

1.2 Advice basis

1.2.1 General context of ICES advice

ICES advises competent authorities on marine policy and management issues related to the impacts of human activities on marine ecosystems and the sustainable use of living marine resources.

An important part of ICES advice regards *the management of the exploitation of living marine resources*. The context for this part of ICES advice is set by several international agreements and policies:

- United Nations Convention on the Law of the Sea (UN, 1982 (known as UNCLOS)), which includes a call for a maximum sustainable yield (MSY) approach to managing fisheries;
- United Nations Conference on Environment and Development (UN, 1992a (known as UNCED)), including Chapter 17 of Agenda 21 which highlights a precautionary approach;
- United Nations Straddling Fish Stocks Agreement of 1995 (UN, 1995 (known as the UN Fish Stocks Agreement or UNFSA)) and the FAO Code of Conduct for Responsible Fisheries (FAO, 1995), both of which call for a precautionary approach;
- Convention on Biological Diversity (UN, 1992b (known as CBD)), which calls for conservation of biological diversity through an ecosystem approach;
- Johannesburg Declaration of the World Summit on Sustainable Development (UN, 2002 (known as WSSD)), which calls for an ecosystem approach and rebuilding fisheries to maximum sustainable yield.

In addition, ICES advice responds to the policy and legal needs of ICES Member Countries and multinational and intergovernmental organizations that use the advice as the scientific basis to manage human activities that affect, and are affected by, marine ecosystems. Some applicable policy and legal instruments are:

- The Common Fisheries Policy of the European Union (EU, 2013)
- The Marine Strategy Framework Directive (EC, 2008)
- Norwegian Marine Resources Act (Lovdata, 2008 (Lov om forvaltning av vilt levande marine ressursar))
- Russian Federal Law on Fisheries and conservation of biological resources in the waters. N 166-P3 20/12/2004 (Anon., 2004)
- Icelandic Fisheries Management Act (No. 38, 15 May 1990) (Anon., 1990)
- Faroe Islands Fisheries Management Act (Løgtingslógnr. 28 um vinnuliganfiskiskapfrá 10. mars 1994) (Anon., 1994)

1.2.2 Advisory products and ICES advisory process

The advisory products provided by ICES can be classified in two categories:

- **Advice** which is adopted by ICES Advisory Committee (ACOM), and
- **Services** provided by the ACOM Leadership and/or the Secretariat under the oversight of ACOM

Advice:

The majority of the advice is provided in response to standing requests (recurring advice) from ICES clients (the European Commission, the North Atlantic Salmon Conservation Organization (NASCO), and the North East Atlantic Fisheries Commission (NEAFC)). In addition to the recurring advice ICES also provides advice in response to special requests from the Commissions mentioned above and from the Helsinki Commission (HELCOM), the OSPAR Commission (OSPAR) and ICES Member Countries.

ICES aims at producing advice based on the best available science that is characterized by quality assurance, developed in a transparent process, unbiased, independent, and is recognized by all parties as being relevant to management.

The advisory process is illustrated in Figure 1.2.1. The scientific basis for the advice is developed by expert groups. An advice drafting group prepares the advice based on the findings of the expert groups. The advice prepared by the advice drafting group is finalized and adopted by ICES Advisory Committee (ACOM).

In accordance with ICES quality policy, ICES operates a peer-review system. The scientific basis for responses to non-recurring requests for advice is subject to a peer-review process, before or in conjunction with the advice drafting group. For recurring advice ICES has implemented a benchmark process in which the methods, including the data series to be used by the expert groups in addressing the requests, are developed. The results from the benchmarks are subjected to a peer-review process similar to the process for non-recurring requests.

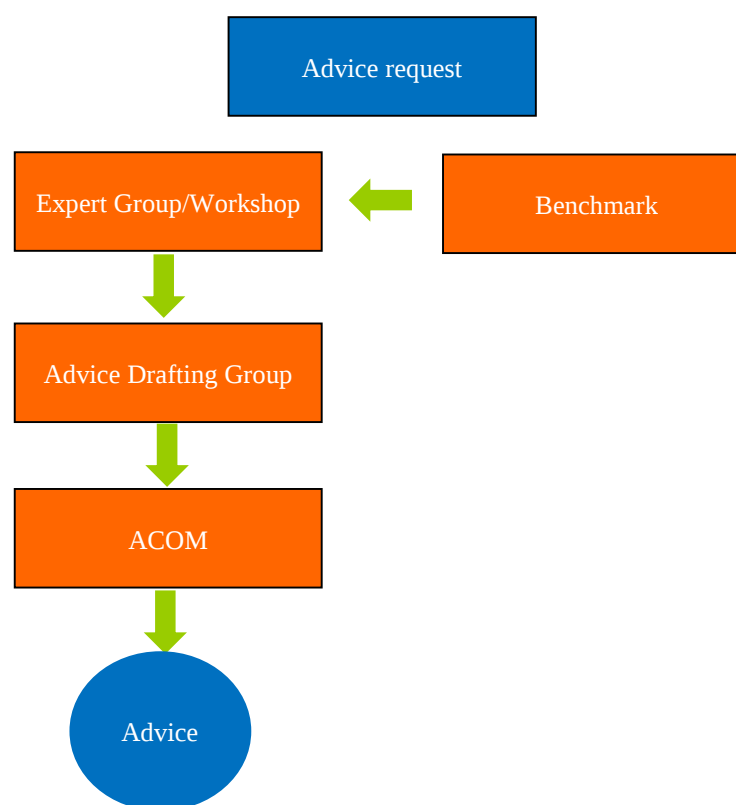


Figure 1.2.1 Overview of the ICES advisory process for recurrent advice.

