

Theme Session O

Flying outside the ICES Assessment WG paradigm – Alternative approaches to providing fisheries management advice

ICES CM 2007/O:01

Bass – what does the assessment tell us, what it doesn't tell us, and what we can learn about management

Sven Kupschus

UK Fisheries for bass do not fit neatly into the 'standard' ICES framework for assessments and advice for a number of reasons. The fisheries are mostly inshore, operated from commercial / semi-commercial small boats that are not obliged to provide trip or even area based landings information. The degree to which bass are targeted depends strongly on the relative availability of bass and other target species. A substantial recreational fishery contributes significantly to mortality, yet little or nothing is known about its absolute magnitude or its effects on stocks. Survey information for bass is limited to estuarine recruitment surveys, which are spatially restricted, and there are no fisheries independent measures of adult abundance. In other words, an age-based VPA type approach is unlikely to be helpful in managing this fishery. Or is it?

The stock synthesis assessment approach has been able to shed considerable light on some of the most important issues for managers of bass stocks. First and foremost, the stocks are expanding under increasing exploitation levels, suggesting that they are exploited sustainably. Estimated selection patterns for the fleets are robust to uncertainty in F , so that these can be used to explore different exploitation scenarios. Fishing mortality is formally linked to effort. Recruitment estimates from the surveys were independently shown to be efficient predictors of future recruitment despite their caveats. Therefore the measures for effectively managing and monitoring a fishery are available. What the assessments can't do is provide short-term forecasts for setting TACs, determine PA reference points for assessing stock status or divide the catch fairly between different sectors. These are the things that managers have become to see as the wholly grail of management under the CFP.

It is unclear to what degree the bass management success is due to luck, design, biology or plain necessity, but it is clear that bass management would have been much poorer in the absence of detailed biological knowledge and the standard ICES approach of annual TAC setting would not have been practical given the availability of data. This implies that a more individual approach to stock management with considerations of data availability, species biology, fishers' behaviour and clear management objectives are more important to fisheries management than precise numbers-at-age tables. This presentation discusses the link that the assessment makes between the available bass data and management needs and emphasises the importance of getting this right.

Keywords: bass, stock assessment, fisheries management.

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ICES CM 2007 /O:02

Science, power and marine spatial planning in the North Sea

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The scientific underpinnings of the European Common Fisheries Policy (CFP) are undergoing extensive revision driven by the persistent failure of fisheries management and demands of stakeholders. The present paper describes a small part of this process and some of the political forces influencing it. Scientific advice for the CFP has focussed on the question of how many fish are in the sea and how these fish should be allocated. Current dilemmas, however, revolve around stakeholder participation and the adoption of the ecosystem approach to fisheries management. One important part of this approach is marine spatial planning. This paper traces the ways that scientific advice for fisheries in the North Sea is being communicated and used as the relationship between stakeholders and scientists evolves through such fora as the North Sea Commission Fisheries Partnership and the North Sea Regional Advisory Council. One important emerging question is marine spatial planning, an area requiring considerable scientific support for decision making that is quite different from the kinds of information used in counting and distributing fish. It is also an area involving large numbers of powerful stakeholders who have not traditionally participated in fisheries debates. The paper focuses on how the informational needs of spatial planning are and are not being met within these shifting political grounds.

Keywords: sociology of science; marine spatial planning; North Sea.

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ICES CM 2007/O:03

A biomass random effects model (BREM) for stock assessment using only survey data: application to Bay of Biscay anchovy

Verena M. Trenkel

Unavailability or unreliability of catch information have encouraged the development of stock assessment methods that do not require catch data. A simple two-stage biomass model is presented for carrying out stock assessment based on survey data only. Recruitment and biomass growth are modelled as random effects, reducing the number of model parameters. Relative biomass reference points are defined based on relative total biomass and recruit estimates. The method is tested for simulated data and demonstrated for the case of anchovy in the Bay of Biscay, for which two survey series, derived from acoustic measures and the daily egg production method were used. For this case it appears that survey based stock assessment is feasible and leads to similar management recommendations as the traditional stock assessment method.

Keywords: survey-based stock assessment, biomass, random effects model.

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ICES CM 2007/O:04

A review of Fishery-Independent assessment models, and initial evaluation based on simulated data

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Large uncertainties in the catch data (official landings and discards) are undermining ICES' ability to provide valid management advice based on the conventional approach of analytical assessments. There is thus an urgent need to consider alternative tools that do not depend on long series of precise catches, with their age composition. We present a few fishery-independent assessment models developed by the EU project FISBOAT (Fishery Independent Survey Based Operational Assessment Tools). We also report on rudimentary tests based on simulated data, following the same protocol as an evaluation study conducted by the US National Research Council in 1997. It appears that the survey-based assessment models at hand are able to reliably capture the major signal in biomass and recruitment, although they smooth out transient changes. However, they cannot provide absolute abundance estimates, but only relative values on an arbitrary scale. Their operationalisation in ICES would thus require an adaptation of the advisory framework, in terms of nature of the advice and definition of reference points; indeed, this might be needed anyway, if we were more lucid about the myth of VPA estimates being absolute. It is also noted that survey-based approaches have the potential to provide much more rapid updates of the state of stocks than catch-based methods.

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Combining fishers perceptions and scientific descriptions of recent trends in the Eastern Channel ecosystem and fisheries

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A survey was conducted in June 2006 to investigate French Eastern English Channel fishers' observation of the past and current state of the marine ecosystem and their wishes for the future. Twenty-nine semi-directive interviews were carried out among fishers of different métiers and shellfish farmers. A majority of interviewees mentioned a decrease of the resource in recent years and pointed out the presence of several problems, such as pollution, degradation of the sea floor and harmful impacts of human activities, including fishing. These statements were compared with the available scientific information: landings, effort and trawl survey data. The two sources of information agreed generally, except for the time frames of identified changes, with fishers' perceptions being more short term even though most of them had been in the business for several decades.

Keywords: English Channel; ecosystem approach to fisheries; fisher knowledge; stakeholder interview.

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ICES CM 2007/O:06

The importance of fishers' knowledge as a management tool: a case study of the 2006 decline of the Moray Firth *Loligo* fishery in North East Scotland and the implications for future management strategies

J.M. Smith, G.J. Pierce, and I. Theodossiou

The present paper reviews the recent history of the directed squid fishery in the Moray Firth, Scotland (UK), including the sharp decline in landings during the 2006 fishing season. This is a small, inshore fishery, in which many vessels are owned and operated by a single fisher, with three months of seasonal *Loligo* catch profits comprising more than 50% of their annual gross income. Face-to-face interviews with vessel owners who participate in the fishery were conducted in the ports of Burghead, Buckie, Lossiemouth, Macduff and Fraserburgh during early to mid 2007 to obtain a greater understanding of the importance of the *Loligo* fishery, with the aim to obtain a picture of (a) spawning and fishing ground locations, (b) environmental conditions perceived to be related to favourable catch per fishing effort, (c) importance of the cephalopod fishery to the fishers as an employment opportunity and source of income and (d) fishers' opinions of possible factors leading to the decline of landings during 2006. It is hoped that suggestions for management produced by these stakeholders, when considered together with biological data such as life history models stemming from growth and maturation relationships, could provide the basis for a successful cephalopod stock management regime in this niche-market fishery, which is vulnerable to both socio-economic and biological collapse.

