Theme session A

Advances in habitat models to inform ecosystem-based management: From theory to practice

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Background

There is a growing consensus that marine resources be assessed using a more integrative, ecosystem-based approach. Habitat models have emerged as both a standalone and an accessory tool for the stock assessment process. Improvements to traditional single-species models have recently been developed that seek to predict the spatial and temporal change in habitat, and provide insights into the mechanisms driving change at the species and community levels. Theme session A surveyed the state of the art in the construction and application of habitat models in the ICES community and other regions.

Practitioners apply a wide range of modelling approaches to estimate habitat including regression, classification techniques, and machine learning. Habitat models are well suited to assimilate a wide range of environmental and biological data, and present a solution to the issue of bringing ecosystem information into the advisory process. Different modelling approaches often produce differing results, making model comparison, ensemble estimates, and model validation areas of active innovation.

Habitat-modelling output has been used to design and interpret surveys, guide dynamic stratification of the ecosystem, calibrate catchability of survey gears, and improve stock size indices, among other applications. This results in an enhanced scientific basis for assessment advice, helping stakeholders and managers understand the expected impacts of management policies.

Habitat models also play a pivotal role in ecosystem assessment and marine spatial planning. The spatial output from these models can be queried to examine the effect of habitat change throughout the ecosystem, and especially how the structure of the community may be affected by climate-driven shifts in the distribution of species.

The aims of the session

Theme session A addressed three topics:

- Novelty in habitat model methods: address improvements in species distribution models and the extension to community-level models, including innovations in characterizing the error structure associated with model output, evaluating the importance of predictor variables, and examining the performance of model ensembles

- From model to assessment: examine examples where habitat model output informs multistock assessment advice or where habitat models guide the development and interpretation of fishery-dependent and -independent survey data
- From assessment to management: consider studies that use habitat models to guide ecosystem-level management, spatial planning, and the management of fishing and industrial sectors

Results

Theme session A - Advances in habitat models to inform ecosystem-based management: From theory to practice – provided a platform to highlight advances in species and community habitat models and their application to inform integrative ecosystem-based management. Presented works addressed the aims of the session.

The use of species distribution or habitat suitability modeling approaches in marine science has increased dramatically in recent years. These models have been used to address issues related to species distribution, management and conservation, estimation of niche tolerances, and forecasting responses to climate change, among other applications. The literature for this area of research has grown to hundreds of papers, with all indications that practitioners are continuing to find novel applications of the data. It would appear timely for ICES to examine this topic in an ASC theme session and in the context of expert working groups.

The session was conducted over two days; on Wednesday 11 September the presentations were mainly focused on new methodologies, while on Thursday 12 September most presentations were focused on applications.

In terms of methodological advances, multiple studies showed how to incorporate new sources of data, such as video footage and high-resolution remote sensing (G. Gonzalez-Mirelis et al., CM Code: A:551, L Weston et al., CM Code: A:396), coupled climate model output (K.R. Tanaka et al., CM Code: A:237), hydroacoustic and underwater light regime data (R. Herrmann, CM Code: A:585), fisheries reporting (S. Funk et al., CM Code: A:308), or archival tag movement tracks (M.J. Schirripa et al., CM Code: A:155). Novel applications of recently developed methods were presented, such as Hierarchical Modeling of Species Communities (B. Weigel et al., CM Code: A:52) and min-max autocorrelation factor analysis (P. Petitgas et al., CM Code: A:329). Additionally, new predictors were tested and proved to significantly increase model performances, such as the connectivity between seascape habitat (G. Cecino et al., CM Code: A:84), thermal habitat characteristic (C.T. Hodgdon and Y. Chen, CM Code: A:152) and multi-species dynamics, represented as EOF (J. Thorson, CM Code: A:22). Contrary to most empirical approaches (data-driven) presented, B. Grieve et al. (CM Code: A:241) showed how a purely mechanistic modelling approach, using temperature and patch dynamics, could predict species habitat.

In terms of applications, habitat models help evaluate and design marine spatial planning and marine protected areas (J.M. Burgos et al., CM Code: A:447, W.N. Probst et al., CM Code: A:73, S. Woolley et al., CM Code: A:83). Additionally, habitat models were

successfully applied to estimate the risk of oil spills (I. Helle et al., CM Code: A:472), reduce by-catch (M. Ching Villanueva et al., CM Code: A:195, F.C Forrestal et al., CM Code: A:467), understand changes in community structure (K. Friedland et al., CM Code: A:125), evaluate the impact of anthropogenic changes on recreational fisheries (U. Bergström et al., CM Code: A:232), help guide sand dredging management (B. Pickens et al., CM Code: A:167), evaluate the impacts of climate change on North-East Atlantic species distributions (L.A. Rutterford, CM Code: A:305), describe benthic species distribution (P. Mayo and L. Kamphausen, CM Code: A:98), and assess habitat suitability of juvenile fish (E. J. Brown et al., CM Code: A:70).