1.1.2 Advice on ecosystem services[1] and effects

ICES approach to advice on ecosystem services and effects

ICES Advisory Plan establishes the ecosystem approach as the central tenet that governs how ICES provides independent advice on the management of human activities in our seas and oceans. Through its advice, ICES strives to advance and share the best scientific understanding of marine ecosystems and the services they provide to meet conservation, management, and sustainability goals. ICES approach to advice on ecosystem services and effects integrates the precautionary approach (PA) with the ecosystem approach and is developed in accordance with the Guide to ICES advisory framework and principles.

Certain key phrases illustrate the central tenet of the ecosystem approach: management of human activities, consideration of collective pressures, achievement of good environmental status, sustainable use, optimization of benefits among diverse societal goals, regionalization, trade-offs, and stewardship for future generations (ICES, 2020a). These are based on the principles outlined by the United Nations Convention on Biological Diversity (CBD) and the United Nations Food and Agriculture Organization ([FAO] Garcia *et al.*, 2003; UN CBD, 2011). Ecosystem-based management (EBM) has been written into natural resource management and the environmental/conservation legislation of most requesters of ICES advice.

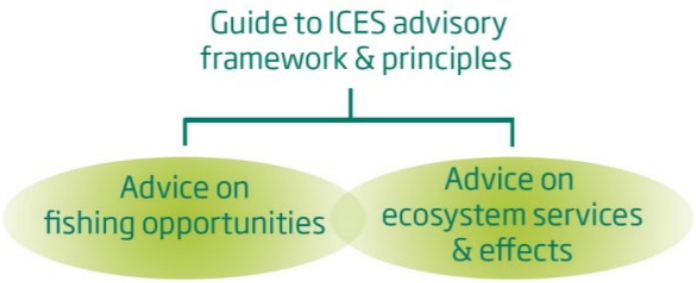

Figure 1 The Advice on ecosystem services and effects is a sister document to the Advice on fishing opportunities. The Guide to ICES advisory framework and principles provides the overarching framework to ICES advice.

The Guide to ICES advisory framework and principles applies to all ICES advice. For ecosystem services and effects advice the definition of management objectives is an ongoing process involving competing goals and various complexities. As a result these objectives may not be explicitly defined, lack in clarity, or require frequent review and/or adjustments. Guidance is required when reconciling multiple societally-determined management objectives where trade-offs are likely. ICES is committed to providing the evidence base to inform trade-off decisions across a suite of pressures from a range of human activities. The broad portfolio of scientific disciplines available to ICES network is used to construct the best available knowledge for advice and to ensure that this advice is developed considering services and effects across approperate spatial scales. Much advice is novel, and thus method development and dialogue with requesters and stakeholders are both key features of advice on ecosystem services and effects. For recurrent advice (e.g. bycatch reporting and analysis of vulnerable marine ecosystems [VMEs]) methods can be benchmarked and processes developed for the recurrent provision of advice.

Recurrent advice

In response to annual or recurrent requests from management bodies, ICES provides recurrent updated advice. Two examples of such recurrent advice are on vulnerable marine ecosystems and on bycatch of protected species.

Vulnerable marine ecosystems (VMEs)

Certain habitats and species of deep-sea bottom living organisms are defined as VMEs, including seamounts, hydrothermal vents, cold-water coral reefs and aggregations of deep-sea sponges. VMEs can be extremely long lived and are particularly

[1] In this context, ecosystem services aspires to include provisioning, regulating, cultural, and supporting services of marine ecosystems, supplementing the services provided through fishing opportunities.

vulnerable to bottom-fishing activity as they are easily disturbed and slow to recover. VMEs are thus protected from bottom fishing under several international treaties that stem from United Nations General Assembly Resolution 61/105 (UNGA, 2006). In this context, ICES provides annual recurrent advice to the European Union (EU) and the North East Atlantic Fisheries Commission (NEAFC) on the distribution of VMEs sensitive to fishing activities, including recommendations on possible management solutions for their protection, such as bottom-fishing closures. When providing advice on VMEs, ICES follows the FAO "International Guidelines for the Management of Deep-sea Fisheries in the High Seas" (FAO, 2009). This guidance provides a list of criteria that should be used in the identification of VMEs:

- uniqueness or rarity
- functional significance
- fragility
- life-history traits
- structural complexity

ICES and the Northwest Atlantic Fisheries Organization (NAFO) through the Working Group on Deep-water Ecology (WGDEC) maintain a database on the distribution and abundance of habitats and species considered as indicators of VMEs across the North Atlantic. This information combined with vessel monitoring system (VMS) and logbook data is used to analyse fisheries activities in the vicinity of VMEs as well as the spatial extent of bottom trawling in the NEAFC and EU areas. See examples of VME advice in EU waters (ICES, 2020b) and in the NEAFC Regulatory Area (ICES, 2020c), as well as the methods and standards section below for a summary of procedures used in the preparation of VME and bottom-fishing advice.

