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Promoting Effective Governance of the Channel Ecosystem
Promouvoir une gouvernance efficace de l'écosystème de la Manche

02

Supporting Marine Strategy Framework Directive indicator development.

ABSTRACT

Interreg IVA projects have used and/or developed several types of ecosystem dynamic indicators. These indicators could potentially be used to assess or monitor progress towards achieving "good environmental status" (GES) of the marine ecosystem, as required by the European Union "Marine Strategy Framework Directive" (MSFD)[1]. The various potential indicators used and developed by the projects examined here, most commonly align with the D1 - Biological diversity and the D3 - Commercial fish descriptors. However, research gaps were observed in the areas of marine litter and underwater noise/energy descriptors.

KEY WORDS

DESCRIPTOR

ECOSYSTEM DYNAMICS

INDICATOR

MARINE STRATEGY FRAMEWORK DIRECTIVE

DESCRIPTION OF KEY FINDINGS

A number of words are used in this report that have specific meanings in the context of the PEGASEAS project cluster. These are:

- **Biological diversity:** Variety of life, which can be measured via genetic, species or ecosystem variations within a certain area or habitat.
- **Descriptor:** a qualitative statement of one specific aspect of the good environmental status of marine environment, for the Marine Strategy Framework Directive.
- **Indicator:** It evaluates the state of the environment in a more practical and economical way than recording every variable of the environment. It can be a status, pressure and/or a response of the environment.
- **Marine litter (or Marine debris):** This is human-created waste, which is released in the marine environment.
- **Marine Strategy Framework Directive** (MSFD): this EU Directive establishes a framework within which Member States shall take the necessary measures to achieve or maintain Good Environmental Status (GES) in the marine environment by the year 2020 at the latest.

1 European Community (2008). *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)*. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:164:0019:0040:EN:PDF

Indicators are invaluable in the development of monitoring methods, allowing assessment of ecosystems where it is not feasible for the full range of variables to be measured. Indicators allow a suite of variables to be assessed which are representative of the ecosystem and therefore provide a measure of the state of the environment, allowing assessment of how this can be maintained or improved to achieve GES. Research to date has shown that common methods and indices are necessary to allow direct comparison of scientific results across local, regional and global scales. The broad scope of Interreg projects means that they cover many scientific domains and the majority of them use or develop indicators to assess the state of the environment. With political support, these may be used to inform directives such as the MSFD, the Habitats Directive and the Common Fisheries Policy (CFP). Each directive has a different specific purpose but their overarching aim is to promote a healthy, clean and productive marine environment that is managed sustainably. The MSFD constitutes a vital environmental component of the European Union's future Integrated Maritime Policy. This policy is designed to achieve the full economic potential of the oceans and seas in harmony with the marine environment through implementation of the Ecosystem Approach, a holistic strategy of managing the marine environment.

Potential Indicators

As part of the MSFD, eleven descriptors of GES were produced by the European Commission and several similar indicators were identified within Directives such as CFP. Table 1 shows a list of potential scientific indicators that were used or developed during specific Interreg IVA projects[2] that could also be used as indicators within other Directives however, many of them have not yet been linked to policy (please note, this list is not exhaustive).

In Table 1, the descriptors of the MSFD were cited in the order they appear in that document, to facilitate the general comprehension of the Table. As explained above, the MSFD is accepted for the EU and looks at the general marine environment domain compared to other Directives that are more specific or national.

The eleven descriptors of GES produced for the MSFD are:

- D1 Biological diversity;
- D2 Non-indigenous species;
- D3 Commercial fish;
- D4 Food web;
- D5 Eutrophication;
- D6 Sea-floor integrity;
- D7 Hydrographical conditions;
- D8 Contaminants and pollution effects;
- D9 Contaminants in fish and other seafood;
- D10 Marine litter;
- D11 Underwater noise/energy.

2 The projects outputs used for this report were: CRESH, CHARM 2 and 3, Marinexus, PANACHE, VALMER, EASYCO, ARCOPOL, RINSE, MESSCENE, AARC, and CHRONEXPO.

