# CONSERVATION BIOLOGY

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# Introduction

- The natural environment provides the basic conditions without which humanity could not survive .
- The natural environment encompasses all those aspects of our world that exist outside the artificial constructs of the human hand and which remain essential to our initial, and continuing, existence.
- Although the human world has been only a tiny moment on the time-scale of the Earth's age, humanity has quickly altered the Earth's delicate balances and destroyed many of its living beings.
- The ***resilience*** ( the ability to recover from disturbance)of the community of life and the well-being of humanity depend upon preserving a healthy biosphere with all its ecological systems
  - Resilience is the capacity of an ecosystem to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes.
  - A resilient ecosystem can withstand shocks and rebuild itself when necessary.
  - Resilience can be measured as the return time to prior conditions after perturbation or the degree of recovery after a set time.
- There are two main Projects to reduce the human effect: ***Conserving biodiversities*** and ***Ecological restorations***.

# The Conservation biology

- Conservation biologists are concerned about species loss because of a number of alarming statistics regarding extinction and biodiversity
  - **Conservation biology** integrates the following fields (Ecology; Evolutionary biology; Physiology; Molecular biology; Genetics; and Behavioral ecology) to conserve biological diversity at all levels
- ***Restoration ecology*** applies ecological principles in an effort to return degraded ecosystems to conditions as similar as possible to their natural state

# The Conservation vs. Restoration

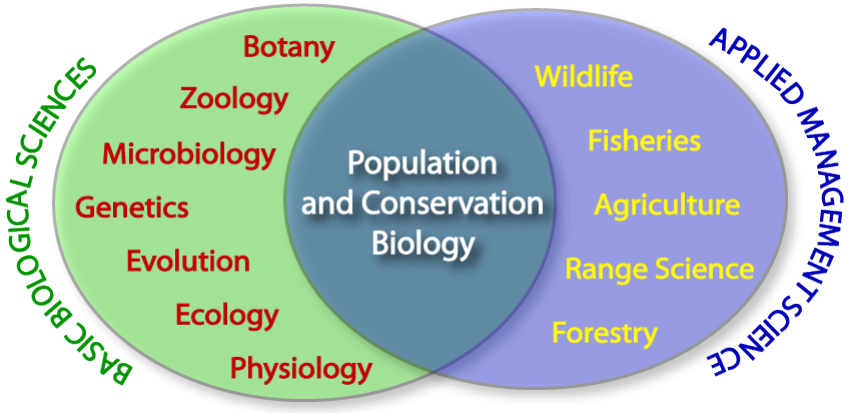
Conservation biology

- Integrates the following fields to conserve biological diversity at all levels :

  - Ecology; Evolutionary biology; Physiology; Molecular biology; Genetics and Behavioral ecology

Restoration ecology

- Applies ecological principles in an effort to return degraded ecosystems to conditions as similar as possible to their natural state.



# Strategies to conserve Biodiversity

1. ***In Situ* Conservation**:
   a) **Eco-Regions Approach**
      - Identifying biodiversity "***hotspots***" regions and focusing conservation efforts on maintaining those ecosystems
      - Establishments of ***Protected sites, or Natural Reserves***
   b) **Small population Approach**
      - **Protection for endangered and threatened species** & their habitats
      - Prohibits ***trade and commerce of threatened*** and endangered species
   c) "**Umbrella Species/ keystone species**" **Approach**
      - Conserve one "***important/keystone***", species and you conserve several others because if the interactions they have with one another

2. ***Ex Situ* Conservation:**
   - ***Zoos*** - *These may involve captive breeding programs,*
   - ***Aquaria*** - *research, public information and education*
   - ***Plant Collections*** - *breeding programs and seed storage (Germplasm collections; Botanic gardens;..etc)*
   - ***Gene bank***- *especially for microbes*