The benchmarking groups, advice drafting groups, and the final ACOM approval of the advice are open to stakeholders who have observer status to ICES. ICES clients can attend the entire advisory process as an observer.

Services:

A Service is the provision of scientific information or a process that produces scientific information asked for by policy-makers. The service may include recommendations made by individual or groups of scientists, but it does not include a recommendation on behalf of ICES (except to reiterate a recommendation previously agreed by ACOM).

While Services are not ICES approved advice, they share the same characteristics of quality assurance and developed in a transparent process that is unbiased and politically neutral.

These Services fall into four categories:

1. **Technical Services:** This service is the provision of factual information with no or minimal interpretation, e.g. provision of data and research results.
2. **Clarification of Advice:** This service helps users understand advice previously provided by ICES.

3. **Process Services:** This service facilitates delivery of, e.g. a report of best scientific understanding of an issue, in cases where ICES is not requested to offer advice but is asked to provide scientific integrity to a process.
4. **Review Services:** This service covers peer review of scientific activity (including research proposals, survey or sampling designs, or research results conducted outside ICES). In provision of the service, ICES is responsible for selecting qualified experts without a vested interest to provide reviews, but it does not interpret the reviews or recommend actions that should be taken in response to the reviews.

1.2.3 Ecosystem and precautionary approaches

ICES advisory approach is based on an ecosystem approach, within a precautionary approach to management.

An ecosystem approach has been defined in various ways but mainly emphasizes a management regime that maintains the health of the ecosystem alongside appropriate human uses of the environment, for the benefit of current and future generations.

An ecosystem approach is expected to contribute to achieving long-term sustainability for the use of marine resources, including the fisheries sector. An ecosystem approach serves multiple objectives, involves strong stakeholder participation, and focuses on human behaviour as the central management dimension.

ICES is in the process of regionalizing its advice and building the scientific foundation for integrated regional ecosystem advice, which will summarize the ecosystem state and pressures documented in “ecosystem overviews”. These overviews will focus on ecosystem processes in order to enable ecosystem drivers to be incorporated into traditional fish stock assessments and to enable operational advice to be given.

A precautionary approach (PA) is described in the UN Fish Stocks Agreement (UN, 1995) as follows:

“States shall be more cautious when information is uncertain, unreliable or inadequate. The absence of adequate scientific information shall not be used as a reason for postponing or failing to take conservation and management measures.”

This implies that as information becomes increasingly limited and/or less certain, ICES advice on management will be more conservative with respect to possible impact on the marine ecosystem.

1.2.4 ICES advice on topics other than fishing opportunities

ICES has developed a set of advice rules to be applied when addressing requests for advice on fishing opportunities (see Section 1.2.5 below). The requests for advice on other topics than fishing opportunities cover a very wide range of subjects and it is not possible to develop generic advice rules for these requests similar to the ones for fishing opportunities. The approach taken by ICES when addressing non-fisheries requests for advice may therefore be classified as *ad hoc* adopted to each specific request. However, it will in all cases be based on the ecosystem approach and apply the precautionary approach. The aim is to address the request while ensuring that the advice is consistent with maintaining healthy marine ecosystems.

To address these requests ICES is dependent on the clients having defined clear objectives and criteria to be applied when developing the advice. An important element of the advisory process is the dialogue with the client to achieve a common understanding on how to interpret the request, the type of advice the client expects, and what ICES can deliver.

1.2.5 ICES advice on fishing opportunities

The ICES approach to advice on fishing opportunities integrates the ecosystem and precautionary approach with the objective of achieving maximum sustainable yield (MSY). The aim is, in accordance with the aggregate of international guidelines, to inform policies for high long-term yields while maintaining productive fish stocks within healthy marine ecosystems.

Annex 2 of the UN Fish Stocks Agreement (UN, 1995) contains guidelines for applying a precautionary approach within an MSY framework. In accordance with a precautionary approach, populations need to be maintained within safe biological limits to make MSY possible. However, within safe biological limits, an MSY approach is necessary to achieve MSY. A precautionary approach is a necessary, but not a sufficient condition for MSY.

Maximum sustainable yield is a broad conceptual objective, aimed at achieving the highest yield over the long term. It is non-specific with respect to: (a) the biological unit to which it is applied; (b) the models used to provide scientific advice; and (c) the management methods used to achieve MSY. The MSY concept can be applied to an entire ecosystem, a fish community, or a single stock. ICES applies the MSY concept to single stocks as well as to groups of stocks in the context of biological interaction and mixed fisheries, where stocks are caught together in a fishery. ICES interpretation of MSY is maximization of average long-term yield from sustainable stocks.

