The starting conditions matter

Ecological succession is change in community composition over time. It can follow the formation of new habitat or a disturbance that removes part of an existing community.

1. PRIMARY OR SECONDARY? CHECK THE SOIL

PRIMARY: little or no developed soil

Bare rock or new lava → Pioneers establish → Soil and community develop

SECONDARY: soil remains after disturbance

Burned or abandoned land → Regrowth and colonization → Community composition shifts

2. PIONEERS CHANGE THE CONDITIONS

Early colonizers tolerate the initial conditions. On bare surfaces, microbes, lichens and plants can contribute to weathering and organic matter accumulation. Some plants associate with nitrogen-fixing microbes. Developing soil, shade and altered moisture can help some later species while restricting others.

3. RECOVERY IS NOT A FIXED LADDER

Secondary succession is often faster because soil, roots, seeds and microbes may remain. But the actual pathway depends on local conditions and arriving species. A relatively stable late-stage community is sometimes called a climax community; it is not permanent, and not every site becomes a forest.

Primary and secondary succession: OpenStax, Biology 2e 45.6.
Pioneer plants and soil development: National Park Service, Glacier Bay.
Variable succession pathways: National Park Service, long-term plot research.

Scope: College Board AP Environmental Science CED, Topic 2.7, p. 58.

Biomass, richness and rates can diverge

Succession changes the amount of living material, the species present and the rate of new production. Do not assume that all three measures rise together indefinitely.

1. COMPARE THREE DIFFERENT MEASURES

Stage	Biomass	Richness	NPP
Early	10	5	20
Middle	80	18	100
Later	150	14	60

Invented teaching data, not a universal sequence. Biomass and NPP use separate arbitrary scales; richness is a species count. Compare stages within each column, not values between columns.

2. BIOMASS IS A STOCK; PRODUCTIVITY IS A RATE

Biomass is living material present at a time. Net primary productivity (NPP) is new producer biomass or stored energy generated per unit area per unit time after producer respiration. A large standing biomass does not require the highest current NPP.

3. USE THE CORRECT PRODUCTIVITY RELATIONSHIP

NPP = GPP - producer respiration

GPP is total primary production. Do not subtract all consumer and decomposer respiration to calculate NPP; that describes a different ecosystem balance.

In the example, biomass rises while richness and NPP peak in the middle stage. Colonization, competition, shading and resource supply can change these patterns. Later-stage NPP need not be zero.

Succession affects biomass, richness and productivity: College Board, ERT-2.J.
Primary productivity and respiration: OpenStax, Biology 2e 46.2.

Scope: College Board AP Environmental Science CED, Topic 2.7, p. 58.

Species can shape or reveal a community

A pioneer is defined by early colonization, a keystone by its strong ecological effect, and an indicator by what it reveals about conditions. These roles are not interchangeable.

1. KEYSTONE: A STRONG EFFECT ON COMMUNITY STRUCTURE

A keystone species has an unusually large effect relative to its abundance. Removing it can reorganize food webs and habitats. It need not be the most numerous species.

Otters eat urchins → Less grazing on kelp → Kelp habitat persists

This kelp-forest example illustrates a keystone effect, not a succession sequence. Other predators and environmental conditions also influence kelp.

2. INDICATOR: EVIDENCE ABOUT ENVIRONMENTAL CONDITIONS

An indicator species reveals something about ecosystem quality through its presence, abundance, scarcity or chemical composition. Stream-bottom invertebrates have different pollution tolerances, so community changes can help assess water quality. One missing species alone does not identify a specific pollutant.

3. SUCCESSION IS NOT THE SAME AS EVOLUTION

A grass community being replaced by shrubs is community change, not grasses turning into shrubs. Pioneer populations can also evolve through natural selection over generations; prolonged divergence may eventually produce new species. Speciation is possible, but is not required for succession to occur.

Track both who is present and what they do. Similar plant cover can hide different species composition, food-web links and environmental conditions.

Pioneers, keystones, indicators and evolutionary change: College Board, ERT-2.I-J.
Otters, urchins and kelp: NOAA Fisheries.
Biological indicators: EPA, Benthic Macroinvertebrates.

Scope: College Board AP Environmental Science CED, Topic 2.7, p. 58.