Ulisses | UNIVERSITY OF LISBON INTERDISCIPLINARY STUDIES ON SUSTAINABLE ENVIRONMENT AND SEAS

Seawater Quality

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Seawater Quality

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Seawater Quality

Learning Objectives

- Earth's Water Distribution
- Seawater composition
- Properties of Seawater
- Water use *versus* water quality
- Marine Strategy Framework Directive
- An overview of European Seawater (Ocean and Sea)
- The main issues about the problems of seawater

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Seawater Quality

The organisms found in the marine environment are determined by the chemical and physical factors

To understand the biology, behavior and survival of marine organisms, we must know something about the environment in which they live

Marine organisms are mostly made of water, 80% or more by weight in most cases (Jellyfish – 95%)

Water makes life possible…

Seawater is the most important water resource on the Earth…

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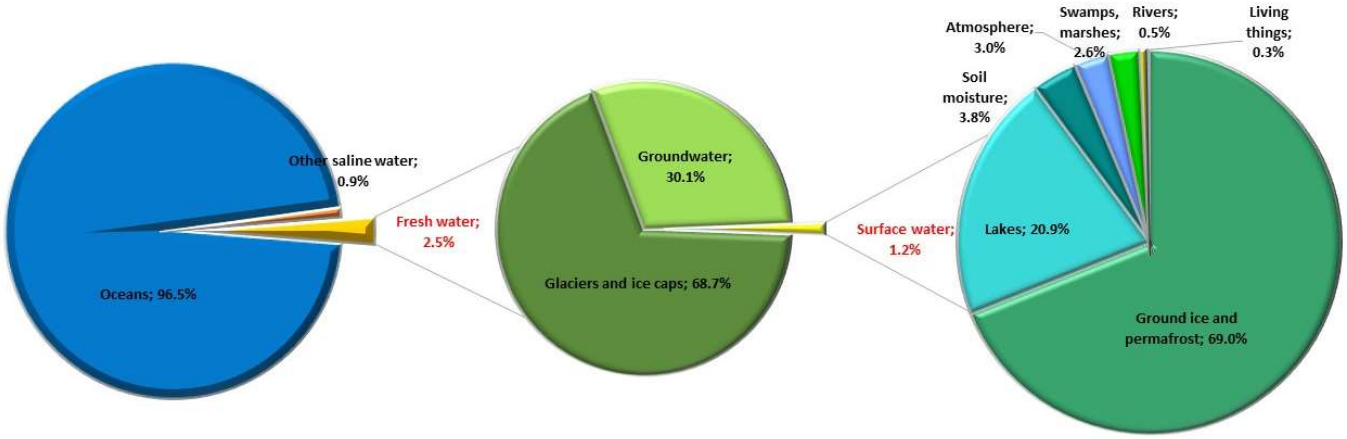
Earth's Water Distribution



Adapted from: https://www.usgs.gov/media/images/distribution-water-and-above-earth

