BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS

- **INTRODUCTION TO THE BIOLOGICAL CONSERVATION AND THE MARINE PROTECTED AREAS**

(Basic Terms, Need for Biological Conservation, International Legislation)

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

BIOLOGICAL CONSERVATION

- Terminology
- Contents
- Threats
- Natural resource conservation
- Conservation priorities
- Economic values and natural capital
- Keystone species
- Indicator species
- Umbrella and flagship species
- Global conservation efforts

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

MARINE PROTECTED AREAS

- Why we need an MPA?
- Basic Terms
- Ecological and Socio-economical benefits
- Current MPA status in the Mediterranean and the Greek Seas
- Problems and perspectives
- Setting up an MPA
- Ecological and Socio-economical criteria
- Systematic conservation planning and MPAs – Different Approaches

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

- **Biological Conservation OR Conservation Biology** is:

'*The scientific study of nature and of* ***Earth*****'s** ***biodiversity*** *with the aim of protecting* ***species****, their* ***habitats****, and* ***ecosystems*** *from excessive rates of* ***extinction*** *and the erosion of biotic interactions*'

The rapid decline of established biological systems around the world means that Conservation Biology is often referred to as a "*Discipline with a deadline*"

The concern stems from estimates suggesting that up to 50% of all species on the planet will disappear within the next 50 years, which has contributed to poverty, starvation, and will reset the course of evolution on this planet.

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

- **BIOLOGICAL CONSERVATION** **relation to other Life Science disciplines**

- Ecology: researching the dispersal, migration, demographics, effective population size, inbreeding depression, and minimum population viability of rare or endangered species.
- Evolution & Genetics: To better understand the restoration ecology of native plant and animal communities, the conservation biologist closely studies both their polytypic and monotypic habitats that are affected by a wide range of benign and hostile factors.
- Biodiversity: Conservation biology is concerned with phenomena that affect the maintenance, loss, and restoration of biodiversity and the science of sustaining evolutionary processes that engender genetic, population, species, and ecosystem diversity.

• BIOLOGICAL CONSERVATION <u>relation to other Life Science disciplines</u>

• Conservation biology – a multidisciplinary discipline

Ecology
- Study the distribution of habitats and species
- Investigate the demographics and dispersal abilities of species
- Estimate effective population size, and produce minimum population viability models

Evolution & Genetics
- Estimate genetic diversity within a species, a community or an ecosystem
- Define population connectivity