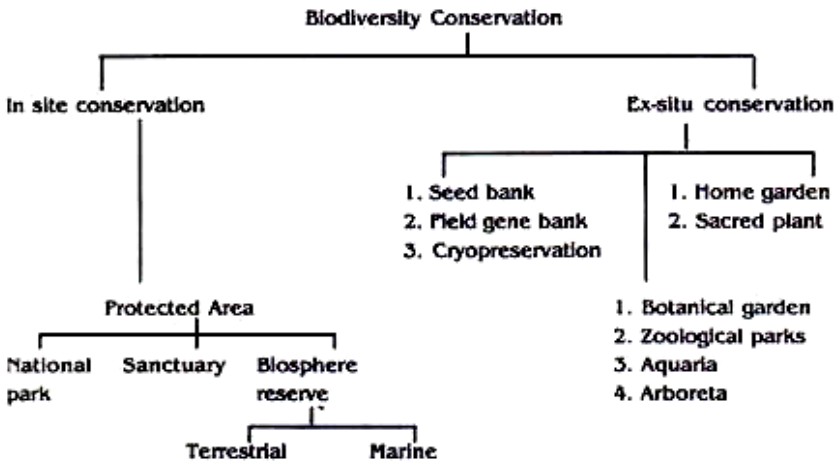
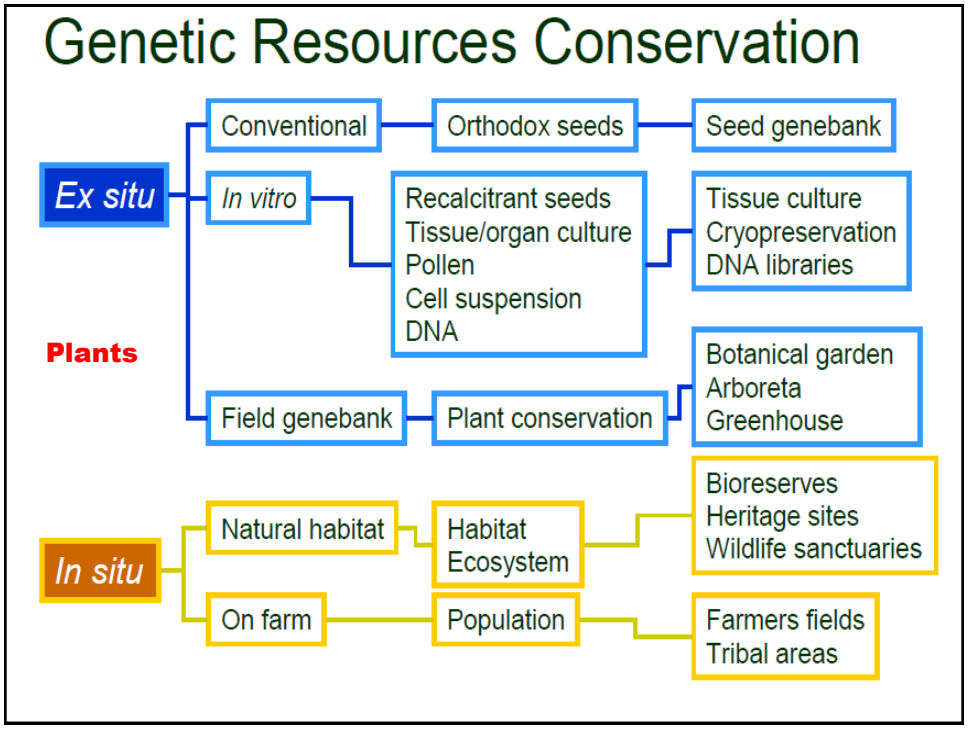



FIG. 5.1 : SCHEME SHOWING BIODIVERSITY CONSERVATION MANAGEMENT SYSTEMS.




