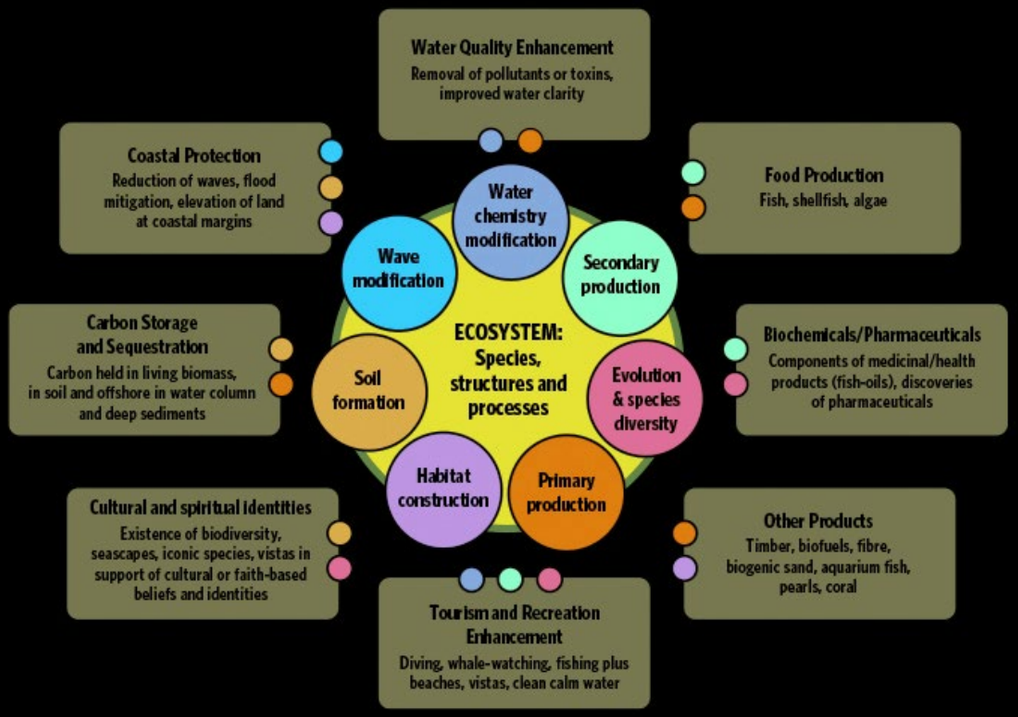
ECOSYSTEM SERVICES

the direct and indirect contributions ecosystems (known as natural capital) provide for human wellbeing and quality of life



Primary production	Secondary production
the process by which living organisms, such as plants and algae, convert energy from sunlight into organic compounds through photosynthesis	the utilization of organic compounds produced through primary production by heterotrophic organisms
example of primary production when plants use sunlight, water, and carbon dioxide to produce glucose and oxygen during photosynthesis.	**example of secondary production** when a herbivore eats plants to obtain energy, or when a carnivore consumes herbivores or other carnivores for energy.

RESOURCE MANAGEMENT

the sustainable utilization and conservation of natural resources to ensure the availability for future generations, we can do it in a few ways

It can be done in a few ways

- **Sustainable harvesting :** using natural resources in a way that does not deplete them beyond their ability to regenerate
- **Ecosystem Conservation :** protecting and conserving ecosystems such as forests, wetlands, and marine environments by establishing protected areas and implementing restoration projects
- **Wildlife management :** managing wildlife populations by stopping overexploitation, implementing habitat conservation measures, and monitoring endangered species
- **Water resource management :** balancing human water needs with the preservation of aquatic ecosystems
- **Invasive species management :** getting rid of invasive species
- **Waste management :** lessening our impact on the environment by recycling, safe disposal of hazardous materials
- **Climate change mitigation :** addressing climate change by reducing greenhouse gas emissions and promoting renewable energy sources.

THEORETICAL SITUATION	ACTUAL SITUATION
Scenarios based on **models, hypotheses,** and **predictions**, it used to simplify the understanding ecological processes	Scenarios based on **real-world conditions** through **observed empirical data**, they take **complexities, variabilities,** and **uncertainties** into the calculations
EX: A theoretical model that might predict how an ecosystem would respond to an environmental change based on mathematical equations and assumptions	**EX:** In an actual ecosystem, a model with factors such as climate variability, species interactions, and human activities in mind

Natural Disturbances

NATURAL DISTURBANCES	HUMAN CAUSED DISTURBANCES
• caused by natural disasters • Frequently happen • Ecosystems recover quickly	• Caused by human activity • Reduce diversity • Ecosystems recover slowly
EX: • Fires • Volcanic eruptions • Blizzards • Tornados • droughts	**EX:** • Deforestation • Farming • Urbanization • Wars • Surface mining

Anthropogenic Disturbances

ECOSYSTEM DISTURBANCES TEIR LIST

You would see that most of the catastrophic disturbances are from humans

Tier 1: Minimal to Moderate

They are often natural and can even be beneficial for the ecosystem's health by promoting renewal

