and for developing the reporting skills required throughout a career in biology.

This Series covers the components of field course assessment, including continuous assessment, practical and oral components, and the final group report; the structure and content expected in the group field report, including how field data and specimen records should be presented; and the professional standards of referencing, academic integrity, and presentation that apply to scientific reporting in biology, equipping students to complete the course with a polished, properly documented record of their field experience.

Series Learning Outcomes

Upon completing this Series, you should be able to:

- **SLO 5.1** describe the components of field course assessment, including continuous, practical, and oral assessment,
- **SLO 5.2** describe the structure of the group field report and present field data and specimen records appropriately, and
- **SLO 5.3** apply correct referencing and academic integrity standards and meet submission requirements to professional scientific standards.

5.1 Field Course Assessment Structure

5.1.1 Components of field course assessment

Field course assessment typically combines several components that together evaluate practical skill, knowledge application, and communication ability; continuous assessment (marks awarded throughout the course for participation, data sheet quality, specimen collection and preparation standard, and adherence to safety and ethical conduct) typically contributes a significant proportion of the total mark, reflecting the importance of consistent, careful practice throughout the field period rather than performance on a single assessment event.

The group field report (a comprehensive written account of the entire field course, covering sampling methods used, data collected, specimens prepared, and institute and industry visits) is usually the largest single assessment component; an individual oral assessment or viva (in which each student is questioned individually on field techniques, specimen identification, and course content to confirm individual understanding within the group effort) and a practical identification test (in which students must correctly identify a set of specimens using keys and reference material) typically complete the assessment package.

Fill in the blank: ________ assessment, covering participation, data sheet quality, and specimen preparation standard, typically contributes a significant proportion of the total field course mark.

5.1.2 Continuous assessment during the field course

Continuous assessment during the field course is based on direct observation by instructors of student performance in the field, including correct application of sampling techniques, accuracy and completeness of data sheet recording, safe and ethical conduct, teamwork and contribution to group activities, and care in specimen handling and preparation; instructors typically use a structured rubric covering these criteria, awarding marks at the end of each field session or at defined checkpoints during the course.

Students should be aware that continuous assessment rewards consistent good practice rather than occasional excellence; arriving prepared for each field session, following safety protocols without prompting, recording complete and accurate data at the time of collection (rather than reconstructing it later), and actively participating in group sampling and specimen preparation activities all contribute positively to continuous assessment marks; conversely, incomplete data sheets, poor specimen preparation, and unsafe or unethical conduct directly reduce these marks.

Fill in the blank: Continuous assessment rewards ________ good practice throughout the field course rather than occasional excellence, based on direct instructor observation against a structured rubric.

5.1.3 Practical and oral assessment

The practical identification test assesses a student ability to correctly name specimens collected during the field course (or comparable reference specimens) using dichotomous keys, reference guides, and morphological knowledge gained during the course; students are typically presented with a set of unknown specimens (plants, insects, or other organisms covered during the course) and must identify each to the appropriate taxonomic level within a defined time, recording the diagnostic characters used to reach each identification.

The oral assessment (viva voce) is an individual interview in which an examiner asks each student questions about field techniques used, the rationale for specific methods, the biological significance of observations made during the course, and their personal contribution to group activities; the oral assessment is particularly important for confirming that the group field report and continuous assessment reflect genuine individual understanding and participation, since the written report is necessarily a group product; students should be prepared to discuss any part of the course content and their own specific field experiences in detail.

Fill in the blank: The oral assessment (viva voce) confirms that the group ________ and continuous assessment reflect genuine individual understanding, since the written report is necessarily a group product.