## *In Situ* Conservation

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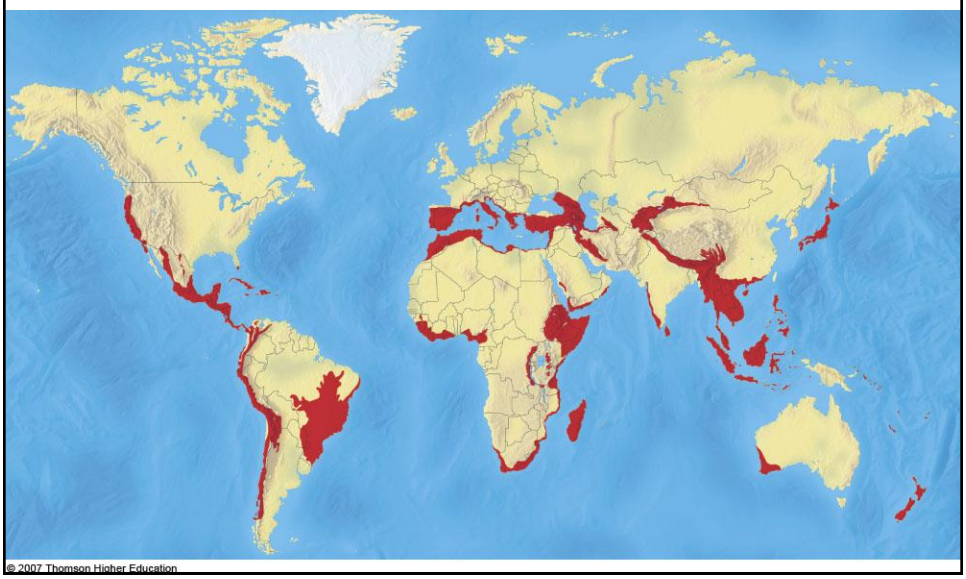
# (a) Eco-Regions Approach

## *Identifying biodiversity "**hotspots**" regions*

- A biodiversity hot spot is a relatively small area with an exceptional concentration of endemic species and a large number of endangered and threatened species
- Biodiversity hot spots are obviously good choices for nature reserves but identifying them is not always easy

- 34 hotspots identified by ecologists as important and endangered centers of biodiversity.




## *Geographic Information System (GIS)*

- Geographic Information System (GIS) mapping can be used to understand and manage ecosystems.
  - Identify areas to establish and connect nature reserves in large eco-regions to prevent fragmentation.
  - Developers can use GIS to design housing developments with the least environmental impact.
- We can prevent or slow down losses of biodiversity by concentrating efforts on protecting global hot spots where significant biodiversity is under immediate threat.
- Conservation biologists are helping people in communities find ways to sustain local biodiversity while providing local economic income.

# Key Biodiversity Areas (KBAs)

- *KBAs* are **sites of importance** for the global persistence of biodiversity.
- Management decisions should be based on **conservation priority-setting exercises,** which combine data on biodiversity importance with the available information on ***site vulnerability*** and the **management actions** needed to safeguard the biodiversity for which the site is important.
  - It is often desirable to incorporate other data into priority-setting, such as *conservation cost*, *opportunity for action*, *importance for conserving evolutionary history* and *connectivity*.
- KBAs thus do not necessarily equate to conservation priorities but are invaluable for informing systematic conservation planning and priority-setting, recognizing that conservation priority actions may also be outside of KBAs.

