

## Theme Session on How to Improve Environmental Monitoring and Biological Studies – Integrating Ecology and Statistics (Z)

### ICES CM 2005/Z:01

#### Can size-spectra reveal the impact of fisheries on biodiversity?

Catherine Longo, Simon P. R. Greenstreet, Helen Fraser, and Graham J. Pierce

Indicators for measuring community level impacts of fisheries are required if an ecosystem approach to management is to be attained. In particular, the relationship between fisheries and changes in species diversity, an aggregate community property that has been set as a priority in conservation policies on an international level (UN Rio conference on Environment and Development), although acknowledged, remains unclear.

Species diversity is believed to influence a range of ecosystem services such as productivity and stability. Previous studies have investigated the relationship between diversity and food web complexity, and recurring patterns have been observed relating diversity to either productivity, disturbance, or abundance/biomass distributions within a community. However, few multivariate models dealing with interactive effects of these parameters have been developed or empirically tested. These models are founded in niche theory and the competitive exclusion principle, linking fisheries disturbance to diversity patterns within trophic levels as opposed to analyzing diversity of the whole community.

As organisms with a larger body mass generally feed at higher trophic levels, we ranked the species within fish communities by size, to obtain biomass size-spectra. Comparing diversity patterns within biomass size-classes allows us to track changes in this parameter in relation to both productivity and energy flow through the trophic levels. We analyzed diversity patterns of ground-fish communities in space (across the North sea) and time (~70 years) in relation to different levels of fishing effort, testing ecological theory assumptions about food web dynamics and the scope for use of biomass size-spectra to yield potential community level descriptors.

Keywords: size spectra, biodiversity, fisheries impact, trophic interactions.

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### ICES CM 2005/Z:02

#### Relationship between survey indices and survey design and wind conditions: Bay of Biscay groundfish survey

Jean-Charles Poulard and Verena M. Trenkel

Abundance indices derived from scientific trawl surveys are used to inform on population trends either directly, e.g., survey-based assessment methods and the indicator approach, or indirectly for tuning stock assessment models. The implicit assumption of such use of survey indices is that they reflect true trends. Furthermore, inter-annual variability in survey indices is partly attributed to sampling variability and partly to yearly differences in recruitment and migration rates. In certain cases indices for a given year might be qualified as outliers if they seem too variable to reflect true abundance changes. If the indices of several species appear to be outliers for the same year, the suspicion is raised that something happened during the survey of the given year. We refer to this result as the annual survey catchability effect whose main characteristics are that it affects many species simultaneously, appears on the whole survey scale, and is not caused by technical problems. We studied the annual survey catchability of the autumn Western IBTS groundfish survey in the Bay of Biscay for the period 1987 to 2003. For explaining annual survey catchability across species we derived several indicators for survey design and wind conditions. Survey starting dates had been gradually delayed by about one month which resulted in stronger westerly winds. Furthermore, gradually fewer hauls had been taken close to the coast. Using GAMs we found that a substantial part of the interannual variation in abundance indices could be explained by those indicators, but not the overall time trend.

Keywords: survey index, catchability, time trends, survey conditions.

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### ICES CM 2005/Z:03

#### Statistical power in coastal fish monitoring with passive gears – effects of sampling strategy and environmental characteristics

Magnus Appelberg, I. Abrahamsson, J. Andersson, U. Bergström, A-B. Florin, B. Fagerholm, F. Franzén, A. Lingman, G. Sundblad, and K. Söderberg

Development of the coastal fish fauna has been monitored for up to three decades in the Baltic Sea, Kattegat, and Skagerrack. Although aims of the monitoring pro-

grammes vary, all address changes in fish community and population characteristics over time. Programmes cover monitoring of fish resources, recipient studies, and long-term studies of natural variation in undisturbed reference areas. Monitoring data provides the basis for developing indicators for assessing changes in coastal fish communities and populations, and is partly used within HELCOM for following up Ecological Quality Objectives. Sampling is performed using passive gears; small fyke nets and gillnet series are used along the Kattegat and Skagerrack coast, whereas multi-mesh gillnets and gillnet series are used in the Baltic Sea. In the present paper we assess the relevance of used sampling strategies from both an ecological and a statistical point of view. Issues of concern are effects of time of year for sampling, sampling strategy, and gear (e.g. stratified, random sampling versus repeated sampling at fixed stations). The importance of physical parameters such as temperature and wave exposure on community and population characteristics (e.g. catch per unit effort, size and age distribution, recruitment), are also assessed. The results show that statistical power ( $1-\beta$ ) of the measured variables varies considerably according to both sampling strategy, type of gear, and time of sampling. Using gillnet series in the Öresund strait in autumn, a power of >90% could be achieved for CPUE of the most frequently occurring species, whereas the statistical power ranged between 20–40% using repeated sampling at fixed stations with fyke nets in spring.