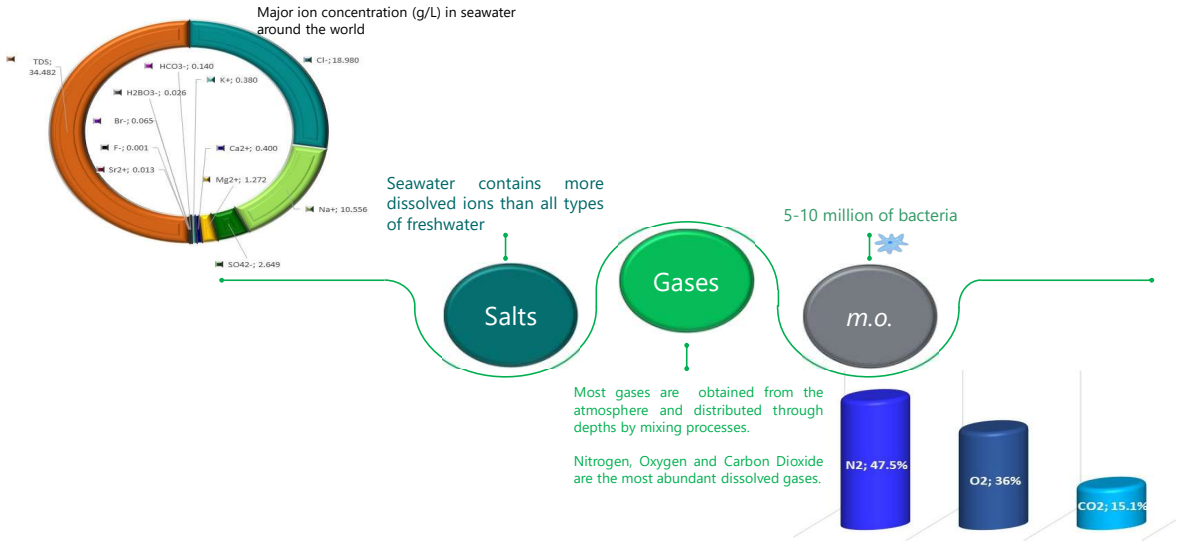
Seawater composition

The "Weather" of the Marine Environment

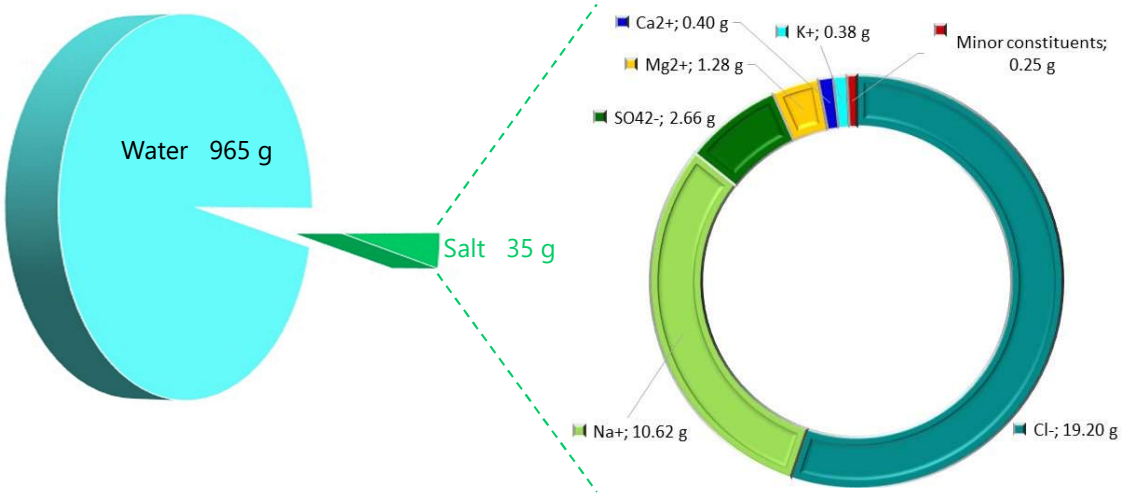
- Wind
- Waves
- Tides
- Currents
- Temperature
- Seawater composition (salt)

- Characteristics of seawater are due both to the nature of the pure water and to the material dissolved in it
- Oceans are chemically well mixed and ocean salinity varies almost entirely as a result of the addition or removal of pure water rather than the addition or removal of salt
- Water is removed from the ocean primarily by evaporation and to a lesser extent by freezing
- Water is added to the ocean by precipitation (water cycle)

Seawater composition



Seawater composition



Seawater composition

Origin	Salinity (g/L)
Baltic sea	17
Black sea	22 – 25
Atlantic and Pacific Oceans	32 – 38
Mediterranea Sea	37 – 40
Red Sea – Arabian Gulf	40 – 47
Dead Sea	270