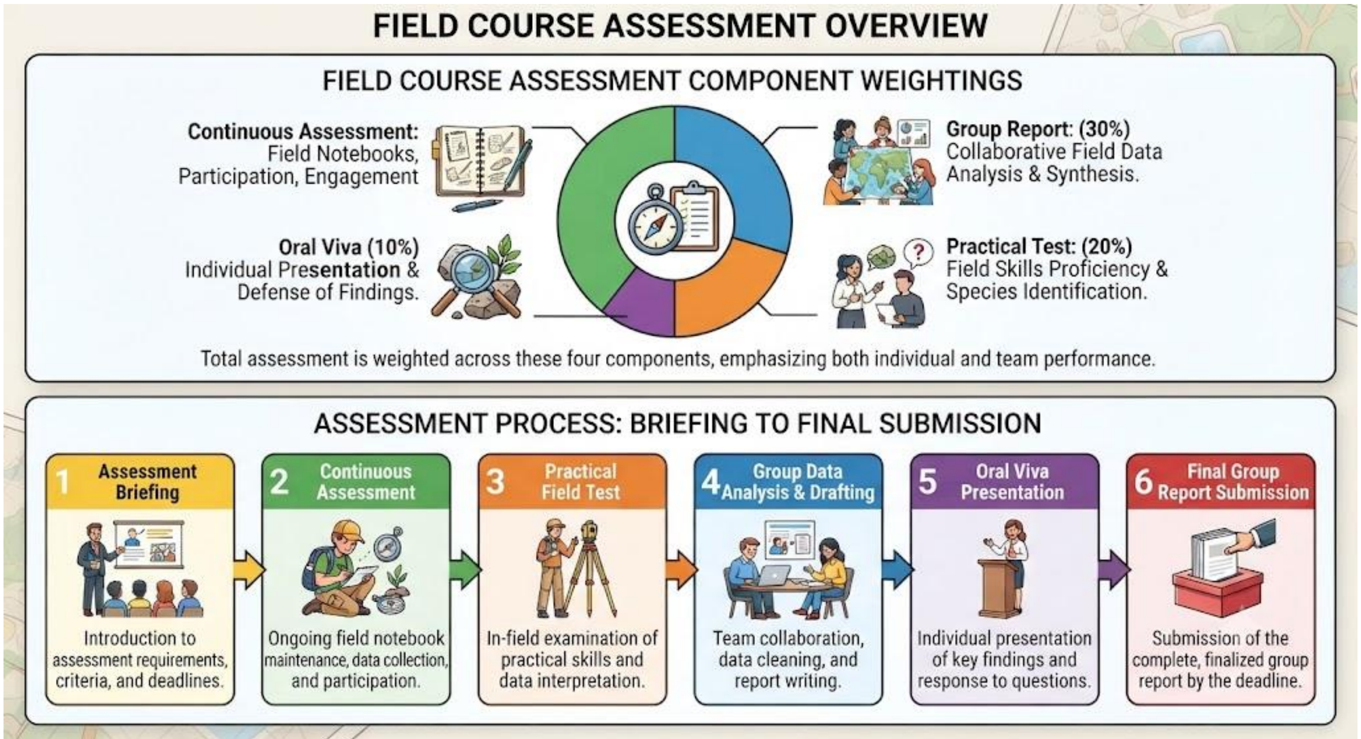

Figure 5.1: Field course assessment structure

Pilot questions 5.1

1. Name four components of field course assessment.
2. Explain what continuous assessment evaluates and how it is typically awarded.
3. Name three behaviours that positively contribute to continuous assessment marks.
4. Describe what is tested in a practical identification test.
5. Explain the purpose of the oral assessment (viva voce).

5.2 Group Field Report Writing

5.2.1 Structure of the group field report

A well-structured group field report typically includes: a title page (course code and title, group members names and matriculation numbers, field course dates and locations, submission date); a table of contents; an introduction stating the aims and objectives of the field course; a methods section describing the sampling techniques, equipment, and study sites used (referring to the methods covered in earlier Series of this course); a results section presenting the data collected, organised by habitat or sampling method.

Further sections typically include: a specimen list (an annotated inventory of all plant and animal specimens collected, identified, and prepared during the course, with collection numbers and identifications); an institute and industry visits section (incorporating the visit reports developed in the previous Series); a discussion section interpreting the findings and reflecting on the field course experience; a conclusion summarising key outcomes; a reference list citing all sources used; and appendices containing raw field data sheets, photographs, and supplementary material.