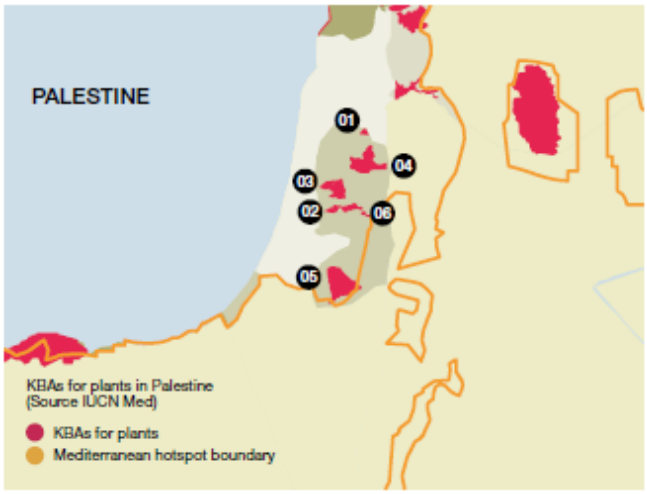
## *Key Biodiversity Areas (KBAs)*

Overview

- In 2016, a partnership of institutions joined forces to agree on a methodology for countries to identify KBAs.
- As a result the **Global Standards for the Identification of KBAs** (hereafter the KBA standards) were published (IUCN, 2016).
  - The reason for developing agreed criteria for identifying KBAs was to harmonize existing approaches to the identification of important sites for biodiversity.
- Since they can be applied consistently and repeatedly by different institutions, the KBA standards are expected to provide improved understanding of why particular sites are important for biodiversity.
- KBAs are sites, meaning that they have a boundary which can be shown on a map, and the KBA boundary should delimit an ecologically meaningful management unit to ensure persistence of the biodiversity elements for which it is important.
  - The identification of KBAs uses multiple criteria and sub-criteria, each with associated thresholds.

## KBAs-Palestine

01 Faqoua`-Jalboun
02 Wad Elbalat-Beitillo
03 Wad Qana – Wad Eshai'r
04 Yaseed-Ibzeik-Tamoun
05 Khalil Gradient
06 Ain Samya- Ain Auja




# Eco-Regions Approach

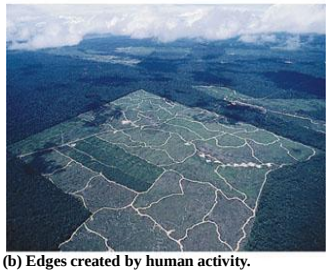
## *Establishments of **Natural Reserves***

- Landscape and regional conservation aim to sustain entire biota as the structure of a landscape can strongly influence biodiversity
- Conserving species often requires resolving conflicts between the **habitat needs** of endangered species and human demands
- Conservation biology has attempted to sustain the biodiversity of entire communities, ecosystems, and landscapes. For examples:
  - Constructing corridors that connect habitat fragments
  - Establishing protected areas

## *Fragmentation and Edges*

- The boundaries, or edges, between ecosystems are defining features of landscapes
- As habitat fragmentation increases and edges become more extensive, biodiversity tends to decrease
  - Research on fragmented forests has led to the discovery of two groups of species those that live in forest edge habitats and those that live in the forest interior

**(a) Natural edges.** Grasslands give way to forest ecosystems in Yellowstone National Park.



**(b) Edges created by human activity.** Pronounced edges (roads) surround clear-cuts in this photograph of a heavily logged rain forest in Malaysia.

## Corridors that connect habitat fragments

- A ***Movement corridor*** is a narrow strip of quality habitat connecting otherwise isolated patches
  - In areas of heavy human use artificial corridors are sometimes constructed
- ***Movement corridors*** promote dispersal and help sustain populations

# Establishing **Protected Areas**

- Conservation biologists are applying their understanding of ecological dynamics in establishing protected areas to slow the loss of biodiversity
- Much of the focus on establishing protected areas has been on *hot spots* of biological diversity
- The zoned reserve model recognizes that conservation efforts often involve working in landscapes that are largely human dominated
- Zoned reserves are often established as "conservation areas"


Costa Rica has consolidated its parks and reserves into 8 **megareserves** designed to sustain 80% if its biodiversity.

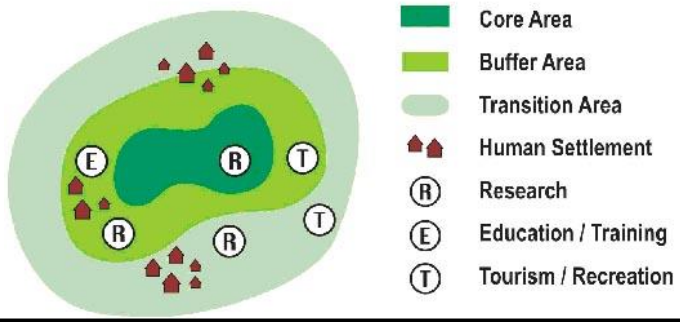
# NATURE RESERVES

- Ecologists call for protecting more land to help sustain biodiversity, but powerful economic and political interests oppose doing this.
- Currently 12% of earth's land area is protected.
  - Only 5% is strictly protected from harmful human activities.
- Conservation biologists call for full protection of at least 20% of earth's land area representing multiple examples of all biomes.
- Nature reserves are biodiversity islands in a sea of habitat degraded to varying degrees by human activity
- One argument for extensive reserves is that large, far-ranging animals with low-density populations require extensive habitats
- In some cases the size of reserves is smaller than the actual area needed to sustain a population

# NATURE RESERVES

- Large and medium-sized ***reserves with buffer zones*** help protect biodiversity and can be connected by corridors.
- A model biosphere reserve that contains a protected inner core surrounded by two buffer zones that people can use for multiple use.