Keywords: *Loligo*, squid fishery, Moray Firth, management strategies

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ICES CM 2007/O:07

Selecting and combining survey based indices of fish stocks using their correlation in time to make diagnostics of their status.

Mathieu Woillez, Jacques Rivoirard, and Pierre Petitgas.

Research fisheries monitoring surveys provide an ensemble of measurements on fish stocks and their environment. Presently fish stock diagnostics are based on the evaluation of abundance and the survey data contribution is through abundance indices only. Here we shall consider a large set of survey-based indices that represent a target stock over its time series through its spatial pattern (longitude of the center of gravity, latitude of the center of gravity, inertia, anisotropy, positive area, equivalent area, spreading area, and microstructure index), its vital traits (L_{bar} , L_{25} , L_{75} , L_{50} at maturity, and Z), and in addition to its abundance (abundance of the recruits, abundance at age, and total abundance). The present work aims at establishing a procedure that could analyse these indices in order to diagnose and forecast the state of a stock.

Because the interannual variability in survey based indices is high and because diagnostics on fish stock cannot be based on noise, the first concern is to select and combine those indices that support a reliable diagnostics, thanks to their continuity in time. First, the set of indices is reduced by selecting the ones that present the highest autocorrelation in time. Then Min/max Autocorrelation Factors (MAF) are used to combine the indices into factors that present the maximal continuity in time, and that will be used here to monitor the population status. A statistical quality control procedure is finally applied on the time series of the set of combined and selected indices, which carry the information on population status. This step results in making a diagnostic by in triggering or not alerts on stock status with assigned risks of false alert. In addition population status forecast to the next year is attempted based on the forecast potential of the MAF method, making use of the variogram of the factors.

The procedures will be applied on North Sea cod and anchovy in the Bay of Biscay, two stocks that have experienced collapse and for which survey series exist for more than 10 years. Results will be presented and discussed in the light of the present ICES assessments, which will demonstrate the potential of the proposed fishery independent indicator based diagnostic procedure.

Keywords: fish stock diagnosis, time correlation, min/max autocorrelation factors, survey based indices, North Sea cod, Biscay anchovy.

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ICES CM 2007/O:08

SpatMan: A spatial management modelling tool for shellfish stocks

Ewen Bell, Mike Bell, Mike Smith, and Julian Addison

There is increasing pressure for the introduction of spatial management regimes, in particular with relation to inshore shellfish stocks. It is unlikely that micro-management of stocks will be supported by full-blown, age-based assessments. Instead regimes are more likely to rely upon semi-permanent measures such as closed seasons and areas or reactive management based upon simple estimates of relative abundance. Investigations into the potential impact of local-scale spatial management should take account of the ability of fishing vessels to move between management areas. A spatial management model was therefore designed to track the decisions and subsequent success of individual fishing vessels in order to evaluate the relative performance of differing management plans. In the model, individual vessels move around a grid of locations populated by sessile organisms (scallops in this example). Each vessel has a daily operational range within which it must find the optimum location to fish, this optimum being based upon the track record of fishing within those grid cells currently open to fishing within the operational area. Grid cells are grouped to form management areas, each with a distinct management regime. Regimes currently implemented are TAC, effort limitation, LPUE limit, rotational closure, permanent closures (Marine Protected Areas), and closed seasons. Model output includes landings and effort by area as well as track record information by vessel. A simple implementation of the model with just four areas and four vessels can produce complex results, and several realisations of each implementation are required to determine the potential range of results.

Keywords: Spatial Management, Marine Protected Area, individual-based modelling, simulation model, scallop.

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ICES CM 2007/O:09

Rebuilding Celtic Sea herring and the development of a long term management plan

Maurice Clarke and Afra Egan

Herring in ICES Divisions VIIaS, VIIg and VIIj are assessed together and managed by means of a combined TAC for the so-called Celtic Sea stock. It is characterised by fluctuations in recruitment and very early age at first maturity. These factors, sharp variations in F and the absence of a recruitment index prevent meaningful short-term predictions from being made. The stock is only exploited by Ireland, and the fishery is managed in conjunction with a local stakeholders' advisory committee. SSB has declined since the late 1990s and is now considered by ICES to be below Bpa and possibly below Blim. In 2006, ICES advised that fishing should not proceed unless accompanied by a rebuilding plan. Work to date in developing such a plan, is presented. This work straddles the boundary between traditional advisory process and a necessarily more adaptive approach. Comparisons with similar fisheries systems are presented.

Keywords: herring, Celtic Sea, rebuilding plan, simulation.

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ICES CM 2007/O:10

Usefulness of the spatial indices to define the distribution pattern of key life stages: an application to the red mullet (*Mullus barbatus*) population in the south Tyrrhenian sea

Maria Teresa Spedicato, M. Woillez, J. Rivoirard, P. Petitgas, P. Carbonara, and G. Lembo

This study aims to explore the performance of the approach based on spatial indicators to characterise with quantitative metrics the spatial dynamics of red mullet life stages (recruits and adults), to identify areas where red mullet recruits are more concentrated, to establish relationships with the adult distribution and to detect the ability of spatial indicators to capture the stability of the spatial occupation of preferential areas across the years. Data are from the GRUND and MEDITS experimental trawl surveys. The methodological approach used in this study is based on the estimate of spatial indicators as developed within the EU Fisboat project. The results proved that many of the 9 examined spatial indicators and pairwise relationships, between indicators and abundance, enabled us to better understand the spatial distribution and interannual variability of the red mullet population life stages and the relationships between spatial distribution and abundance. In addition, we identified the geographical area (southwards, along the Calabria coast) where recruits of red mullet resulted mainly distributed and we also verified that these locations are stable across years.

Keywords: spatial indices, Tyrrhenian sea, red mullet.

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ICES CM 2007/O:11

Resource assessments for multi-species fisheries in NSW, Australia: qualitative status determination using life history characteristics, empirical indicators and expert review

James Scandol and K. Rowling

As the scope of fisheries management continues to broaden, there is continual pressure on scientific assessment processes to consider a greater number of species. This expanded list of species will inevitably include those with a range of life-history strategies, heterogeneous sources of information, and diverse stakeholder values. When faced with this challenge in New South Wales (Australia), the Department of Primary Industries developed systems and processes that scaled efficiency as the number of species requiring consideration increased.

The key aspects of our approach are:

- A qualitative determination of exploitation status based upon expert review. The current categories are: growth/recruitment overfished, fully fished, moderately fished, lightly fished, undefined and uncertain.
- Application of management rules that require a Species Recovery Program should any species be determined to be overfished or recruitment overfished.
- An emphasis on readily calculated empirical indicators (such as catch, catch-rates, length and age composition), rather than model-based estimates of biomass or fishing mortality.
- Use of databases and electronic reporting systems to calculate empirical indicators based upon specified rules.

Currently, there are over 80 species considered with around six scientific and technical staff. These species were identified by commercial fishers as the important species from five multi-species and multi-method input-controlled fisheries. Many of these species are currently determined to be “undefined”. Performance indicators have been specified that promote a re-allocation of resources to improve our understanding of the status of the full range of species.

Keywords: multi-species; empirical indicators; expert judgement; data-poor fisheries.