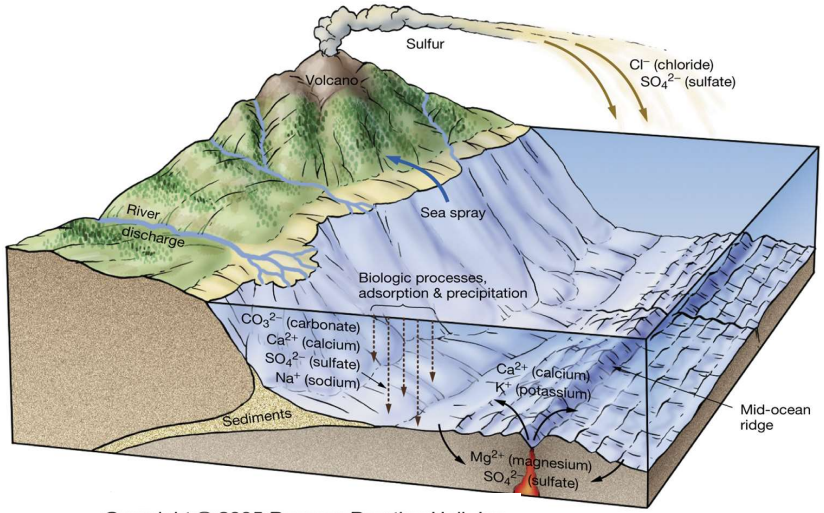
Seawater properties

Properties	Pure water	Seawater (35‰)
Odor	Odorless	Distinctly marine
Taste	Tasteless	Distinctly salty
pH	7.0 (neutral)	8.1 (slightly alkaline)
Density at 4 °C	1,000 g/cm^3	1,028 g/cm^3
Specific condutivity	---	0.0532 ohm^{-1}cm^{-1} (25 °C)
Freezing point	0 °C	-1.9 °C
Boiling point	100 °C	100.6 °C
Velocity of sound	1407 m/s (0 °C)	1450 m/s (0 °C)

Each of these changes can be explained as due to the interactions of ions with the water molecules.

Sanghyun Jeong et al, in Comprehensive Membrane Science and Engineering (Second Edition), 2017

Seawater properties

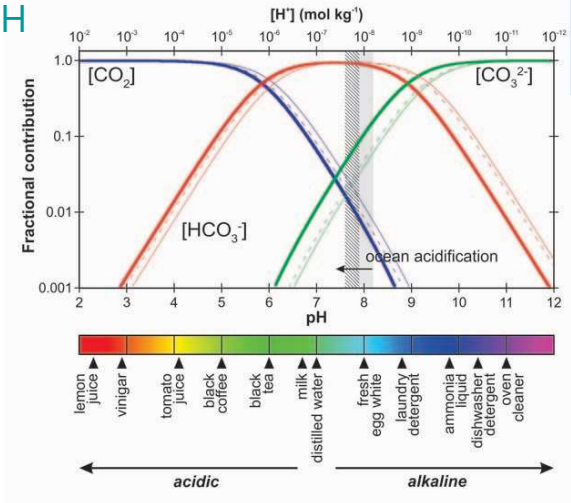


Ions are added to seawater by:
- River discharge
- Volcanic eruptions
- Hydrothermal activity at the mid-ocean ridge

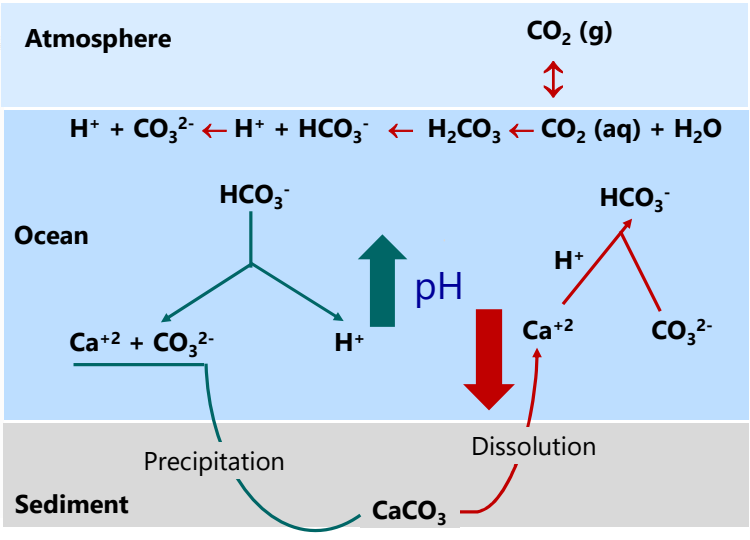
Ions are removed from seawater by:
- Adsorption and precipitation
- Sea spray
- Biologic processes
- Hydrothermal activity at the mid-ocean ridge

