• Prey population is stable when its rate of change is zero:

$$\frac{dN}{dt} = 0 = rN - cNP \rightarrow rN = cNP \rightarrow \frac{r}{N} = P$$

• Hence, a prey population is stable when the addition of prey is balanced by the consumption of prey. The prey population will increase when the addition of prey exceeds the consumption of prey: r

$$rN > cNP \rightarrow P < \frac{1}{c}$$

Predator population is stable when its rate of change is zero:

$$\frac{dP}{dt} = 0 = acNP - mP \rightarrow acNP = mP \rightarrow \frac{m}{ac} = N$$

- Equilibrium (zero growth) isocline: the population size of one species that causes the population of another species to be stable. As the number of predators or prey changes and moves away from the equilibrium isoclines, populations will increase or decrease.
- Functional response: the relationship between the density of prey and an individual predator's rate of food consumption. Whenever prey density increases and a predator can consume a higher proportion of those prey, the predator can regulate the growth of the prey population.
- Type I functional response: when a predator's rate of prey consumption increases in a linear fashion with an increase in prey density until satiation occurs.

As prey density increases, predators consume a constant proportion of prey until satiation.

- Type II functional response: when a predator's rate of prey consumption begins to slow as prey drust fill cleases and then plateaus; often happens bit use predators must spend more time handling increases. Any increase in the vensity is associated with a slowing integer (Rey consumption.
- Type III functional response: when a predator exhibits low, rapid, and slowing prey consumption under low, moderate, and high prey densities, respectively. Low consumption at low prey densities may occur for three reasons: Prey can easily find refuges to hide, Predators may have less practice at locating and catching prey but develop a *search image* at higher prey densities - Search image: a learned mental image that helps a predator locate



image: a learned mental image that helps a predator locate and capture food. Predators may exhibit *prey switching* by changing their diet preferences to the more abundant prey.

- Numerical response: a change in the number of predators through population growth or population movement due to immigration or emigration. Populations of predators usually grow slowly relative to populations of their prey, but the movement of mobile predators can occur rapidly when prey density increases.
- Herbivore population dynamics 2 types: interactive herbivore system herbivores affect plant population traits, non-interactive no relationship between herbivore densities and plant population.
- Behavioural defences Alarm calling warns relatives that predators are approaching, Spatial
 avoidance occurs when a prey moves away from a predator. Some prey reduce activity to
 avoid being detected by a predator. Crypsis; camouflage that either allows an individual to
 match its environment or breaks up the outline of an individual to blend in better with the

because forests are not near warm ocean currents. Precipitation exceeds transpiration. Soils are podsolized, slightly acidic, and support a layer of small plants beneath the dominant trees. Warmer and drier parts of the biome are dominated by pines.

- Woodlands/shrublands A biome characterized by hot, dry summers and mild, wet winters, a combination that favors the growth of drought-tolerant grasses and shrubs.
 (Also known Mediterranean climate, *chaparral, matorral, fynbos*, and *maquis*.) There is a 12-month growing season, but dry summers, cold winters, and frequent fires limit plant growth. Dominated by schlerophyllous vegetation, which has small and durable leaves that resist dessication.
- Temperate grassland/ cold deserts A biome characterized by hot, dry summers and cold winters; dominated by grasses, non-woody flowering plants, and drought-adapted shrubs (Also known as *prairies, pampas, steppes.*) *Tallgrass prairies* occur when rainfall is high; *shortgrass praires* occur in areas with less precipitation. Soils are low in acidity and nutrient-rich with lots of organic matter. Unproductive, cold deserts occur when precipitation <250 mm.
- Tropical rainforests A warm and rainy (at least 2,000 mm annually) biome, with multiple layers of lush vegetation. There is a canopy of 30–40 m trees with an *understory* containing smaller trees, shrubs, epiphytes, and vines. Species diversity is higher than anywhere else in the world. Organic matter decomposes quickly; vegetation rapidly takes up nutrients. Soils are devoid of humus and clay, and retain nutrients very poorly.
- Tropical seasonal forests / savannas A biome with warm temperatures and pronounced wet and dry seasons (due to movement of the intertropical convergence zone), dominated by deciduous trees that shed leaves during the dry season. Savannas have long dry periods and contain grasses and occasional trees. Fire and grazing maintain savannas.
 Soils do not hold nutrients but the warm climate favors rapid decide provision and fast growth.
- Subtropical deserts biome characterized by hot temperature, scarce rainfall, long growing seasons, and sparse vegetation. Associated with div, descending air of Hadley cells. Soils are shallow and devoid of organic matter, and neutral in pHoMois er sites support succulent cacti, shrubs, and small trees (e.g. mesquite, palovera).
- Streams and rive entropy to the characterized by flowing water. Stream (or creek): a narrow channel of pre-flowing fresh water. Downstream, ecosystems are more nutrient-rich, complex, and productive. Streams support fewer species than other aquatic biomes. Small streams are often shaded and nutrient poor, which limits primary productivity. Riparian zone: terrestrial vegetation alongside rivers and streams that is influenced by seasonal flooding and elevated water tables. Allochthonous: inputs of organic matter, such as leaves, that come from outside of an ecosystem (e.g., from a riparian zone). Autochthonous: Inputs of organic matter that are produced by algae and aquatic plants inside an ecosystem. Much of the organic matter in streams is allochthonous, whereas organic matter in rivers is autochthonous.

