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Water quality — Guidance standard on assessing the hydromorphological features of transitional and coastal waters

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National foreword

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Wasserbeschaffenheit - Anleitung zur Beurteilung der hydromorphologischen Merkmale der Übergangs- und Küstengewässer

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CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (EN 16503:2014) has been prepared by Technical Committee CEN/TC 230 “Water analysis”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2015 and conflicting national standards shall be withdrawn at the latest by February 2015.

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Introduction

Hydromorphology of transitional and coastal (TraC) waters is one of the basic features of marine and coastal ecosystems controlling the presence of biota. Hydromorphology is the result of the interaction between the structure of the systems and their functioning. Structure includes sea-bed geology, sediment features, morphology and water depth, whereas functioning includes hydrodynamics, sediment dynamics and morpho-dynamic processes.

Over the past several millennia, human developments in TraC waters throughout Europe have caused substantial changes in the hydromorphological characteristics and ecological functioning of many water bodies. Hydromorphological changes are an important consideration in implementing the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD). In addition, for the Habitats Directive there is a need to maintain certain 'features' in favourable condition, which has also given rise to a focus on hydromorphological assessments.

In a general sense, transitional waters (e.g. estuaries, fjords, some lagoons) are neither fully open coastal systems nor enclosed or flowing freshwater areas. (for the WFD definition, see Clause 2). Their boundaries may be defined by hydromorphological features and discontinuities, by salinity, or by any other hydrographic feature (e.g. water depth and tidal regime). The term 'coastal waters' has been defined for various legal and political purposes (e.g. see Clause 2) but in this hydromorphological standard they are defined as waters characterized by coastal features and influenced by coastal processes.

This European Standard:

a) supports environmental and conservation agencies in meeting monitoring requirements of the WFD and MSFD;

b) provides information supporting other environmental reporting requirements (e.g. in relation to biodiversity or environmental impact assessment);

c) supports management and restoration initiatives;

d) identifies and defines the main pressures affecting European TraC waters.

Note that in this standard, "assessment" is used as a broad term referring to the general description of features and the pressures that impinge upon them. It is not used to imply the judgement of particular levels of "quality" or "value", whether related to status under the WFD, MSFD or more generally.

WARNING — Persons using this European Standard should be familiar with usual laboratory and fieldwork practice. This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

IMPORTANT – It is absolutely essential that tests conducted according to this European Standard be carried out by suitably trained staff.

1 Scope

This European Standard gives guidelines for characterizing the hydromorphology of transitional or coastal (TraC) waters, but does not prescribe detailed methods of assessment. The main aim of this document is to improve the comparability of hydromorphological survey methods, data processing, and the interpretation and presentation of results.

This European Standard:

a) lists essential features and processes of TraC waters that should be characterized as part of a hydromorphological survey and used for determining hydromorphological condition;

b) gives guidance on strategies for collecting and presenting hydromorphological data depending on the resources available and the anticipated use of the assessment;

c) describes how to generate data sets appropriate for monitoring and reporting on the condition of Natura 2000 sites designated under the Habitats Directive and the Birds Directive;

d) provides guidance on data quality assurance.

This European Standard does not deal with biological assessments in TraC waters such as the presence or absence of individual species or community composition, nor does it attempt to link specific hydromorphological features with their associated biological communities. However, it is relevant where plants or other organisms form significant structural elements of the habitat (e.g. saltmarshes, biogenic reefs).

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
aquatic macrophyte
larger plant of marine and brackish water which is easily seen with the naked eye, including angiosperms and macroalgae

EXAMPLE Examples for angiosperms: reeds, saltmarsh and seagrass beds; example for macroalgae: seaweed.

[SOURCE: EN 16039:2011, 3.1, modified]

2.2
attribute
specific recorded elements of a hydromorphological feature

EXAMPLE ‘Silt’ and ‘boulders’ are natural substrate texture attributes, ‘sheet piling’ and ‘gabions’ are attributes of engineered banks.