Type of dynamic ecosystem	Interreg IVA scientific indicators	Potential contribution to MSFD descriptor
Cephalopods	**Cephalopods (squid and cuttlefish):** Biodiversity Spatial distribution Distribution of egg clusters Proportion of prey species	D1, D3 and D4
	Spawning sites of cuttlefish: Structure (size, type of substratum) Spatial and temporal changes/distribution (abiotic and biotic parameters)	D1,D3 and D7
	Life cycle of cuttlefish: Measurement of the poly-modal decomposition and quantity of lipofuscin (age pigment)	D3 and D1
Vertebrates	**Cetaceans, Seals and Sea turtles:** Abundance Distribution	D1 and D4
	Fish: Abundance Distribution Community structures Nursing habitats Relationship spawning/nursery sites and recruitment Prediction of population trajectories (under the following scenarios: nursery habitat degradation and fishing pressure)	D1 and D3
	Spatial distribution of fishing activities and efforts	D3
	Diversity of large marine vertebrates	D1 and D4
	Birds: Abundance Distribution Breeding succes Hydrocarbon contamination and microplastics ingestion Functional areas: foraging site	D1, D4, D8 and D10
Non-indigenous species	**Native and non-indigenous tunicate *(Botrylloides)* and invasive ascidian *Asterocarpa*:** Genetic population/population structure Spatial distribution Abundance	D2 and D1
	Invasive macroalgae *Undaria pinnatifida* and tunicate *Ciona intestinalis*: Spatial distribution	D2 and D1
	Identification of spatial and temporal distribution of invasive species in both sides of the Channel	D2 and D1
Marine (phyto/zoo/ ichthyo-) Plankton	Diversity/species identification Population structure/community Abundance Spatial and temporal distribution	D1 and D5
	Physicochemical, biological and photosynthetic parameters Primary production and productivity	D1, D4 and D7
Filter feeders	Growth Carrying capacity Primary production	D1 and D4
Benthic population	**Benthic community (micro and macro):** Diversity Sensitive habitats Abundance Spatial and temporal distribution	D1, D3 and D4
	Subtidal fine sand macrobenthic community: Diversity Abundance Environmental changes of abiotic and biotic parameters	D1, D4 and D7
	Presence/absence probabilities for key benthic and demersal species in various climate change scenarios	D3 and D1
Food web	Structure Biomass Consumption rate Ecotrophic efficiency Food conversion efficiency Changes due to fishing, implementation of MPA and climate changes	D4, D4, D1 and D7
Biogeochemical dynamics	Abiotic parameters of coastal environment (e.g. temperature, nutrients concentration and optics) Biogeochemical parameters Air-sea CO2	D7 and D5
	Forecast of waves, currents and meteorology in the whole Atlantic Space	D7
Aggregate extraction	Evaluation and forecast of the impact of aggregate extraction on food web functioning	D1, D3, D4 and D7
Contamination	Toxicological indicators on 24 hazardous and noxious substances	D8, D9 and D3
	Values of contamination and decontamination of acrylonitile in sea bass	D9 and D3
	Measurements of the effects of chronic exposure of marine species to human-generated pollutants and pesticides by using macroscopic parameters of these organisms (e.g. enzymatic activities, expression of interest genes, status of body tissues, genotoxicity, development of the larvae stages, reproduction changes, adults survival, spawning and developmental success of the embryos)	D9 and D3
	Nutrient discharges in coastal zones (from industrial effluents, agricultural runoff, and municipal sewage)	D8 and D5

Table 1: Potential scientific indicators developed in the Interreg IVA projects and the MSFD descriptors to which they could potentially relate. The final column identifies which descriptor the indicator relates to in terms of monitoring towards GES of the marine environment.

In order to identify gaps in potential MSFD indicators developed during the Interreg IVA projects, the project outputs were analysed in terms of their relation to those descriptors (as described in Table 1) and the results are shown in Figure 1. D1 - Biological diversity and D3 - Commercial fish were studied most frequently, followed by the D4 - Food webs, D5 - Eutrophication and D7 - Hydrographical conditions. This figure highlights that among the indicators proposed within the Interreg IVA projects, some aspects of MSFD were not investigated in significant detail, or at all in the case of marine litter and underwater noise/energy.