- Forest fires : they are mostly harmful as they kill most biodiversity, but small fires can be sometimes beneficial as they clear out dead overgrowth
- Floods : they are mostly harmful as they destroy crops and what not, but they sometime help spread fossils which are fertilizers
- Grazing: is when animals eat the vegetation, this can be dangerous when in large numbers. But it is sometimes good as it keeps vegetation numbers in check

Tier 2: Moderate to High

They can cause significant damage to an ecosystem, but they still can be recovered overtime

- **Invasive species** : they are species introduced outside of the ecosystem, they can outcompete native ones and disrupt food webs
- **Pollution :** pollution to air, water, and soil can harm plant and animal life and takes a long time to remediate
- **Habitat loss:** cleaning the original land can lead to species loss and ecosystem degradation

Tier 3: Catastrophic

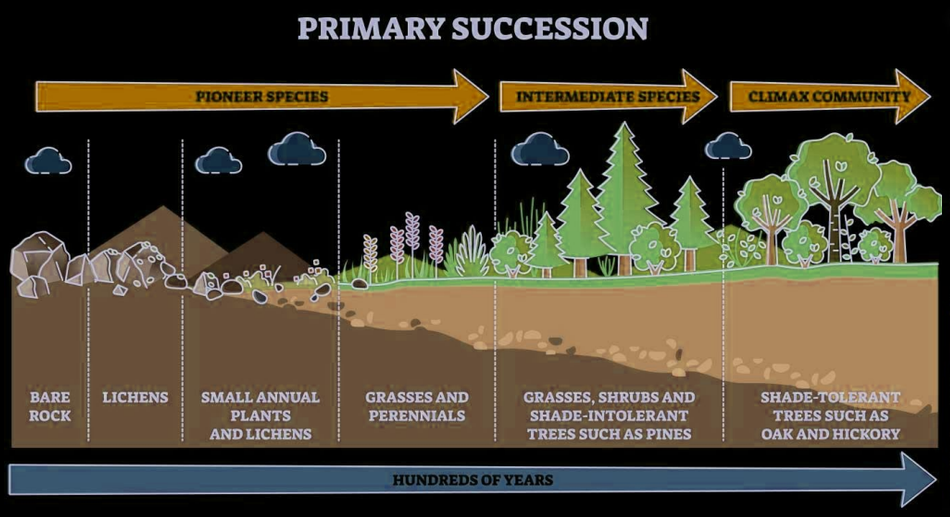
very damaging and can cause long-term or even permanent changes to an ecosystem. Recovery may be difficult or impossible

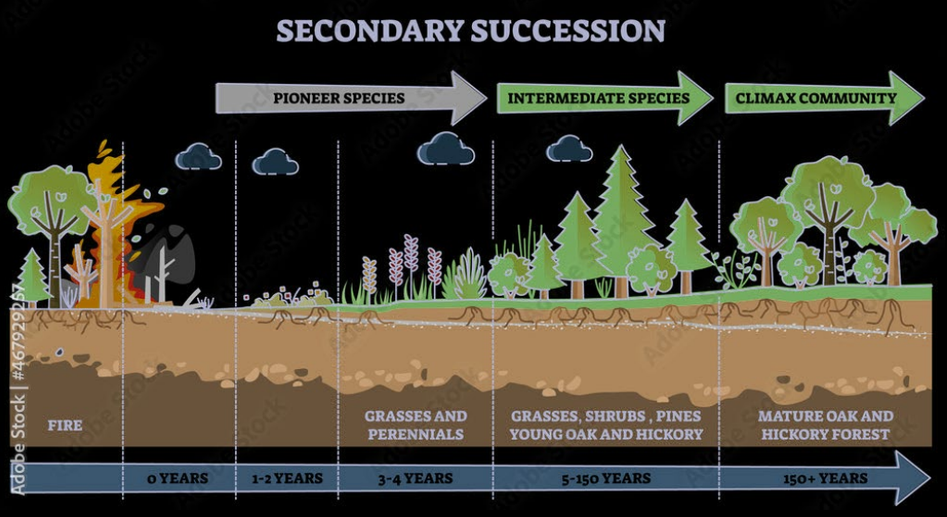
- **Climate change :** can change the ecosystem and its habitants by itself, unlike habitat loss, where the organisms can build a new one, climate change will attack both organisms and the habitat
- **Overexploitation :** attacks the habitants the most, as their resources are used up which kills the ecosystem
- **Nuclear disaster** : does everything mentioned before, but at a very large magnitude, it kills everything, and the radiation stays for YEARS

RECOVERY AND SUCCESSION

Succession is the way an ecosystem can recover, it is a gradual process, it involves the gradual change in the types of living species, it has two types

PRIMARY SUCCESSION	SECONDARY SUCCESSION
The staged regrowth of an ecosystem in a **previously barren area (area was dead before)**	The staged regrowth of an ecosystem in a **previously existing but damaged/disturbed ecosystem (area was there but it got damaged)**
Plants colonizing a new volcanic island	A forest regenerating after a fire





