SEASONAL CHANGES

Content Statements:

D4.3.9 Phenology as research into the timing of biological events

D4.3.10 Disruption to the synchrony of phenological events by climate change

D4.3.11 Increases to the number of insect life cycles within a year due to climate change

D4.3.12 Evolution as a consequence of climate change

PHENOLOGICAL EVENTS

Phenology is the study of the **timing of biological events** and how these events are influenced by seasonal variations or habitat factors. These biological events are controlled by chemical signals that are triggered in response to environmental fluctuations – such as the length of days (photoperiod) or temperature patterns.

There are numerous examples of phenological events that occur within nature. Some key examples include:

- The development of buds (**bud set**) and the emergence of new leaves (**bud burst**) in deciduous plants
- Blooming of flowers to coincide with pollinator activity or weather conditions conducive to pollination
- The migration of birds to different parts of the world in concordance with annual changes in the climate
- Timing of nesting to ensure that eggs are laid at times when there are resources to support a hatchling
- The suppression of metabolic activity during winter months to limit energy expenditure (hibernation)


Budding


Flowering


Migration


Nesting


Hibernation

Events are controlled by seasonal changes in day length (photoperiod) and temperature patterns

CLIMATE DISRUPTIONS

Changes in climate can disrupt the synchrony of phenological events by altering the environmental cues that trigger the events. Examples of climate disruptions impacting phenological events can be observed in the migration of reindeer, the nesting times of great tits (bird) and the life cycle of the spruce bark beetle.

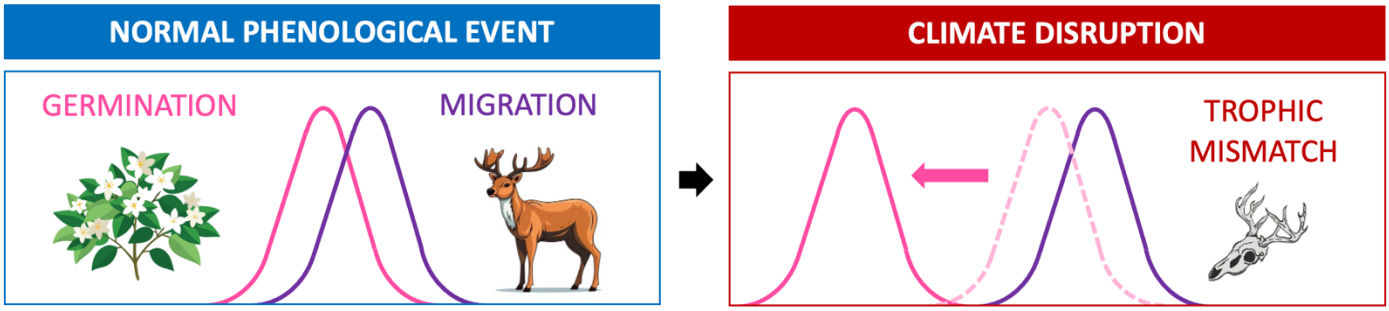
Spruce Bark Beetle

Spruce bark beetles are insects that lay their eggs within the bark of spruce trees that are endemic to Europe and North America. The larvae will feed on the tree phloem and other plant tissues while they mature, which will cause damage to the spruce tree. The life cycle of the beetle is usually regulated by *temperature*, and global warming is increasing the number of life cycles that occur per year (increasing from one reproductive cycle annually to two). The increase in spruce bark beetle population within the spruce trees is resulting in higher amounts of damage and increasing the rate of tree death. Without their root system (stabilises the soil), their foliage (used for nesting sites) or their seeds (food source), the communities that they support risk collapse.


Spruce Bark Beetle

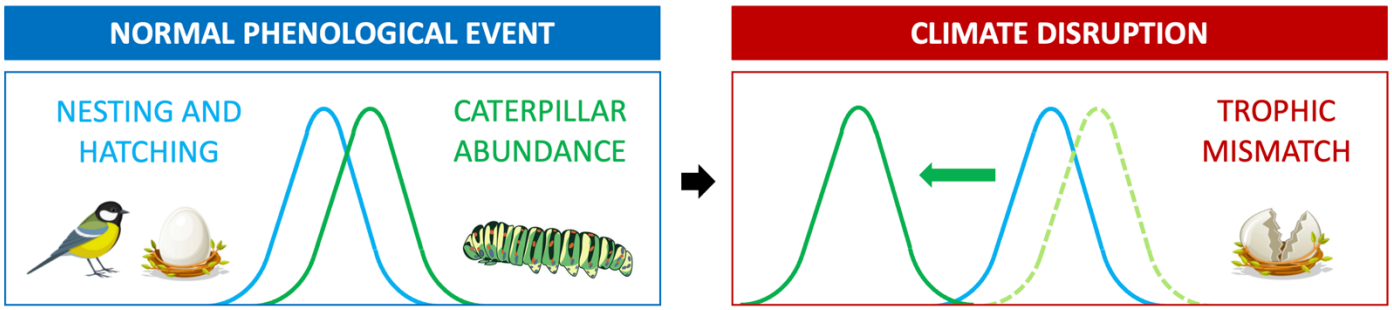
Arctic Mouse-Ear Chickweed and Reindeer

Reindeer are migratory animals that rely on *day length* as an environmental cue for seasonal movement. The Arctic mouse-ear chickweed is a plant that forms part of the reindeer's diet and its germination pattern is regulated by *temperature* (spring growth). Anthropogenic climate change is causing higher temperatures but does not affect the daylength. This creates a temporal mismatch between the normal migratory timing of the reindeer and the availability of their food source – threatening the ongoing survival of the reindeer.



Great Tits and Caterpillars

Great tits are a small bird that rely on caterpillars as a food source for their hatchlings. While both timing of egg hatching and caterpillar activity is controlled by *temperature cues*, the caterpillars are more susceptible to temperature changes. Global warming is causing peak caterpillar activity to occur prematurely, reducing the amount of biomass available to the newly hatched chicks and lowering survival rates among hatchlings.



TAWNY OWL EVOLUTION

The process of natural selection is driven by **environmental selection pressures** which determine the biological fitness of a species (the capacity to survive and reproduce). Climate change introduces new selection pressures and hence cause species to evolve via natural selection. A specific example of evolutionary change due to climate disruptions can be seen in the changing frequency of feather colouration within the tawny owl. In snowy conditions, pale grey owls will be less visible to both predators and prey and so will be more likely to survive and reproduce – making grey owls more common in the larger population. But in warm forest conditions with no snow, brown owls will be better camouflaged and so are better equipped to survive and reproduce. Climate change is resulting in global warming and mild winters (less snowfall), leading to grey owls becoming less frequent – intermediate phenotypes are becoming dominant (**stabilising selection**).