[SOURCE: EN 16039:2011, 3.2]

2.3
bay closing line
straight line drawn between prominent physical features on either side of a bay

2.4
bedform pattern
morphology of the seabed

Note 1 to entry: The bedform patterns may be simple or complex depending on the size and shape of the system and the nature of the local sediment transport processes. Deposition produces features such as sand and gravel bars, while erosion results in scour features.

2.5
biogenic reef
mass consisting of the hard parts of organisms, or of a biogenically constructed frame enclosing detrital particles, in a body of water

Note 1 to entry: Most biogenic reefs are made of corals or associated organisms.

2.6
coastal cell
length of coastline confined by natural or artificial barriers across which little or no sediment is transported

2.7
coastal plain estuary
submerged coastal river valley

2.8
coastal water
body of surface water on the landward side of a line, every point of which is at a distance of one nautical mile on the seaward side from the nearest point of the baseline from which the breadth of territorial waters is measured, extending where appropriate up to the outer limit of transitional waters

Note 1 to entry: This definition from Article 2 of the EC Water Framework Directive (2000/60/EC) is one example of a definition of 'coastal water' used for legal purposes.

2.9
connectivity
linkage within and between water bodies through exchange of water, sediment and organisms

2.10
ecological status
expression of the quality of the structure and functioning of aquatic ecosystems, by comparing the prevailing conditions with reference conditions

Note 1 to entry: As classified in accordance with Annex V of the EC Water Framework Directive (2000/60/EC).

[SOURCE: EN 16039:2011, 3.15]

2.11
fetch
fetch length
distance of open water over which the wind can blow and generate wind-driven waves

[SOURCE: EN 16039:2011, 3.19, modified — "fetch length" was added as synonym]

2.12
fjord
long narrow and glacially eroded inlet with steep sides, created in a valley often with a shallow entrance at the mouth

2.13
headland
promontory of land projecting into water

[SOURCE: EN 16039:2011, 3.20]

2.14
highest astronomical tide
HAT
highest tide that can be expected to occur under average meteorological conditions and at the spring and autumn equinox

2.15
hydromorphology
physical, hydrological and hydrodynamic characteristics of transitional and coastal waters including the underlying processes from which they result

[SOURCE: EN 16039:2011, 3.22, modified]

2.16
intertidal area
foreshore
zone between high and low tide lines

2.17
lagoon
expanses of shallow coastal salt water, of varying salinity and water volume, wholly or partially separated from the sea by sand banks or shingle, or, less frequently, by rocks

Note 1 to entry: The EC Water Framework Directive (2000/60/EC) classifies lagoons as 'transitional waters'.

2.18
micro-tidal
tidal range < 2 m

2.19
mixing
blending of waters of different characteristics (e.g. temperature, turbidity, salinity) by turbulence and diffusion, caused by tides, winds, waves, currents and river runoff

2.20
normal tidal limit
NTL
point at which the level of a river or stream ceases to be affected by the tidal flow

2.21
physiography
prominent coastal landform features

2.22
planform
view of transitional or coastal water body from above

EXAMPLE Sinuous, straight.

2.23
reef
ridge of rock, or other material, lying seawards of the low water line

2.24
reference condition
condition which is totally or nearly totally undisturbed by human activity

2.25
residence time
retention time
length of time it takes for a transitional water, sea loch or fjord to exchange its water

Note 1 to entry: For enclosed bays “retention time” is the preferred term.

2.26
saltmarsh
area having characteristic vegetation adapted to saline soils and to periodic inundation by sea water

2.27
sandbank
low-energy feature created at the mouth of a river where it flows into the sea

Note 1 to entry: Characteristic of the coast, often poorly defined.