**Structure of a model biosphere reserve.**




# (b) *Small-Population Approach*

- Biologists focusing on conservation at the **population and species levels** follow two main approaches:
  I. ***Small-Population Approach***
  II. ***Declining-Population Approach***

- Conservation biologists who adopt the small-population approach study the processes that can cause very small populations finally to become extinct

# Threatened & Endangered species

- Globally, 12% of birds, 20% of mammals, and 32% of amphibians are threatened with extinction
- ***Threatened species*** are those that are considered likely to become endangered in the foreseeable future
- ***Endangered species*** is the one that is close of becoming extinct throughout its range
- Harvard biologist E. O. Wilson has identified the ***Hundred Heartbeat Club Species*** that number fewer than 100 individuals and are only that many heartbeats from extinction

**(a) Philippine eagle**

**(b) Chinese river dolphin**

**(c) Javan rhinoceros**

# How to determine the commonness of a population

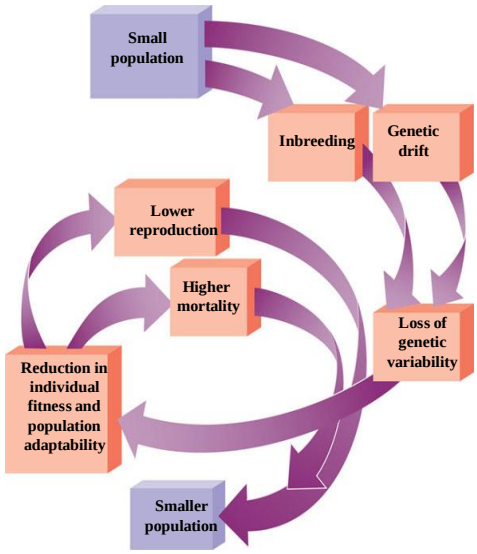
- Population conservation focuses on
  - **Population size**
  - **Genetic diversity**
  - **Critical habitat**

- *Rabinowitz* devised **commonness classification** of Species based on three factors:
  1. **Geographic Range**
  2. **Habitat Tolerance**
  3. **Local Population Size**

- **Notes**:
  - Populations that are least threatened by extinction, must have Extensive geographic ranges, broad habitat tolerances, and some large local populations.
  - **Population density** is the number of individuals of a species per unit of area or volume

# The Extinction Vortex hypothesis

- First coined by Gilpin & Soulé in 1986, the **extinction vortex** is the term used to describe the process that declining populations undergo when "*a mutual reinforcement occurs among biotic and abiotic processes that drives population size downward to extinction*"
  - A small population is prone to positive-feedback loops that draw the population down an ***extinction vortex***
- The key factor driving the extinction vortex is the loss of the genetic variation necessary to enable evolutionary responses to environmental change

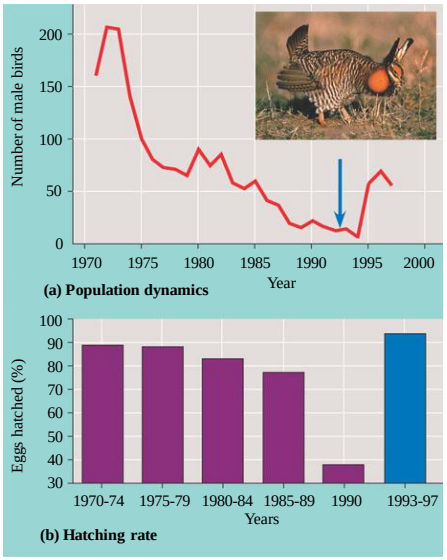



(Brook, Sodhi & Bradshaw 2008)

**EXPRIMENT** Researchers observed that the population collapse of the greater prairie chicken was mirrored in a reduction in fertility, as measured by the hatching rate of eggs. Comparison of DNA samples from the Jasper County, Illinois, population with DNA from feathers in museum specimens showed that genetic variation had declined in the study population. In 1992, researchers began experimental translocations of prairie chickens from Minnesota, Kansas, and Nebraska in an attempt to increase genetic variation.