Many of the models (mathematical and conceptual) used to estimate MSY and associated parameters typically assume that factors not explicitly included in the models remain constant or vary around a historical long-term mean. However, marine ecosystems are dynamic and fish stocks will change not only in response to the fisheries, but also to changes in fishing patterns and fishing pressures on their prey or their predators. ICES considers MSY estimates to be valid only in the short term and to be subject to regular re-estimation.

To support the European stock by stock management system, the ICES framework for fisheries advice needs to be applicable to individual stocks. This does not remove the need to modify stock-specific advice to take account of technical interactions (e.g. bycatch in mixed-species fisheries) or of biological interactions (e.g. predator–prey relationship), but the underlying basis for ICES fisheries advice remains the individual fish stock.

The advice rule applied by ICES in developing the advice on fishing possibilities depends on management strategies agreed by relevant management bodies and the information and knowledge available for the concerned stocks.

If the relevant management authorities have agreed on a management plan or strategy and the plan/strategy has been evaluated by ICES to be consistent with the precautionary approach, ICES will provide advice in accordance with the plan/strategy.

If no management plan/strategy has been agreed by all relevant management parties or the agreed plan/strategy has been evaluated by ICES not to be consistent with the precautionary approach, ICES will provide advice applying the ICES MSY advice rule or the precautionary approach (see below for details on when to use the MSY advice rule or the precautionary approach for providing advice).

ICES MSY advice rule requires a relative high level of data and knowledge on the dynamics of the stocks concerned. If the data and knowledge requirements are not fulfilled ICES cannot provide advice consistent with MSY; instead ICES applies an advice rule that is only based on precautionary considerations.

For the purposes of identifying the advice rule to be applied when giving advice on fishing possibilities, ICES classifies the stocks into six main categories on the basis of available knowledge.

Category 1 – *stocks with quantitative assessments*. Includes the stocks with full analytical assessments and forecasts as well as stocks with quantitative assessments based on production models.

Category 2 – *stocks with analytical assessments and forecasts that are only treated qualitatively*. Includes stocks with quantitative assessments and forecasts which for a variety of reasons are considered indicative of trends in fishing mortality, recruitment, and biomass.

Category 3 – *stocks for which survey-based assessments indicate trends*. Includes stocks for which survey or other indices are available that provide reliable indications of trends in stock metrics, such as total mortality, recruitment, and biomass.

Category 4 – *stocks for which only reliable catch data are available*. Includes stocks for which a time-series of catch can be used to approximate MSY.

Category 5 – *landings only stocks*. Includes stocks for which only landings data are available.

Category 6 – *negligible landings stocks and stocks caught in minor amounts as bycatch*. Includes stocks where landings are negligible in comparison to discards and stocks that are primarily caught as bycatch species in other targeted fisheries.

For category 1 and 2 stocks ICES provides advice in accordance with agreed management plans/strategies evaluated to be consistent with the precautionary approach. If such plans/strategies are not agreed or have been evaluated by ICES not to be precautionary, ICES will give advice on the basis of the ICES MSY approach or, in the absence of defined F_{MSY} reference point, on the precautionary approach.

For category 3–6 stocks the available knowledge is insufficient to apply the ICES MSY approach and the advice rule is therefore based on the precautionary approach. ICES is in the process of developing an MSY approach for stocks in categories 3 and 4.

Limitations on fisheries may be required to achieve environmental objectives, especially regarding biodiversity, habitat integrity, and foodwebs. This will not affect the catch that can be taken from a stock in accordance with the objectives of MSY and the precautionary approach and will therefore not affect ICES advice on fishing possibilities. However, the limitations may affect the possibilities for the fisheries to fully utilize the advised fishing possibilities. ICES may, if requested, advise on the likely impact of such limitations on the catch but will, as explained, not include such considerations in the advice on fishing opportunities.

The Common Fisheries Policy adopted in 2013 (EU, 2013) includes the introduction of landing obligations (discard bans) for most of the commercial species. For stocks for which the ban enters into force before 2017, ICES provides catch advice for 2016 on the assumption that catches previously discarded will now be landed. To provide a clear linkage to previous advice on catch and landings the advised catches are split into two components, the wanted catch and the unwanted catch. “Wanted catch” is used to describe fish that would be landed in the absence of the EU landing obligation. The “unwanted catch” refers to the component that was previously discarded. This split, based on the past performance of the fishery, is expected to evolve and the relative magnitude of these components will change.

1.2.5.1 ICES MSY advice rule

Fisheries directly affect fish stocks through catches. The fishing mortality (F) is a measure for fishing pressure, the proportion of the number of fish in a year class that is taken by fisheries during one year. The fishing mortality referred to in ICES advice is estimated as the average over the year classes that dominate in the catches. For a very small number of stocks, such as Icelandic cod and saithe and some *Nephrops* stocks, ICES uses harvest rates (HR) instead of fishing mortality. The harvest rate is defined as the fraction of a reference biomass that is caught during a year. The reference biomass can be total stock biomass, spawning–stock biomass, or biomass above a minimum size or minimum age.

The production in a fish stock can be highly variable. It is related to stock size (often expressed as spawning–stock biomass, SSB) and the size structure in the stock, which in turn depend also on the fishing mortality and fishing pattern.