Fill in the blank: The ________ list is an annotated inventory of all plant and animal specimens collected, identified, and prepared during the field course, with collection numbers and identifications.

5.2.2 Presenting field data and specimen records

Field data should be presented in clearly labelled tables and figures rather than as raw, unprocessed data sheets in the main body of the report (raw data sheets belong in an appendix); tables should have concise, informative titles, clearly labelled columns with units, and should be referred to and discussed in the accompanying text rather than left to speak for themselves; graphs and charts should be chosen to suit the data type (bar charts for categorical comparisons, line graphs for trends over time or along gradients, scatter plots for relationships between two continuous variables).

Specimen records should be presented as a structured table or list including, for each specimen: the collection number, scientific name (genus and species), family, common name if known, locality and habitat, date of collection, and the collector name; specimens that could not be identified to species level should be recorded to the most precise level achieved (genus, family, or order) with a note explaining the limitation; photographs of representative specimens, particularly any species of special interest or difficulty, strengthen the specimen record section of the report.

Fill in the blank: Raw, unprocessed field data sheets belong in an ________ of the report, while the main body should present data in clearly labelled tables and figures.

5.2.3 Common weaknesses and how to avoid them

Common weaknesses in student field reports include: describing methods in vague or generic terms rather than the specific protocols actually used (for example, stating "quadrats were used" without specifying size, number, or placement strategy); presenting data without adequate labelling or units; failing to discuss or interpret results, simply presenting tables and figures without commentary; copying text directly from source material without proper citation or paraphrasing (plagiarism, addressed further in the next section); and submitting incomplete specimen lists or identification records.

These weaknesses are avoided by recording complete methodological detail at the time of fieldwork (rather than trying to reconstruct it later from memory), drafting the report progressively throughout the course rather than only after fieldwork ends, having a team member responsible for checking that all data tables are properly labelled and discussed, and allowing time before submission for proofreading and cross-checking that the specimen list matches the actual specimens deposited in the herbarium or museum collection.

Fill in the blank: A common weakness in field reports is describing methods in ________ or generic terms rather than the specific protocols actually used, such as omitting quadrat size or sampling strategy.