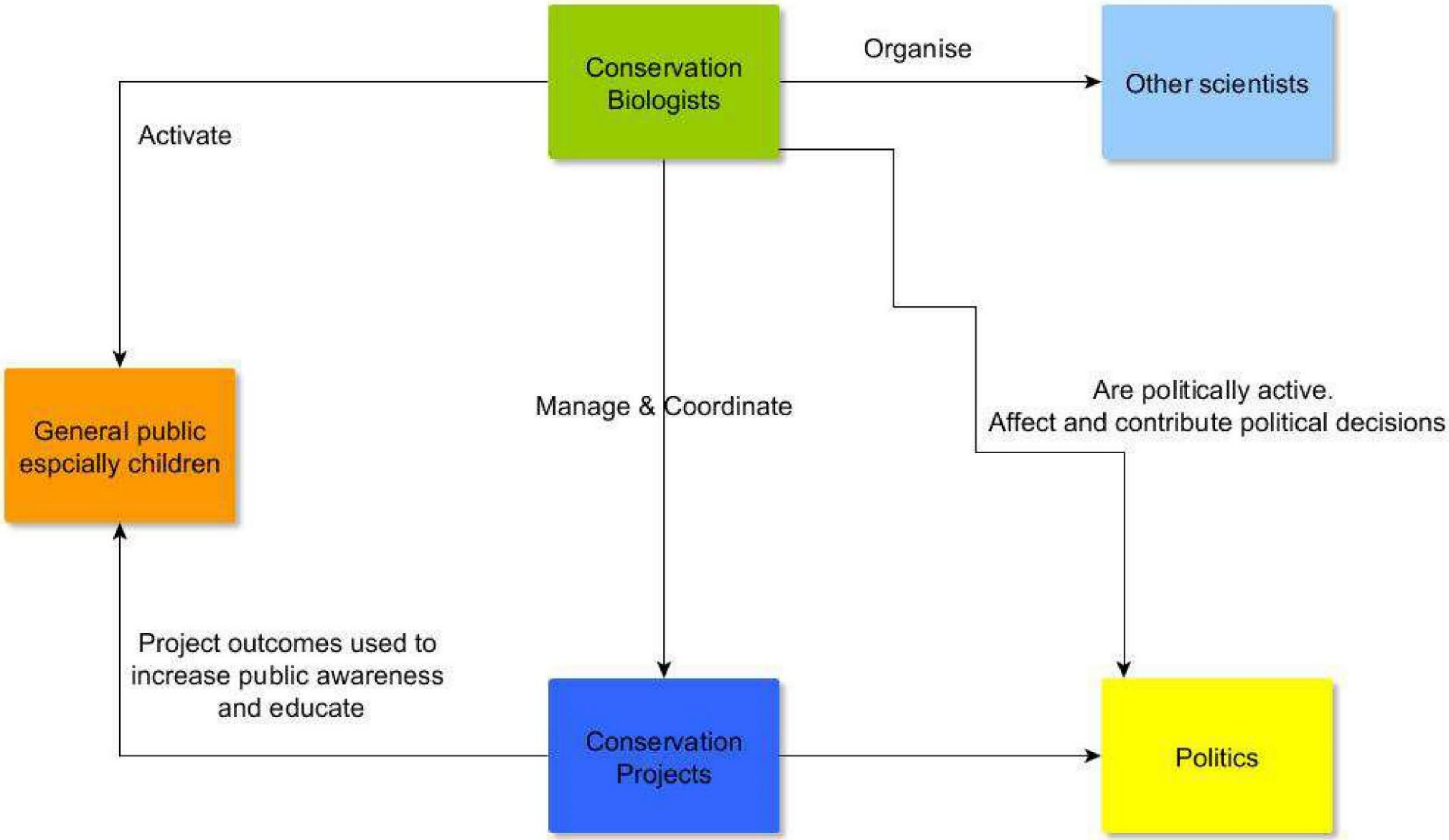
Environmental economics
- Estimate the value of biodiversity or subsequent biodiversity loss

Social & Political sciences
- Identifying socio-political and economical conflicts, developing legal instruments to ensure biodiversity conservation

Spatial planning & environmental management
- Identifying potential threats.
- Developing tools for conservation.
- Finding optimum solutions between conservation targets and other human interests

• BIOLOGICAL CONSERVATION relation to other Life Science disciplines

• Conservation biology – a multidisciplinary discipline



Source: Primarck et al. 2017

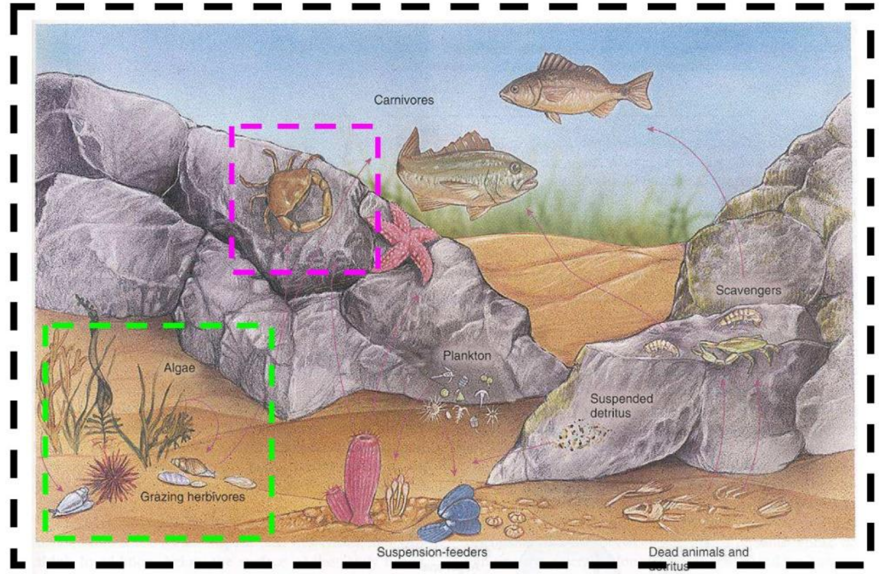
• BIODIVERSITY

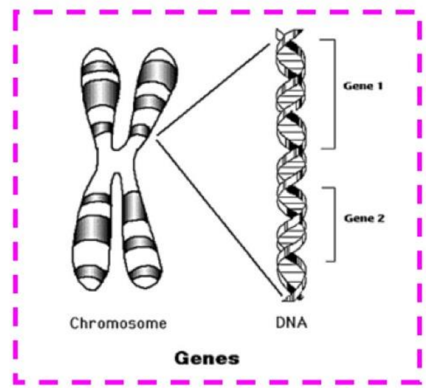
Biodiversity is defined at three levels:

- ***Ecosystem diversity***
  Including the number of marine ecosystems, habitat types, or communities, found across the seascape of an entire region.