Surplus production of a stock is the catch that can be harvested without changing the average production in the long term. For a given fishing pattern there is a level of fishing mortality that in the long term will generate the highest surplus production. This peak of the surplus production is the MSY, and the fishing mortality generating this peak is F_{MSY} .

Fishing mortality is the only variable that can be directly controlled by fisheries management. Fisheries management cannot directly control the stock size, it can only influence it through the fishing mortality. Stock size is also subject to natural variability that on a year-to-year basis can overwhelm the influence of fishing. MSY is a long-term average. A management strategy that harvests variable yields in response to the natural variability in stock size will on average give yields closer to the long-term MSY than a strategy operating with the maximum constant yield that could be taken sustainably.

Due to the natural variability in stock size there may be situations where the spawning stock is so low that reproduction is at significant risk of being impaired. A precautionary approach implies that fisheries management in such situations should be more cautious. For stocks where quantitative information is available, a reference point B_{lim} may be identified as the stock size below which there may be reduced recruitment. A precautionary safety margin incorporating the uncertainty in ICES stock estimates leads to a precautionary reference point B_{pa} , which is a biomass reference point designed have a low probability of being below B_{lim} . In most cases the safety margin is taken as a standard value, such that in most cases $B_{pa} = B_{lim} \times 1.4$. When the spawning stock size is estimated to be above B_{pa} , the probability of impaired recruitment is expected to be low.

For short-lived species, the biomass can fluctuate wildly between years. A precautionary approach in this situation implies that a minimum stock size, $B_{escapement}$, should remain in the sea every year after fishing.

F_{lim} is the fishing mortality which in the long term will result in an average stock size at B_{lim} . Fishing at levels above F_{lim} will result in a decline in the stock to levels below B_{lim} . Again, to account for the uncertainty in the assessment, ICES applies a precautionary buffer F_{pa} to avoid that *true* fishing mortality is above F_{lim} .

Biomass Reference Points

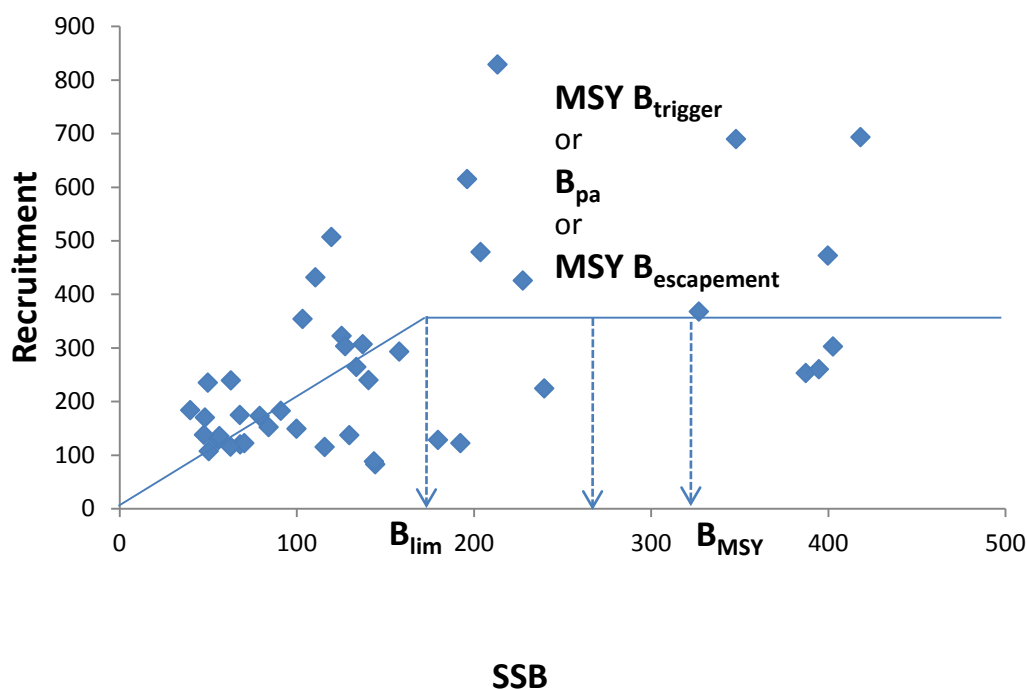


Figure 1.2.2

Illustration of biomass-based biological reference points. B_{lim} and B_{pa} are precautionary reference points related to the risk of impaired reproductive capacity, while $MSY B_{escapement}$ (often equal to B_{pa}) is used in the advice framework for short-lived species. $MSY B_{trigger}$ is the parameter in the ICES MSY framework which triggers advice on a reduced fishing mortality relative to F_{MSY} . B_{MSY} is the expected average biomass if the stock is exploited at F_{MSY} . Diamonds show the variable recruitment versus SSB that have been observed over the years. Recruitment can be seen to be generally lower when SSB is below B_{lim} .

Some fish eat other fish, which means growth for the predator and mortality for the prey; fish populations also compete for food or habitat. This means that the size and productivity of a fish stock may depend on the state of other stocks as well as on its own abundance. It also means that as a population of fish increases one cannot expect that growth and mortality for that species remains constant as there will be increasing competition for food and habitat within that population.

