

# An Introduction Marine Biodiversity

## "Biological diversity"

- means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.



**Ecosystems**



**Communities**



**Species**



**Genes**

# Biodiversity-the Web of Life

In its most simple form, **biodiversity** is 'Life on Earth'. **Marine biodiversity** is therefore all '**life in the seas and oceans**'. It refers to a variety of life forms including plants, animals and micro organisms, the genes that they contain, the ecosystems they form and habitats they occur in

**Biological Diversity:** 'Biodiversity is the fruit of billions of years of **evolution**, shaped by natural processes and, increasingly, by the influence of humans. It forms the web of life of which we are an integral part and upon which we so fully depend'

# What is biodiversity?

- ▶ Genetic diversity
- ▶ Species diversity
- ▶ Ecosystem diversity



# Genetic diversity

- ▶ **Genetic diversity** is the variation in the genetic composition of individuals in a population, community or species
- ▶ Evolves as a result of many different processes: e.g. chromosomal/sequence mutation, and physical or behavioural isolation of populations
- ▶ Allows individuals to adapt to different conditions. Thus, high genetic diversity increases ability of populations and species to survive major changes in their environment (e.g. climate change)



# Species diversity

- ▶ **Species diversity** is the variety of species (group of interbreeding organisms) in a particular habitat or ecosystem
- ▶ About 1.75 million species described. Total number estimated at approx 12.5 million. There may be 10 million undescribed species in the deep sea alone.
- ▶ The diversity of the smaller organisms (e.g. phytoplankton, the plants of sea) is less well known than the larger organisms (e.g. mammals such as dolphins and whales)



# Ecosystem diversity

- ▶ **Ecosystem diversity** describes the variation in all living and non-living things in a particular geographic or ecological region.
- ▶ Ecosystems comprise unique combinations of animals, plants, micro-organisms and physical characteristics that define a location.
- ▶ Novel marine ecosystems continue to be discovered. In the ocean, hydrothermal vents, extremely distinct habitats with many endemic species, were discovered less than 25 years ago!



# Ecosystem Functioning

- ▶ **Ecosystem functioning** is a term that comprises both the ecological and evolutionary processes and the individual components within a system
- ▶ Many scientists believe that ecosystems with a high variety in processes and components are more resilient to change than ecosystems with fewer functional roles

# Why is marine biodiversity so important ?

- ▶ Oceans occupy **70%** of earth
- ▶ Over 50% of humans live in the coastal zone and draw **90%** of our marine-living resources from this region

The marine environment provides us with

- ▶ Natural **beauty** (used for recreation)
- ▶ **Goods** (food, medicine, drugs, energy)
- ▶ **Services** (e.g. moderation of climate and weather extremes; processing of waste)
- ▶ **Employment** (e.g. fisheries, tourism)
- ▶ **Education** on evolution, ecology



# Marine Biodiversity

## ❖ **Geographic**

- ▶ Atlantic Ocean
- ▶ Arctic Ocean
- ▶ Baltic Sea
- ▶ Mediterranean Sea
- ▶ North Sea
- ▶ Black Sea

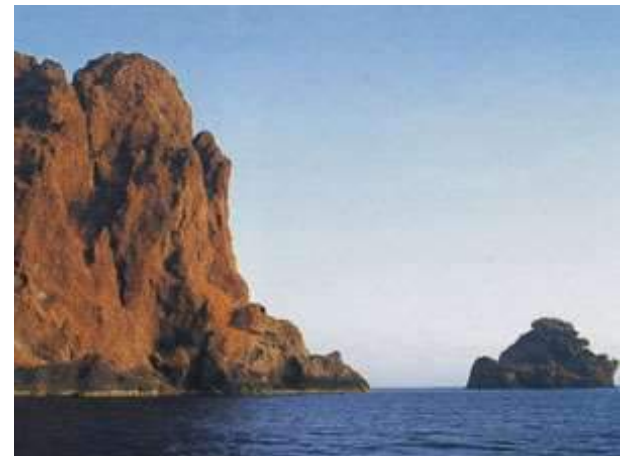
# Atlantic Ocean

- ▶ Second largest of earth's oceans extending from the Arctic to sub tropical latitudes.
- ▶ Productivity high on continental shelves and marine ridges and biodiversity high, but several highly exploited commercial species threatened.
- ▶ Main threats to biodiversity are
  - overexploitation of fisheries
  - pollution
  - lack of information & monitoring in open waters



# Mediterranean Sea

- ▶ Almost a closed basin; connected with Atlantic .
- ▶ High biodiversity, low productivity
- ▶ 67% of species specific to the region and holds 6% of the world's fauna in less than 1% of the total ocean areas
- ▶ Main threats to biodiversity are
  - introduction of alien species
  - eutrophication
  - pollution
  - overexploitation of fisheries



# Arctic Ocean

- ▶ Almost completely enclosed with harsh climate
- ▶ Relatively low productivity with most fauna of Atlantic origin
- ▶ Norwegian and Barents Seas unique with wide diversity of pelagic and benthic organisms
- ▶ Primary threats to biodiversity are
  - extensive fishing
  - potential effects of global warming
  - accumulation of pollution by atmospheric and oceanic circulation
  - exploration for and development of oil and gas reserves



# North Sea

- ▶ Relatively shallow, young ecosystem formed some 20,000 years ago
- ▶ Highly productive with vast array of plankton, fish, seabirds and benthic communities.
- ▶ Higher biodiversity in deeper northern regions than shallow southern regions
  
- ▶ Main threats to biodiversity are:
  - overexploitation of fisheries
  - resource exploitation (oil, gas and aggregate extraction)
  - nutrient input from coastal regions
  - recreational use
  - habitat loss.