- ***Species diversity***
  The number of species found within a specific habitat type, community, or ecosystem.

- **Genetic diversity**
  The diversity of genes found within a species population [important for the survival of a species]





• Why is it important to protect biodiversity?

- All three levels of biodiversity are equally important, and they are interlinked.

Example

- ***Posidonia oceanica***

Priority habitat type

Traps & stabilizes sediment

Weaken water movement (up to 70%) – coastal protection

Primary production is large

Much of this primary production is exported to other ecosystems

Hosts approx. 400 plant species & >2000 animal species

Complex & rich foodweb

- The **loss of genetic diversity** may lead to the **loss of an entire population.** This may subsequently affect other species or communities, and finally the whole ecosystem through a cascading process.

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

- **BIOLOGICAL CONSERVATION focuses**

- Conservation biologists work in the **field** and **office**, in Government, Universities, Non-profit Organizations and Industry. They are funded to research, monitor, and catalog every angle of the earth and its relation to society. The topics are diverse, because this is an interdisciplinary network with professional alliances in the biological as well as social sciences. Those dedicated to the cause and profession advocate for a global response to the current biodiversity crisis based on morals, ethics, and scientific reason.

- **Organizations and Citizens** are responding to the **biodiversity crisis** through **conservation action plans** that direct research, monitoring, and education programs that engage concerns at local through global scales

• **BIOLOGICAL CONSERVATION focuses**

- Conservation biologists research and educate on the trends and process of **biodiversity loss**, species **extinctions**, and the negative effect these are having on our capabilities to **sustain** the well-being of human society.

Earth has witnessed five major mass extinctions:

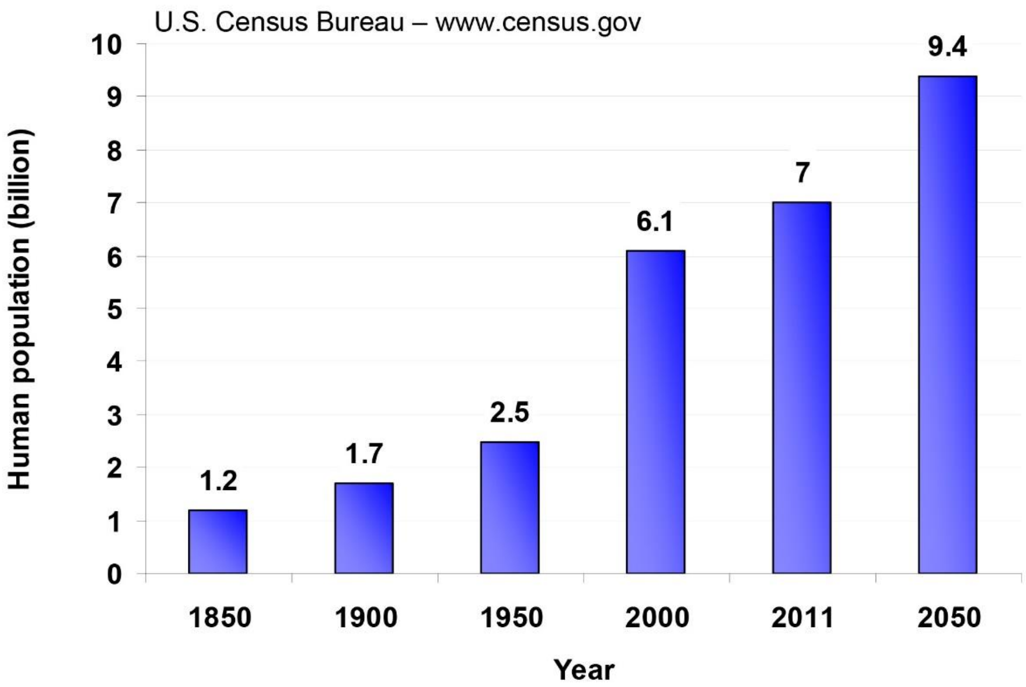
- End Ordovician, 444 milion years ago ~ 86% species loss [suspected cause: short severe ice age]
- Late Devonian, 375 million years ago ~ 75% species loss [suspected cause: evolution of land plants released nutrients, possibly triggered algal blooms that suffocated benthic animals]
- End Permian, 251 million years ago ~ 96% species loss [suspected cause: storm of natural disasters]
- End Triassic, 200 million years ago ~ 80% species loss [no clear cause]
- End of Cretaceous, 66 million years ago ~76% species loss [suspected cause: asteroid impact]