Bycatch of protected, endangered and threatened species

Fishing may result in unwanted species being caught and killed. This incidental bycatch can potentially include more than 200 protected, endangered, and threatened species (PETS) of birds, fish, mammals (seals and cetaceans), and turtles. Various legislative instruments have been put in place to eliminate or reduce rates of bycatch. In response to this, ICES is requested to provide annual advice on bycatch of PETS, covering the Northeast Atlantic Ocean, the Baltic Sea, and the Mediterranean Sea. ICES is also asked to advise on:

- monitoring of bycatch
- assessments of bycatch impacts
- mitigation measures to reduce bycatch

In the context of EBM, ICES has published a Roadmap for ICES bycatch advice that describes the legislative background, the science needs, and a path forward to strengthening ICES advice on bycatch. These strategic developments include methodological work towards developing threshold values for bycatch based on agreed conservation/management objectives. As such, the roadmap helps align ICES regional scientific work and advice provided to different management bodies. See example of advice on bycatch of protected and potentially vulnerable marine vertebrates (ICES, 2020d) and methods and standards section below for a summary of procedures used in the preparation of such advice.

Special request advice products

ICES special request advice products are tailor-made depending on the topic and the needs of the requester. The list below of such products relating to ecosystem services and effects demonstrates the breadth of both subject area (in bold font) and advice requesters (in parentheses alongside links):

- **Identification of ecologically valuable areas** in the Barents Sea by adapting international criteria for Ecologically or Biologically Significant Marine Areas (EBSA) (Norway; sr.2019.16);
- Monitoring of **marine foodwebs** and use surveillance indicators as early warning signals to ensure healthy foodwebs (for the EU's Marine Strategy Framework Directive [MSFD] Descriptor 4; sr.2015.1.6.2.1);
- Assessment of **healthy fish stocks** under the MSFD for Descriptor 3 commercial fish and shellfish (EU MSFD D3; sr.2017.07);
- The potential effects of **renewable energy** developments such as wet renewable technologies and marine energy storage systems on the marine environment (OSPAR; sr.2019.05);
- The type of bottom-fishing activity occurring in **marine protected areas** of the Baltic Sea (HELCOM; sr.2015.8.2.3.2);

- The potential effects of **electric or pulse bottom-trawl fishing** on the marine environment (the Netherlands; sr.2020.03);
- **Seabed assessment procedure** for human activity that results in physical loss and disturbance of benthic habitats, as well as the associated **trade-offs** (EU MSFD D6; sr.2017.13);
- New **substances and/or chemicals of concern** that are being introduced to the marine environment (OSPAR; sr.2017.21);
- Developing **marine mammal indicators** for the grey seal, harbour seal, and ten cetacean species – harbour porpoise; white-beaked, bottlenose, common, and striped dolphin; minke, fin, sperm, pilot, and beaked whale – in European Atlantic waters (OSPAR; sr.2016.cetaceans, sr.2016.dolphins, sr.2016.seals);
- Review of protocols on monitoring **excess nutrients** in marine waters using abundance data on **algal species blooms** (OSPAR; sr.2015.1.6.6.2);
- Review of criteria for **CITES non-detriment finding** for European eel (EU; sr.2015.9.2.3.2);
- Analysis of the **IUCN process for the assessment of the conservation status of marine species** in comparison to the process used by fisheries management bodies (EU; sr.2018.26).

Technical services

ICES technical services complement formal ICES advice. A technical service can be technical assistance, clarification of advice, a process service, or a review service. The service may include recommendations made by individual, or groups of, scientists but is not a formal statement by ICES. Nonetheless, all technical services are based on an objective and transparent scientific process that ensures quality and uses the best available science.