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ICES 2007/O:12

The assessment of the spawning-stock biomass of sprat in the Gotland Basin (Eastern Baltic Sea) with the Hensen – Apstein method with some innovations

Andrei Makarchouk

Spawning-stock biomass of sprat (*Sprattus sprattus balticus* Schneider) has been calculated for the year 2005 from 6 ichthyoplankton surveys performed in the Gotland Basin from April to August. The temperature of ambient water and thus the duration of the developmental stages were determined with the help of empirical model of vertical distribution of sprat eggs. Mortality rates were computed in a new way: these indices were calculated from the total amounts of sprat eggs on stages 1 and 2 in the investigated area. That amount was taken from the maps of distribution of eggs. This method allowed taking into account the drift of eggs during their incubation, and also avoiding the influence of the irregularities in the distribution of sampling positions. After the calculation of mortality rates we could draw the maps of horizontal distribution of daily production of sprat eggs on the 1st stage, and then calculated the seasonal production, which gave the number of spawning females in the investigated area. Fecundity of fishes was defined dependently on their mean weight in the spawning-stock for the year. Also the assessment of spawning-stock biomass of sprat has been made based on the results of one ichthyoplankton survey in the peak of spawning season, when nearly all adult fishes must have been spawning. The results obtained by those two methods were very similar. The obtained results have been compared with the assessment from hydro-acoustic surveys.

Keywords: sprat, eggs, Baltic, spawning-stock biomass.

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ICES CM 2007/O:13

Including socio-economic considerations within fisheries advice: interdisciplinary models for fisheries stock assessment

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By relying on biological stock assessments the scientific advice for EU fisheries management does not include social and economic issues to the same extent as biological ones. Fisheries management is however about managing people and not the stocks directly. Moreover, there seems to be convincing evidence that pure "command - control" management hardly leads to successful results. It is therefore of interest to link socio-economic elements to the assessment so that the biological information is more meaningful to actors. By linking variables of interest to stakeholders to assessment and management models, cause and effect chains are made clearer. We propose a theoretical-methodological frame using Bayesian network models to combine fisheries research and fisheries management, and to examine fisheries systems as an entity constituting of biological, economic, and social sides. Bayesian network models allow us to combine data collected by different disciplines, and to link this together with results of traditional stock assessment models and expert knowledge which is an unavoidable part of any applied management problem. Linking management options with the variables of interest to stakeholders and examining the alternative outcomes can also be a way to improve commitment of fishermen, the industry, NGO's, decision makers and other stakeholders towards the scientific advice.

Keywords: Bayesian belief network, interdisciplinary modeling, scientific advice, socio-economic aspects.

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ICES CM 2007/O:14

Bioeconomic analysis of Mauritanian cephalopods fishery

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Cephalopods represent a very significant fishing resource in Mauritania. In particular, *Octopus vulgaris* (Cuvier 1797) is the most valuable species and thus is strongly targeted and showing a significant reduction in abundance. The traditionally artisanal fishery has experienced changes over the last decade; the rapidly increased fishing effort in the industrial fleet is reflected in the diminishing trend of *O. vulgaris* landings indicating overexploitation of the stock. Minimum landing size and closed season are the two management measures currently applied to this species where value increases according to individual's weight. In this study, a single species probabilistic bioeconomic analysis is conducted for Mauritanian *O. vulgaris* using biological parameters adopted from previous studies. Applying monthly cohort analysis enabled us to examine the effects of interannual variability in growth and recruitment. Parameters from the stock assessment, together with price information, are employed in a hierarchical Bayes model using MCMC sampling. Size at first capture and timing the closed season are assessed with respect to surplus growth of the stock and profit maximization using yield-per-recruit analysis. Effects of different management actions on the overall value of yearly yields are discussed. The findings of this study will contribute to the sustainable use of cephalopod fishery resources in Mauritania by providing indicators for the economically optimal harvest of the species. The information may assist policy makers and interested parties in making informed decisions about the management of the fishery and may also be applicable to other cephalopods fisheries.

Keywords: *Octopus vulgaris*, cephalopods, fisheries management, bioeconomic, Bayes model.

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ICES CM 2007/O:15

Evaluation of standard ICES stock assessment and Bayesian stock assessment in the light of uncertainty: North Sea herring as an example

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Uncertainty has been recognized to play a major role in fisheries management. This has been also acknowledged by ICES by including the development of precautionary approach (PA) to fisheries management in the Action Plan of the Council. In order to rigorously implement PA, the uncertainty regarding the current and future status of the stock under different management actions needs to be quantified. The probability of stock collapse must be estimated, and kept low, which means that the correct way to estimate the tails of the probability distributions is important for managers. This poses a challenge to the stock assessment working groups consisting of domain experts. In this work we evaluate the most

commonly used stock assessment methods within assessment working groups in the light of the science that underpins the way how uncertainty is handled. These are compared to the principles of Bayesian approach to scientific reasoning both in theory and practice: assessment of the North Sea herring is used as an example for which both approaches were taken. We investigate whether the quantitative measures of uncertainty produced by standard ICES methods conceptually match with the quantities of interest such as the status of the stock or not. The findings are compared to the Bayesian approach, which is designed to provide a conceptually sound framework for quantifying uncertainty about unknown state of the nature such as the current and future status of the stock and provides seamless integration of empirical evidence, such as commercial catches and independent surveys, and other types of knowledge, like basic biological knowledge about the species. Our practical example reveals also potential problems in the feasibility of the Bayesian approach.

Keywords: Population dynamics, statistical inference, MCMC, probability.

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ICES 2007/O:16

Comprehensive indicator-based diagnostics of fish stocks using fishery-independent survey data: the FISBOAT report

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Research fisheries surveys are now implemented as monitoring programs of fish stocks and provide a large set of measurements on the evolution of their state. Here we show how fishery-independent diagnostics of fish stocks can be achieved using a comprehensive set of indices and analysis procedures inspired from environmental monitoring.

We present fish stock indices, analysis procedures and diagnostics results for nine stocks in European waters. The set of indices considered comprises two population abundance indices, four indices for population vital traits and nine indices for spatial organisation by age. The indices are combined and selected using multivariate techniques that maximise correlation between variables and also continuity in time. Trend detection and quality control techniques are then applied on the time series of the combined and selected indices. Based on these analyses diagnostic tables are filled, leading to comprehensive indicator-based diagnostics of fish stocks.

Similar analysis procedures are applied to all case studies and results are reported using standardised templates. The application to a wide range of fish stocks in different health conditions with different behaviours and past histories demonstrates the potential of the tools and indices for delivering diagnostics in operational mode. The paper is intended to be a manual summarising the results of the EU-project Fisboat (Fishery-independent survey-based operational assessment tools) for general use outside the project.

Keywords: fishery-independent assessment, indicators, quality control, spatial statistics, vital traits, anchovy, hake, cod, herring, red mullet.

