

# Q1. Biodiversity documentation using GIS (for Earth Science students)

## (a) Definitions (3 marks)

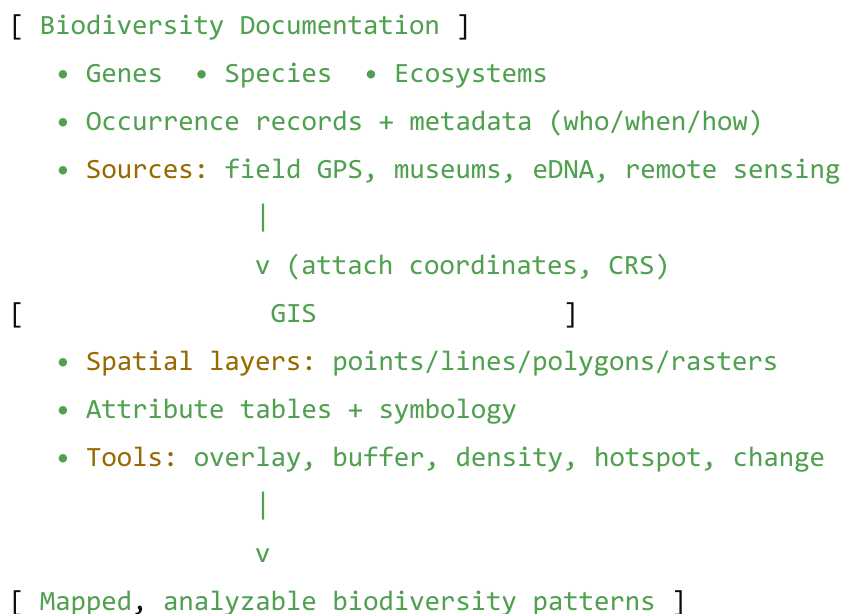
### Biodiversity documentation

Systematic recording of the variety of life—**genes**, **species**, and **ecosystems**—along with where and when each record was observed. It includes field and museum records, remote-sensing observations, eDNA results, photos, and the **metadata** (who/when/how) needed to verify and reuse those records.

### Geographic Information System (GIS)

A framework (software + data + methods) to **store, manage, analyze, and map spatial data**. In GIS, information is organized as **layers** (points, lines, polygons, rasters) with a **coordinate reference system** and an **attribute table**. GIS lets us link each biodiversity record to a location, visualize patterns, and run spatial analyses.

### Schematic (what each term covers and how they relate)



---

## (b) Process: mapping biodiversity using GIS tools (4 marks)

### 1) Frame the study

Define **objective** (e.g., map amphibian hotspots), **extent/scale** (watershed, ecoregion), and **time window** (e.g., 2015–2025).

### 2) Gather data

- **Occurrence data:** GPS points from surveys, citizen science, museum records (species, date, accuracy).

- **Environmental layers:** land cover, elevation/derived terrain (slope, aspect), soils/geology, hydrography, climate/bioclim variables.
- **Remote sensing:** optical indices (e.g., NDVI), thermal, radar; multi-date imagery for change detection.
- **Administrative layers:** protected areas, roads, settlements.

### 3) Quality control & harmonization

De-duplicate, remove obvious errors (e.g., points in the ocean for terrestrial species), standardize taxonomic names, set a **common projection/CRS**, and document **positional accuracy**.

### 4) Build the geodatabase

Organize clean layers (vector + raster) with clear naming, metadata, and scales/resolutions matched to the question.

### 5) Spatial analysis

- **Presence mapping:** plot points with accuracy buffers.
- **Sampling effort correction:** thin clustered records; or use effort layers.
- **Density/Hotspots:** Kernel density, Getis-Ord Gi\*, or grid-based **species richness** (count species per cell).
- **Habitat suitability (optional):** environmental overlays or species distribution modeling (SDM) to estimate suitable areas.
- **Connectivity (optional):** least-cost paths or circuit theory for corridors between habitat patches.
- **Change analysis:** compare land cover or habitat metrics across dates.

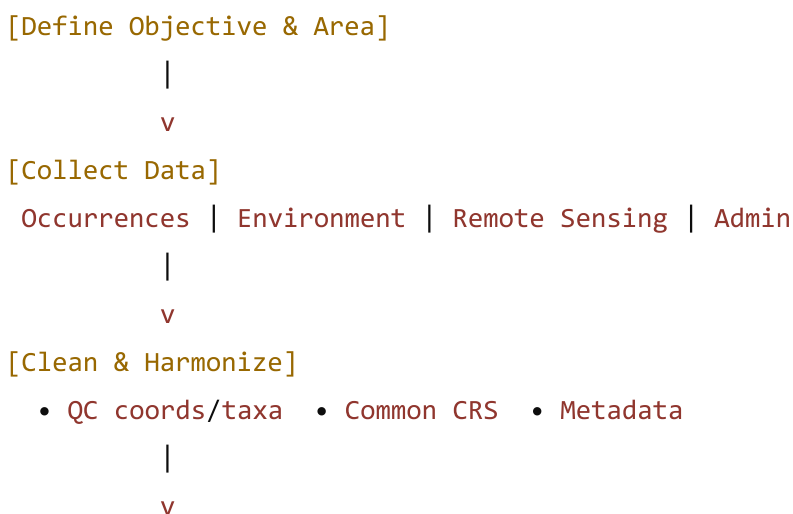
### 6) Cartography & communication

Design clear maps (legend, scale bar, north arrow, source/metadata, classification), export layouts, and—if needed—publish web maps/dashboards.

### 7) Validation & iteration

Ground-truth a subset of sites, update with new surveys, refine layers and models.

### Schematic (end-to-end workflow)



[Geodatabase]  
Structured layers & scales  
|  
v

[Spatial Analysis]  
• Points -> buffers  
• Density/Hotspots/Richness  
• Suitability (SDM)  
• Connectivity / Change  
|  
v

[Map Layouts & Web Maps]  
Legend • Scale • Credits  
|  
v

[Validation & Update]  
Field checks • Iterate

---

## (c) Two advantages of using GIS in biodiversity conservation (3 marks)

### 1. Reveals spatial patterns & priorities

GIS exposes **hotspots, gaps, and corridors**—supporting decisions like **where to protect, restore, or survey next**. This improves cost-effectiveness and transparency compared with ad-hoc choices.

### 2. Integrates multi-source data for monitoring & scenarios

GIS fuses field observations with **land cover, hydrology, geology, and climate** layers, enabling **change detection** (e.g., habitat loss since 2016) and **what-if planning** (e.g., proposed road vs. corridor integrity).

### Schematic (how GIS strengthens decisions)

[Multi-source Inputs]  
Occurrence ▶ Land Cover ▶ DEM ▶ Soils/Geology ▶ Hydro  
  \        |        |        |        /  
  \        |        |        |        /  
  v        v        v        v        v  
  [ GIS Integration & Analysis ]  
    • Hotspots • Connectivity • Trends  
  |

v

## [ Conservation Actions ]

Protected areas ▶ Restoration ▶ Monitoring design