Ecosystem, fisheries, and aquaculture overviews

Different human activities may result in pressure(s) that impact ecosystems in terms of both structure and function. Given the large amount of scientific information available to managers, maintaining an overview of the main priorities is a challenge. ICES ecosystem, fisheries, and aquaculture overviews provide a holistic narrative for each ICES ecoregion, covering the ecosystems in general as well as focusing in on fisheries and aquaculture activities and effects. Such overviews constitute a key mechanism by which ICES provides information for ecosystem-based management (EBM). The overviews complement other types of advice by providing supporting context and allowing readers to understand the implications of sectoral decisions and the effects of human activity in an ecosystem setting. They provide science-based statements, supported by quantitative and qualitative data, that are of use to ICES advice requesters, stakeholders, and regional managers. The overviews are living documents and are updated and further developed every few years.

Ecosystem overviews

Ecosystem overviews are products that intend to advance the delivery of integrated advice, taking account of the effects of multiple human pressures on the environment and the most influential environmental and ecosystem processes, while considering multiple objectives. The overviews are key products in ICES approach to supporting EBM. Ecosystem overviews identify the key signals and trends of importance to EBM, describing: 1) the location, scale, and management and assessment boundaries of each ecoregion; 2) the main regional pressures and associated human activities; and 3) the state of the ecosystem components and the pressures (including climate change) that account for changes in state. Areas in which information is uncertain or data are lacking are also highlighted.

Fisheries overviews

ICES provides information for approximately 220 stocks. However, fishing opportunities advice, which is based on single stocks, does not integrate across fisheries or address the impacts of fisheries on the ecosystem. The fisheries overviews are summaries of the activities and impacts of the different fleets fishing in each ICES ecoregion. The purpose of these overviews is to describe: 1) the national fishing fleets operating in each ecoregion, including their fishing gears and spatio-temporal patterns; 2) the status of the fisheries resources and the level of exploitation relative to the agreed objectives and reference points; 3) mixed-fisheries considerations of relevance to the management of the fisheries together with providing management advice; and 4) the impacts of fishing gear on the ecosystem in terms of the seabed and the bycatch of protected, endangered, and threatened species.

Aquaculture overviews

Aquaculture is one of the fastest growing food production sectors. ICES work on aquaculture is part of a wider portfolio of work that seeks to advance and share scientific understanding of marine ecosystems and the services they provide, and to use this knowledge to generate state-of-the-art advice for meeting conservation, management, and sustainability goals. The ICES aquaculture overviews will: 1) summarize regional and temporal information on aquaculture activities, practices, and production of the cultured taxa; 2) describe the relevant policy and legal foundation; 3) consider the environmental and socio-economic interactions of aquaculture activities and practices; 4) provide insights on the interaction of environmental, economic, and social drivers; and 5) consider future projections and emerging threats and opportunities.

Viewpoints

Scientific knowledge that has matured and is considered appropriate for use by policy-makers is published in advisory products known as ICES Viewpoints. These Viewpoints enable bottom-up initiatives to publish *ad hoc* advice from ICES network of around 150 expert groups. Criteria for publication must be met, one of which is that the Viewpoint topic is relevant to a known or potential management issue of likely high importance to managers and society. Two examples of Viewpoints are Biofouling on vessels – what is the risk, and what might be done about it? (ICES, 2019a) and Scrubber discharge water from ships – risks to the marine environment and recommendations to reduce impacts (ICES, 2020e). See section below on methods and standards.

Methods and standards

Ecoregions

Ecoregions are the spatial units used to develop and synthesize the evidence for the ecosystem approach (see Definition and rationale for ICES ecoregions). They enable ICES to monitor, assess, and address regional scientific challenges and are used for geographical allocation and reporting of ICES advice. Ecoregions were developed using biogeographic, oceanographic, ecological, and human impact/management issues. Ecosystem services and effects assessments need to consider a range of spatial scales, both within and across ecoregions, and to elaborate a rationale for the choice of spatial scale used when providing advice.

Figure 2 Map of ICES ecoregions.

Data and visualization products

Increasingly ICES advice includes data layers and/or visualization tools. These data products are often a more effective way of communicating the evidence base and advice. A fully referenceable data product is created with a DOI. One example is the data layers of fishing intensity for a number of OSPAR regions (ICES, 2018a) with the associated data product available as a zip file (ICES, 2018b).

Advice products now also include visualization tools such as interactive maps. An example is the advice on the deep sea access regulations where a visualization tool showed the options with regard to depth, where VME are known or likely to

occur and the existing deep sea fishing areas (ICES, 2021). The VME data portal[2] also displays as an interactive map containing ICES VME data as well as advice with regard to the NEAFC area.