Ammonites fossil

Nautilus - Ammonites oldest relative

- **Biodiversity loss AND** species **extinctions** – TODAY ???? **Why** ????

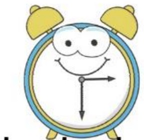
The problem today



- More than 10.000 years for *Homo sapiens* to reach a global population of one billion
- Only 150 years to increase ×5
- Current rate of increase = 1.1% per year = 70 million in one year

- **Biodiversity loss AND** species **extinctions** – TODAY ???? **Why** ????

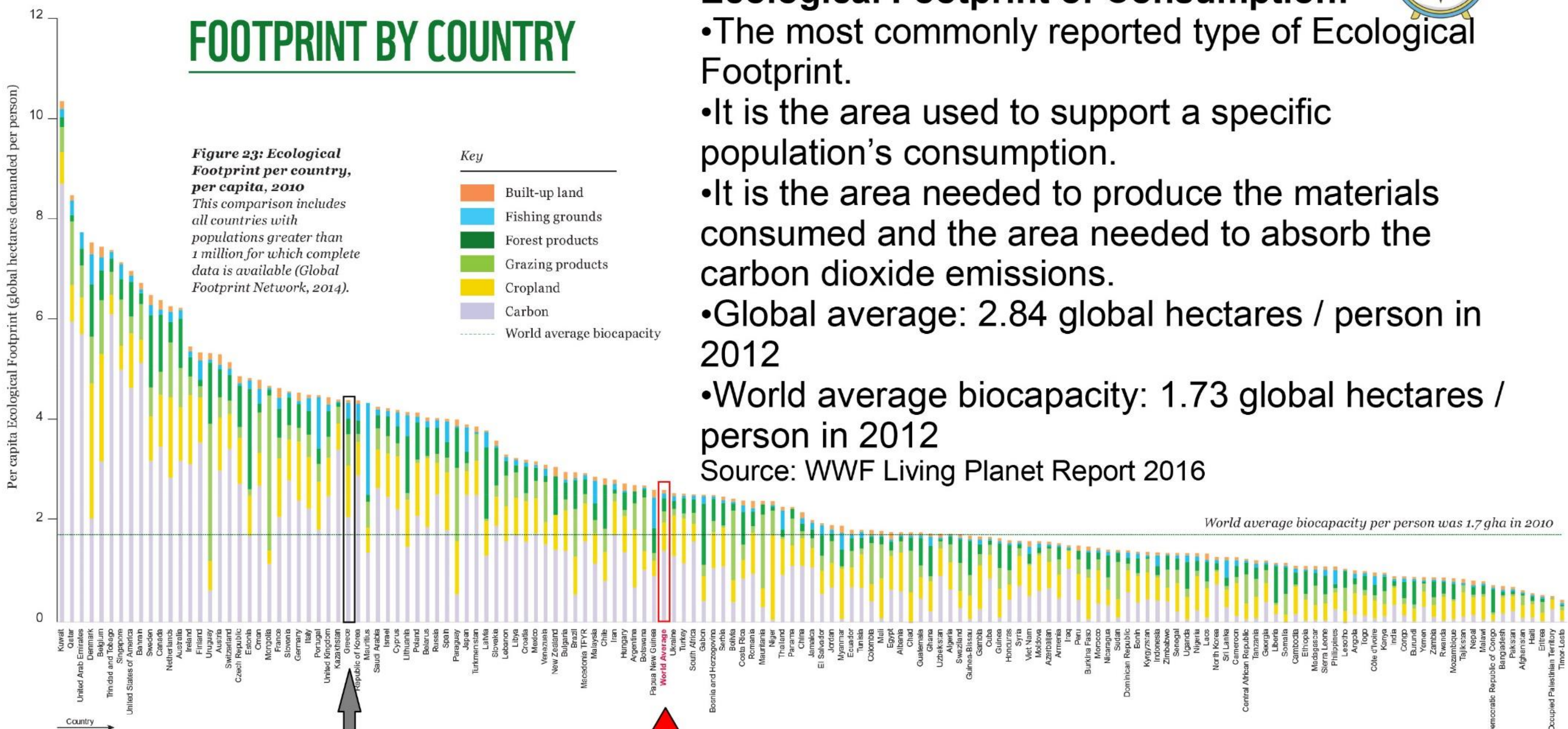
The problem today



Ecological Footprint of Consumption:

- The most commonly reported type of Ecological Footprint.
- It is the area used to support a specific population’s consumption.
- It is the area needed to produce the materials consumed and the area needed to absorb the carbon dioxide emissions.
- Global average: 2.84 global hectares / person in 2012
- World average biocapacity: 1.73 global hectares / person in 2012

Source: WWF Living Planet Report 2016



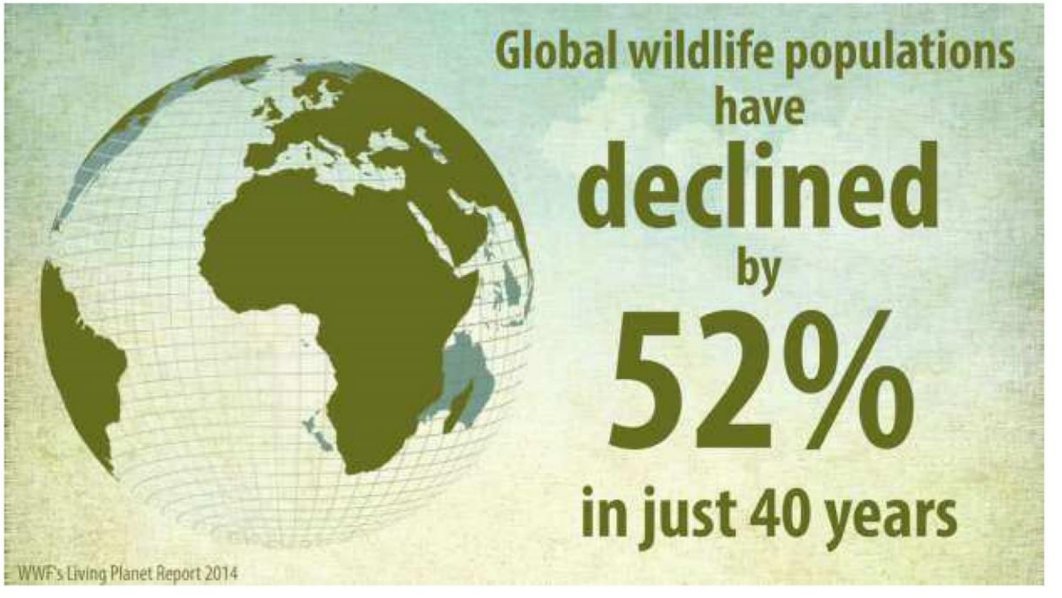
Greece

Global average

- **Biodiversity loss AND** species **extinctions** – TODAY ???? **Why** ????

The problem

- Increase of human population
- Increase of needs for:
  - raw materials – wood, coal, oil, gas, fish and other animal resources.
  - Land – natural biotopes for cities, industries, mining, agri/aquaculture, fisheries, human activities.



Natural threats

- extreme events [e.g. extreme storms, volcanic eruptions, tsunamis]

Anthropogenic threats

- **Coastal threats**: Population increase & urbanisation, coastal engineering, inorganic / organic pollution, agriculture, aquaculture, hypoxia.
- **Fisheries related threats**: Overfishing, bycatch, seabed destruction
- **Maritime activities**: shipping lanes, ports, marinas, oil rigs
- **Ocean-based pollution**: Marine debris, oil pollution
- **Invasive species**
- **Climate change related threats**: SST increase, SL increase, pH decrease (acidification)

- **Biodiversity loss AND** species **extinctions** – TODAY ???? **Why** ????

Natural threats

Anthropogenic threats

- **Biodiversity loss AND** species **extinctions** – TODAY ???? **Why** ????

❑ **Biodiversity loss AND** species **extinctions** – TODAY ???? **Why** ????