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ICES CM 2007/O:17

Success in fishery management using harvest control rules derived from reconciling stakeholder objectives

Dorothy Jane Dankel, Ulf Dieckmann, and Mikko Heino

The inherent conflicts between objectives in fisheries management (e.g. MSY vs. conservation interests) are a hurdle for managers and scientists. However, some objectives may be compatible (e.g. economic yield and ecosystem preservation) and could promote stakeholder consensus. Harvest control rules (HCRs) are dependent on clearly defined objectives, which may or may not be in conflict with each other. The purpose of this study is to develop a formal and quantitative approach to defining and implementing fisheries management objectives, by examining their translation into HCRs tested on simulated fish populations. First, multiple objectives are reflected in a clearly defined utility function. Second, this utility function is maximized for optimal management under a variety of conditions and based on a numerical model of an age-structured stochastic population. Third, optimization results are translated into an implementable HCR, the performance of which can subsequently be evaluated with respect to the originally formulated objectives and through the assessment of risks. The results illustrate a formal route towards deriving appropriate management regimes with focus on compatible management goals to promote stakeholder consensus, incentives, and success in fishery management.

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ICES CM 2007/O:18

Fisheries-independent estimates of trends in North Sea plaice (*Pleuronectes platessa*) abundance: a Bayesian analysis of research vessel survey data

Hans Bogaards, Lisa Borges, Marcel Machiels, Sarah Kraak, and Adriaan Rijnsdorp

We present fisheries-independent estimates of trends in North Sea plaice abundance and compare those with trends from conventional ICES assessments. Our estimates are obtained by Bayesian analysis of age disaggregated indices of abundance from three research vessel surveys: two beam trawl surveys, providing information on the southern and the central North Sea from 1985 and 1996 onwards, respectively, and the sole net survey, providing information on the coastal zones since 1970. Although each survey relates to a different subpopulation, together they cover the distribution area of the North Sea plaice stock. We use a separable model with regard to fishing mortality and model the temporal component of fishing mortality as a stochastic process. Moreover, we allow for the possibility of a changing exploitation pattern over time and consider the integration of the different survey data in a metapopulation model. Our results are partly in agreement with the most recent ICES assessment, where spawning stock biomass is estimated to have declined during the 1990s. However, the conventional assessment shows a temporary increase in the early 2000s whereas our results suggest the temporary recovery took place in the late 1990s. We support the finding that older fish seem to be less affected by fishing effort in recent years than they were before. The dependence on a relatively small sample size is generally viewed as the biggest disadvantage in performing survey-based assessments. Our analysis demonstrates the usefulness of Bayesian analysis as a flexible tool for extracting integrated signals from disaggregated survey data.

Keywords: Bayesian statistics, plaice, metapopulation dynamics, North Sea.

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ICES CM 2007/O:19 Poster

Bayesian mark-recapture model for migrating fish populations: Ascent of Atlantic salmon (*Salmo salar* L.) in River Kymijoki and the effects of river discharge and recreational fishing

V-P. Antti-Poika, S. Mäntyniemi, and S. Kuikka

The purpose of the study was to estimate the amount of salmon ascending to River Kymijoki, and how river discharge managed by stream regulation, and recreational fishing in river area and its estuary affected it. We developed a Bayesian mark-recapture-model, which described the probabilities of movement and capture of ascending salmon in the river area. The data consisted of monthly discharge averages, catch statistics from the river and its estuary, recaptures of arrow- and Carlin-marked individuals, and radio-telemetry data. Expert knowledge was utilized in deriving prior distributions. This study offers new insights into the debate on the potential improvements in natural breeding of River Kymijoki salmon population. The results show, that river discharge has major effect on the spawning migration of salmon in the river Kymijoki by first controlling the divide of ascending fishes to the two tributaries and then by effecting the probability of a fish passing through the regulatory dam in the other-one of them. Also, the probability of a salmon to be captured in the gill-net fishery located in the mouth of one of the tributaries proved to be very high, diminishing significantly the number of fish reaching the spawning grounds. The sequential model structure developed here could also be adapted to other mark-recapture studies that consider the migration of fish.

Keywords: anadromic fish, fisheries management, dam, river flow regulation.

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ICES CM 2007/O:20

A new scientific initiative with the Pelagic RAC to develop a management plan for western horse mackerel

Maurice Clarke, Andres Uriarte, Aukje Coers, Andrew Campbell, Mark Dickey-Collas, Afra Egan, Marc Ghiglia, Ingvild Harkes, Ciarán Kelly, Johan Müller, Sean O' Donoghue, Christian Olesen, Beatriz Roel, Andrew Tait, and Gerard van Balsfoort (Authors after corresponding author, M. Clarke, appear in alphabetical order)

The western horse mackerel stock is currently managed by separate TACs covering only part of its distribution area. No benchmark assessment has been possible and recent ICES advice has consistently been for status quo catches. In 2006, the Pelagic Regional Advisory Committee asked scientists to help with developing a harvest control rule for the stock. An initial questionnaire was circulated to the industry, to elicit feedback on possible management options. A series of Harvest Control Rules were developed. These were tested by simulation and presented to the RAC at a number of meetings. Results will be presented within the ICES advisory process and elsewhere in the scientific literature. This is a novel approach involving scientists and stakeholders in an iterative process. The problems encountered and lessons learned, are discussed.

Keywords: Pelagic Regional Advisory Committee, western horse mackerel, harvest control rule.

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ICES CM 2007/O:21

Towards Bio-Economic Assessment of the Baltic Salmon Stocks

Soile Kulmala, Polina Levontin, and Catherine Michielsens

The management of the Baltic salmon fisheries has emphasized biological objectives, and past management measures have drawn criticism from the fishing industry. Despite the management based on stock conservation goals the reported salmon catch has been below both the scientific recommendation and the actual total allowable catches (TACs). Consequently, the system is not responding to the current management measures but other forces like economic circumstances drive the behaviour of salmon fleet. In order to have effective management system, the scientific recommendation of future catch options should consider the changes in the fish markets like competition with aquaculture or the effect of increasing energy price on the fishing effort. The paper puts forward a model currently used in the Baltic salmon stocks assessment. Designed to give economically and biologically sound management recommendations, the model accounts four countries whose fleets target salmon with different types of gear in a different time of year. The model can be used to run different scenarios for catch or effort options and the model outcome results both the status of the stocks and the economic performance of the fishing fleet. The model is easy to apply for every commercial fishery and therefore provides a general tool for bio-economic stock assessment.

Keywords: fisheries economics, stock assessment, Baltic salmon.

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ICES CM 2007/O:22

Management with sparse data

Dankert W. Skagen and Dorothy J. Dankel

We consider a management that aims at controlling the removal from the stock, guided by a perception of the state of the stock derived from limited data that does not allow an ordinary analytic assessment.

In simulation modeling, there is a 'real' stock and 'real' removals, and the stock develops according to these removals. The management part creates a feed back loop through a noisy link between the state of the true stock and the actual removals. The performance of the management will depend on how the real removal responds to the stock, and how the stock responds to the removals. Structurally, this is a quite simple feed-back system. The interior of the building blocks is complex and diverse, however, and include obstacles like time lags and stochastic terms. When an analytical assessment is not available, the link between the real stock and the management decisions is harder to understand and model, and it may be noisier.

The main emphasis in this paper is finding decision rules that rely on sparse and noisy data. A simulation tool runs as a bootstrap and was made to cover a variety of stocks, decision rules and noise in a versatile way, but on a quite generic level. The link between state of the stock and the basis of the decision was modeled as SSB (or alternatively total stock biomass TSB) derived from the real stock numbers at age, but with random noise and a random year factor. Several types of harvest rules were explored, and pros and cons of various types are highlighted.