Seawater properties

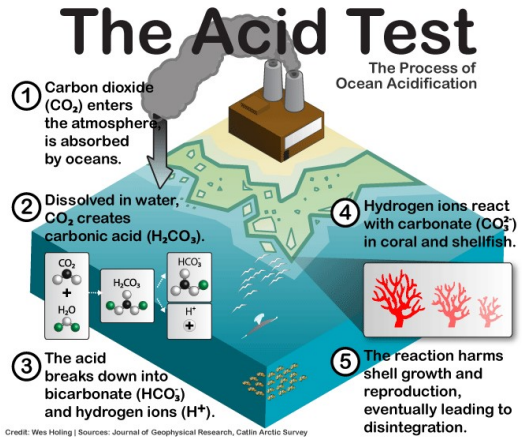
pH

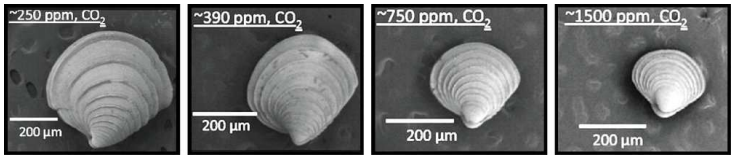


https://www.nature.com/scitable/knowledge/library/ocean-acidification-25822734/



Seawater properties

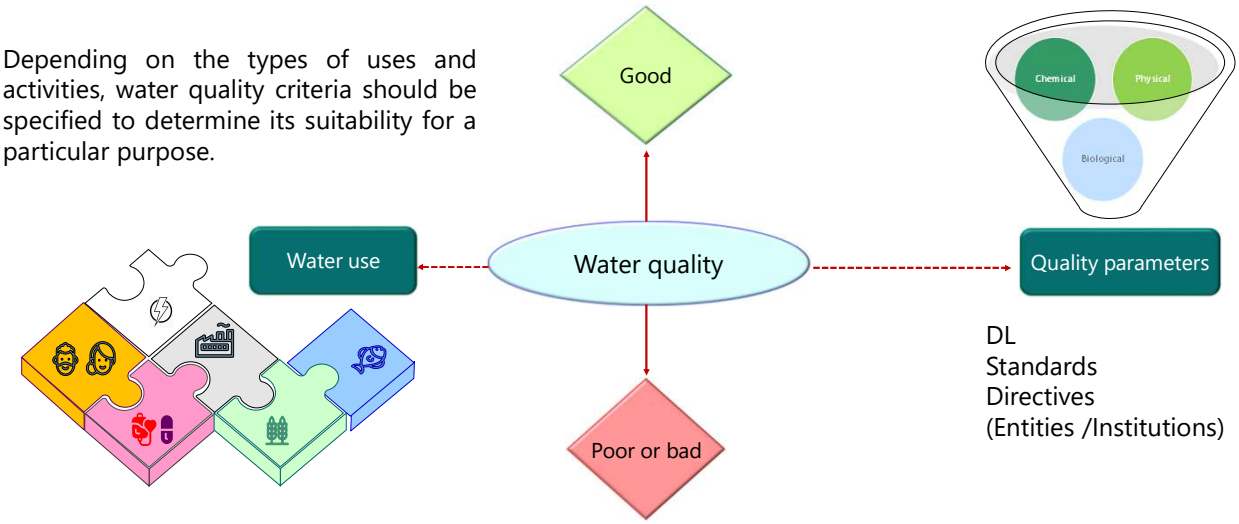




https://www.savecoastalwildlife.org/ocean-acidification

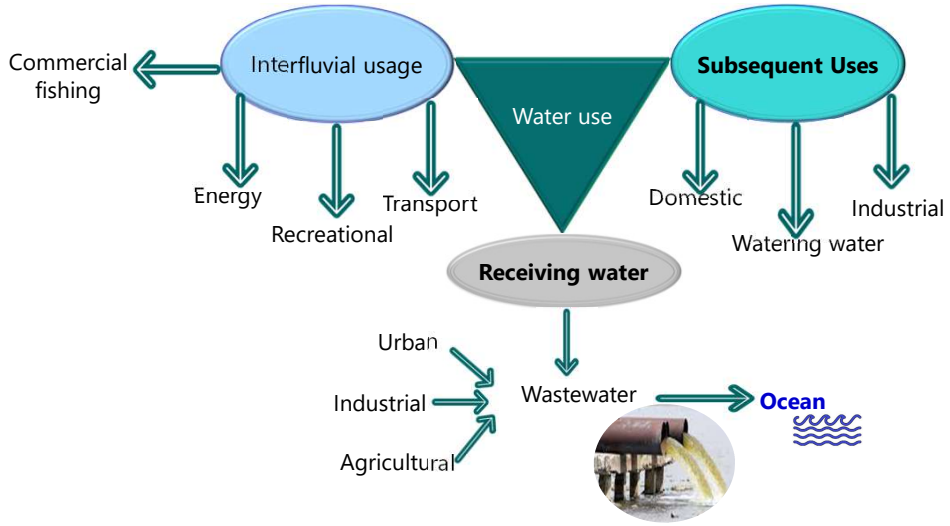
Seawater Quality

Depending on the types of uses and activities, water quality criteria should be specified to determine its suitability for a particular purpose.



DL
Standards
Directives
(Entities /Institutions)

Seawater Quality



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Marine Strategy Framework Directive (MSFD)

Directive 2008/56/EC, Marine Strategy Framework Directive (MSFD)

The European Union boasts a framework that requires EU Member States to develop strategies to achieve 'good environmental status' in their marine waters by 2020.

- Provides a strategy for the entire marine environment
- Protects marine biodiversity
- Assesses the impact of all human activities
- Drives new research and legal initiatives
- Aims for Good Environment Status (GES) for the EU's marine waters

Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) (OJ L 164, 25.6.2008, p. 19)

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Marine Strategy Framework Directive (MSFD)

On the horizon

- More ambitious and coherent definitions of "good environment status"
- More resources and collective action to address key pressures
- Coherent and effective networks of marine protected areas
- Marine data that is comparable across regions

Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) (OJ L 164, 25.6.2008, p. 19)

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D1- Biodiversity
D2- Non indigenous species
D3- Commercial fish and shellfish
D4- Food webs
D5- Eutrophication
D6- Sea-floor integrity
D7- Hydrographical changes
D8- Contaminants
D9- Contaminants in seafood
D10- Litter
D11- Energy, including underwater noise

Marine Strategy Framework Directive
Annex I
11 qualitative descriptors
Commission Decision 2017/848/EU