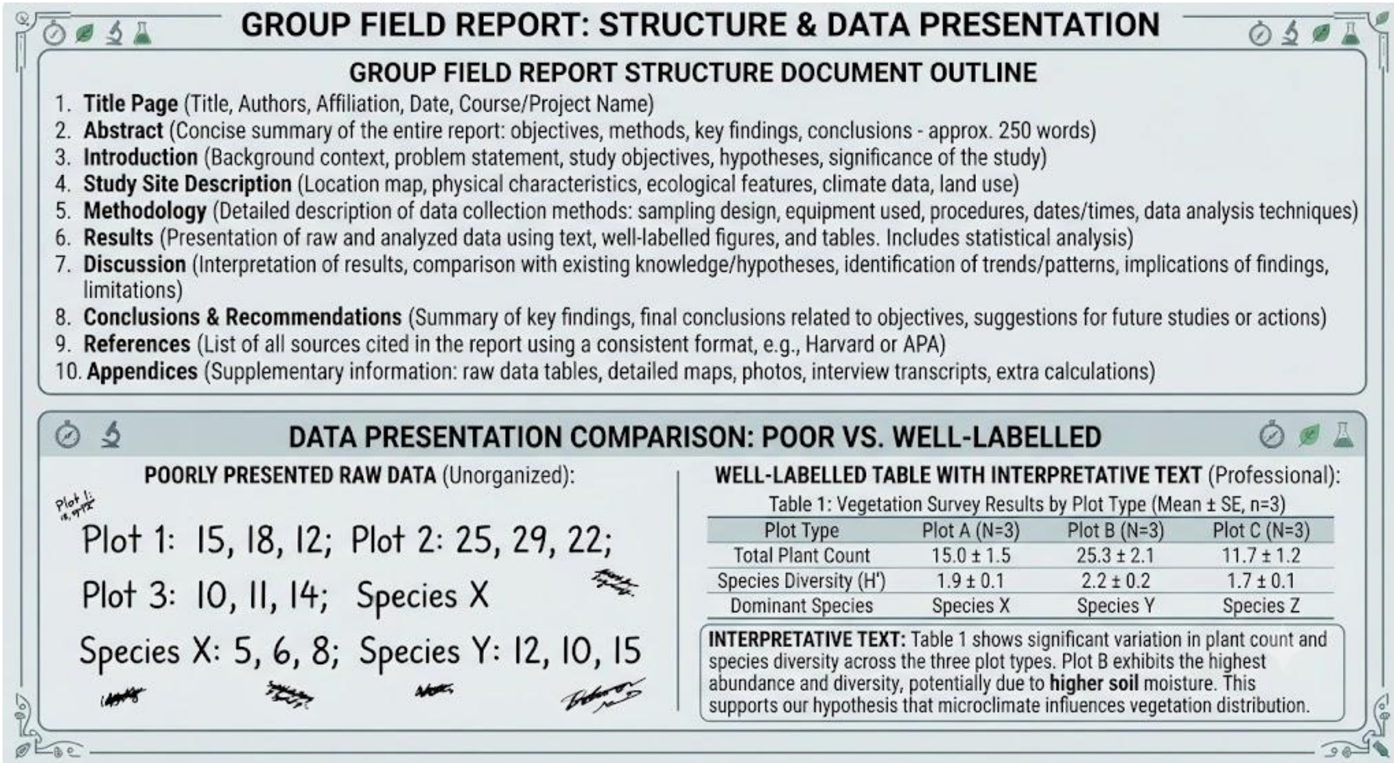

Figure 5.2: Group field report structure and data presentation

Pilot questions 5.2

1. Name six sections that should appear in a group field report.
2. State the information that should be included for each specimen in the specimen list.
3. Explain where raw field data sheets should be placed in the report.
4. Name three common weaknesses found in student field reports.
5. Explain how methodological weaknesses in reports can be avoided.

5.3 Final Submission and Professional Standards

5.3.1 Referencing and academic integrity

All sources used in the group field report, including textbooks, identification guides, institute publications, and websites, must be cited using a consistent referencing style (typically APA style for biology field reports) both in the text (in-text citations giving author and year) and in a complete reference list at the end of the report; direct quotations should be used sparingly and clearly marked, while paraphrased information should still be cited to the original source; failure to cite sources, whether intentional or accidental, constitutes plagiarism and is a serious academic offence with significant consequences.

Academic integrity in group reports also requires that the contribution of all group members is genuine and fairly represented; group reports should include a statement of individual contributions (which member was primarily responsible for which sections, data collection activities, or specimen preparation tasks), and any data, photographs, or specimens used from outside the group own collection must be properly attributed; fabrication or falsification of field data (recording results that were not actually obtained) is a severe academic integrity violation and undermines the entire scientific value of the field course exercise.

Fill in the blank: ________ or falsification of field data, recording results that were not actually obtained, is a severe academic integrity violation that undermines the scientific value of the field course.

5.3.2 Submission requirements and deadlines

Field course reports typically have strict submission requirements specified by the course coordinator, including the required format (printed and bound copy, electronic submission, or both), the required length or page limit, the citation style to be used, and the specific deadline for submission; late submission policies are usually strict, reflecting professional norms where missed deadlines have real consequences, and students should plan their report writing schedule to allow adequate time for drafting, review, and any final corrections well before the deadline.

Before submission, the report should be checked against the assessment rubric or marking guide provided by the course coordinator to ensure all required sections and content are present; specimens to be deposited in the herbarium or museum should be finalised, labelled, and submitted alongside or before the written report according to the course requirements, with the voucher numbers assigned upon deposit included in the final specimen list of the report; group members should review the complete report together before submission to ensure consistency and accuracy across sections written by different members.

Fill in the blank: Before submission, the report should be checked against the assessment ________ or marking guide provided by the course coordinator to ensure all required content is present.