ICES incorporates such species interaction considerations into the single-species framework by applying natural mortality and growth rates derived from models of species interactions, using size, age, and stomach data for several species in the Baltic, the Barents Sea, and the North Sea. ICES routinely incorporates short-term changes in growth and maturation in short-term projections to account for competition and food supply. ICES also expects to update MSY reference points (typically as part of the benchmark process) to ensure they reflect current dynamics.

1.2.5.2 Long-lived category 1 and 2 stocks

For long-lived category 1 and 2 stocks, ICES bases its MSY approach on attaining a fishing mortality rate of no more than F_{MSY} while maintaining the stock above B_{lim} with at least 95% probability.

In this approach, ICES uses the fishing mortality and biomass reference points F_{MSY} and $MSY B_{trigger}$. F_{MSY} is estimated as the fishing mortality with a given fishing pattern and current environmental conditions that gives the long-term maximum yield. To ensure that fishing at F_{MSY} is sustainable, F_{MSY} is not allowed to be above F_{pa} . This is appropriate since a precautionary approach is a necessary boundary to ensure sustainability, even though it is in itself not a sufficient condition for achieving the maximum sustainable yield implied by the MSY framework.

$MSY B_{trigger}$ is considered the lower bound of spawning–stock biomass fluctuation around B_{MSY} . It is a biomass reference point that triggers a cautious response. The cautious response, in cases where the spawning stock falls below $MSY B_{trigger}$, is to reduce fishing mortality to allow a stock to rebuild to levels allowing for MSY. The reduction in fishing mortality is proportional to the ratio between the size of the spawning stock and $MSY B_{trigger}$.

The advice rule leads to catch advice corresponding to a fishing mortality of:

- $F = F_{MSY}$ when the spawning–stock biomass is at or above $MSY B_{trigger}$, and
- $F = F_{MSY} \times \text{spawning–stock biomass} / MSY B_{trigger}$ when the stock is below $MSY B_{trigger}$.

If the stock is below B_{lim} ICES advice is based on bringing the stock above B_{lim} in the short term. This may result in advice of zero catch.

The approach does not use a B_{MSY} estimate. B_{MSY} is a notional value around which stock size fluctuates when fishing at F_{MSY} . B_{MSY} strongly depends on the interactions between the fish stock and the environment it lives in, including biological interactions between different species. Historical stock size trends may not be informative about B_{MSY} (e.g., when F has exceeded F_{MSY} for many years or when current ecosystem conditions and spatial stock structure are, or could be, substantially different from those in the past).

Determination of $MSY B_{trigger}$ requires contemporary data with fishing at F_{MSY} to identify the normal range of fluctuations in biomass when stocks are fished at this fishing mortality rate. If the observation on fluctuation in biomass is insufficient to estimate $MSY B_{trigger}$, the reference point is normally set at B_{pa} (when this reference point is available) and there is no sound basis for using a different value). In the future, when sufficient observations of SSB fluctuations associated with fishing around F_{MSY} are available, the $MSY B_{trigger}$ should be re-estimated to correspond to the lower bound of the range of stock sizes associated with MSY.

Conceptually, spawning–stock biomass in the advice rule is the estimated spawning stock size at the beginning (or at spawning time) of the year to which the advice applies (advice year). For example, for an assessment performed in 2015 using data through 2014, the reference spawning stock size will for most stocks be the projected size at the beginning of 2016.

Most fisheries catch a mixture of species and it is not entirely possible to control which species and how much of each is caught. For stocks exploited by mixed-species fisheries, it may not be possible to achieve the single-stock MSY catch advice for all the stocks simultaneously. Either the advised catches for some stocks will be exceeded in trying to catch the TACs of other stocks, or the TACs for some stocks will not be caught in order to prevent overshooting the TACs of other stocks. ICES has developed a mixed-species fisheries model to address this (ICES, 2009a, 2010); for the main demersal stocks in the

North Sea and the Celtic Sea ICES provides information on catch composition of different fisheries strategies to illustrate the trade-offs between the strategies.

1.2.5.3 Short-lived category 1 and 2 stocks

The future size of a short-lived fish stock is very sensitive to recruitment because of the few age groups in the natural population. Incoming recruitment is often the main or only component of the fishable stock. In addition, care must be given to ensure a sufficient spawning-stock size as the future of the stock is highly dependent on annual recruitment. For short-lived species, estimates or predictions of incoming recruitment are typically imprecise, as are the accompanying catch forecasts.

For most short-lived stocks, similar to the long-lived ones, the ICES MSY approach is aimed at achieving a high probability (95%) of having the minimum amount of biomass required to produce MSY (B_{lim}) left to spawn the following year. To do this ICES uses two reference points, $MSY_{B_{escapement}}$ (see Figure 1.2.2) and F_{cap} . $MSY_{B_{escapement}}$ is estimated each year to be robust against low SSB and includes a biomass buffer to account for uncertainty in the assessment and catch advice. F_{cap} is defined to limit exploitation rates when biomass is high. A large stock is usually estimated with greater uncertainty, i.e. when the catch is taken, the uncertainty in the escapement biomass is greater. By capping the F , the escapement biomass is increased in proportion to stock size, maintaining a high probability of achieving the minimum amount of biomass left to spawn.