Rivers typically accumulate sediments from land, and high turbidity can block light and reduce primary production.

• Ponds and lakes - Pond: An aquatic biome that is smaller than a lake and is characterized by non-flowing fresh water with some area of water that is too deep for plants to rise above the water's surface. Lake: An aquatic biome that is larger than a pond and is characterized by non-flowing fresh water with some area of water that is too deep for plants to rise above the water's surface. Many lakes and ponds formed as glaciers retreated, or in geographically active regions where shifting land created basins. *Oxbow lakes* are broad bends of what was once the river, cut off by shifts in the main channel.

Littoral zone: the shallow area around the edge of a lake or pond containing rooted vegetation. Limnetic (pelagic) zone: the open water beyond the littoral zone, where the dominant photosynthetic organisms are floating algae (i.e., phytoplankton). Profundal zone:

the area in a lake that is too deep to receive sunlight; typically has low concentrations of oxygen. Benthic zone: the area with sediments at the bottom of lakes, ponds, and oceans; is habitat for burrowing organisms. Layers - Epilimnion: the surface layer of water in a lake or pond. Hypolimnion: the deeper layer of water in a

lake or pond; can include the lower limnetic profundal zone. Thermocline: A middle depth of water in a lake or pond that experiences a rapid change in temperature over a relatively short distance in depth; slow mixing between the epilimnion and hypolimnion.

Most production occurs in the epilimnion, which is well-aerated. In the hypolimnion, lack of light and high rates of bacteria-driven organic matter decomposition create anaerobic conditions.

- Circulation Seasonal temperatures alter water density; water becomes more dense as it cools to 4°C and less dense as it cools below 4°C. Winds also drive surface currents that can cause deep water to rise. Spring overturn: the vertical mixing of lake water that occurs in early spring, assisted by winds that drive the surface currents. Stratification: the condition of a lake or pond when the warmer, less dense surface water floats on the cooler, denser water below. Fall overturn: the vertical mixing that occurs in fall, assisted by winds that drive the surface currents. Vertical mixing of water causes an exchange of benthic nutrients and oxygen from the epilimnion; can cause algal blooms. Fall bloom: a rapid increase in the population of phytoplankton in fall that occurs with the infusion of nutrients from fall overturn.
- Freshwater wetlands Freshwater wetland: an aquatic biome containing standing fresh water, or soils saturated with fresh water for at least part of the year; shallow enough for emergent vegetation throughout all depths. Wetlands provide animal habitat, and are important natural purification systems
- Salt marshes/ estuaries Salt marshes: a saltwater biome that contains non woody emergent vegetation. Salt marshes are often found at continental coasts and *Destuaries* where the mouths of rivers mix with salt water from oceans. Estuaries of the abundant nutrients and sediments carried downstream by rivers. This upports extremely high biological productivity. Estuaries are often surrounded by the Dharshes, which are some of the most productive habitats on Earth.
- Mangrove swame: Mangrove swame: a bome that occurs along tropical and subtropical or a tropical and subtropical or a tropical tropical and subtropical or a tropical tropical and subtropical or a tropical and tropic
- Intertidal zones Intertidal zones: a biome consisting of the narrow band of coastline between the levels of high tide and low tide. As the tide comes and goes, water exhibits widely fluctuating temperatures and salt concentrations. Can occur in a variety of areas, from rocky coastlines to sloping mudflats.
- Coral reefs Coral reefs: a marine biome found in warm, shallow waters that are 20°C yearround. Corals are tiny animals in a mutualistic relationship with algae; corals produce CO₂, and algae produce sugars. They are hollow tubes with exoskeletons and tentacles that collect detritus and plankton. Corals live in colonies; their exoskeleton contributes to the structure of reefs.
- Open ocean The open ocean is characterized as the part of the ocean that is away from the shorelines and coral reefs. Neritic zone: the ocean zone beyond the range of the lowest tidal level and which extends to depths of about 200 m; generally a region of high productivity. Oceanic zone: the ocean zone beyond the neritic zone; nutrients are sparse and production is limited. Photic zone: the area of the neritic and oceanic zones that contains sufficient light for photosynthesis by algae. Aphotic zone: the area of the neritic and oceanic zones where water is so deep that sunlight cannot penetrate; less productive but organisms have adaptations (e.g., *chemosynthesis, bioluminescence*)