5.3.3 Professional standards in field biology reporting

The standards expected in field course reports mirror those expected in professional scientific reporting throughout a career in biology: accuracy (data and identifications must be correct and verifiable, never invented or guessed without indication of uncertainty), completeness (all relevant methods, data, and observations should be included, not selectively reported), clarity (writing should be precise, unambiguous, and appropriately technical for a scientific audience), and proper attribution (all sources and contributions correctly acknowledged).

Developing these habits during the field course, when the consequences of error are primarily academic, builds the professional discipline required later in research, regulatory, industrial, or conservation careers, where inaccurate, incomplete, or improperly attributed scientific reporting can have serious legal, financial, or public health consequences; the field course is therefore not only an opportunity to learn biological field techniques but also a structured introduction to the professional standards of practice and communication expected throughout a scientific career.

Fill in the blank: The professional standards of accuracy, completeness, clarity, and proper ________ developed during the field course mirror those expected throughout a scientific career.

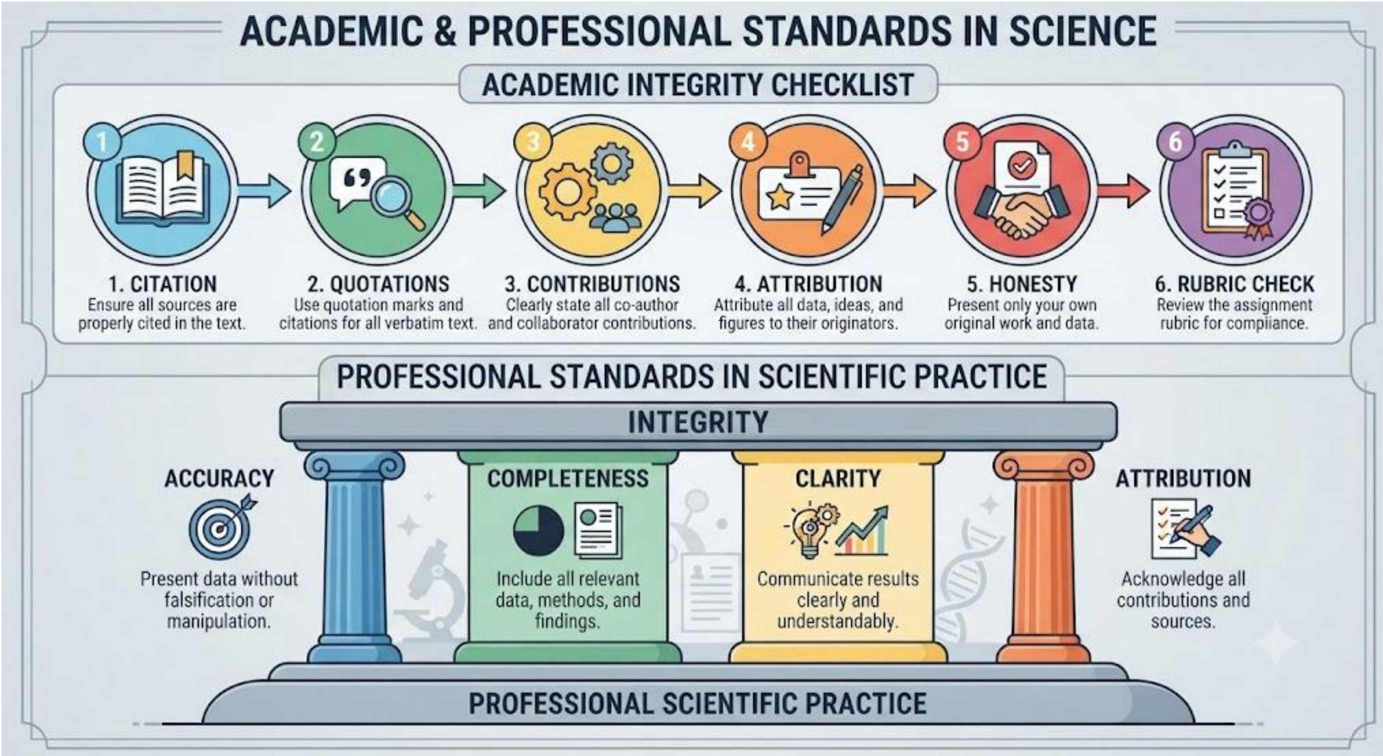

Figure 5.3: Academic integrity and professional reporting standards

Pilot questions 5.3

1. Explain why all sources used in a field report must be cited, even when paraphrased.
2. Explain what a statement of individual contributions is and why it is included in group reports.
3. Define fabrication of field data and explain why it is a serious academic integrity violation.
4. Name three things that should be checked before submitting a field report.
5. Name and briefly explain the four professional standards expected in field biology reporting.