Keywords: fish monitoring, sampling strategy, passive gears, coastal fish, Baltic Sea, Kattegat.

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#### **ICES CM 2005/Z:04**

##### **Pragmatic estimation of uncertainty in normalized concentrations of contaminants in sediments**

F. Smedes, I. M. Davies, and R. Fryer

International environmental assessment exercises concerned with environmental contaminants commonly seek to combine data over time and between laboratories. It has been recognized for some years that significant variations can exist in the quality of the underlying analytical data. For example, performance might be expected to be better in experienced laboratories than in relatively inexperienced laboratories, and performance might improve with time as instrumentation has developed. However, uncertainties in the quality of some data and the possible misleading impacts that poor data might have on the final assessment have led to various approaches being taken to try to minimize the influence of data of poor quality.

Contaminant data held on the ICES Environmental Database must be accompanied by supporting quality assurance (QA) information, for example analyses of

certified reference materials (CRMs) or results from participation in laboratory performance studies (LPSs). Examination of these data led to the development of thresholds for minimum analytical quality, and the subsequent exclusion of data which failed to pass the thresholds. Such procedures were effective, but were subsequently criticized for eliminating data which originators considered to be of good quality.

Subsequently, data analysis methods were developed which could take account of the differing degrees of confidence in data points by a weighting process, and the fitting of weighted time smoothing functions to time-series. These methods did not require data points to be eliminated, but poor quality was reflected in lower weighting. The application of these methods required that an expression of the associated analytical uncertainty be assigned to each data point. This report describes an approach to the derivation of analytical uncertainties for normalized concentrations of contaminants in sediment, using information held on the ICES Database.

Keywords: sediment, contaminant, concentration, uncertainty, normalization, trend analysis.

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#### **ICES CM 2005/Z:05**

##### **Redesign of the UK National Marine Monitoring Programme for contaminants in sediment**

Rob Fryer, Judy Dobson, Alistair McIntosh, Brian Miller, and Lynda Webster

The UK National Marine Monitoring Programme (NMMP) currently monitors chemical concentrations in sediment by taking five samples each year from each monitoring station. The stations are small, covering an area with radius 20 m in estuaries and 50 m elsewhere. The power of the programme for detecting temporal trends is reasonable for metal, but poor for organic contaminants. Small stations have historically been advocated as a way of controlling spatial variability to focus on temporal variability. However, small stations can be ineffective if a) there is random spatio-temporal variability in contaminant concentrations on a scale that is localised, but greater than the size of the station; b) there is cluster sampling due to navigational procedures; c) there is a need to provide environmental advice about wider management areas. The design of the NMMP is now being broadened to allow sediment samples to be taken from larger areas, aligned to Water Framework Directive water bodies where possible. Monitoring will follow a stratified design, with sampling locations either chosen at random each year, or chosen at random in the first year and then fixed. These designs should improve power by controlling local spatio-temporal variation; remove problems associated with navigation; and lead to management

advice about water bodies. We illustrate using the proposed changes for Scottish waters.

Keywords: power, contaminants, sediment, spatio-temporal variability, stratified design, water body.

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## ICES CM 2005/Z:06

### Application of modeling to Baltic environmental monitoring design

Robert Aps, R. Tamsalu, T. Kollo, T. Kullas, and V. Zalesny

Coupled atmosphere-ocean 3D modeling suite FRESKO is used as an operating model representing the best available understanding of atmosphere-ocean interactions and the Baltic Sea hydrodynamics from which simulated data are sampled by observation model (monitoring simulation). Sampled data are processed using SAS software and the appropriate statistical methods for time-series analysis. Results are used to evaluate the effectiveness of sampling design and the levels of probability of detecting an environmental impact. Sampling data from the FRESKO operating model enable us to analyze the different sources of uncertainty such as process error (natural variability), measurement error (observation sampling), estimation and model errors (attributable to environmental monitoring assessment), and implementation error (generated by imperfect management actions). In addition to monitoring the levels of pollutants in certain sea areas it is important to know from where these pollutants might have originated. Adjoint equations based on inverse modeling enable us to track the pollutant transport back to the source sea area. As an example, the sensitivity of the Southern Archipelago Sea (Finland) and of Kõpu Peninsula on Hiiumaa (Estonia) is evaluated in relation to the Baltic potential pollution source areas.