2.28
storm surge
change in water level as a result of meteorological forcing (wind, high or low barometric pressure) additional to the astronomic tide; it may be positive or negative

2.29
stratification
layering of water column due to density differences resulting from changes in temperature, turbidity or salinity with depth

2.30
substrate
rocky or sedimentary material making up the bed of a transitional or coastal water body

2.31
subtidal area
zone seawards below the mean low tide line

2.32
tidal prism
volume of water that flows into a tidal channel on the flood tide

[SOURCE: EN ISO 772:2011, 2.49]

2.33
tidal range
difference in level between high water and low water of a tide

[SOURCE: EN ISO 772:2011, 2.50]

2.34
tidal regime
parameters characterizing tides including levels, periods, frequencies, harmonics, phases and spectra

2.35
tidal bore
tidal phenomenon in which the leading edge of the incoming tide forms a “wave” (or waves) of water that travel up a narrowing estuary or bay against the direction of the river or bay's current

2.36
topography
bathymetry
sea-bed level with reference to a given elevation

2.37
transitional water
body of surface water in the vicinity of river mouths which is partly saline in character as a result of their proximity to coastal waters but which is substantially influenced by freshwater flows

Note 1 to entry: In accordance with Article 2 of the EC Water Framework Directive (2000/60/EC).

2.38
turbidity
reduction of transparency of a liquid caused by the presence of suspended particulate matter

[SOURCE: ISO 6107-2:2006, 145]

2.39
wave exposure
wave energy environment of a shoreline

Note 1 to entry: An important variable, along with substrate composition and water depth, that influences the habitat characteristics of the shoreline.

2.40
wetland
habitat occupying the transitional zone between permanently inundated, and generally dry, environments

EXAMPLE Saltmarsh or wetland fed by groundwater.

[SOURCE: EN 14614:2004, 3.42, modified]

3 Principle

A standard protocol is described for recording the physical features of TraC waters. The range of features, and the methods used for survey, may vary according to the type of water body and the objectives of the study. This European Standard provides a general framework for these different methods, details of which can be found in the references cited in the Bibliography. It relies on a combination of measurements, models and expert judgement, which in turn will help to improve the current state of knowledge of this subject area.

Guidance is given on the hydromorphological features that should be used for characterizing TraC water-body types and for further assessment of hydromorphological integrity through comparisons with reference conditions. The selection of features for survey will depend upon the type of pressures affecting the hydromorphology of a water body and the impacts they may cause, taking account of its particular hydromorphological context.

4 Survey requirements

4.1 General

Survey design should record the water body's hydromorphological form and function, the nature and location of pressures acting upon it, and provide an understanding of the likely impacts of those pressures.

4.2 Defining hydromorphological units

It is necessary to determine the relevant spatial scales for assessment to support the planning of surveys and for describing reference conditions. Units for assessing TraC waters should be defined using morphological features, geographical units and discontinuities in coastlines, water column characteristics, coastal cells, inputs of fresh water, and dimensions. The aim should be to delimit manageable areas for hydromorphological assessment.

Coastal waters may be dynamic and long-shore boundaries should be identified. These can be defined at various scales, depending on the purpose of the study. No one definition of the landward boundary of coastal waters accurately fits all conditions. Highest Astronomical Tide limit provides a consistent and definable landward boundary, although internationally recognized baselines are now used to delimit the start of territorial waters. In non-tidal or micro-tidal systems, a locally agreed high water mark, which allows for storm surges, will suffice.

The seaward boundary of coastal waters is usually defined geo-politically based on distance from the accepted baselines – normally to the 12-mile limit although this has no scientific justification. For the purpose of hydromorphological assessment, the seaward limit along active shorelines in coastal waters is the boundary beyond which significant nearshore hydrodynamic changes (e.g. sediment transport) cannot be detected. For rocky coasts, where such processes are less significant, a more pragmatic seaward limit can be set, such as the 1 nautical mile boundary in the WFD.