Series Summary

This Series brought together the practical, communication, and professional dimensions of the field course assessment process. Field course marks combine continuous assessment of daily practice, a comprehensive group field report, a practical identification test, and an individual oral viva, together evaluating both group output and personal understanding. Continuous assessment rewards consistent good practice in technique, data recording, and conduct throughout the course rather than performance on any single occasion.

The group field report draws together methods, results, specimen records, and visit accounts into a structured professional document, with careful attention to proper data presentation, complete specimen listing, and avoidance of common weaknesses such as vague methods description or unsupported data tables. Academic integrity through correct referencing, honest reporting, and fair representation of individual contributions, alongside accuracy, completeness, clarity, and attribution as core professional standards, completes the transition from field practitioner to scientific communicator that this course has been building toward across all five Series.

Glossary of Terms

- **Academic integrity:** the ethical standard requiring honest, properly attributed, and non-fabricated reporting of academic and scientific work.
- **Continuous assessment:** marks awarded throughout a course based on ongoing observation of performance, participation, and conduct rather than a single examination event.
- **Fabrication:** the academic integrity violation of recording or reporting data that were not genuinely obtained.
- **Group field report:** the comprehensive written account of an entire field course produced collectively by a student group, covering methods, data, specimens, and visits.
- **Oral assessment (viva voce):** an individual spoken examination in which a student is questioned to confirm personal understanding and contribution within a group assessment.

- **Plagiarism:** the academic integrity violation of using another person work or words without proper citation or attribution.
- **Specimen list:** an annotated inventory of all specimens collected and identified during a field course, including collection numbers and identifications.
- **Voucher number:** the institutional accession number assigned to a specimen when deposited in a herbarium or museum, linking a written report to the physical specimen.

Concept Check Questions [Series 5]

Objective Questions

1. ________ assessment evaluates participation, data sheet quality, and specimen preparation standard throughout the course. (Linked to SLO 5.1)
2. The oral assessment (viva voce) confirms genuine individual understanding since the written ________ is necessarily a group product. (Linked to SLO 5.1)
3. The ________ list is an annotated inventory of all specimens collected and identified during the field course. (Linked to SLO 5.2)
4. Raw, unprocessed field data sheets belong in an ________ of the report rather than the main body. (Linked to SLO 5.2)
5. ________ or falsification of field data is a severe academic integrity violation undermining the scientific value of the course. (Linked to SLO 5.3)

Short-Answer Questions

1. Name four components of field course assessment. (Linked to SLO 5.1)
2. Name six sections that should appear in a group field report. (Linked to SLO 5.2)
3. State the information included for each specimen in a specimen list. (Linked to SLO 5.2)
4. Explain why all sources used must be cited, even when paraphrased. (Linked to SLO 5.3)
5. Name the four professional standards expected in field biology reporting. (Linked to SLO 5.3)

Long-Answer Questions

1. Describe the components of field course assessment and explain how continuous assessment and oral assessment are conducted. (Linked to SLO 5.1)
2. Describe the structure of the group field report and explain how field data should be presented and common weaknesses avoided. (Linked to SLO 5.2)

Answers to Concept Check Questions [Series 5]

Objective Questions

1. Continuous.
2. Report.
3. Specimen.
4. Appendix.
5. Fabrication.

Short-Answer Questions

1. Continuous assessment, group field report, practical identification test, and oral assessment (viva voce).
2. Title page, introduction, methods, results, specimen list, and discussion (or institute/industry visits, conclusion, references, appendices).
3. Collection number, scientific name, family, common name (if known), locality and habitat, date of collection, and collector name.
4. Paraphrased information still originates from another source, so omitting citation would misrepresent the idea as the student own and constitutes plagiarism even without direct quotation.
5. Accuracy, completeness, clarity, and attribution.