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A seagull's view

4 marine regions
5,720,000 km^2

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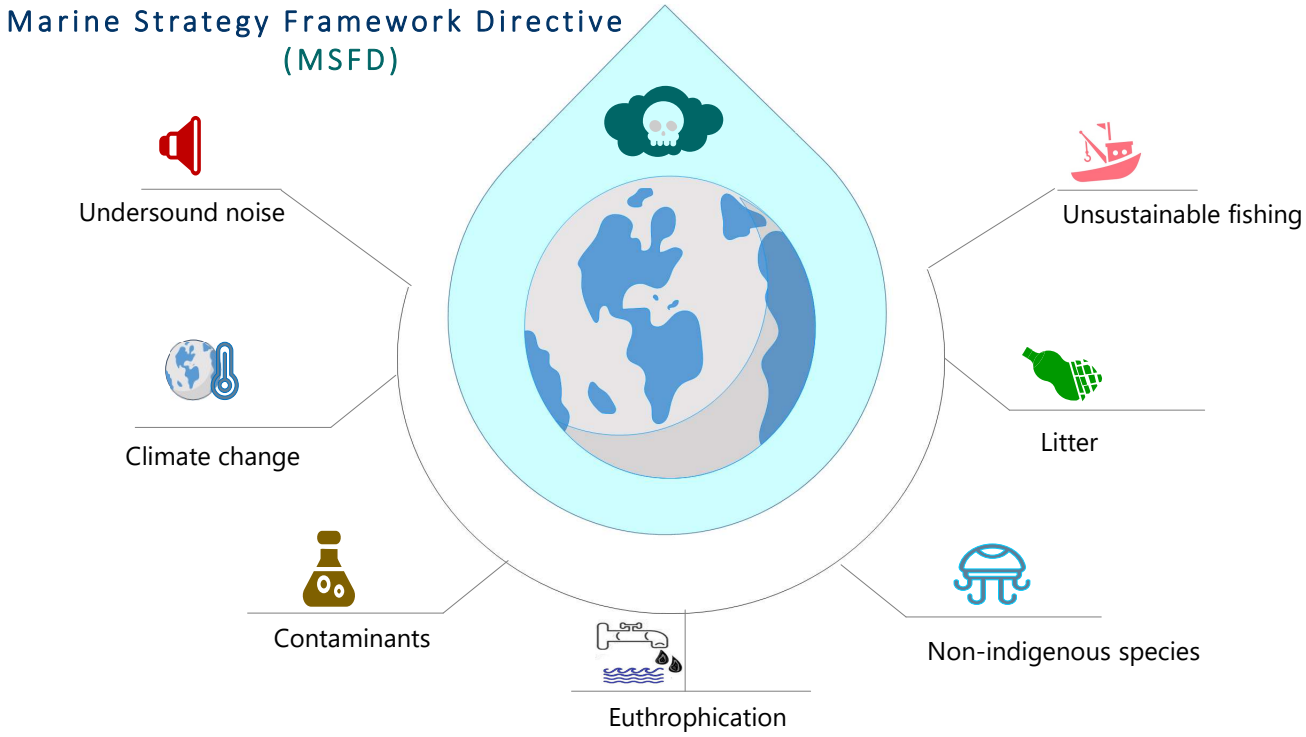
Marine Strategy Framework Directive
(MSFD)
Undersound noise
Unsustainable fishing
Climate change
Litter
Contaminants
Non-indigenous species
Euthrophication

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Unsustainable fishing
Climate change
Litter
North-east Atlantic Ocean
41% of assessed fish and shellfish stocks are within safe limits
Over 25% of marine birds species have declined
93% of fulmar birds assessed had ingested plastic

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Unsustainable fishing

Climate change

Litter

Non-indigenous species

Monk seal populations have estabilised.

Around 40% of sharks, rays and skates are declined.

85% of turtles assessed had ingested litter.

87% of of fish and shellfish species are overfished.

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Climate change

Euthrophication

Unsustainable fishing

White-tailed eagle populations are recovering.

The Baltic Proper Harbour porpoise population is down to a few hundred.

Certain fish regularly exceed maximum dioxin limits.

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Unsustainable fishing

Contaminants

Climate change

87% of of fish and shellfish species are overfished.

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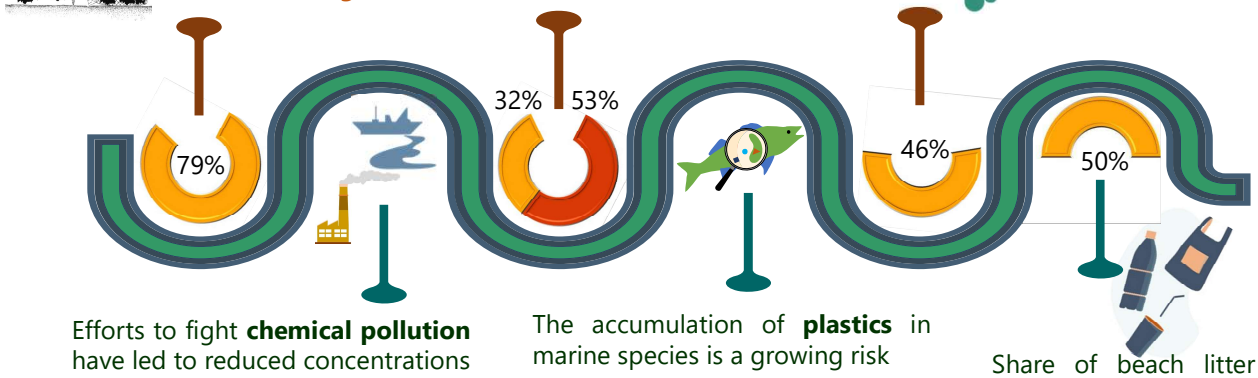
Marine Strategy Framework Directive (MSFD)
Some facts and figures

