

Overview of data-limited stock assessment

Summary

Fish stock assessment informs fisheries managers how to avoid stock depletion and optimise yields. Many stocks do not have sufficient data available for conventional models and, instead, whatever data are available must be utilised when assessing their status. The [International Council for Exploration of the Sea \(ICES\)](#) is responsible for stock assessments in the Northeast Atlantic and Baltic Sea. This document describes ICES's methods for assessing data-limited stocks and outlines worldwide trends in data-limited stock assessment, summarising the Guide to data-limited Stock Assessment.

The ICES Data-Limited assessment framework uses time series of information on stocks including abundance indices and/or catch data and is designed to provide precautionary advice. The precautionary element was initially implemented through the advice for a 20% decrease in advised catches (the precautionary (PA) buffer) where stocks are considered at risk. This is still the case where only catch or bycatch data are available for a stock. To avoid repeated advice for catch reduction, the precautionary buffer is applied at intervals of three to five years.

However, from 2021 a new set of precautionary advice rules which do not use the PA buffer are being implemented where feasible. These advice rules are used in assessments of stocks for which a stock size indicator (from research or in some cases commercial catch per effort data) is available. These advice rules also use so called 'proxy' reference points that are based on data that is relatively easy to collect: growth rates, catch, catch per unit effort, and the size distribution of the catch, to indicate stock health. They have been tested by simulation modelling to ensure they are precautionary in the long term. Currently, (2022) these advice rules are being rolled out to those stocks for which they are applicable.

This use of this framework has grown rapidly with the first assessments carried out in 2012. By 2014, 64% of the 256 ICES stocks assessed for which management advice is provided by ICES were assessed using data-limited methods, including stocks of commercially important species such as anglerfish, North Sea lemon sole, and skates and rays.

Worldwide there have been considerable efforts to develop methods for assessing stocks with minimal data, with some methods being demonstrated to show good correspondence with conventional analytical techniques. The development and implementation of data-limited stock assessment methods should result in better fisheries management in the long term.

Background

Stocks without full assessments account for 80% of world fish catches. Both stock abundance and yield could be potentially be increased if these stocks were fully assessed and managed. Full analytical assessments require extensive data on stock age structure, which is time-consuming and expensive to collect. Existing or

relatively easy-to-collect data can be adequately informative for precautionary advice if the right methods are used to draw a picture from these less complex data.

In 2011, ICES recognised the need to standardise and refine data-limited methods, given many Northeast Atlantic stocks lacked science-based management advice. Since 2011, annual workshops have developed, tested, and continuously refined a number of assessment methods. The results have been used to provide guidance for stock assessments, and have been increasingly taken up in stock management, including for commercially important species.

ICES stock categories

All ICES stocks are divided into six categories:

1. Full analytical assessments and forecasts are possible.
2. Analytical assessments possible, but forecasts treated qualitatively (as trends).
3. Data on how fish abundance and/or biomass has changed over time (mostly from research vessel surveys) is used to provide advice
4. Advice is given on the bases of specialised modelling methods that use time series of catch data.
5. Only commercial landings data are available.
6. Only bycatch data are available.

This document concerns categories 3-6, the data-limited stocks. Assessment of stocks in Categories 5 and 6 use data on previous years' catches, risk assessment and a precautionary buffer implemented based on expert judgment (see below).

Making stock advice precautionary

Following the precautionary approach requires uncertainty to be taken into account. The ICES data-limited method includes an advised reduction in Total Allowable Catch (TAC) of 20% when there is significant uncertainty (the 'precautionary buffer'). This buffer is only applied if justified by (a lack of) evidence and is not applied when expert judgement determines that the stock is within safe biological limits or the stock size is increasing. To avoid repeated advice to reduce catches the precautionary buffer is not applied every year. If there is poor information and the stock may be at risk, a very low or zero catch level may be advised.

Since there is uncertainty that such data actually represents the stock's true state, it is important to avoid large changes in catch. If the precautionary buffer is not applied, an 'uncertainty cap' of no more than a 20% change from last year's advice is applied to limit changes in catch. Without the precautionary buffer, this limits catch

advice to $\pm 20\%$. If the precautionary buffer is applied, catch reductions greater than 20% can be advised.

Category three assessments

Category three assessments account for over half of ICES' data-limited assessments and are used when data on abundance or biomass are available. These are gathered from either research vessel surveys or sometimes commercial data that provide a time series of catch per unit effort (CPUE) termed the 'stock size indicator'. Advice is based on trends in these data and, when available, the stock's location in relation to proxy reference points (see below).

Recently, (from 2021) further developments have been made for category 3 stocks based on the use of so called 'proxy' reference points. This has enabled the removal of the need to advise the use of precautionary buffer, thus eliminating the reliance for expert judgment. A set of advice rules has been designed and tested using long term simulations and found to be precautionary. The advice rule used is dependent on the data available and the growth rate of the fish in the stock.