Keywords: Baltic Sea, monitoring design, coupled atmosphere-ocean 3D modelling, time series analysis, adjoint equations, inverse modeling.

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## ICES CM 2005/Z:07

### A new statistic for sampling design investigation: an application to length-structured landings sampling

Joel Vigneau and Stéphanie Mahévas

The question of sampling intensity has been largely studied, particularly to assess the best compromise between the length and the age numbers to sample in order to achieve a certain precision level for landings at age. The purpose of this paper is to propose an estimator, called Lambda ( $\lambda$ ), resuming the information of the discrepancy between one sample of length structure and the overall length structure coming from all the samples. This scalar-type estimator will enable the analysis of the sampling design following the common rules of the sampling theory. At the sample level, this statistic enables to point out possible outliers. At the strata level, the heterogeneities can be used to define appropriate stratification by combining strata showing the same pattern or by adding another strata if patches are visible.

Different issues are addressed: is there a difference in the length structure of the market categories between métiers, fleets, etc.? Are the fishery units as they are defined good candidates for discriminating different fishing patterns? Is it possible to improve the precision of these sampling plans? It is impossible to sample all the combinations of gear/area/time developing a fishing effort on a given stock. Two case studies coming from the French market sampling will be used as support to the method: sole (*Solea vulgaris*) in Eastern Channel ICES Sub-Division VIII and hake (*Merluccius merluccius*) in Eastern Atlantic, ICES Divisions VII and VIII.

Keywords: sampling design, stratification, precision, length-structure.

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## ICES CM 2005/Z:08 – Poster

### Eelpout (*Zoarces viviparus*), an useful bio-indicator in coastal fish monitoring

B. Fagerholm, F. Franzén, G. Sandberg, and K. Söderberg

Eelpout (*Zoarces viviparus* L.) has become an important indicator species in environmental monitoring in coastal areas. Due to its stationary behaviour, its specific life history traits (e.g. being viviparous), wide distribution and broad salinity tolerance, eelpout has proven to be a good environmental indicator in marine habitats. More than one decade of eelpout monitoring in coastal recipient areas and in undisturbed reference areas in Sweden has provided data on natural variability of life history characteristics. The indicators used include both mature females features and fry development. The methodology

is generally cost-effective and analyses can partly be performed in the field. In annual sampling during autumn, about fifty females are examined with reference to age and physiological status (liver, blood, and pancreas). Fry from each female are analysed and sorted into five different classes; dead, living, living malformed, dead malformed, small length (compared to the total brood). Length of all fry in the brood is measured providing information on between-year variation and relation in size between female and fry. In the present study we discuss the results from thirteen years of eelpout monitoring along the Swedish coast. In total five areas are included, covering the northern part of the Bothnian Sea to coastal areas in Skagerack. Results achieved are assessed in relation to habitat changes, environmental disturbance, and natural variability.

Keywords: eelpout, *Zoarces viviparus*, bio-indicator, fry status, coastal monitoring.

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## **ICES CM 2005/Z:09 – Withdrawn**

### **ICES CM 2005/Z:10**

#### **Geolocation of Cape Cod Bay cod using tidal information**

Joachim P. Gröger, Rodney Roundtree, and Uffe Høgsbro Thygesen

Information derived from archival tags (DST tags) has been utilized by SMAST<sup>1</sup> in order to backtrack the migration of 11 tagged cod during years 2001 to 2002 in Cape Cod Bay. This effort was part of the “SMAST (School of Marine Science and Technology at the University of Massachusetts) Cod Tagging Program” targeting cod in the Cape Cod Bay area of the Gulf of Maine. Two types of archival tags were used by SMAST researchers during this period: one was produced by Star-Oddi which continuously recorded time, temperature, pressure, and salinity; the other was produced by Lotek (formerly CDI) which continuously recorded time, temperature, and depth. The tags were attached to the fish at a central point approximately 1 cm below the first dorsal fin using two 7.7 cm stainless steel pins and two 2 cm round plastic disks that serve as anchors. Seventeen of the 101 Lotek tags, and one of the four Star-Oddi tags were recaptured after 20 to 210 days at large. However, data could be extracted from only 13 of the tags. In order to geolocate fish positions during its time at large, we first extracting the tidal signal from the pressure recordings on the tags. This was compared to the dominant M2 lunar tidal signal with a semi-diurnal period of 12.4 hours known for Cape Cod bay which explains about 90% of the tidal energy in Cape Cod Bay. We fit a combination of sine and cosine terms to the depth data within a time window of 13 hours for each tag time series, based on the M2 tidal component. For each tag we itera-