The coastal sea bed disturbed due to **bottom trawling**

From 32% to 53% of sharks, rays and skates are threatened **by-catch**

Coastal waters with poor **eutrophication** status



Efforts to fight **chemical pollution** have led to reduced concentrations

The accumulation of **plastics** in marine species is a growing risk

Share of beach litter from **single use plastic**

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Marine Strategy Framework Directive (MSFD) Evolution

DIRECTIVE 2008/56/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 17 June 2008

establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)

COMMISSION DECISION

of 1 September 2010

on criteria and methodological standards on good environmental status of marine waters

(notified under document C(2010) 5956)

(Text with EEA relevance)

(2010/477/EU)

COMMISSION DECISION (EU) 2017/848

of 17 May 2017

laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision 2010/477/EU

Marine Strategy Framework Directive (MSFD) Directive 2008/56/CE

01

Annex I

10 Qualitative descriptors for determining good environmental status

02

Annex III

Indicative lists of characteristics, pressures and impacts

03

Table 2

Pressures and impacts

Marine Strategy Framework Directive

Directive 2008/56/CE

ANNEX I

Qualitative descriptors for determining good environmental status

(referred to in Articles 3(5), 9(1), 9(3) and 24)

(1) Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.

(2) Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.

(3) Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.

(4) All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.

(5) Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.

(6) Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.

(7) Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.

(8) Concentrations of contaminants are at levels not giving rise to pollution effects.

(9) Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.

(10) Properties and quantities of marine litter do not cause harm to the coastal and marine environment.

(11) Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

To determine the characteristics of good environmental status in a marine region or subregion as provided for in Article 9(1), Member States shall consider each of the qualitative descriptors listed in this Annex in order to identify those descriptors which are to be used to determine good environmental status for that marine region or subregion. When a Member State considers that it is not appropriate to use one or more of those descriptors, it shall provide the Commission with a justification in the framework of the notification made pursuant to Article 9(2).

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Marine Strategy Framework Directive

Directive 2008/56/CE

Physical and chemical features	— Topography and bathymetry of the seabed, — annual and seasonal temperature regime and ice cover, current velocity, upwelling, wave exposure, mixing characteristics, turbidity, residence time, — spatial and temporal distribution of salinity, — spatial and temporal distribution of nutrients (DIN, TN, DIP, TP, TOC) and oxygen, — pH, pCO_2 profiles or equivalent information used to measure marine acidification.
Habitat types	— The predominant seabed and water column habitat type(s) with a description of the characteristic physical and chemical features, such as depth, water temperature regime, currents and other water movements, salinity, structure and substrata composition of the seabed, — identification and mapping of special habitat types, especially those recognised or identified under Community legislation (the Habitats Directive and the Birds Directive) or international conventions as being of special scientific or biodiversity interest, — habitats in areas which by virtue of their characteristics, location or strategic importance merit a particular reference. This may include areas subject to intense or specific pressures or areas which merit a specific protection regime.
Biological features	— A description of the biological communities associated with the predominant seabed and water column habitats. This would include information on the phytoplankton and zooplankton communities, including the species and seasonal and geographical variability, — information on angiosperms, macro-algae and invertebrate bottom fauna, including species composition, biomass and annual/seasonal variability, — information on the structure of fish populations, including the abundance, distribution and age/size structure of the populations, — a description of the population dynamics, natural and actual range and status of species of marine mammals and reptiles occurring in the marine region or subregion, — a description of the population dynamics, natural and actual range and status of species of seabirds occurring in the marine region or subregion, — a description of the population dynamics, natural and actual range and status of other species occurring in the marine region or subregion which are the subject of Community legislation or international agreements, — an inventory of the temporal occurrence, abundance and spatial distribution of non-indigenous, exotic species or, where relevant, genetically distinct forms of native species, which are present in the marine region or subregion.