The advised yearly catches correspond to the estimated stock biomass in excess of the $MSY_{B_{escapement}}$, but constrained to allow a fishing mortality that is no higher than F_{cap} .

For some short-lived species, assessments are so sensitive to incoming recruitment that the amount of biomass in excess of the target escapement cannot be reliably estimated until data on the incoming year class is available. For most of the stocks concerned such data is obtained just before the fishery starts (or during the fishing year). Therefore, the advice on fishing possibilities is often given just prior to the start of the fishing season or after the fisheries has started.

1.2.5.4 Category 3–6 stocks

A substantial part of the stocks for which ICES provides advice do not have population estimates from which catch options can be derived using the MSY framework. ICES has therefore developed a precautionary framework for quantitative advice regarding such stocks.

The overall aim of the approach for these stocks is to ensure that the advised catch is sustainable. The underlying principles of the approach are that (a) the available information should be used, (b) the advice should, where possible, be based on the same principles as applied for stocks with analytical assessments and catch forecasts, and (c) a precautionary approach should be followed. The latter implies that as information becomes increasingly limited, more conservative reference points should be used and a further margin of precaution should be adopted when there is limited knowledge of the stock status. The margin of risk tolerance is a management prerogative, but in the absence of any proposal by managers ICES applies the values given below.

In order to apply a precautionary approach for categories 3–6 the framework for these stocks includes the following considerations regarding uncertainty and precaution which have been applied in sequence:

- As the methodologies used to estimate stock status, trends, and forecasts, due to the limited data or knowledge about their biology, are expected to be more susceptible to noise than methods used to produce forecasts for data-rich stocks, a change limit of $\pm 20\%$ (uncertainty cap) has been applied in the advice. This change limit is relative to the reference on which it is based and may be, e.g. recent average catches or a projection of a trend.
- A principle of an increasing precautionary margin with decreasing knowledge about the stock status has been applied:
 - The reference points for exploitation used have, when proxies could be identified, been selected on the lower margins of F_{MSY} – either at the lower range of an interval, as $F_{0.1}$, or similar.

- o A precautionary margin of –20% (precautionary buffer) has been applied for those cases when it is likely that $F > F_{MSY}$ or when the stock status relative to candidate reference points for stock size or exploitation is unknown. Exceptions to this latter rule have been made in cases where expert judgement determines that the stock is not reproductively impaired, and where there is evidence that the stock size is increasing significantly or exploitation has reduced – for instance, based on survey indices or a reduction in fishing effort in the main fishery if the stock is taken as a bycatch species.

The advice is applicable to a time-frame which is compatible with a measurable response in the metrics used as the basis for the advice. Where the least amount of information is available, including cases where the 20% precautionary margin has been applied, ICES therefore considers that the advice is not expected to be changed for a fixed and determined period such as, for example, three years, unless important new knowledge emerges regarding a stock which may justify a revision of the advice.

The advice rule used to provide quantitative advice on fishing possibilities depends on the available information, and ICES has developed separate advice rules for each of the stock categories listed in Section 1.2.5.1.

Category 3. Stocks for which survey-based assessments indicate trends. The advice is based on the recent advice; catch or landings data are adjusted to change in the abundance index for the two most recent values relative to the three preceding values. Other reference years may be used, based on the knowledge of the biology of the stock (e.g. species with a relatively large longevity) or the quality of the data.

Category 4. Stocks for which reliable catch data are available. The approach is to use catch information to evaluate whether the stock is fished sustainably or whether a reduction in catch is required to achieve sustainability. Decreases or increases in catch are incremental and slow.

Categories 5 and 6. Landings only stocks or negligible landings stocks and stocks caught in minor amounts as bycatch. In situations where only landings data are available, and no relevant life-history or fishery information can be gleaned from similar stocks or species in the ecoregion or beyond, ICES will normally provide advice on the basis of recent catches/landings, applying the precautionary buffer. If catches have declined significantly over a period of time and this could represent a reduction in stock size ICES may advise zero catch or the implementation of a management strategy.

1.2.5.5 ICES approach to provide stock status

ICES uses specific terminology and symbols or pictograms to describe the status of stocks. The terminology aims to use a nomenclature which is less prone to misinterpretation, but at the same time allows for a match to the legal description, which still uses “safe biological limits” (“stock within safe biological limits” is defined in the CFP (EU, 2013) as a stock with a high probability that its estimated spawning biomass at the end of the previous year is higher than the limit biomass reference point (B_{lim}) and its estimated fishing mortality rate for the previous year is less than the limit fishing mortality rate reference point (F_{lim})).

The terminology now uses different wording depending on the approach (MSY approach, a precautionary approach, and existing and implemented management plans). The structure and the associated symbols and text are given below in Tables 1.2.1 and 1.2.2 for MSY and precautionary approaches:

Table 1.2.1 Symbols and text for MSY status.