tively moved this time window through the data series. After some noise filtering, we selected only those resulting window slots, and thus records per day, which best fit the data based on the Akaike Information Criterion (AIC) and the standard error of the estimated amplitude. Output of this procedure was average sea level, amplitude, date and time of high tide, AIC, mean squared error, and coefficient of determination of the regression. These records of good fit were then statistically compared to data predicted with a Cape Cod Bay tidal model that provided us with geographical coordinates at a given date and time. Using some least-squares criteria within an estimated geographical region of confidence that were constrained by biological and statistical information we were able to geolocate the fish.

Keywords: archival tags, DST tags, geolocation, tidal model.

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### **ICES CM 2005/Z:11 – Poster**

#### **An assessment of the efficiency of ballast water exchange**

Tracy McCollin and Aileen Shanks

Ballast water exchange has been used for a number of years as a method of reducing the risk of introducing non-native species via ballast water, but there have been very few studies assessing the efficiency of this method. Alternative ballast water treatments have been under development but the lack of a treatment standard meant that full scale testing onboard vessels has been limited and that ballast water exchange remained the only readily available technique for many vessels. The International Maritime Organization agreed to the Ballast Water Convention in 2004 and this outlines a phase in period for technologies to be fitted to vessels in order to meet a treatment standard. The phase in period varies for vessels of different ages and sizes and for the older, larger vessels there will be a reliance on ballast water exchange for some time. In order to ensure that the environmental impact of introducing non-native species is reduced it is necessary to examine whether ballast water exchange is a method that is efficient at reducing the abundance and diversity of organisms within the ballast water. The use of a Generalised Linear Model to assess which factors (e.g., method of exchange, season, location of exchange) influence the outcome of exchange will provide information to inform sampling design for the future monitoring of the efficiency of ballast water exchange in order to reduce the risk of introducing non-native species. The information could also be used to assess whether it would be possible to use ballast water exchange in combination with other treatment methods.

Keywords: non-native species, environmental protection, ballast water, ICES area, GLM.

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### **ICES CM 2005/Z:12 – Poster**

#### **Monitoring of the impact of Muuga Port activities on fish communities and fishery in Muuga Bay in 1994–2004: difficulties in results definition and needs for method improvement**

Ahto Järvi, Tenno Dreves, Leili Järvi, Tiit Raid, and Andres Jaanus

The changes in size/species structure of the fish communities in catch dynamics in the Muuga Bay have been monitored in 1994–2004 using experimental gill nets settled along the western coast of the Bay within the area of potential impact of the Port of Muuga, one of the largest multifunctional ports in the Baltic Sea. The possible rate of impact, potentially caused by different activities of the Port, such as dredging, navigation intensity, and pollution, were studied in conjunction with the natural changes in the ecosystem of Muuga Bay. Also the fish communities and catch dynamics in neighbouring bays were studied for control purposes.

It has been found that clearly defined effects of Port activities on fish communities are very difficult to estimate because of the large number of natural ecosystem factors involved, and also due to the influence of fishery. Furthermore, additional uncertainties were discovered due to peculiarities of the monitoring gears used. Especially should be pinpointed the necessity of accounting for the size/species selectivity of monitoring gears.

Keywords: Muuga Port, fish communities, fishery, monitoring gears, selectivity.

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### **ICES CM 2005/Z:13 – Poster**

#### **Dissolved oxygen and organic matter in a harbor and a bay in Egypt receiving organic pollutants from different sources**

Massoud A. H. Saad and Nadia B. El-Sayeda

Two shallow Mediterranean coastal basins in Egypt are subjected to different pollution levels from various land-based sources. The Eastern Harbor (EH) receives untreated domestic wastes mainly from Alexandria. The Abu-Kir Bay receives highly polluted water from several industries and contaminated brackish water from Lake Edku. Distribution of dissolved oxygen (DO) and

dissolved organic matter (DOM) was investigated in both basins. In the EH, photosynthetic activities and DO exchange with the atmosphere controlled the surface DO budget. The high DO and low DOM at the El-Boughaz opening reflect the mixing of the EH waters with the neritic Mediterranean. The high DOM content in the EH coincided with the sewage and shipyard waste discharges. The DO budget in the bay was found to depend upon the discharged Lake Edku waters, wind and current regimes, besides the industrial waste discharges. Contrary to the conditions in winter, the decrease in DO in summer coincided with temperature elevation. In the EH, a significant negative correlation existed between DO and DOM in the surface water, whereas it was insignificant in the bottom water. The surface annual means of DOM were higher than the middle and bottom means, reflecting direct effect of organic waste discharges. In the bay, the DOM showed a noticeable decrease seaward. The high DOM at the lake-sea connection coincided with the effect of the high fertile lake water loaded with organic matter. The insignificant correlations between DO and DOM and the empirical regression equations relating both variables indicate that DO was not the only factor affecting DOM decomposition.