ANNEX III

Indicative lists of characteristics, pressures and impacts

Table 1

Characteristics

Other features	— A description of the situation with regard to chemicals, including chemicals giving rise to concern, sediment contamination, hotspots, health issues and contamination of biota (especially biota meant for human consumption), — a description of any other features or characteristics typical of or specific to the marine region or subregion.

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Marine Strategy Framework Directive
Directive 2008/56/CE

Table 2

Pressures and impacts

Physical loss	— Smothering (e.g. by man-made structures, disposal of dredge spoil), — sealing (e.g. by permanent constructions).
Physical damage	— Changes in siltation (e.g. by outfalls, increased run-off, dredging/disposal of dredge spoil), — abrasion (e.g. impact on the seabed of commercial fishing, boating, anchoring), — selective extraction (e.g. exploration and exploitation of living and non-living resources on seabed and subsoil).
Other physical disturbance	— Underwater noise (e.g. from shipping, underwater acoustic equipment), — marine litter.
Interference with hydrological processes	— Significant changes in thermal regime (e.g. by outfalls from power stations), — significant changes in salinity regime (e.g. by constructions impeding water movements, water abstraction).
Contamination by hazardous substances	— Introduction of synthetic compounds (e.g. priority substances under Directive 2000/60/EC which are relevant for the marine environment such as pesticides, anti-foulants, pharmaceuticals, resulting, for example, from losses from diffuse sources, pollution by ships, atmospheric deposition and biologically active substances), — introduction of non-synthetic substances and compounds (e.g. heavy metals, hydro-carbons, resulting, for example, from pollution by ships and oil, gas and mineral exploration and exploitation, atmospheric deposition, riverine inputs), — introduction of radio-nuclides.
Systematic and/or intentional release of substances	— Introduction of other substances, whether solid, liquid or gas, in marine waters, resulting from their systematic and/or intentional release into the marine environment, as permitted in accordance with other Community legislation and/or international conventions.
Nutrient and organic matter enrichment	— Inputs of fertilisers and other nitrogen — and phosphorus-rich substances (e.g. from point and diffuse sources, including agriculture, aquaculture, atmospheric deposition), — inputs of organic matter (e.g. sewers, mariculture, riverine inputs).
Biological disturbance	— Introduction of microbial pathogens, — introduction of non-indigenous species and translocations, — selective extraction of species, including incidental non-target catches (e.g. by commercial and recreational fishing).

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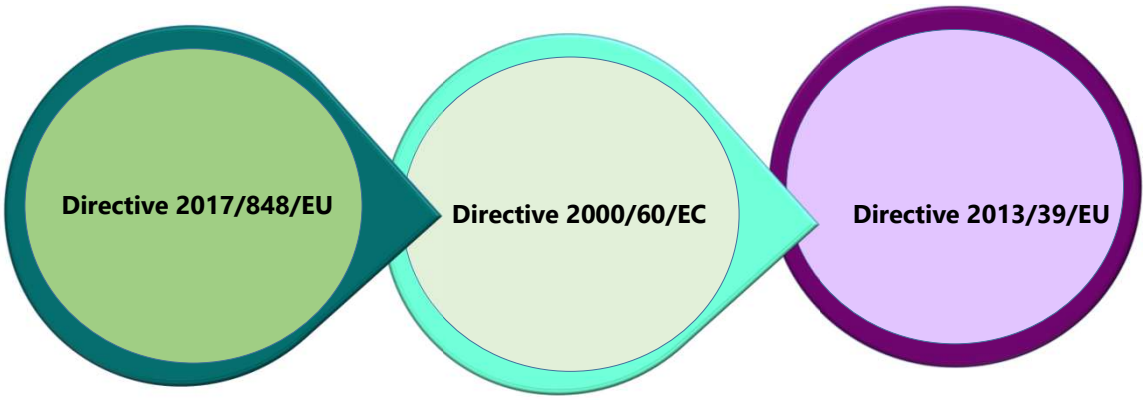
Sea Water Quality



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