Transparent Assessment Framework (TAF)

The TAF is an openly accessible framework that enables users to find, reference, download, and run assessments that leads to advice. The assessment procedure for impact on seabed habitats (for some > 1500 species) from bottom fishing, as well as the associated trade-offs, is fully documented in the TAF for several ecoregions (Greater North Sea, Baltic Sea, Barents Sea, Norwegian Sea, and Celtic Seas) with a different level of implementation (see the FBIT GitHub repository[3]). The fisheries overviews use TAF by ecoregion (see the ICES_TAF GitHub repository[4]). Working in TAF will facilitate the re-running of assessments when new VME and/or fishing activity data becomes available via the annual ICES data calls.

Ecosystem overviews

Ecosystem overviews are usually based on information provided by integrated ecosystem assessment (IEA) working groups and expert groups that specialize in state descriptors. Data should come from accepted legitimate sources. The focus of the overviews was developed through a series of workshops with requesters of advice. While all relevant expert groups are actively encouraged to contribute, the central role in delivery of the overviews lies with the IEA groups. Updates of information/data and correction of mistakes in the overviews occurs annually. A complete review and revision is recommended approximately every five years. The incorporation of new topics into the ecosystem overviews takes place through the five-step 'pipeline process'. Detailed methodology to develop pressure–ecosystem state relationships (the network diagram, which is a core element of ecosystem overviews) is provided in the ecosystem overview technical guidelines. The overviews are produced in accordance with ICES advisory framework and are subject to independent review as well as approval by ICES Advisory Committee (ACOM).

Fisheries overviews

These overviews are compiled through workshops and the synthesis of fishing opportuntites advice using an R package (Fisheries-O) that accesses data directly from STECF and ICES databases (historical catch statistics, SAG and VMS logbook data). Experts also provide additional information that highlight specific issues in ecoregions. There are usually ten sections in the fisheries overviews describing who is fishing, the main fisheries, management plans in place and where relevant mixed fisheries considerations, alongside a summary of the status of the stocks. The overviews are reviewed each year by experts and the relevant assessment working groups. The primary purpose of the review is to correct errors and review fisheries that have changed dramatically since the previous overview publication. The figures are updated each year. The overviews are produced in accordance with ICES advisory framework and are subject to independent review as well as approval by ACOM.

Aquaculture overviews

The knowledge for aquaculture overviews is synthesized from relevant expert groups and other sources. Potential requesters and stakeholders were surveyed on their knowledge needs. The overviews will have nine sections: executive summary; introduction; description and location of marine aquaculture activities and practices; production over time; policy and legal foundation; ecosystem/environment interactions; social and economic context; interaction of environmental, economic and social drivers; and future projections, and emerging threats and opportunities. Data for the overviews should come from accepted legitimate sources. The data flows will be mapped and be in compliance with the ICES data policy. The aquaculture overviews will be produced in accordance with ICES advisory framework and subject to independent review as well as approval by ACOM.

[2] https://vme.ices.dk/map.aspx.
[3] https://github.com/ices-eg/FBIT.
[4] https://github.com/ices-taf.

Viewpoints

The criteria for producing a viewpoint are that the topic addressed should:

- be relevant to a known or potential management issue of likely high importance to managers and society;
- not be a replication of a topic for which ICES already gives advice;
- be based on maturing science (i.e. science not narrow, speculative, or lacking external peer review);
- be linked to one or more ICES expert groups;
- be relevant to ICES Strategic Plan;
- be sufficiently focused that it can be succinctly and unambiguously described.

Upon acceptance, the viewpoint is developed in accordance with the ICES advisory framework. Viewpoints are based on the scientific report (knowledge synthesis phase), which will be subjected to independent external review. Based on the scientific report and reviewers comments, the draft viewpoint will be created. The draft will then be submitted to ACOM for approval, after which the viewpoint and supporting scientific report will be published.

Bycatch of protected, endangered, and threatened species (PETS)

An annual data call is made for national total fishing effort, monitored effort (i.e. trips/fishing days with dedicated observers on board), and bycatch events. Data are received and stored in a specific PETS bycatch database[5] and maintained by the ICES data centre. Several ICES working groups (e.g. WGMME, JWGBIRD) may assemble additional data and qualitative information (including on strandings and entanglement) from other sources (such as through interviews). The submissions are evaluated and quality checked. In addition, where possible, the range of (minimum/maximum) mortality (in number of individuals) due to bycatch on PETS populations is evaluated in order to assess likely conservation-level threats. ICES also also reviews information on PETS bycatch mitigation measures and ongoing bycatch mitigation trials. For more information, see the technical guidelines on bycatch.