For hydromorphological assessments of transitional waters, a 'whole estuary approach' works well for small and medium-sized estuaries. In large estuaries, geological constraints combined with greater contrasts in wave energy dissipation can produce two or more distinctive 'behavioural zones' within the estuary. Transitional waters (except for non-tidal lagoons) where not constrained by artificial structures, often do not have clear boundaries with surrounding habitats. However, their boundaries need to be defined in a consistent way so that valid comparisons can be made. The upstream limit should be defined as the Normal Tidal Limit. The location of a boundary at the seaward limit of transitional waters should take account of the particular geography of each site. Often, geographical features such as deltaic sandbanks, narrow mouth entrances (e.g. lagoons), or discontinuities (breaks) in the coastline create a locally agreed boundary, hence the need for local expertise and agreement. In some areas and countries, consistency has been achieved using a 'bay closing line' across the mouth of an estuary although this is difficult to determine in wide-mouthed, funnel-shaped, coastal plain estuaries.

4.3 Survey strategy

The hydromorphology of transitional and coastal waters is often very complex, reflecting a large number of forcing factors operating over different temporal and spatial scales. In order to develop meaningful survey and assessment strategies it is necessary, therefore, to establish a conceptual understanding of how these forces shape hydromorphology and how this may change over time. This understanding can then help in evaluating the likely significance of human pressures and in designing monitoring strategies.

The scale of survey is important in hydromorphological assessment of TraC waters, especially with respect to resolution and connectivity, and in assessing the severity of impacts. Different survey techniques are scale-dependent. Different applications require different levels of detail. In some instances, survey may be extended beyond the hydromorphological units of interest to provide a complete picture of the relevant physical processes involved.

Timing and frequency of survey will vary among the different TraC waters because of their individual dynamic behaviour, and will depend upon the reason for assessment. Hydrodynamic attributes should generally be recorded at a higher frequency than morphological attributes. The timing of survey will depend upon the objectives of the work and the methods used. To measure certain conditions and regimes in continuously changing dynamic systems, measurements should be continuous or periodic according to the dominant daily, tidal, seasonal, lunar, annual or other cycles. The frequency of survey should ideally be linked with the rate of hydromorphological change; this in turn is partly related to the resistance to change and the resilience of the system to recover from a specific set of pressures. Other survey frequencies may be dictated by specific monitoring requirements.

As a general rule, knowledge from all relevant sources and disciplines should be considered; networking and collaboration among experts and institutions at national and international levels will ensure consistency across broad scales, help to harmonize monitoring, and increase understanding of the hydromorphological functioning of TraC water bodies.

4.4 Reference conditions

4.4.1 General

The identification of hydromorphological reference conditions is an essential pre-requisite for assessing the condition, or degree, of hydromorphological modification present in TraC waters. Reference conditions should be identified within each type of TraC water (taking account of natural changes) reflecting conditions that are totally, or nearly totally, undisturbed by human activities. In this context, scale is important in considering human effects on hydromorphological modifications. These reference conditions may be identified where undisturbed sites still exist, but also by combining expert judgement with modelling or by using historical data.

In most cases reference conditions will not constitute the target for restoration or for assessing the environmental impact of particular developments. Instead, achievable restoration targets based on present hydromorphological conditions, should be defined using the guidance in this standard on which features to assess and on a strategy for their survey.

4.4.2 Morphological and hydrological conditions

4.4.2.1 Basic requirements

In reference condition, variations of the following attributes should be within the envelope of natural variability (either observed or modelled) and consistent with natural dynamic processes. In addition, connectivity should be maintained to avoid disrupting processes.

4.4.2.2 Hydrodynamic regime

Hydrographic attributes such as tides, currents and waves, salinity, temperature, stratification and mixing processes, fronts, etc. match with the characteristics of the particular hydromorphological units (or sub-areas of TraC waters).

4.4.2.3 Bedform patterns, substrates and morphodynamics

These attributes correspond to conditions that are controlled by the natural hydrodynamic regime or the subsurface geology of the hydromorphological units. Changes in bedform patterns, substrates and morphodynamics minimally alter the characteristics of the hydromorphological unit. Along active coastlines subject to water level changes (e.g. by tides) the spatial distribution of submerged and exposed areas is minimally altered.