Long-Answer Questions

1. Components: continuous assessment (daily observation of technique, data quality, conduct), group field report (comprehensive written account), practical identification test (specimen identification using keys), oral assessment (individual viva confirming understanding). Continuous assessment uses a structured rubric applied throughout the course; oral assessment is an individual interview on techniques, rationale, and personal contribution, confirming the group report reflects genuine individual learning.
2. Structure: title page, contents, introduction, methods, results, specimen list, institute/industry visits, discussion, conclusion, references, appendices. Data presented in labelled tables/figures with units, discussed in text; raw data sheets in appendix; specimen list with full collection details. Common weaknesses: vague methods, unlabelled data, no discussion, plagiarism, incomplete specimen lists; avoided by recording detail at the time, drafting progressively, and proofreading before submission.

Answers to Pilot Questions [Series 5]

Part 5.1

1. Continuous assessment, group field report, practical identification test, and oral assessment (viva voce).
2. Continuous assessment evaluates technique application, data recording accuracy, safety/ethical conduct, and teamwork; it is awarded by instructors using a structured rubric at checkpoints throughout the course.
3. Arriving prepared, following safety protocols without prompting, and recording complete accurate data at the time of collection (or active participation in group activities).
4. Students identify a set of unknown specimens to the appropriate taxonomic level using dichotomous keys and reference material within a defined time, recording diagnostic characters used.
5. To confirm that the group report and continuous assessment reflect genuine individual understanding and participation, since the written report is necessarily a group product.

Part 5.2

1. Title page, table of contents, introduction, methods, results, specimen list, institute/industry visits, discussion, conclusion, references, appendices (any six).
2. Collection number, scientific name, family, common name, locality and habitat, date of collection, and collector name.
3. Raw field data sheets should be placed in an appendix, not in the main body, where data should instead appear as clearly labelled, processed tables and figures.
4. Vague methods description, unlabelled data without units, and failure to discuss or interpret results (or plagiarism, incomplete specimen lists).
5. Record complete methodological detail at the time of fieldwork rather than reconstructing from memory, and draft the report progressively throughout the course rather than only afterward.

Part 5.3

1. Paraphrased information still originates from another source; omitting citation misrepresents the idea as original work, which constitutes plagiarism regardless of direct quotation.
2. A statement of individual contributions records which member was responsible for which sections, data collection, or specimen preparation tasks, ensuring fair and honest representation of group effort.
3. Fabrication is recording results that were not genuinely obtained; it is serious because it undermines the entire scientific value of the field course and constitutes scientific dishonesty.
4. The report against the assessment rubric, specimens finalised and labelled for deposit, and consistency across sections written by different group members.
5. Accuracy (correct, verifiable data), completeness (all relevant methods/observations included), clarity (precise, unambiguous writing), and attribution (sources and contributions properly acknowledged).

References and Attribution

Textual References (Books and External Sources)

- American Psychological Association. (2020). Publication manual of the American Psychological Association (7th ed.).
- Sutherland, W. J. (Ed.). (2006). Ecological census techniques: A handbook (2nd ed.). Cambridge University Press.
- Day, R. A., & Gastel, B. (2016). How to write and publish a scientific paper (8th ed.). Cambridge University Press.
- National Open University of Nigeria (NOUN). (2023). Field course I course material. NOUN Press.

Figures, Plates, Tables, and Boxes

- Figure 5.1: Field course assessment structure Attribution: AI generated. Suggested OER search string: "field course assessment structure continuous assessment group report viva practical identification test biology OER".
- Figure 5.2: Group field report structure and data presentation Attribution: AI generated. Suggested OER search string: "group field report structure specimen list data presentation table figure field biology report writing OER".
- Figure 5.3: Academic integrity and professional reporting standards Attribution: AI generated. Suggested OER search string: "academic integrity referencing field report professional standards plagiarism citation scientific reporting biology OER".