

The CUSUM out-of-control table to monitor changes in fish stock status using many indicators

One method to assess fish stocks using a suite of indicators is the traffic light approach. In this approach, the time series of the different indicators are mapped on a common colour scale to highlight alerts that occur when indicators cross reference limit values. Until now, however, the procedure has lacked a statistical framework. Here, we propose the cumulative sum (CUSUM) monitoring scheme as a suitable statistical framework. CUSUM is a statistical process control method that detects deviations from a reference mean, according to defined performance criteria. With the CUSUM monitoring scheme, alarm signals can be triggered when indicators cross defined in-control limits that correspond to defined probabilities of false alarm and non-alarm (i.e., precision and power of the CUSUM monitoring scheme). A table of CUSUM out-of-control deviations is constructed to serve as a diagnostics table. In this table, the deviations in the different indicators are quantitative and given in similar units of variance, which facilitates their integrated assessment. The CUSUM out-of-control table also shows how deviations accumulate over time and thus provides a view of the stock history. The procedure was applied to the North Sea cod stock to illustrate how a fishery-independent integrated assessment can be achieved using a suite of indicators derived from research survey data. The indicators used were related to the spatial distribution, abundance, length structure, length at maturity and apparent mortality. The stock was found to be outside its reference limits from 2001 and has shown a continued degradation in status since this time.

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