4.4.2.4 Hydromorphological connectivity

There are no structural impediments or significant abstraction or discharge pressures that prevent natural sediment transport and exchange with surface waters.

5 Features for survey and assessment

5.1 Features and attributes

Table 1 sets out the principal feature categories for hydromorphological assessment of TraC waters. However, some hydromorphological processes or features do not occur in all types of coastal systems or parts of systems. Thus, areas for hydromorphological assessment should accord with natural coastal processes and coastal cells.

Characteristics should be selected that are relevant to the water-body type or category, e.g. tidal regime is less relevant for the Baltic Sea, density regime is less relevant for coastal lagoons, etc.

Table 1 — Hydromorphological characteristics of transitional and coastal waters

Assessment Categories	No.	Generic features	Examples of attributes assessed
Morphology	1	Physiography/ Depth/Elevation	Topography, bedforms, mouth width, intertidal area: subtidal area ratio; tidal volume; linear coastlines, beach types, artificial structures
	2	Connectivity	Presence of adjoining physical features and links within and between water bodies, and between TraC waters and wetlands; mouth width, presence of artificial structures (e.g. dams)
	3	Geology	Substrate type, bedform patterns
	4	Biogenic structures	Presence of aquatic macrophytes and biogenic reefs
Hydrodynamic regime	5	Tidal regime, water level and current	Current velocity and direction, water level variability, tidal range, tidal prism, presence of tidal bore
	6	Wave regime	Exposure, wind speed and direction, fetch, wave height
	7	Freshwater inputs and runoff	Residence time/flushing rate (transitional waters), retention time (enclosed bays), freshwater discharge
	8	Sediment dynamics	Sediment supply, erosion/ deposition/ transport cycles
	9	Stratification or degree of mixing	Salinity, turbidity, density, temperature

5.2 Pressures on hydromorphology

5.2.1 General

The extent to which a human-induced pressure will affect the physical structure and functioning of TraC waters depends on a number of variables which might include one or more of the following:

— type of operation or activity;

— spatial scale, duration and frequency of operation or activity;

— hydrodynamic conditions (e.g. tidal range, current velocities);

— coastal landforms;

— substrate type, sediment characteristics (e.g. particle size), bedform patterns;

— seasonal and meteorological conditions (e.g. exposure to waves);

— cumulative impacts when combined with existing developments and activities.

Some impacts may be the result of pressures far from water bodies; these should be included in hydromorphological assessment. Local impacts may occur where a specific pressure is small-scale and occurs on a sheltered stretch of coastline. However, it is inevitable that in some cases direct effects from human activities have the potential to lead to indirect effects on the surrounding system. For example, the presence of coastal defences and flow and sediment manipulation structures along dynamic coastlines can interrupt the supply and transport of sediment, leading to problems of erosion along adjacent stretches. In turn, this can have a potential impact on biodiversity through changes in food supply, recruitment of colonizing organisms, or by disrupting the life-cycles of migratory species.

5.2.2 Classes of human pressures

Both engineering and ‘use-related’ pressures should be considered in hydromorphological assessment. Table 2 lists specific pressures and activities grouped into broad categories. This list is extensive but not all-inclusive. The definitions of the engineering activities and pressures on hydromorphology presented here are consistent and compatible with desk top, remote sensing and field data collection using recognized survey methods.