MSY reference points	Explanation	Sign	Text
Fishing mortality (F_{MSY})	$F < F_{MSY}$ and	✓	Appropriate
	$F \ll F_{MSY}$ (~ 0)	✓	Below
	$F > F_{MSY}$	✗	Above
	No reference point defined	?	Undefined
	Stock status unknown (even if reference point is defined)	?	Unknown
Biomass (MSY $B_{trigger}$)	$SSB = MSY B_{trigger}$ or $SSB > MSY B_{trigger}$	✓	At trigger or above trigger
	$SSB \geq MSY B_{escapement}$	✓	At or above escapement
	$SSB < MSY B_{trigger}$	✗	Below trigger
	$SSB < MSY B_{escapement}$	✗	Below escapement
	No reference point	?	Undefined
	Stock status unknown	?	Unknown

Table 1.2.2 Symbols and text for precautionary status.

Precautionary reference points	Explanation	Sign	Text
Fishing mortality (F_{pa}, F_{lim})	$F \leq F_{pa}$	✓	Harvested sustainably
	$F_{lim} > F > F_{pa}$	○	Increased risk
	$F > F_{lim}$	✗	Harvested unsustainably
	No reference point	?	Undefined [or Below possible reference points]
	Stock status unknown	?	Unknown
Biomass (B_{pa}, B_{lim})	$SSB \geq B_{pa}$	✓	Full reproductive capacity
	$B_{lim} < B < B_{pa}$	○	Increased risk
	$SSB < B_{lim}$	✗	Reduced reproductive capacity
	No reference point	?	Undefined [or Above possible reference points]
	Stock status unknown	?	Unknown

In the case of management plans, the terminology changes depending on the characteristics of a specific reference point; namely, if the reference point is considered a target or a limit. If considered a target, this reference point would usually come with a target range, which means that a green symbol can be used when the stock is within the estimated or defined range, although for most of the stocks a range has not been defined. It is necessary to identify whether the reference points are defined as targets or as limits for each individual plan.

Table 1.2.3 Symbols and text for status of stocks fished under management plans.

Management plan ¹ reference points	Explanation	Sign	Text
Fishing mortality (F_{MP})	$F < F$ mgt target / limit	✓	Below
	F within defined range	✓	At or Within range
	$F > F$ mgt target / limit	✗	Above
Biomass (SSB_{MP})	$SSB > \text{target, limit or trigger biomass}$	✓	Above
	SSB within defined range	✓	At or Within range
	$SSB < \text{target, limit or trigger biomass}$	✗	Below

In situations where very limited information is available and the stock status table is filled with grey question mark symbols, ICES provides additional, qualitative information where available. For example, this information could be based on survey information and give an indication of stock status or trend.

¹Only included when plan is considered consistent with PA by ICES and agreed on by all relevant clients

Table 1.2.3 Symbols and text for stocks with limited information.

Qualitative evaluation	Explanation	Sign	Text
Fishing mortality or exploitation rate	If there is an idea of the exploitation of this stock in relation to any possible reference points:		
	If F is very high i.e. $F >$ possible reference points	✗	Above possible reference points [or other short description]
	If F is very low i.e. $F <$ possible reference points	✓	Below possible reference points [or other short description]
Biomass	If there is an idea of the state of this stock in relation to any possible reference points:		
	If SSB is very low, i.e. $SSB <$ possible reference points	✗	Below possible reference points [or other short description]
	If SSB is very high i.e. $SSB >$ possible reference points	✓	Above possible reference points [or other short description]
If only trends are known	If parameter increases	↗	Increasing
	If parameter decreases	↘	Decreasing
	If trend is stable	→	Stable

1.2.6 Fisheries management strategy evaluations

Multiannual management plans and strategies have been agreed for a number of fish stocks or fisheries within the ICES area, and new plans are being proposed. ICES has evaluated such management plans according to their compliance with a precautionary approach regarding risks to maintenance of reproductive capacity, and according to the likelihood that high yields will be produced in the long term. Stakeholders and authorities may have raised other issues that have also been addressed in a specific management plan evaluation, such as stability of yield and risks under specific recruitment regimes.

ICES has adopted a precautionary criterion for long-lived stocks and a second similar criterion for short-lived stocks.

- **Long-lived stocks**

- a) The management plan/strategy is precautionary if the *maximum* probability that SSB is below B_{lim} is $\leq 5\%$, where the maximum (of the annual probabilities) is taken over all years in the plan/strategy (i.e. short and long terms).

- **Short-lived stocks**

- a) If, under natural conditions of no fishing, the long-term annual probability of SSB being below $B_{lim} \leq 5\%$, then the same criteria as for long-lived stocks is used.
- b) If, under natural conditions of no fishing, the long-term annual probability of SSB being below $B_{lim} > 5\%$, then the management plan/strategy is precautionary if the maximum probability that SSB is below B_{lim} is $\leq 5\%$ (after the fishery) in any year when a fishery takes place. In all other years the fishery should be closed. Accepted plans with the above or more stringent criteria should not imply an increase of the long-term annual probability of SSB being below B_{lim} by more than a factor of 2 compared to natural conditions of no fishing.

The management plans/strategies in place by 2012 were generally agreed prior to the introduction of MSY in the ICES advice, and on the basis of management plan compliance with a precautionary approach. Some plans have since been evaluated with regard to generating high long-term yields, and these plans are considered also to be in accordance with an MSY approach.