- Increase in the **rate of extinction** of wild species and natural habitats: Estimates suggest that up to 50% of all species on the planet will disappear within the next 50 years
- Increase in the **rate of biodiversity loss**

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

• BIOLOGICAL CONSERVATION priorities

- The **International Union for the Conservation of Nature (IUCN)** has organized a global assortment of scientists and research stations across the planet to monitor the changing state of nature in an effort to tackle the extinction crisis. The IUCN provides annual updates on the status of species conservation through its **Red List**.
- The **IUCN Red List** serves as an international conservation tool to identify those species most in need of conservation attention and by providing a global index on the status of biodiversity. More than the dramatic rates of species loss, however, conservation scientists note that the sixth mass extinction is a biodiversity crisis requiring far more action than a priority focus on rare, endemic or endangered species.

Summary of 2006 IUCN Red List categories.

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

- **BIOLOGICAL CONSERVATION** <u>The **IUCN Red List**</u>

- **Extinct (EX)** – No known individuals remaining.
- **Extinct in the wild (EW)** – Known only to survive in captivity, or as a naturalized population outside its historic range
- **Critically endangered (CR)** – Extremely high risk of extinction in the wild
- **Endangered (EN)** – High risk of extinction in the wild
- **Vulnerable (VU)** – High risk of endangerment in the wild
- **Near threatened (NT)** – Likely to become endangered in the near future
- **Least concern (LC)** – Lowest risk. Does not qualify for a more at-risk category. Widespread and abundant taxa are included in this category

Summary of 2006 IUCN Red List categories.

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

- **BIOLOGICAL CONSERVATION** **priorities**

- More than the dramatic rates of species loss, however, conservation scientists note that the sixth mass extinction is a biodiversity crisis requiring far more action than a priority focus on rare, endemic or endangered species.
- Concerns for biodiversity loss covers a broader conservation mandate that looks **at ecological processes** such as:

  - **migration**
  - a **holistic examination of biodiversity** at levels beyond the species, including genetic, population and **ecosystem** diversity

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

- **BIOLOGICAL CONSERVATION** **priorities**

- Extensive, systematic, and rapid rates of biodiversity loss threatens the sustained well-being of humanity by limiting supply of ecosystem services that are otherwise regenerated by the complex and evolving holistic network of genetic and ecosystem diversity. While the conservation status of species is employed extensively in conservation management, some scientists highlight that:

  - it is the **common species** that are the primary source of exploitation and habitat alteration by humanity.
  - Moreover, common species are often undervalued despite their role as the **primary source of ecosystem services**.

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

- **BIOLOGICAL CONSERVATION** **Ecosystem services & Biodiversity - Human Benefits**
  OR Economic values and Natural capital

- **Conservation biologists** have started to **collaborate with leading global economists** to determine how to measure the wealth and services of nature and to make these values apparent in global market transactions.This system of accounting is called **Natural Capital** and would, for example, register the **Value of an Ecosystem** before it is cleared to make way for development.
- The **WWF** publishes its **Living Planet Report** and provides a global index of biodiversity by monitoring approximately 5,000 populations in **1,686 species of vertebrate** (mammals, birds, fish, reptiles, and amphibians) and report on the trends in much the same way that the stock market is tracked.

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

- **BIOLOGICAL CONSERVATION** **Ecosystem services & Biodiversity - Human Benefits**
  OR Economic values and Natural capital

- This method of measuring the **Global Economic Benefit of Nature** has been endorsed by the G8+5 leaders and the European Commission. Nature sustains many ecosystem services that benefit humanity. Many of the **earths ecosystem services are public goods without a market** and therefore no price or value. When the stock market registers a financial crisis, traders on Wall Street are not in the business of trading stocks for much of the planet's living natural capital stored in ecosystems. There is no natural stock market with investment portfolios into sea horses, amphibians, insects, and other creatures that provide a sustainable supply of ecosystem services that are valuable to society.
- The **ecological footprint of society** has exceeded the bio-regenerative capacity limits of the planet's ecosystems by about 30%, which is the **same percentage of vertebrate populations that have registered decline** from 1970 through 2005.

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

• **BIOLOGICAL CONSERVATION** **Ecosystem services & Biodiversity - Human Benefits** **OR Economic values and Natural capital**

- Although a direct market comparison of natural capital is likely insufficient in terms of human value, **one measure of ecosystem services suggests the contribution amounts to trillions of dollars yearly**.