Table 2 — Causes of potential hydromorphological change due to human activities, and the TraC features likely to be affected

Category	Specific causes	Description	TraC features likely to be affected (see Table 1)
Engineering and use-related activities	Shore reinforcement – hard engineering	The use of materials, e.g. rock armour, concrete armour, revetments, retaining walls, artificial headlands, gabion baskets, vertical seawalls, sheet piling, groynes, breakwaters to stabilize vulnerable coastlines from erosion and protect land from flooding.	1, 2, 3, 4, 6, 8
	Shore reinforcement – soft engineering	Stabilization of the shoreline using sand and gravel to maintain beach levels and protect against erosion. Also includes beach nourishment, sediment bypassing, re-sectioning and re-profiling, sand fencing, dune stabilization (e.g. by grass planting) and using dredged mud to feed degraded areas of salt marsh.	1, 2, 3, 4, 6, 8
	Flow and sediment control structures	Range of engineering structures designed to afford shelter for ports, harbours, marinas and anchorage sites. These structures include breakwaters, piers, artificial salt marshes, flow deflectors, dams, groynes and training walls. Also includes detached breakwaters offshore.	1, 2, 3, 4, 5, 6, 8
	Foundations	Range of structures on the sea bed or raised on one or more piles extending out from the coastline or across tidal channels (e.g. bridges, piers, jetties). Also includes wind and tidal stream renewable energy devices (e.g. wind turbine monopiles and sea-bed-mounted underwater turbines). Piles typically support platform structures (e.g. for oil and gas exploration).	1, 2, 3, 4, 5, 6, 8
	Outfalls and intakes	Outfalls are artificial discharge structures (e.g. turbine releases from hydropower stations, discharges from sewage treatment plants, industry) whereas intakes are installations for abstracting cooling water from a TraC water body.	1, 3, 4, 5, 6, 7, 8, 9
	Flood defence embankments	An artificial bank of earth or stone created to prevent inundation of estuarine and coastal floodplains, also termed a dike or levee.	1, 2, 3, 4, 5, 7, 8, 9
	Coastal farming and aquaculture	Farms situated close to the coastline often allow livestock to graze saltmarsh and drift seaweeds from the beach. Fin-fish and shellfish farming may cause changes in substrate and turbidity.	1, 3, 4, 8, 9
	Collecting	Collection of marine invertebrates for use as anglers' bait by digging in mud and muddy sand shores. Also includes disturbance resulting from sample collection for laboratory research or collecting statutorily protected invertebrates from rocky shores. May also include the commercial harvesting of kelp and wrack species or reeds.	3, 4, 8

Category	Specific causes	Description	TraC features likely to be affected (see Table 1)
	Recreation and navigation	Pressures associated with formal or informal recreation; on the shoreline these include walking, swimming, bathing, horse riding, and erosion of sand dunes by trampling and motor bikes. Increased sediment disturbance may also result from the wash from commercial, ferry and recreational craft.	3, 4, 8
	Weirs and impoundments (impermeable)	Barriers that extend either across the entire width of an estuary or embayment whose foundations extend to the sea bed, modifying or removing tidal influence completely, or across coastal sounds and straits.	1, 2, 3, 4, 5, 6, 7, 8, 9
	Impoundments (semi-permeable)	A semi-permeable barrier that lets natural processes operate partially, for controlling storm surge, harnessing tidal energy (e.g. tidal barrages), or for amenity.	1, 2, 3, 4, 5, 6, 7, 8, 9
	Land claim	The enclosure of intertidal or subtidal areas, or the drainage of adjacent wetlands, for use by agriculture, housing, industry and ports, or as waste disposal sites. Tidal channel realignment includes the alteration of the course or planform of upper estuaries.	1, 2, 3, 4, 5, 6, 7, 8, 9
	Dredging	Capital dredging is the excavation of undisturbed bed material for building new infrastructure, laying cables and pipelines, and for navigation.	1, 3, 4, 5, 6, 8, 9
		Maintenance dredging is the routine periodic removal of material to keep a channel or berth open for navigation. Occasional dredging may also be used to remove the accumulation of toxic materials in sediments.	
	Extraction	Extraction of substrates (e.g. gravel, sand, shell) to provide material for the construction industry, land infilling or coastal nourishment. Also includes the dredging of metalliferous deposits on the sea bed.	1, 3, 4, 5, 6, 8, 9
		Removal of calcareous maerl deposits (living or dead) for use as a soil conditioner, filtration medium or in the pharmaceutical or cosmetic industry.	1, 3, 4, 5, 6, 8, 9
	Disposal	The deposit of material dredged during maintenance and capital dredging campaigns onto intertidal and subtidal areas for the purposes of disposal; also includes marine tailing materials and relocated toxic and non-toxic sediments from harbours; capping of toxic sediments with clean material.	1, 3, 4, 5, 8