It is anticipated that in the future competent authorities will aim at management plans/strategies that are consistent with MSY. Evaluations will be conducted to determine how plans perform in terms of long-term average catch, average stock size, average fishing mortality rate, and the statistical distributions of these variables. Unless managers agree on specific performance criteria, the management plan/strategy evaluation can only be comparative; that is, ICES will not recommend one plan/strategy over another and would have no basis for rejecting a management plan/strategy if it is consistent with an MSY approach and it does not violate the precautionary approach.

Sources

- Anon. 1990. Icelandic Fisheries Management Act (No. 38, 15 May 1990).
- Anon. 1994. Faroe Islands Fisheries Management Act (Løgtingslógnr. 28 um vinnuliganfiskiskapfrá 10. mars 1994).
- Anon. 2004. Russian Federal Law on Fisheries and conservation of biological resources in the waters. N 166-P3 20/12/2004.
- Beddington, J. R., and May, R. M. 1977. Harvesting Natural Populations in a Randomly Fluctuating Environment. *Science*, 197 (4302): 463–465 (DOI: 10.1126/science.197.4302.463).
- De Oliveira, J.A.A., Darby, C.D., Earl, T.J. and O'Brien, C. M. 2010. Technical Background Evaluation of Annex IV Rules. ICES CM 2010/ACOM:58: 28 pp.
- EC. 2002. Council Regulation (EC) No. 2371/2002 of 20 December 2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy.
- EC. 2006. Implementing sustainability in EU fisheries through maximum sustainable yield. Communication from the Commission to the Council and the European Parliament. COM (2006) 360 (final).
- EC. 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).
- EU. 2013. Regulation (EU) no 1380/2013 of the European Parliament and of the Council of 11 December 2013 on the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002 and (EC) No 639/2004 and Council Decision 2004/585/EC.
- FAO. 1995. Code of Conduct for Responsible Fisheries. FAO Fisheries Technical Paper 350. <http://www.fao.org/WAICENT/FAOINFO/FISHERY/agreem/codecond/codecon.asp>.
- FAO. 2001. Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem. Iceland, 1–4 October 2001. <http://www.refisheries2001.org/>.
- ICES. 2004. Report of the Thirteenth ICES Dialogue Meeting: Advancing scientific advice for an ecosystem approach to management: collaborating amongst managers, scientists, and other stakeholders. Dublin, Ireland, 26–27 April 2004. ICES Cooperative Research Report, 267.
- ICES. 2008. Report of the ICES Advisory Committee 2008. ICES Advice, 2008.
- ICES. 2009a. Report of the *Ad hoc* Group on Mixed Fisheries in the North Sea (AGMIXNS), 3–4 November 2009. ICES CM 2009/ACOM:52.
- ICES. 2009b. Introduction, Overviews and Special Requests. Report of the ICES Advisory Committee 2009. ICES Advice, 2009. Book 1.
- ICES. 2010. Report of the Working Group on Mixed Fisheries Advice for the North Sea (WGMIXFISH), 31 August–3 September 2010. ICES CM 2010/ACOM:35.
- ICES. 2012a. Report of the Workshop on the Development of Assessments based on LIFE history traits and Exploitation Characteristics (WKLIFE), 13–17 February 2012, Lisbon, Portugal. ICES CM 2012/ACOM:36. 121 pp.
- ICES. 2012b. ICES implementation of advice for data limited stocks in 2012. Report in support of ICES advice. ICES CM2012/ACOM:68.
- ICES. 2012c. Report of The Workshop to Finalize the ICES Data-limited Stock (DLS) Methodologies Documentation in an Operational Form for the 2013 Advice Season and to make Recommendations on Target Categories for Data limited Stocks (WKLIFE2). ICES CM 2012/ACOM:79.
- Lovdata. 2008. Lov om forvaltning av viltlevande marine ressursar LOV-2008-06-06-37. <http://www.lovdata.no/all/hl-20080606-037.html> <http://www.lovdata.no/all/hl-20080606-037.html>.
- Russel, F. S. 1931. Some theoretical considerations on the “overfishing” problem. *J Cons. Cons. Int. Explor. Mer.* 6(1) 3–27.
- Sissenwine, M. P. 1978. Is MSY and adequate foundation for optimum yield? *Fisheries*, 3: 22–42. (doi: 10.1577/1548-8446(1978)003<0022:IMAAFF>2.0.CO;2).
- UN. 1982. United Nations Convention on the Law of the Sea (UNCLOS). http://www.un.org/Depts/los/convention_agreements/convention_overview_convention.htm.
- UN. 1992a United Nations Conference on Environment and Development (UNCED), Rio de Janeiro, Brazil. http://www.un.org/esa/dsd/agenda21/res_agenda21_00.shtml.
- UN. 1992b. Convention on Biological Diversity. <http://www.cbd.int/convention/text/>.

- UN. 1995. United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks. http://www.un.org/Depts/los/convention_agreements/convention_overview_fish_stocks.htm.
- UN. 2002. World Summit on Sustainable Development (WSSD), Johannesburg, South Africa. http://www.un.org/jsummit/html/documents/summit_docs.html.
- WCED. 1987. Our Common Future. Report of the UN World Commission on Environment and Development 1987 <http://www.un-documents.net/wced-ocf.htm>.