- For example, **one segment of North American forests** has been assigned an **annual value of 250 billion dollars**

- as another example, **honey-bee pollination** is estimated to provide between **10 and 18 billion dollars of value yearly**.

- The value of **ecosystem services on one New Zealand island** has been imputed to be **as great as the GDP of that region**.

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

• **BIOLOGICAL CONSERVATION** **Ecosystem services & Biodiversity - Human Benefits** **OR Economic values and Natural capital**

- The **Ecological Credit** crunch is a global challenge. The WWF Living Planet Report 2008 tells us that:

more than three-quarters of the world's people live in ***nations that are ecological debtors*** *– their national consumption has outstripped their country's* ***biocapacity****. Thus, most of us are propping up our* ***current lifestyles, and our economic growth****, by* ***drawing*** *(and increasingly overdrawing)* ***upon the ecological capital of other parts of the w****orld.*

This planetary wealth is being lost at an incredible rate as the **demands of human society is exceeding the bio-regenerative capacity of the Earth**. While biodiversity and ecosystems are resilient, the danger of losing them is that **humans cannot recreate many ecosystem functions through technological innovation**

- **BIOLOGICAL CONSERVATION** **Ecosystem services & Biodiversity - Human Benefits** **OR Economic values and Natural capital**

- The inherent **Natural Economy** plays an **essential role in sustaining humanity**, including:

- the regulation of global atmospheric chemistry
- pollinating crops
- pest control
- cycling soil nutrients
- purifying our water supply
- supplying medicines and health benefits
- unquantifiable quality of life improvements.

There is a relationship, a correlation, between markets and natural capital, and social income inequity and biodiversity loss. This means that there are **greater rates of biodiversity loss in places** where the **inequity of wealth is greatest**

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

• BIOLOGICAL CONSERVATION <u>Keystone species</u>

- ❑ Some species, called **<u>keystone species</u>**, form a central supporting hub in the ecosystem. The <u>loss of such a species results in a collapse in ecosystem function</u>, as well as the <u>loss of coexisting species</u>.
- ❑ The importance of a keystone species was shown by the **extinction of the Steller's sea cow** (*Hydrodamalis gigas*) through its interaction with sea otters, sea urchins, and kelp.
- ❖ Kelp beds grow and form nurseries in shallow waters to shelter creatures that support the food chain.
- ❖ Sea urchins feed on kelp, while sea otters feed on sea urchins.
- ❖ With the rapid decline of sea otters due to overhunting, sea urchin populations grazed unrestricted on the kelp beds and the ecosystem collapsed. Left unchecked, the urchins destroyed the shallow water kelp communities that supported the Steller's sea cow's diet and hastened their demise.

The **sea otter was thought to be a keystone species** because the coexistence of many ecological associates in the kelp beds relied upon otters for their survival.

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

- **BIOLOGICAL CONSERVATION** **Indicator species**

- An **indicator species** has a narrow set of ecological requirements, therefore they become useful targets for observing the health of an ecosystem. Some animals, such as amphibians with their semi-permeable skin and linkages to wetlands, have an acute sensitivity to environmental harm and thus may serve as a miner's canary.
- Indicator species are **monitored in an effort to capture environmental degradation** through pollution or some other link to proximate human activities.
- Monitoring an indicator species is a **measure to determine if there is a significant environmental impact that can serve to advise or modify practice**, such as through different forest silviculture treatments and management scenarios, or to measure the degree of harm that a pesticide may impart on the health of an ecosystem.
- It is generally recommended that **multiple indicators** (genes, populations, species, communities, and landscape) be monitored for effective conservation measurement that prevents harm to the complex, and often unpredictable, response from ecosystem dynamics

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

• BIOLOGICAL CONSERVATION Umbrella and Flagship species

- An example of an **umbrella species** is the monarch butterfly, because of its lengthy migrations and aesthetic value. The monarch migrates across North America, covering multiple ecosystems and so requires a large area to exist. Any protections afforded to the monarch butterfly will at the same time umbrella many other species and habitats. An umbrella species is often used as **flagship species**, which are species, such as:

- the giant panda
- the blue whale
- the tiger
- the mountain gorilla and
- the monarch butterfly

that **capture the public's attention** and **attract support for conservation measures**.