Also, from 2021, for category 3 stocks, the 'stability clause' replaced the uncertainty cap, which allows a plus 20% or minus 30% change in catches to be advised, provided the stock size indicator is above a pre-set trigger level (see biomass reference points). If the stock size is below the trigger, a larger catch reduction can be advised.

Proxy reference points

Data-rich stocks (categories 1 & 2 above) are assessed against ICES reference points for maximum sustainable yield (MSY). For data-limited stocks, there is insufficient information available to use standardised indicators of stock health, so best estimates or 'proxy' reference points are used instead. These are derived for category 3 stocks from abundance, catch, effort, growth and length distribution data from research vessel and/or commercial catches.

Both production models and length-based indicators used (see below) rely heavily on assumptions. Consequently, results from these indicators are only included when there's sufficient confidence in them.

Production models

Production models assume that if a population is reduced by fishing, the fish will grow faster and/or breed more successfully, creating 'surplus production'. By modelling surplus production at different levels of biomass, the biomass which produces MSY can be estimated (see the Guide to Maximum Sustainable Yield (MSY) page 7 for more information). ICES uses a specialised production model to provide data-limited advice (see Guide to data-limited Stock Assessment (page 11)). The model can use multiple time series of catch and effort data to estimate changes in population and fishery dynamics and takes variations between datasets into account.

In the ICES data-limited advice the catch advice from outputs from production models is reduced to the 35th percentile (approximately 70%) of that associated with MSY to ensure that it is precautionary.

Length-based indicators

Length-based indicators use the size distributions of fish in catch samples, together with other information on life history (growth rate, length at maturity, length at first capture etc.) to determine the health of data-limited stocks. Length based indicators have been developed for conservation of larger individuals (that is the breeding potential of the stock) and the conservation of immature fish. However, the main length-based proxy reference point used in the guidelines is for F_{MSY} , the rate of fishing mortality corresponding with maximum sustainable yield.

Biomass reference points

In ICES fisheries assessments, biomass reference points are used to designate levels of spawning stock above which stocks should be maintained to ensure sufficient stock for reproduction. Therefore, to define biomass reference levels there is a need to obtain information on the relationship between spawning stock biomass levels and recruitment.

For data-limited stock assessment this information is not usually available. Under the new data-limited advice rules biomass reference levels for category 3 stocks have been introduced as levels of the stock size indicator (CPUE from research or commercial vessels; see above). These consist of a trigger level, below which the advised catch is reduced in order to prevent the stock falling below the limit reference level, that is outside safe biological limits. These reference levels are usually related to the lowest observed level of the stock size indicator.

However, this approach is caveated because in cases where the stock has been lightly exploited or the index period does not cover a time of low biomass, it may result in the advice being too precautionary.

ICES advice

[ICES publishes its advice online](#) in a PDF document for every stock that it covers. The advice documents include historical information, current stock status, catch options and fishing opportunities as well as details relevant to management, including the quality of the stock assessment, the basis for the advice and relevant issues see Guide to Data-limited stock assessment (page 13).

Data-limited assessments outside ICES

Worldwide, there have been parallel developments in data-limited stock assessment. For instance, the US has developed a [toolkit](#) designed to enable wider uptake and use of data-limited methods.

Assessments without seasonal growth rings

Obtaining information on growth and age structures of stocks is a basis for many stock assessment methods. Due to crustaceans shedding their shells each moult as they grow, traditional ageing techniques, which require annual rings laid down on hard structures don't work for these species. Similar problems occur in fish species

where there are no clear seasonal growth rings on hard structures such as the fish's otoliths.

Instead, techniques such as mark and recapture help gather these data where captured individuals are measured, tagged and released into the wild, and re-measured upon recapture after a known time interval.

Bivalve molluscs

Since many mollusc stocks are stationary, surveys of the entire stock are possible. Sampling using quadrats (square frames placed on the seabed) or grabs ('grabbing' a sample of shellfish within a set area) allow fixed areas to be regularly sampled. This data can be used to estimate stock density (stratified by year class if shell growth rings provide a good estimate of age), and can be extrapolated to estimate the total tonnage of the stock. This enables assessments of how much can be harvested. Other factors, such as seabirds' dependence on shellfish for food, can be included to ensure sustainability across the ecosystem.

Cephalopod molluscs

Cuttlefish, squid and octopus populations are characterised by rapid growth, short life-spans and adults that die after spawning. One assessment method used monitors stock abundance using catch per unit effort. A target is set for the amount of stock that escapes capture to enable the stock to reproduce and be replenished. As escapement approaches the target, actions such as fishery closures are advised to ensure sufficient adults survive to spawn.

Further information

Seafish Guides;

Guide to Fisheries Management SR741 ISBN 978-1-911073-47-5

Guide to Fish Stock assessment and ICES reference points SR742 ISBN 978-1-911073-48-2

Guide to Fishing at Maximum Sustainable Yield SR743 ISBN 978-1-911073-49-9

Guide to Data-Limited Stock Assessment SR744 ISBN 978-1-911073-50-5