Category	Specific causes	Description	TraC features likely to be affected (see Table 1)
	Floating and tethered structures, moorings	Anchorage sites, typically concrete or metallic mooring blocks to which boats are attached. Often associated with marina and harbour developments and sheltered bays or leeward of headlands. Multiple forms including pontoons, floating platforms, aeration systems and cages/structures used for commercial fin-fish and shellfish farming. Can also apply to moored wave power generation devices and pontoons	1, 3, 4, 5, 6, 8
	Pipeline and cables	Pipelines (e.g. oil and gas) and cabling works can either be laid on the sea bed and stabilized using concrete mattresses or rock/gravel dumps, or trenched and buried.	1, 3, 4, 8
	Artificial reefs and wrecks	Any intertidal or subtidal man-made structure that offers new hard substrates for increasing biodiversity, enhancing amenity (e.g. for surfing) and improving fisheries.	1, 3, 4, 5, 6, 8
	Fishing	Includes mobile fishing gear (e.g. mobile benthic trawls and dredges) and static fishing gear, such as fixed nets and pots.	1, 3, 4, 8, 9
	Military	Building intertidal and subtidal structures for training and firing ranges, effects of controlled or accidental explosions of ammunition.	1, 3, 4, 6, 8
Catchment hydromorphology	Alteration to catchment hydrological regime	Activities that affect the supply of fresh water to the marine environment; for example, river water retention, and abstraction of surface water and groundwater for agriculture and industry.	2, 5, 7, 9
	Alteration to catchment land-use	Changes of sediment and water inflow caused by intensive land-use in the catchment (e.g. urban, arable or plantation forestry)	5, 7, 8, 9
Climate change	Increase in temperature; sea-level rise	Changes to freshwater run-off, sea-level rise, melting of sea-ice, hydrodynamic processes, etc., causing, e.g. retreating coastlines, inundation, increased need for new and strengthened coast protection and flood defence structures in the future.	1, 2, 3, 4, 5, 6, 7, 8, 9

5.3 Data sources and methods of obtaining information

The following list provides examples of the data sources and methods appropriate for characterizing TraC waters and hydromorphological conditions:

a) digital terrain maps based on topographic data and digital geospatial databases (e.g. Light Detection and Range (LIDAR) data);

b) vegetation and habitat maps (e.g. from spectrographic images, aerial photographs);

c) aerial photographs used in geodesy and cartography;

d) hydrographic and freshwater source data;

e) historical maps (provided they are orthorectified using known benchmarks);

f) descriptions and reports on a site from the scientific literature;

g) estuarine and lagoon databases linked to hydromorphological pressures within a catchment;

h) outputs from tidal, dispersion, wave models, etc.;

i) field survey including use of sidescan sonar, remotely operated vehicles (ROVs) and associated laboratory analysis (e.g. sediment particle size analysis).

6 Reporting hydromorphological assessment and classification

6.1 General

The procedure for assessing hydromorphological data will vary according to the purpose of the assessment, e.g. contributing to the monitoring requirements of EC directives, undertaking environmental impact assessment, or supporting management and restoration initiatives.

This European Standard takes account of the present level of sophistication of national hydromorphological methods and provides guidance to enable a basic assessment of the extent of deviation from reference conditions. It is intended that further development of national methods and inter-comparison of the results that they produce will lead to harmonized assessments based on type-specific occurrence of physical features within TraC waters.

The extent of deviation from reference conditions is used to place a water body into one of five classes according to its degree of modification (Table 3). This is achieved by assessing data from maps, remote sensing or field survey to determine how far the criteria in 4.4 are met.