**RESULTS** After translocation (blue arrow), the viability of eggs rapidly improved, and the population rebounded.

**CONCLUSION** The researchers concluded that lack of genetic variation had started the Jasper County population of prairie chickens down the extinction vortex.



## Case study-The bilby (*Macrotis lagotis*) in Australia

- The bilby is protected throughout Australia where it occurs.
- **A national Recovery Plan** is being developed to ensure the survival of the bilby.

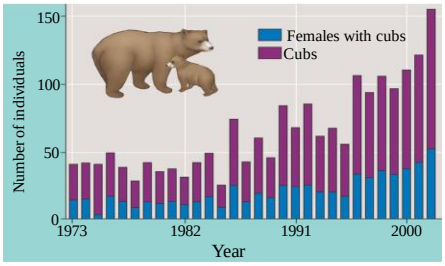
- Key recovery actions include:
  1. Managing the bilby's remaining habitat
  2. Breeding in captivity
  3. Monitoring existing populations
  4. Re-establishing bilbies in areas where they previously occurred.

## Terms on population conservation

- **The minimum viable population (MVP)**
  - It is the minimum population size at which a species is able to sustain its numbers and survive
- **Effective Population Size**:
  - A meaningful estimate of MVP requires a researcher to determine the effective population size, which is based on the breeding size of a population
- **A population viability analysis (PVA)**
  - Predicts a population's chances for survival over a particular time

# Analysis of Grizzly Bear Populations

- One of the first population viability analyses was conducted as part of a long-term study of grizzly bears in Yellowstone National Park
- This study has shown that the grizzly bear population has grown substantially in the past 20 years

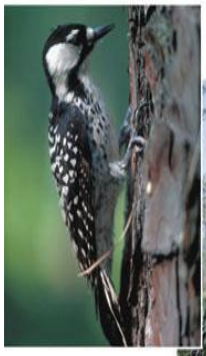



# *Declining-Population Approach*

- The declining-population approach
  - Focuses on threatened and endangered populations that show a downward trend, regardless of population size
  - Emphasizes the environmental factors that caused a population to decline in the first place
- Steps for Analysis and Intervention
  - The declining-population approach requires that population declines be evaluated on a case-by-case basis
  - It involves a step-by-step proactive conservation strategy

# Decline of the Red-Cockaded Woodpecker

- Red-cockaded woodpeckers
  - Require specific habitat factors for survival
  - Had been forced into decline by habitat destruction
- In a study where breeding cavities were constructed new breeding groups formed only in these sites
- On the basis of this experiment a combination of habitat maintenance and excavation of new breeding cavities has enabled a once-endangered species to rebound



**(a)** A red-cockaded woodpecker perches at the entrance to its nest site in a longleaf pine.

**(b)** Forest that can sustain red-cockaded woodpeckers has low undergrowth.

**(c)** Forest that cannot sustain red-cockaded woodpeckers has high, dense undergrowth that impacts the woodpeckers' access to feeding grounds.

## (c) Umbrella Species Approach
*Conserve **keystone** species*

- Example is: "***Reintroducing Wolves to Yellowstone***"
- It is a **Keystone Species**
  - Keeps prey away from open areas near stream banks.
  - Vegetation reestablishes.
  - Species diversity expands.
- It is endangered Species
  - 1850-1900 two million wolves were destroyed.