Vulnerable marine ecosystems (VMEs)

New records of VMEs are submitted to the VME database annually by ICES Member Countries through a data call. These records come from a variety of sources such as from dedicated deep-sea research cruises with high-resolution seabed imaging systems to fishing trawl and longline bycatch records. VME records are classified into VME habitats, VME indicators, and absence of VME data. VME habitats are records demonstrating the unequivocal presence of a VME, generally those records from visual survey data (e.g. remotely operated vehicle [ROV] or towed/drop camera seabed imagery). VME indicators are records that suggest the presence of a VME with varying degrees of uncertainty. For these indicators, a weighting system of likelihood and confidence is used called the "VME weighting algorithm". This algorithm produces an index that is based on the underlying data from the VME database and confidence in the likelihood of a given area containing a VME. The index is created on a spatial C-square grid of 0.05 × 0.05 degrees (approximately 3 km × 5 km), allowing multiple records of a VME indicator in the same grid cell to be used to detect likelihood (see technical guidelines on vulnerable marine ecosystems). The information on VMEs is analysed together with information on fishing activity to evaluate potential management solutions to protect VMEs.

Spatial description of fishing activity using VMS and logbook data

The coupling of VMS data with logbook data is currently the most practical and cost-effective way to describe the spatial dynamics of fishing activities. An annual data call requests VMS and logbook data from ICES Member Countries. The access and use of VMS data follows a data policy. The data are quality checked, harmonized, and used to estimate the spatial distribution of fishing activity and the impact of such activity on the seabed. Maps of the spatial distribution of average fishing effort show the distribution of effort (in megawatt [mW] fishing hours) by vessels > 12 m having VMS. Currently vessels below 12m are not required to have VMS. Impact on the seabed is measured by surface and subsurface abrasion, accounting for differences in gear penetration or disturbance. The average annual surface and subsurface disturbance by mobile bottom-contacting fishing gear is expressed as average swept-area ratios (SAR). Swept area is calculated as hours fished × average vessel speed × gear width. SAR is expressed on a spatial C-square grid of 0.05 × 0.05 degrees (approximately 3 km × 5 km; see the technical guidelines). ICES uses anonymized and aggregated VMS and logbook data in a number of its recurrent advice products (fisheries overviews, ecosystem overviews), special requests (e.g. on seafloor

[5] https://bycatch.ices.dk/index.aspx.

assessment process for physical loss and disturbance; ICES, 2019b), and technical services (e.g the production of spatial data layers of fishing intensity/pressure; ICES, 2018a) products.

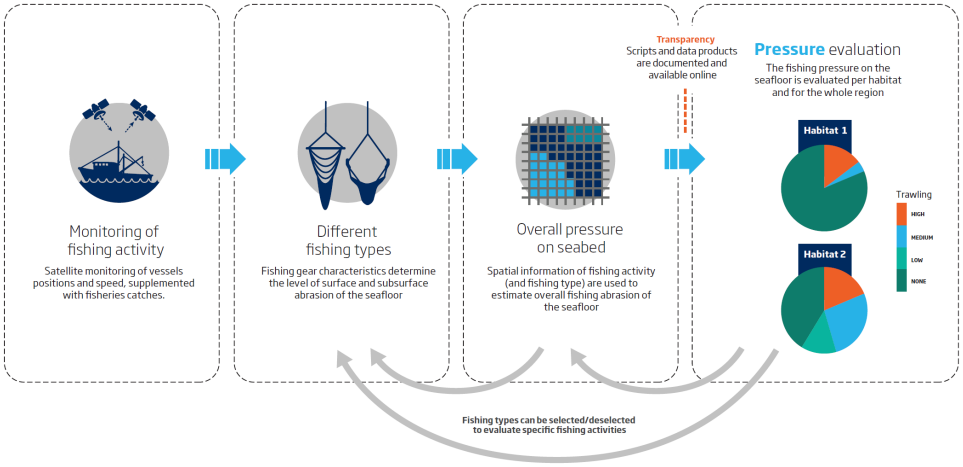

Figure 3 The assessment process that expresses the spatial extent and distribution of physical disturbance of the seabed

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[6] Version 2: Error in references corrected