# Baltic Sea

- ▶ Largest brackish sea in the world with limited exchange to more open seas
- ▶ Unusual flora and fauna with co-existing freshwater, brackish and saltwater species
- ▶ Major threats to biodiversity are:
  - introduction of alien species
  - overexploitation of fisheries
  - eutrophication
  - pollution from contaminants and oil





# Black Sea

- ▶ Enclosed coastal basin with low oxygen levels and relatively low salinity
- ▶ Relatively low species diversity
- ▶ Historically, one of most productive regions in the world, but environmental degradation severe
- ▶ Major threats to biodiversity are:
  - introduction of invasive species
  - overexploitation of resources
  - chemical contamination, especially from oil products
  - eutrophication
  - pollution from industrial, agricultural and domestic sources



# Marine Biodiversity

## Ecosystems

- ▶ Deep sea
- ▶ coral reefs
- ▶ Seamounts
- ▶ Pelagic ecosystems
- ▶ Coastal waters
- ▶ Intertidal ecosystems
- ▶ Estuaries



# Deep Sea Ecosystems

- ▶ Largely undiscovered ecosystem covering 62% of the globe
- ▶ May contain up to 10 million unknown species
- ▶ Home to many specialised communities with unique species
  
- ▶ Main threats to biodiversity are:
  - unsustainable fisheries
  - habitat destruction by trawling and resource exploration
  - lack of knowledge on ecosystems



# Deep sea communities

- ▶ Seamounts
- ▶ coral reefs
- ▶ Whale carcasses
- ▶ Hydrothermal vents



# Pelagic Ecosystems

- ▶ Shallow open seas including entire depth of water column
- ▶ Environment patchy in resources with upwellings, fronts, and gyres providing sufficient nutrients for high biological production
- ▶ Wide diversity of plankton supports fish and invertebrate species, which feed large predatory fish and mammals
- ▶ Main threats to biodiversity are:
  - commercial fishing
  - disease
  - eutrophication
  - chemical contamination
  - habitat invasion and damage



# Estuaries

- ▶ Harsh environments subject to large influxes of freshwater at low tide and more saline conditions at high tide
- ▶ Comprise many unique ecosystems such as salt marshes, seagrass beds and mudflats
- ▶ Important nursery grounds for larval and juvenile stages
- ▶ Main threats to biodiversity are:
  - commercial fisheries
  - pollution
  - introduction of alien species
  - construction (harbours, marinas)



# Intertidal Ecosystems

- ▶ Area of the shore that is alternately exposed during low tides and submerged during high tides
- ▶ Characterised by rocky shores, sandy beaches and muddy shores, depending on the amount and strength of wave action
- ▶ Provides important habitat for diversity of bird species, both residential and migratory
- ▶ Main threats to biodiversity are:
  - human developments
  - recreational use
  - pollution from nearby high population densities





# Coastal Waters

- ▶ Marine benthic and pelagic ecosystems that have substantial influence from the land
- ▶ High productivity, being home to major fisheries, but generally low species diversity.
- ▶ Major threats to biodiversity are:
  - commercial fisheries
  - coastal development
  - poor water quality resulting from pollution



# Biodiversity loss

One of the greatest environmental concerns of the last century!

- Human population explosion
- Realisation of value of biodiversity and consequences of biodiversity loss
- Extinction is irreversible

# Threats to marine biodiversity

- ▶ Habitat destruction and fragmentation
- ▶ Overexploitation of resources
- ▶ Pollution
- ▶ Introduced species
- ▶ Climate change



# Consequences of biodiversity loss

- Reduced capacity of ecosystems to respond to disaster
- Accelerated global climate change
- Economic loss
- Social/political instability
- Very real threat to our own existence

# A mass extinction?

- A Mass Extinction is an event in which very large numbers of species die out in a relatively short period of time
- An estimated 34,000 plant and 5,200 animal species - including one in eight of the world's bird species - currently face extinction
- Five geologic mass extinctions have occurred in the Earth's history. These were driven by geological and astronomical processes and took millions of years to take their toll on biodiversity
- Current extinction rates are 50-100 times the natural rate, the effects are measurable over mere decades and the causes are attributable to a single species - humans

# How can we prevent biodiversity loss?

- Research
- Legislation
- Education/Awareness
- Sustainable use of biodiversity
- Integration/Co-ordination

# International biodiversity legislation

- 1972 United Nations Environment Programme (UNEP)

Regional & international agreements to tackle biodiversity issues (e.g. protecting wetlands and regulating trade in endangered species); helped to slow the destruction but have not reversed it

- 1987 World Commission on Environment & Development

"Humanity has the ability to make development sustainable-to ensure that it meets needs of the present without compromising the ability of future generations to meet their own needs"

- 1992 Rio Earth Summit-Convention on Biological Diversity

Agreement to conserve biological diversity, to use its components in a sustainable way, and to ensure fair and equitable sharing of benefits from the use of genetic resources. Ratified by over 175 countries

# MarBEF-a novel integrated approach

- A network of 82 excellent marine biodiversity research and educational institutes in Europe
- A novel approach to integrating marine biodiversity and ecosystem research from a wide variety of disciplines
- Provides training, exchange, outreach, and links to industry and the public at large
- Supports international legal obligations of the EU and member states