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ICES CM 2007/O:23

The use of underwater TV surveys in the provision of advice for *Nephrops* stocks around Scotland

Helen Dobby, N. Bailey, and N. Campbell

The assessment of *Nephrops* stocks has long proved problematic due to the lack of age-composition data and difficulties obtaining reliable information on growth. Additionally, the poor quality of the landings data for many of the stocks around Scotland, has led the assessment working groups to conclude that catch-based assessments are, for the time being, likely to be unreliable. As a consequence, alternative approaches for providing catch options for these stocks have had to be developed. TV survey estimates of stock abundance in numbers are used to estimate a potential landings level based on a 'harvest ratio' defined as the ratio of total catch in numbers to stock abundance in numbers. This paper suggests methods for deriving sustainable harvest ratios for the *Nephrops* stocks around Scotland based on yield-per-recruit curves. Further consideration is then given to the application of the fixed harvest ratio approach in non-equilibrium conditions.

Keywords: underwater television survey, harvest ratio, yield-per-recruit, sustainable.

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ICES CM2007/O:24

A regional computable general equilibrium model for fisheries: results of the EU PECHDEV project

Pierre Failler, Haoran Pan, and Christos Floros

Under the PECHDEV we developed a regional computable general equilibrium model (CGEM) with particular description of fisheries sector. Based on rigorous microeconomic theory, computable general equilibrium modelling nowadays is becoming standard but not yet in fisheries. The CGEM model is linked with a biological model in order to provide interactions between fleet and fish stocks. It also gives indications on how much the health of coastal marine ecosystems affects regional economy of regions that are highly dependant on fishery. The presentation will focus on the building of CGEM and main results obtained, from both scientific (with further development needed) and policy (structural funds, cohesion) points.

Keywords: CGEM, fishery; region; development.

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ICES CM2007/O:25

Probabilistic assessment, management and advice model for fishery management in the case of poor data availability: the EU POORFISH project

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The objective of the POORFISH project is to create an advisory system (assessment, advice, and/or management) approach based on methods able to deal with data poor systems (utilizing both expert knowledge and published information in addition to existing data sets). There are basically at least three types of data poor situations:

- Small scale fisheries with usually several target species of otherwise mixed fisheries (many coastal fisheries in Mediterranean and northern Baltic areas)
- Large scale, but recently developed fisheries (many deep sea fisheries belong to this group)
- Large scale fisheries, where the quality of data is getting worse (poor data due to e.g. misreporting and discarding)

The paper will present the methodology developed in the project and its first application of to selected fisheries in the Baltic Sea, North Sea, Mediterranean Sea and along West African coasts.

Keywords: poor data; fishery; Bayesian method; FLR.

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ICES CM 2007/O:26

A length-structured and spatialised assessment model for the Northern stock of European hake (*Merluccius merluccius*)

Hilaire Drouineau, S. Mahévas, and M. Bertignac

Most ICES Assessment Working Groups use catch-at-age models to achieve their diagnostic. Despite being useful to detect trends in biomass and fishing mortality, this kind of model has several drawbacks. One limit often mentioned is the age-structure which implies an uncertain and expensive age-length conversion of available data, and poorly match many biological (maturity) and exploitation processes (selectivity). A second limit is the lack of consideration for spatial heterogeneities in both fish population and fishing activity distribution which may lead to unreliable assessment and makes impossible the assessment of alternative spatialised measure such as Marine Protected Areas.

For these reasons, we decided to develop a length-structured and spatialised model for the Northern stock of European hake. The model aims at assessing the stock but also at improving the biological knowledge on the specie, especially on migration and growth. As a consequence, the population dynamics model is rather complex and a large amount of data (commercial landings, scientific abundance index, tagging data) is required to estimate the unknown parameters. The estimation process is achieved by maximum likelihood. Statistical comparisons of model performance, especially at different spatial scale and with different length classes' width, are carried out to detect the most relevant level of complexity. Can this kind of model constitute a pertinent complement to usual assessment model?

Keywords: length-structured model, spatialised model, and European hake.

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ICES CM 2007/O:27

FISBOAT Manual of indicators and methods for assessing fish stocks using only fishery independent survey data.

John Cotter and Pierre Petitgas

The FISBOAT project (EC FP 6, 2004 - 2007) has the main objective to develop and test methods for assessing stocks of commercial fish using fishery-independent monitoring surveys, usually conducted by research vessels annually. Many indicators and analytical methods, some well-known, some novel, have been applied to 10 case studies spanning a diverse range of European fish stocks and regional seas, and the results assessed. Indications are that these methods will support stock assessments that could be used as a basis for managerial decisions. Many of the methods are biologically focussed and could be used as a basis for discussions with members of the fishing industry. Other, more technical methods have also been considered. The purpose of the present paper is to draw attention to a manual prepared during the project to present the various indicators and methods studied in a brief, informative format intended for general use outside the project. The indicators include traditional, biological measures of the health of a stock, as well as geostatistical indicators which take advantage of the spatial information available with survey data in order to derive biological signals about the stock from the spatial disposition of fish-at-age. The methods include various time-series techniques for looking at trends in indicator values, and techniques for combining the results from studying several indicators. The methods range in complexity from quasi-intuitive to specialised multivariate statistical methods that are being newly applied in the fisheries field. A length-based, stock simulation system is also included as an aid for finding useful reference points for some indicators.

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ICES CM 2007/O:28

Technical measures can be shown by experiment to reduce capture of unwanted fish, but can we see the effect on the stock in a stochastic world?

B. E. Eustace and C. J. Kelly

Technical Control measures (TCM's) have the potential to reduce fishing mortality by reducing unwanted catch. Gear trials were conducted by BIM in June 2005 as part of the EU funded NECSSITY project to assess the potential benefits of using a coverless trawl. Results from these trials indicate that substantial reductions in bycatch are possible with little or no reduction in the catch of target species. However, the putative effect of this TCM on fishing mortality has received little attention to date. The analysis presented here has been conducted as part of the EU funded EFIMAS project to evaluate the potential effect of such TCM's on whitefish stocks in the Celtic Sea. For this paper we have focused on whiting VIIe-k stock which had lower catches with the coverless trawl. Stock projections for this stock were simulated using F-PRESS (Fisheries

Projection & Evaluation by Stochastic Simulation), a simulation tool for evaluating fisheries management strategies. Our results indicate that while a difference in stock development can be shown deterministically, following the introduction of the coverless trawl, such a difference is difficult to detect when assessment uncertainty is added. We then try to answer, given the volume of whiting catch by the Nephrops fleets (putatively subject to the technical measure), and the assessment uncertainty; how big would the effect of the technical measure have to be, such that we could measure a difference (with confidence) in 10 years. The results raise some interesting questions on how we can evaluate the merit of effects we cannot measure.

Keywords: TCM, coverless trawl, stochastic simulation.

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ICES CM2007/O:29

Application of a biomass dynamics model on edible crab stock of the western Channel and fitted using Bayesian estimation

Martial Laurans and M. Smith

Important edible crab fisheries have existed in the western Channel for several decades. In some years landings exceed 10000 tons and the fisheries are very important to both France and the UK which are the countries most involved. The main gear used to catch edible crab is the pot and this provides a particular set of problems in estimating fishing effort. There is an inshore fishery where the boat perform one day trip and an offshore fishery with one week trip. Due to some uncertainties in the data and biological parameters of edible crab few stock assessments have been carried out and none have been applied on a routine basis. In this communication we propose to show the application of a biomass dynamics model taking account of French and British data for the western Channel and fitted using Bayesian estimation.