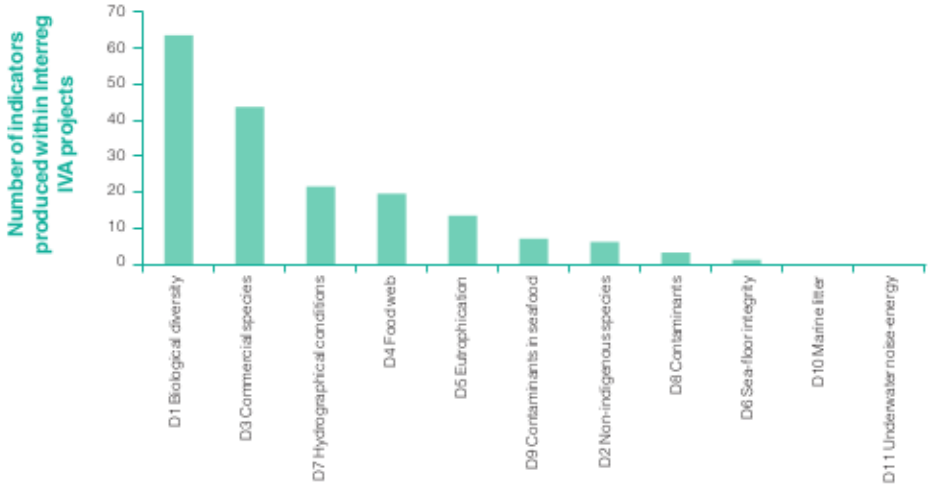

Figure 1: Number of indicators produced within the Interreg IVA projects that could be related to MSFD descriptors.

Gaps

Marine litter (D10) was not taken into account within Interreg IVA projects, except microplastics in the project MICRO (Interreg IVA 2 Seas) and some monitoring studies of marine birds in PANACHE (D8 and D10). Human pressures on the coast and at sea increased during the last century with industrialisation, urbanisation, port activities, fishing, maritime transport and tourism development. These activities notably generate marine litter, which can cause negative effects on organisms and their environment. Marine litter is mainly composed of plastic, glass, metal, paper, cardboard, fabric and wood. In addition to the aesthetic nuisance of such an increase in anthropogenic activity, studies have shown many potentially harmful effects to the marine environment such as increased transport, persistent organic pollutants, the diffusion of toxic compounds (e.g. pharmaceutical drugs, chemicals), transportation of non-native species, distribution of algae associated with red tides, entanglement of large marine organisms, mortality of many marine species (marine mammals, seabirds, turtles) and changes in the structure of benthic communities.

The noise pollution relative to marine energies (D11) was also not taken into account within Interreg IVA projects. Increased noise in the ocean can reduce communication ranges of marine species, which is likely to affect a cetacean behaviour. It is now recognized that some species are able to adapt to this change in the acoustic environment, but the variability of anthropogenic pressures generally operates at shorter temporal scales than species adaptation. Therefore, this pollution type (amplitude and temporal variations) must be assessed in order to assess good environmental status. This was unfortunately not taken into account within Interreg IVA projects although the English Channel ecosystem is highly subjected to the establishment of marine energies and maritime traffic and therefore to noise pollution.

The remaining MSFD descriptors (from D1-Biological diversity to D9-Contaminants in fish and other seafood) were used and/developed within Interreg IVA projects but several gaps have still been identified for descriptors 1, 2 and 8.

Indicators on Biological diversity (D1) were largely investigated but several gaps are identified. Species were the most often considered independently and classical Biological diversity index were poorly used at the community scale (i.e. all species taken together within an index). Several distribution maps were produced (one map per species) but none were done at community scale.

Indicators on non-indigenous species introduced by human activities (D2) were identified during the Marinexus project but the possible impacts of such non-indigenous species (ascidians, brown algae, etc.) on the rest of ecosystems were not investigated (e.g. trophic cascade, competitive exclusion, etc.).

CONCLUSIONS/WORK LEADS

Descriptors used or produced within the Interreg IVA projects focused on MSFD descriptors:

- Biological diversity (D1)
- Non-indigenous species (D2)
- Commercial species (D3)
- Food webs (D4)
- Eutrophication (D5)
- Sea-floor integrity (D6)
- Hydrographical conditions (D7)
- Contaminants and pollution effects (D8)
- Contaminants in fish and other seafood (D9)

The descriptors most studied were D1 and D3, followed by D4, D5 and D7.

Gaps were identified for:

- Marine litter (D10)
- Marine energies including underwater noise pollution (D11)

Negligible gaps were identified for:

- Biological diversity (at both population and community scale D1)
- Non-indigenous species (impacts on other biological compartments D2).

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