Keywords: dissolved oxygen, organic matter, Mediterranean coastal regions, organic pollution.

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### **ICES CM 2005/Z:14 – Poster**

#### **SEA-SEARCH – Your gateway to oceanographic and marine data & information in Europe**

Lotta Fyrberg

Keys to the success of community research projects and to an effective support of marine economic activities are the speed and the ease with which users can identify, locate, get access to, exchange, and use oceanographic and marine data & information. Furthermore, these data & information must carry a certain overall data quality level. Data and Information Management plays a vital role in achieving these goals. The Sea Search website, services, and infrastructure are developed and operated by a partnership of 33 institutes/centres from 30 different European coastal states in response to these questions and opportunities. The Sea Search partners are highly skilled in management and added-value services on a wide range of oceanographic and marine data and information. Each of these centres operates in their home country as a national data centre or focal point for oceanographic and marine data and information. They are representative nodes in their countries with links to other organisations, active in marine research and marine environmental management, thus monitoring and overseeing national marine research activities and marine data flows. The partnership has working relations with

and is supported by EuroGOOS and MedGOOS, is active in operational oceanography and the European Space Agency, and is also active in promoting access and further use of marine remote sensing data and information.

Keywords: oceanographic marine data and information, marine research and environmental management, meta-data, data catalogues.

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### ICES CM 2005/Z:15 – Poster

#### **A statistical examination of the ability of phytoplankton monitoring to act as an indicator of toxin accumulation in the blue mussel (*Mytilus edulis*)**

E. Bresnan, R. Fryer, S. Fraser, N. Smith, A. Scott, N. Brown, E. Smith, and L. Stobo

Selected dinoflagellate species (*Dinophysis* spp. and *Prorocentrum lima*) have been associated with the production of the shellfish toxins okadaic acid and dinophysistoxins. Consumption of shellfish containing high concentrations of these toxins can pose a serious risk to human health. Currently a comprehensive monitoring programme (measuring the concentrations of toxins in shellfish and the concentrations of the causative organism in the water column) is in operation in Scotland fulfilling the requirements of the EU shellfish hygiene directive 91/492/EEC. From 2001–2003 a high frequency sampling programme was instigated to statistically examine the relationship between the presence of toxin producing phytoplankton in the water column and toxin concentrations in shellfish flesh (*Mytilus edulis*). Samples were taken weekly in 2001 and twice weekly during 2002. Cross correlations calculated at a series of time lags revealed a moderate association between numbers of *Dinophysis* cells in the water column and toxin levels in *M. edulis* flesh. The study indicates that phytoplankton monitoring can act as an early warning of potential toxic incidences in *M. edulis*. It also highlighted the importance of weekly phytoplankton sampling to allow accu-

rate interpretation of monitoring results as fortnightly sampling would miss potential toxic events.

Keywords: time-series, statistics, dinoflagellates, shellfish toxins, monitoring, interpretation.

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### ICES CM 2005/Z:16 – Poster

#### **Year-to-year variation and quantification of German Bight Water in the Skagerrak and Kattegat in the years 1996–2000**

T. Kristiansen, D. S. Danielssen, E. Svendsen, and E. Aas

In April each year from 1996 to 2000, an extensive data series of hydrography, nutrients and yellow substance was collected from the Skagerrak, the Kattegat, and off the Jutland west coast. A total of 3454 observations of salinity and yellow substance content have been used to quantify the spatial distributions of water from the German Bight, the Baltic, and the North Sea (Atlantic Water). The water masses of the Skagerrak and the Kattegat are typically a mixture of three or four dominant water types. An algorithm is used to determine the different percentages of three water types at a given location and depth, provided the salinity and yellow substance content at this depth are known. The German Bight Water differs from its surrounding waters by a higher content of nitrate and higher nitrate/phosphate and nitrate/silicate ratios after the spring bloom, and the spreading of this water type thus becomes of special interest with regard to toxic algal blooms.

Keywords: harmful algal bloom, water types, Skagerrak.

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