Keywords: edible crab; fishery; biomass dynamics model; Bayesian method.

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ICES CM 2007/O:30

Spatial management procedures for early closure of the *Loligo gahi* fishery off Falkland Islands based on a precautionary analysis using bootstrapping and Bayesian techniques

Ignacio Payá

An early fishery closure is a difficult decision in short lived species; managers delay the decision until they feel very sure about resource depletion but they also want to warn the industry in advance to reduce the disruption. This may jeopardize the management target when this decision is taken too late. To deal with this a management procedure is presented, which was successfully applied to a squid fishery managed by fishing effort regulation. The decision rule was to close the fishery if the projected spawning biomass falls below 10000 tons under the constraint of warning fishing industry with 2 weeks in advance. A spatial operating model was developed using a depletion model, a catch projection model, and a spawning biomass projection model. The uncertainty was estimated during the fishing season by bootstrapping and after the season by Bayesian inference (MCMC). The risk was the probability of leaving less than 10000 tons of spawning biomass. For spatial analysis a graphic interface was developed based on real-time electronic logbook system. Depletion events were localized in two areas, the main area was closed at four and the other at three weeks before the normal season ended. The escaping spawning biomass was estimated at 13708 tons and the risk of being below 10000 tons at 0.01. During warning period fishing industry actively participated in monitoring the depletion events and discussing the spatially sequential closure strategy. The warning period gave fishing industry transparency and confidence in the new procedure, so closure decision was much easier.

Keywords: Short lived species, management procedure, precautionary, early fishery closure.

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ICES CM 2007/O:31

Using expert opinions and prior knowledge within fisheries stocks assessments: the Baltic salmon case study

Catherine Michielsens, Atso Romakkaniemi, Samu Mäntyniemi, and Sakari Kuikka

Fisheries management advice within ICES relies on expert groups who evaluate the stocks using predominantly standard assessment models based on standard data series. The groups' expertise is used to put

the necessary data together, choose assessment models and interpret their results. In a bid to avoid subjectivity, any information besides the assessment data is ignored within the formal assessment. The experts' knowledge or additional information is only brought in at a later stage in a non-formal way when interpreting the results. Within this paper we advocate the use of case-specific assessment models based on diverging expert opinions on the status and dynamics of the stocks and incorporating all available knowledge and data within the assessment. Bayesian methods offer a clear and formal way to introduce these sources of information within stock assessments. They express the expert opinions and prior knowledge about model parameters and the stock status in the form of probability distributions and then update this knowledge using the available data. Expert opinions can be obtained from fisheries scientists, fishermen and other stakeholders and prior knowledge can be obtained from separate analyses using different data from the same stock or the same data from similar populations. During the last 6 years, the ICES working group for Baltic salmon and trout has been using this methodology for the assessment of the salmon stocks. Using this case study, some of the practical implications of the application of this methodology are illustrated.

Keywords: expert opinion, prior knowledge, stock assessment, Bayesian, Baltic salmon.

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ICES CM 2007/O:32

Underwater television surveys of Nephrops around Scotland – population trends since 1992

Nick Bailey, N. Campbell, H. Dobby, and A. Weetman

Underwater television (UTV) surveys of Nephrops burrows provide a quantitative approach to estimating population abundance which avoids the difficulty of interpreting variable catch rates inherent in traditional trawl surveys that arise from the emergence behaviour of Nephrops. UTV surveys have been conducted on Nephrops grounds around Scotland since 1992 and offer an efficient way of monitoring the diverse inshore and offshore populations of Nephrops. In this paper a brief resume of the technical developments and constraining factors is first provided. The opportunity is then taken to present a synthesis of the data covering 15 years and 6 of the principle exploited Nephrops populations. In addition to describing recent trends in the different areas, comparison is made of the overall densities observed on the grounds and of the relationships between abundance and physical features of the sediment in different areas. Increasing abundance has been a feature of a number of these populations over the last few years and some speculative discussion is offered on possible reasons for this. An important aspect of this assessment approach is its utility as a provider of an absolute estimate of stock size - in recent years ICES has used the technique in the formulation of its catch advice for a number of Nephrops stocks. The concluding part of this paper discusses how the technique can be enhanced to facilitate this.

Keywords: underwater television surveys, Nephrops, stock abundance trends, population density, catch advice.

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ICES CM 2007/O:33

Solving the credibility crisis in mixed fisheries management

A. D. Rijnsdorp, N. Daan, W. Dekker, and J. J. Poos

Despite decades of quota (TAC) management, mixed demersal fisheries in the ICES area have depleted major demersal stocks and caused serious ecosystem effects. The failure of mixed-fisheries management can be ascribed to: incorrect management advice; the tendency of politicians to set the TAC well above the recommended level; and non-compliance of the fisheries with the management regulations. Further TAC management will inevitably lead to unsustainable exploitation of stocks caught in mixed demersal fisheries as it promotes discarding of over-quota catch and misreporting of catches, thereby corrupting the basis of the scientific advice and increasing the risk of stock collapse. This failure has resulted in the loss of credibility of both scientists and managers. An approach is developed to convert the TAC system into a system that controls the total allowable effort (TAE). The approach takes account of the differences in catch efficiency between fleets as well as seasonal changes in the distribution of the target species, can also be applied in the recovery plans for rebuilding specific components of the demersal fish community, such as plaice, cod and hake, and can easily be accommodated to reduce the broader ecosystem impacts of the fisheries.

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ICES CM 2007/O: 34

A quantitative assessment framework for the Greenland halibut (*Reinhardtius hippoglossoides*) stock off East Greenland, Iceland and the Faroe Islands using a production model in a state-space structure and Bayesian inference

Carsten Hvingel, Jesper Boje, and Kaj Sünksen

Management advice for the stock of Greenland halibut (*Reinhardtius hippoglossoides*) in ICES Subareas V, VI, XII and XIV. GHL has recently been formulated by qualitative assessment of trends in various indices of stock condition in response to the catch history. Management advice is given as an annual Total Allowable Catch (TAC) and a statement about the sustainability of the applied fishing practice as agreed to by the assessment board (Anon. 2006b).

An alternative quantitative assessment and management framework was constructed based on the logistic stock-recruitment function, a State-space model structure and Bayesian inference. Fishery effect was modelled explicitly while other mortality was included in the parameter for overall realised population growth rate, r .

The model was able to produce a reasonable simulation of the observed data and was relatively insensitive to input priors. However, widening the priors scaling survey biomass indices to absolute stock size so they would include also very low values – considered unrealistic by experts – resulted in increased uncertainty of model estimates and on average slightly more optimistic results.

Estimated stock biomass has shown and overall decline since the mid 1980s. Biomass is below its maximum sustainable yield level (BMSY) and mortality by fishery exceeds the value that maximizes yield (FMSY). The inter-quartile range of the maximum annual production surplus was estimated to 12-35 ktons.

Catches around 15 ktons are likely to maintain stock size around its current low level, while larger catches have a higher probability of causing further reductions in stock size.

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ICES CM 2007/O:35

Bayesian quota – a resilient policy for fisheries management?