## Protest on Reintroducing Wolves to Yellowstone!!!


1996 – Montana Wolf Reintroduction Protest

## Remarkable notes

- Only 16 of 145 reintroductions of captive bred individuals have been successful
- 86% of reintroductions of native game animals have been successful
- 46% of reintroductions of native threatened, endangered or sensitive animals have been successful

## *Ex Situ* Conservation

- ***Zoos*** *- These may involve captive breeding programs,*
- ***Aquaria*** *- research, public information and education*
- ***Plant Collections*** *- breeding programs and seed storage (Germplasm collections; Botanic gardens;..etc)*
- ***Gene bank-*** *especially for microbes*

# *Ex situ* conservation

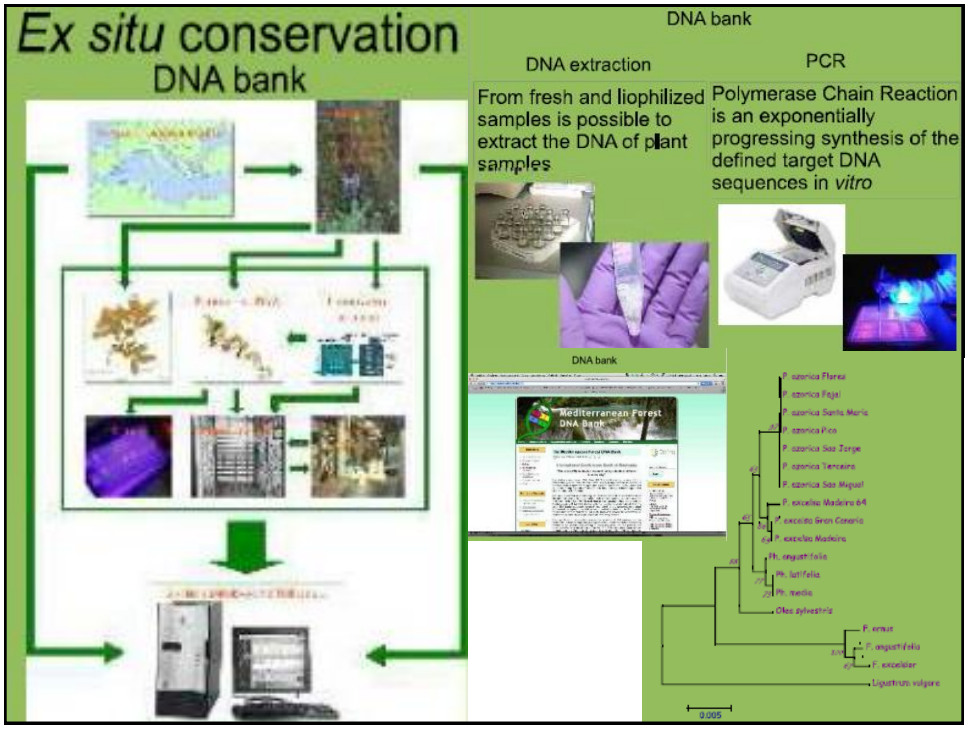
The main procedures to preserve biodiversity *ex situ* are the development of:

- botanical gardens and arboreta
- herbaria
- germoplasm banks
- DNA banks

# Botanical gardens


Ex situ conservation
Herbarium


Ex situ conservation
Germoplasm bank
Svalbard, Global seed Vault




# Biotechnology has great impact in Ex-situ conservation

- **Biotechnology is providing tools in:**
  1. ***Breeding and propagation programs*** (micropropagation; IVF; embryogenesis)
  2. ***Identification of the genetic diversities*** (Molecular markers-DNA fingerprinting; Serological –serotypes)
  3. ***Monitoring genetic erosion*** (molecular assessments and phylogeny)
  4. ***Preservation methods*** (*In vitro* culture; Cryopreservation; Germplasms collections and Gene banks)
  5. ***The pests and pathogens Controlling and sanitation methods*** (***Sanitation process and Biological control***)
- In addition to that, transgenic technology can lead to producing of a new category of germplasms and cell lines with special attributes to genetically transformed material

## Breeding and propagation programs

- **Breeding programs** that can be carried out in zoos and botanical gardens to preserve populations of animals and plants that are genetically varied.
  - Tools: IVF; tissue culture; micropropagation;..etc
- Plant genetic resources are genotypes of particular species, collected from different sources and geographical origins, for use in plant breeding to develop new cultivars

## Identification of the genetic diversities

- **DNA fingerprinting** was inevitable for taxonomy of many species.
  - Molecular genetic techniques can help in identifying duplicate accessions and assembling core collections (a subset of accessions that aims to include the maximum genetic variation).