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

- **BIOLOGICAL CONSERVATION** **Umbrella/Flagship species** **Groups other than Vertebrates**

❑ Serious concerns also being raised about **taxonomic groups that do not receive the same degree of social attention** or attract funds as the vertebrates. These include:

❖ **Fungal** (including lichen-forming species) - As mycorrhizal symbionts, and as decomposers and recyclers, fungi are essential for sustainability of forests.

❖ **Invertebrate** (particularly insect) - The value of insects in the biosphere is enormous because they outnumber all other living groups in measure of species richness (This great ecological value of insects is countered by a society that often reacts negatively toward these aesthetically 'unpleasant' creatures).

❖ **Plant communities** where the vast majority of biodiversity is represented - The greatest bulk of biomass on land is found in plants, which is sustained by insect relations.

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

- **BIOLOGICAL CONSERVATION** **Umbrella/Flagship species** **<u>Groups other than Vertebrates</u>**

- One area of concern in the insect world that has caught the public eye is the **mysterious case of missing honey bees** (*Apis mellifera*). Honey bees provide an **indispensable ecological service** through their acts of pollination supporting a huge variety of agriculture crops. The sudden disappearance of bees leaving empty hives or colony collapse disorder (CCD) is not uncommon. However, in 16-month period from 2006 through 2007, 29% of 577 beekeepers across the United States reported CCD losses in up to 76% of their colonies. This sudden demographic loss in bee numbers is placing a strain on the agricultural sector. The <u>cause behind the massive declines is puzzling scientists</u>. **Pests**, **pesticides**, and **global warming** are all being considered as <u>possible causes</u>
- Another highlight that links **conservation biology to insects, forests, and climate change** is the <u>mountain pine beetle</u> (*Dendroctonus ponderosae*) epidemic of British Columbia, Canada, which has infested 470,000 km2 (180,000 sq mi) of forested land since 1999. An Action Plan has been prepared by the Government of British Columbia to address this problem.

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

• BIOLOGICAL CONSERVATION Status of Oceans and Reefs

- ❑ Global assessments of **coral reefs** of the world continue to report **drastic and rapid rates of decline**. By 2000, 27% of the world's coral reef ecosystems had effectively collapsed. The largest period of decline occurred in a dramatic "bleaching" event in 1998, where approximately 16% of all the coral reefs in the world disappeared in less than a year.

- ❑ **Coral bleaching** is caused by a mixture of environmental stresses, including **increases in ocean temperatures and acidity**, causing both the **release of symbiotic algae and death of corals**.

- ❑ **Decline and extinction risk in coral reef biodiversity** has risen dramatically in the past ten years. The loss of coral reefs, which are predicted to go extinct in the next century, will have **huge economic impacts, threatens the balance of global biodiversity, and endangers food** security for hundreds of millions of people.

- ❑ Conservation biology plays an important role in **international agreements covering the world's oceans** (and other issues pertaining to biodiversity)

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

• BIOLOGICAL CONSERVATION Status of Oceans and Reefs

- The oceans are threatened by **acidification** due to an **increase in CO2 levels**. This is a most serious threat to societies relying heavily upon oceanic natural resources. A concern is that the majority of all marine species will not be able to evolve or acclimate in response to the changes in the ocean chemistry

- The prospects of averting mass extinction seems unlikely when **90% of all of the large (average approximately ≥50 kg), open ocean tuna, billfishes, and sharks in the ocean" are reportedly gone**.

- Given the scientific review of current trends, the **ocean is predicted to have few surviving multi-cellular organisms** with only microbes left to dominate marine ecosystems

INTRODUCTION TO THE BIOLOGICAL CONSERVATION & MARINE PROTECTED AREAS (MPAs)

- **BIOLOGICAL CONSERVATION** <u>**Systematic conservation planning**</u>

❑ The **Systematic conservation planning** is an effective way to seek and identify efficient and effective types of reserve design to capture or sustain the highest priority biodiversity values and to work with communities in support of local ecosystems. Margules and Pressey identify 6 interlinked stages in the systematic planning approach:

- ❖ The Compile data on the biodiversity of the Planning region
- ❖ Identify conservation goals for the Planning region
- ❖ Review existing conservation areas
- ❖ Select additional conservation areas
- ❖ Implement conservation actions
- ❖ Maintain the required values of conservation areas

❑ Conservation biologists regularly prepare detailed **Conservation Plans** for grant proposals or to effectively coordinate their plan of action and to identify **best management practices**. Systematic strategies generally employ the services of <u>Geographic Information Systems </u>to assist in the **Decision Making Process**