N. Holmgren, S. Kuikka, H. Granath, A. Jonsson, T. Jonsson, and E. Sernland

Recent advances on improved fishery management has been to refine stock estimation. Alternative quota models are currently discussed and evaluated. The traditional total allowable catch (TAC) with time delays does not take into account information useful for stock size estimate in on-going fishing, except that the total catch is used to limit the fishery. Effort-control has its advantages as creating "temporal refuges". We have developed a concept of Bayesian quota (BQ) that combine total catch and effort, in which TAC and fixed effort are special cases. The concept has been developed in animal foraging models predicting information use in optimal behaviour. Here we compare the performance of BQ and TAC on artificial fishing on a simple logistic population model with stochastic growth. Each type of quota is applied with, and without, highly idealized research surveys that in the model return the actual population size before stochastic growth. Quotas are set to maximize sustainable yield. The results shows that BQs return on average higher yields than TACs when the variance in stochasticity of population growth is moderate or high. Interestingly, the BQ without research surveys exhibit the least interannual variation in yield, which is a clear benefit to the economy of the fisheries. The BQ could be applicable especially to fisheries with high uncertainty in stock size estimates and high variability in catchability which create problems for effort- and TAC-based management. For example sandeel and salmon management may benefit from BQ that determine when the combined real-time effort and catch indicate the goal stock size remaining.

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ICES CM 2007/O:36

Estimating uncertainty in nonlinear models: applications to survey-based assessments

Coby L. Needle and Richard Hillary

Stock assessments based on research vessel surveys or other fishery-independent sources of information are becoming increasingly important as drivers of fisheries management advice, in Europe and elsewhere. In some cases this approach has arisen as a consequence of stringent management measures which have led to less reliable commercial catch and effort data; in others, the stock trends indicated by fishery-independent data are used as informative counterparts to more traditional assessment methods. An important feature of

any survey-based method should be the estimation of the variance (or distribution) of output quantities such as mortality and abundance. There are many ways to estimate these variances. In this paper, we explore the characteristics of five such methods, namely the analytic delta method, bootstrapped residuals with refitting, parametric residual bootstraps, parametric multinomial resampling, and Bayesian methods. We use each approach to analyse the variance and bias properties of linear and nonlinear model fits to simple bivariate data, before extending the analysis to a simple separable survey-based stock assessment model (SURBA) applied to both real and simulated data. We conclude that variance estimators need to be considered carefully for such models, as the incorrect choice can result in misleading fisheries management advice.

Keywords: variance estimation, model fitting methods, survey-based assessment, data simulation.

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ICES CM 2007/O:37 Poster

The Brief History of Traffic Lights in the Northwest Atlantic

Peter Koeller

Simple tabulations and categorizations of variables have a long history in environmental impact assessment (EIA) and decision making. Here they are used primarily as consensus-building tools and to organize, display, and communicate different types of relevant information (e.g. quantitative, qualitative, anecdotal) from disparate sources (e.g. ecological, social, economic). One such method, the so-called "traffic light" (TL) approach to displaying multiple indicators of stock health, has had an interesting but controversial, and sometimes short-lived, history in Northwest Atlantic fisheries management. An analysis of its development, use, and abandonment is highly informative about the nature of the continuing crisis in applied fisheries science. It is particularly informative that its failures have mainly been associated with groundfish applications, while its use in invertebrate stocks, especially crab and shrimp, appears to be flourishing. In this paper I discuss the history of the method as applied to various stocks in the Northwest Atlantic, including a detailed case history for the Scotian Shelf shrimp stock. In addition, I argue that extensions of this method have great potential in practical applications of the ecosystem approach.

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ICES ASC 2007/O:39 Poster

Industrial fishing, sandeels, and predatory fish condition

Georg H. Engelhard, Julia L. Blanchard, David A. Righton, Steven Mackinson, John K. Pinnegar, Jeroen van der Kooij, and Ewen D. Bell

We emphasise the use of fish body condition as an alternative approach to providing support to fisheries management advice. Typically, body condition is not only related to growth, reproduction and survival chances, but is also directly affected by food availability. In case of the North Sea industrial fisheries for sandeels, the extent to which predatory fishes (including "human consumption" species) might be deprived of food by large-scale depletions of sandeels forms a topic of primary concern. Within the North Sea, a substantial proportion of sandeel fishing activity takes place in the Dogger Bank region. We studied predator-sandeel interactions in two study sites on the western Dogger Bank in the region of the Flamborough front. The two sites differed widely in sandeel abundance as well as local sandeel fishing effort. Surveys took place in 2004, 2005 and 2006 which were years when sandeel abundance at least locally was comparatively low, rather high, and high respectively. In the two sandeel-rich years, as well as in the sandeel-rich study area, a range of predatory fish species did not only show higher sandeel consumption than under sandeel-poor conditions, they also exhibited better body condition indices. Given the likely links between body condition and reproductive potential, these links between sandeels, sandeel consumption, and predator condition hint that, if large-scale localised depletions of sandeels were to occur, negative indirect effects on predatory fish species might become apparent, thus underlining the importance of considering the sandeel fishery in an ecosystem context.

Keywords: industrial fishing, sandeel, Dogger Bank, ecosystem, food web.

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ICES CM 2007/O:40 Poster

Selection against large size: declines in mean weight within and among species in the Gulf of Maine/Georges Bank region over the past 40 years

A. Jordaan and David O. Conover

There has been a considerable decline in the mean weight of fish species captured in the National Marine Fisheries Service trawl survey since it was initiated in 1963. This pattern is common in exploited marine systems and has potentially significant ecological and evolutionary consequences. We will consider two hypotheses that could lead to this pattern. First, that within a single species there has been a shift in the size frequency distribution towards smaller individuals. Second, that among the multiple species that are present in the survey region there has been a shift from larger bodied species to smaller bodied species. The larger Gulf of Maine region can be sub-divided into smaller components based on the fish assemblages that are present. Changes in the size-frequency and species assemblage will be discussed in relation to temporal shifts in species catch statistics and ecological sub-components in the Gulf of Maine. The ecological and evolutionary consequences will be discussed in relation to possible solutions and caveats in adapting fisheries management to meet the ecosystem-based paradigm.

Keywords: Ecosystem approach, fisheries, indicators, weight, size frequency, spatial and temporal trends.

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ICES CM 2007/O:41 Withdrawn

ICES CM 2007/O:42 Poster

Random effects modeling in fisheries science using AD Model Builder

Hans J. Skaug and David Fournier

Random effects are flexible building blocks in statistical modelling, and can be used to achieve over dispersion for Poisson counts and to account for correlation among variables. We review these principles in the context of fisheries science. Examples include population dynamics, trawl surveys and mark-recapture experiments. It is illustrated how models with random effects easily can be implemented in the statistical software package AD Model Builder.