6.2 Data presentation

Although the WFD and the MSFD do not require hydromorphology to be reported in five classes, this European Standard recommends the use of an equivalent five-band classification system in which reference conditions (or near-reference conditions) are defined as Class 1, and the remaining classes as 2 to 5. For the purposes of this standard, use of the WFD terms such as ‘good status’ and ‘moderate status’ should be avoided as they are linked entirely to the WFD assessments of biological conditions (except at high ecological status). Where maps of hydromorphological quality are produced, it is recommended that the terminology and colours shown in Table 3 are used (as recommended in EN 14614).

Table 3 — Hydromorphological condition (modification) classes recommended for reporting purposes

Score (class)	Name	Map colour
1	Near-natural	Blue
2	Slightly altered	Green
3	Moderately altered	Yellow
4	Extensively altered	Orange
5	Severely altered	Red

The names used to describe each class have been deliberately chosen to be different from terms used in the WFD and the MSFD. This is to emphasize that classifications made using this European Standard are not systematically linked to classifications of ecological status or environmental status made for the WFD and the

MSFD, respectively. Although the five colours recommended in Table 3 are the same as those used in the WFD, they are also used routinely for reporting other (non-WFD) aspects of environmental quality.

7 Training and quality assurance for survey and assessment

7.1 General

The validity of hydromorphological assessments depends on the accuracy and precision of all activities involved in the collection and analysis of data. For this reason, assessments should be subject to quality assurance procedures. It is recommended that the surveyors should have established a quality management system (see EN ISO/IEC 17025 for an example). Detailed documentation of the methods should be provided, and regular training of staff undertaken to ensure consistency in recording the hydromorphological features of TraC waters. Investigations within and between organizations should be carried out regularly to examine the comparability of results.

7.2 Areas for training

Training should be structured to cover aspects such as:

— basic understanding of hydromorphological concepts and development of a conceptual understanding of driving forces;

— planning and conducting surveys, including issues of access and permission;

— how to collect, evaluate and interpret hydromorphological data;

— how to collect, evaluate and interpret non-survey data (historical maps, aerial photographs, modelling data, etc.);

— recognizing features and pressures;

— sediment sampling and analysis (i.e. grain-size distribution, etc.);

— accurate completion of recording forms;

— setting up an appropriate data management and archiving system;

— ensuring that operating staff are suitably experienced and skilled in data handling protocols and familiar with up-to-date software (e.g. use of digital databases, GIS systems and remotely sensed data).

Training should:

— incorporate a certification system;

— include regular refresher courses;

— be carried out over a wide range of TraC waters (in the absence of this, certification may in some instances only be valid for the range of TraC water types experienced during the training);

— be fully supported by manuals and other teaching aids.

Survey vessels should have permission(s) for operating in TraC waters according to national and international regulations.

Manuals and/or Standard Operating Procedures (SOPs) should present basic information on hydromorphological principles, general background on the development of the method, and unambiguous information on how to carry out the survey, with accurate description of the features to be recorded. Text should be supported by illustrative material (e.g. photographs, videos, DVDs, CDs) to illustrate what features look like (not just the typical, but the full forms that might be encountered).

Manuals and/or SOPs should include guidance on:

— how to transfer information from field sheets to databases;

— how to obtain and interpret information from maps;

— how to apply the results to assessment of hydromorphology;

— how to apply Quality Assurance systems;

— issues of Health and Safety;

— matters relating to access to TraC waters.

7.3 Data entry and validation

It is important that no errors occur when transferring data from field sheets to databases. Suitable quality assurance methods should be used. Random testing should also be carried out on hydromorphological assessments and other applications to ensure that consistent results are obtained from the same data. Data corruption can occur when systems are up-dated or during information transfer; some form of checking procedure is required following such changes.

Technologies enabling field survey data to be directly entered into database systems should be regularly reviewed and adopted as appropriate.

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