## Monitoring genetic erosion

- The expansion of the agricultural frontiers and use of improved varieties resulted in the reduction of traditional varieties and contributed to the risk of loss of the wild relatives of crop species. Molecular genetic data can be used to **monitor genetic erosion** in the field.
  - ***Genetic erosion:*** is the loss of genetic diversity and variability caused by either natural or man-made processes.
- Biotechnology also provides tools for **monitoring**, and hence **controlling, genetic drift** during regeneration and for characterizing and evaluating collections.
  - ***Genetic drift*** : is the variation in the relative frequency of different genotypes in a small population, owing to the chance disappearance of particular genes as individuals die or do not reproduce

## Preservation methods

- **By Tissue culture techniques** are also valuable for conserv plant species that are vegetative propagated or that produce seeds that cannot be dried for storage at low temperatures without losing their viability
- Large collections of such plants can be maintained as tissue cultures growing in petri dishes or test tubes.
  - These may be maintained in growth chambers and on culture media that minimize the growth rate of the cultures and thus maximize the period of time needed between successive regenerations
- The culture of cells and tissue; an area within biotechnology, is being used for **maintenance of live collections** of the most varied types and plant species of economic importance or others at risk for extinction.

# Preservation methods

- **By Cryopreservation** is one of the biotechnological method of ex situ plant conservation and applicable for long term storage of plant genetic material.
  - It is extremely helpful method to conserve rare, endangered, threatened plant species
- The genetic stability can be maintained during cryopreservation that has been proved by molecular marker study
- When there is a need for more long-term preservation, such as for preserving some specific types of plant tissue used in tissue culture or preservation of pollen, cryopreservation in liquid nitrogen at (–196°C) is the appropriate alternative.

# Preservation methods

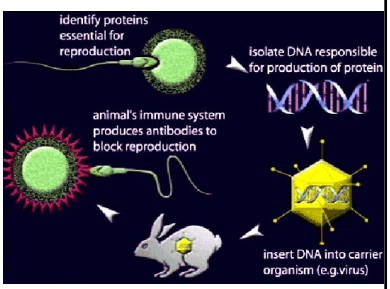
- **By Germplasm collections /Gene Banks** broadly refers to the hereditary material (total content of genes) transmitted to the offspring through germ cells.
  - ***Gene Banks*** are created for that preservation of microbial diversity (bacteria, fungi, and viruses) has also been made possible by biotechnological methods by.
  - ***Germplasm collections*** for various species of plants, animals, and microorganisms have been collected and stored, so the huge number of species variation might not be lost.

## The pests and pathogens Controlling and sanitation methods

- ***Sanitation process*** is becoming useful in ensuring the safe movement of genetic resources and to prevent diseases from distribution along with the plant materials
- Biotechnology's, such as ***Meristem-tip culture*** methods and ***heat treatments***, can be used therapeutically to help clean up infected materials

## The pests and pathogens Controlling and sanitation methods

- **Biological control** is by definition, *biotechnology*, in which one of living organism (such as natural predators, parasites, disease carrying bacteria or viruses) used to be as a tool to control the pest
  - This concept should keep a **balance in the ecosystem**
- Examples:
  - The uses of biotechnology major insect pest of the cotton plant is the **cotton bollworm** (*Helicoverpa*) that can be controlled by the GM *Baculovirus sp.* or *GM cotton plants.*
  - This biotechnique was used in rabbits, and depends on the insertion of genes using the myxoma virus
  - Mosquitoes were genetically modified to be less able to transmit the disease



## What else can be done to conserve biodiversity

Beside ex-situ and in-situ conservation of biodiversities; the following actions must be taken into considerations:

1. Human population control
2. Reviewing the agricultural practices
3. Controlling urbanization
4. Imparting (spreading) environmental education
5. Restoration of ecosystems
6. Conservation biodiversity through Biotechnology