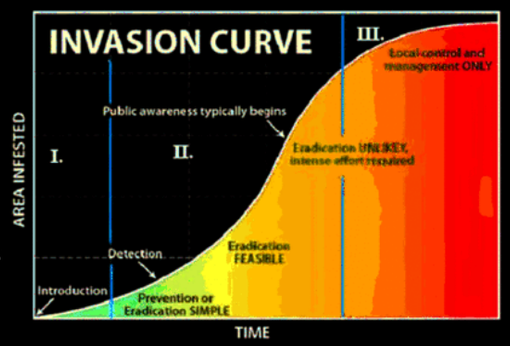
INVASIVE SPECIES

non-native (or alien) to the ecosystem under consideration which outcompete the native species and take over the food sources, leading to endangering and eradicating native species

INVASION CURVE

Shows the stages of the invasive species eradication difficulty

I. Just been detected and are still very easy and have not multiplied
II. Began multiplying and taking over, the public knows
III. They have took over the food supplies and began eradicating the natives, very hard to stop



Pioneer species : are the first species to colonize a barren or disturbed area, they play a crucial role in initiating the ecosystem by stabilizing soil, adding organic matter, etc.

Intermediate species : are the plant and animal species that establish themselves after the pioneer species prepared the area, they are more competitive, but they are the beginning of a complex ecosystem

ECOSYSTEM RESISTANCE	ECOSYSTEM RESILIENCE
the ability of a population (or a community) to withstand the disturbance	the ability to recover after suffering from the disturbance.

SUSTAINABLE DECISIONS

Refers to making choices and implementing practices to ensure long term health and resilience of an ecosystem, these decisions were explained in **resource management**

COST-BENEFIT RATIO OF MANAGEMENT

It involves considering the financial, environmental, and social cost of implementing a management in an ecosystem

For example:

let's imagine a scenario where a lake ecosystem is experiencing overfishing

Solution : decline fishing activities

Benefit :

- recovery of fish populations,
- improved ecosystem health,
- sustainable long-term fishing opportunities,
- enhanced recreational opportunities for fishing enthusiasts,
- preservation of biodiversity.

Cost :

- financial costs of implementing
- enforcing fishing regulations
- costs of monitoring fish populations
- potential economic impacts on fishing communities
- any environmental costs associated with the management actions.

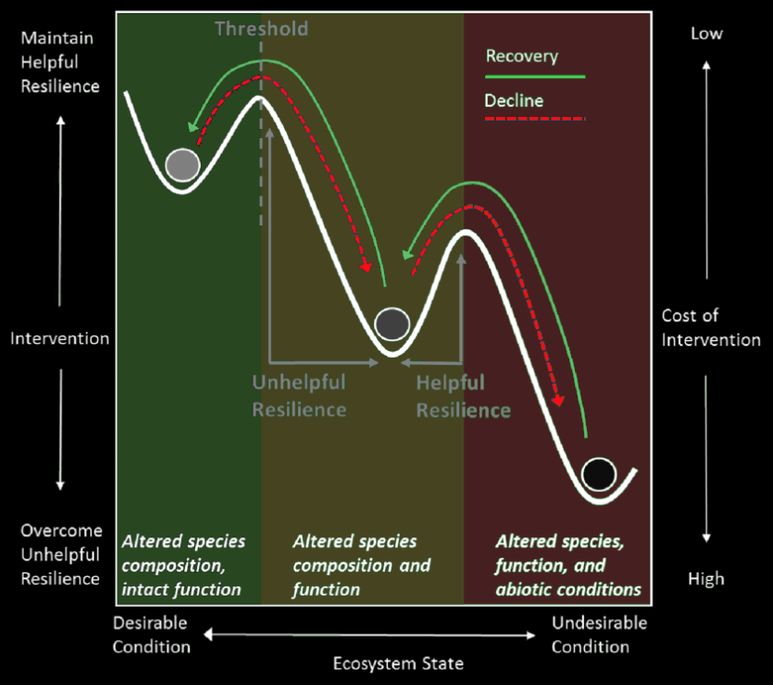
If the cost-benefit ratio is

- more than 1, then the management of that ecosystem is **expensive and not worth it** and should be replaced a better one
- Less than 1, then the management of that ecosystem is **very great**

INDICATORS FOR MANAGEMENT DECISIONS

It refers to the measurable factors that provide information about the status of an ecosystem, some of them like

- **Biodiversty metrics :** low biodiversity means that the ecosystem is in bad shape
- **Population trends :** decline in populations means that the ecosystem has a disturbance in its food source or something else
- **Habitat quality :** a good habitat is needed for the functionality of an ecosystem, for example
  - habitat fragmentation "destruction / separation"
  - Connectivity "between the habitats of an ecosystem"
  - the presence of critical habitat features for key species.
- **Water & air quality :** bad air quality or water quality indicates pollution
- **Ecosystem functioning :** low productivity of an ecosystem indicates a problem
- **Community structures :** break ups in the community means something wrong



In this graph

We have

- **Resilience :** ability to recover
- **Threshold :** a point if crossed can be hard to go back
- **Intervention :** action taken to restore the conditions of an ecosystem

this graph says that

- sometimes intervention helps "maintain helpful resilience" until crossing a threshold which then any intervention leads to a worst state
- The cost of intervention increases when the conditions of the ecosystem decrease