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ICES CM 2007/O:43 Poster

New methodology for studying large valuable fish in data poor situations: Commercial mark-recapture of meagre *Argyrosomus regius* in the southern Portuguese coast

N. Prista, J. L. Costa, M. J. Costa, and C. M. Jones

Life history parameters of some valuable marine fish remain unstudied in European waters. Such situations frequently arise because fishery independent sampling methods are logistically difficult and/or costly to undertake given the scarcity of available biological knowledge. Thus, adequate and cost-effective surveys cannot be designed. In such cases fishery dependent sampling can provide representative samples while simultaneously keeping the costs per sample low. We developed a new fishery dependent sampling methodology that combines representative sampling of fishery landings with economically feasible market sampling, and thus is capable of providing life-history information on previously unstudied marine resources. This new methodology, termed "Commercial mark-recapture", involves tagging of landed fish and the posterior recapture of their body parts in the marketplace. As a case study, we applied this method to meagre *Argyrosomus regius*, the largest and most expensive sciaenid landed in European coasts. Little is known about its age, growth and reproduction even though it is economically important to local fleets of the Portuguese, Spanish and French Atlantic coasts. Our results show that Commercial mark-recapture was highly effective, allowing a significant number of samples to be obtained, at low cost, with quantifiable spatial, temporal, size and gear coverage of landings. The conditions and assumptions required for the successful application of this methodology are discussed, as well as its applicability to the study of life history and fishery details of other European marine fish.

Keywords: Life-history, Fishery dependent sampling, Market sampling, *Argyrosomus regius*.

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Applying ZooScan imaging system for automated counting and identification of pelagic fish eggs from a continuous underway sampling in the North Sea

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Since the late 90's, changes in abundance of important commercial fish species have been reported in the North Sea due to climate changes and/or overexploitation of resources. The egg being a critical phase in the life cycle of fish, the spawning grounds are regarded as sensitive habitats. In this context, studying spatial extent and location of spawning habitats is critical for understanding and forecasting fisheries recruitment evolution and will support ecosystem-based management. One of the main problems confronting modelling of spawning habitats is low sampling resolution, both spatial and temporal. Although it is widely recognized that small scale sampling would be relevant to increase model accuracy, the work involved in fish egg sample analysis has made it impossible to sample at very high resolution in most programs. To some extent, the lack of sampling capability has been resolved using a continuous underway fish egg sampler (CUFES), but the analysis of such amount of samples is still a very time consuming and laborious task. Recently, the development of a new laboratory imaging system, the ZooScan, capable of obtaining relatively good resolution images at high sampling rates makes possible automated taxonomic identification using supervised learning algorithms. We apply this new approach on fish egg samples collected by the CUFES during the winter campaign International Bottom Trawl Survey (IBTS-2006) in the Southern North Sea. Automatic recognition of seven fish egg species was compared with results of the visual identification in order to validate the method of training used.

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The use of bycatch monitoring schemes in augmenting assessment data

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Observer schemes have become commonplace in many fisheries, but they are often focused on specific tasks, such as assessing the scale of non-target catches or of discards. Using an 11-year marine mammal bycatch monitoring scheme in the UK as an example, we explore some of the benefits that are available from deploying observers into commercial fisheries. While the primary goal of this scheme has been to estimate the bycatch rate of marine mammals, the collection of biological data on some of the mammals that have been monitored also enables biological parameters to be assessed, which assists in determining conservation status. By monitoring certain fisheries where non-target bycatch rates are relatively high for more than one species, the programme has also enabled assessments of bycatch rates of species, such as sharks, to be made. The detailed information collected also enables good quality CPUE data to be collected, and enables changes in fishing practice that might influence CPUE trends to be monitored. Trends in abundance of non-target species may also be ascertained and the effects of environmental change may be monitored through the quantification of more unusual fish species, for example of thresher sharks and triggerfish that have in recent years become plentiful in the English Channel, but which may not always be landed. Monitoring programmes also serve to integrate the scientific community with the fishing industry and enable science – industry partnerships to be developed.

Keywords: Observer programme; bycatch; environmental monitoring.

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Development of an ovigerous lobster (*Hommarus gammarus*) curve model from data collected by a fisherman. Analysis of an annual variation and seasonal evolution of the curve.

Martial Laurans,

In a lot of exploited crustaceans, the biological parameters are not well known, and this is the case for lobster. One of the most important elements is to get some data. Here, thanks to a good contact with a fisherman who

targeted lobster in south Brittany, an important data base has been constituted. All the lobster he caught over a 5 year period were measured, and the ovigerous state of females noted. We developed a model of the ovigerous curve, where we note an annual variation and seasonal evolution in the shape of the curve and absolute value of the asymptote. These interesting results improve the knowledge of the dynamics of the lobster stock and provide information relevant for management rules aimed to assure the sustainability of fisheries.

Keywords: edible crab; fishery; biomass dynamics model; Bayesian method.

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Can length structure of English Channel cephalopod landings reveal trends in exploitation?

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The need of alternative methods for the assessment of fishing pressure is often advocated in Cephalopod stocks in relation with their short life span and presumably variable life traits. English Channel Loliginid squid and cuttlefish are among the first Cephalopod resources in the Northeast Atlantic. English Channel fishery data collection programmes have yet enabled to apply slightly modified versions of "classical single species methods" like monthly cohort analysis. The present study revisits landings length frequency sampling (which is carried out at the Port-en-Bessin fish market and now extends over a number of months) and analyses if length structures can reveal changes in cohort exploitation patterns. Changes in length structure are explored via multivariate correspondence analysis (CA) in which variables (i.e. length-classes) and records (i.e. sampling dates) can be plotted simultaneously. The largest dataset concerns *Loligo forbesi* with 9 fishing seasons sampled consistently from June-N to march N+1 (90 monthly observations in a species with length classes ranging from 7 to 50+ cm DML). Factorial analysis splits differences in length structures into a series of independent factors of decreasing importance. Factor 1 describes changes in modal length and underlines that the main source of variability in length data is seasonal modal progression. Factor 2 reveals differences in length variance and projections in the F1-F2 plane show a V-shaped scatter plot (Guttman effect). Interannual differences between fishing seasons are less visible and appear only along factor 2 and nexts. Length-structure changes are discussed in the light of recruitment strength and fishing mortality estimates (in previously assessed cohorts) and in relation with English Channel water temperature changes. Recruitment variability determines stock size and fishery yields but seems to have little influence on length structure of exploited stages.

Keywords: English Channel, *Loligo forbesi*, length-frequency, correspondence analysis.

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AFRAME: A framework for fleet and area based fisheries management

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AFRAME is a VI Framework Program project aimed to develop a framework for fleet and area-based fisheries management. The three research themes will be attempted: 1, the development and testing of a framework for describing fleet activity in terms of the fisheries in which the fleet participates, and how it allocates its effort across these fisheries; 2, the development of indicator approaches to summarising information and presenting advice in relation to multi-fleet, multi-species fisheries; and 3, stakeholder perceptions and institutional implications of a shift to fleet and area based management. Themes will be developed through application in three contrasting case study areas: 1, the demersal fisheries of the North Sea 2, the demersal fisheries of ICES areas VII and VIII (the Channel, Celtic Sea and the Bay of Biscay) 3, the Mediterranean sea. As the complexity of the fisheries, in terms of number of fleets, areas and species, increases, it becomes more necessary to develop an integrated approach to accounting for this complexity in the advice. Such an approach would require developments in a number of areas including the explicit representation of area and fleet aspects of fisheries, and the basis for, and nature of, the advice. Further, one implication of basing advice on fleets or fisheries, is the switch in focus from a biological unit (a fish stock) to a social one (a fleet or fishery). This necessitates much greater contact with stakeholders so the development of such approaches would also require social science input.

Keywords: area, fleet, framework, management.

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