

ESTIMATING SPATIAL AND TEMPORAL VARIABILITY OF MARINE SPECIES FROM OPPORTUNISTIC DATA: A NORTH SEA PLAICE CASE STUDY

Poos J.J.¹, G. Aarts^{1,2}, S. Vandemaele^{3,4}, W. Willems³ and A.T.M. van Helmond¹

¹ Institute for Marine Resources and Ecosystem Studies, Wageningen IMARES, PO Box 68, 1970 AB IJmuiden, the Netherlands
E-mail: janjaap.Poos@wur.nl

² Royal Netherlands Institute for Sea Research (NIOZ), PO Box 59, 1790 AB Den Burg, the Netherlands

³ Institute for Agricultural and Fisheries Research (ILVO Fisheries), Ankerstraat 1, B-8400 Oostende, Belgium

⁴ University of Antwerp, Groenenborgerlaan 171, B-2020 Antwerpen, Belgium

Major concerns have been raised regarding the state of living resources and the ecosystem they live in (Halpern *et al.*, 2008). Ecosystems are affected by a variety of human activities. Management and conservation of species in this changing environment requires a profound understanding of spatial ecosystem properties and trends.

However, most sampling programs measuring biological processes have either a good coverage in space, or a good coverage in time. Examples are marine mammal or fish surveys that occur only annually or even less frequently, and single spot continuous monitoring such as the 'Helgoland Roads' time series (Wiltshire *et al.*, 2010). If we are to understand the dynamic and spatiotemporally heterogeneous processes, intensive sampling in both space and time is required, especially in the marine environment where biological survey sampling is generally a logically complex, expensive, and time consuming operation (e.g. see Schiermeier, 2008). As a result, regular monitoring of relevant components in the marine environment is often lacking.

Complementary to the use of research vessels, sampling on board commercial vessels of opportunity can be a powerful strategy to monitor the distribution of species. Our objective is to estimate population distribution in space and time using such opportunistic data. In particular we use data on North Sea plaice (*Pleuronectes platessa*) caught and subsequently discarded on commercial fishing vessels (Catchpole *et al.*, 2005), estimated from discard sampling programs of the Dutch and Belgian fisheries. The limitations of these opportunistic data can be accounted for by employing spatial interpolation methods. Within-vessel or small scale residual spatial autocorrelation is accounted for by including a random effect of the intercept and incorporating a spatial correlation function into the error structure. This statistical method successfully reconstructs the spatio-temporal distribution based on opportunistic spatially non-uniform sampling.

Our results indicate that the discarded plaice are small juveniles, representing crude spatial abundance indices. Although the haul-specific observations of juvenile plaice appear highly variable in space and time, our results show a simple pattern of the gradual offshore movement of recruits from the nursery areas, corroborating earlier observations in the nursery areas (Bailey 1997).

The spatial distribution of the different age groups in our results clearly differs from that observed in the first half of the previous century (Beveton and Holt, 1957). The causes for the changes in migration patterns of juvenile plaice are unknown, but likely linked to changes in temperature, food availability, competition, or predation (Teal *et al.*, 2008).

The statistical model presented here could be used to combine data coming from annual research vessel surveys and vessels sampling opportunistically, covering a large part of the coastal waters in the eastern North Sea. Combining such data could lead to further insight into the seasonal spatial distribution of marine species.

References

Bailey K.M. 1997. Structural dynamics and ecology of flatfish populations. *J. Sea Res.* 37: 269-280.

Beveton R.J.H. and S.J. Holt. 1957. On the dynamics of exploited fish populations. Her Majesty's Stationery Office, London (UK).

Catchpole T.L., C.L.J. Frid and T.S. Gray. 2005. Discards in North Sea fisheries: causes, consequences and solutions. *Marine Policy* 29:421-430.

Halpern B.S., S. Walbridge, K.A. Selkoe, C.V. Kappel, F Micheli, C. D'Agrosa, J.F. Bruno, K.S. Casey, C. Ebert, H.E. Fox, R. Fujita, D. Heinemann, H.S. Lenihan, E.M.P. Madin, M.T. Perry, E.R. Selig, M. Spalding, R. Steneck and R. Watson. 2008. A global map of human impact on marine ecosystems. *Science* 319:948-952.

Schiermeier Q. 2008. Oil cost hits ship studies. *Nature* 454:372.

Teal L.R., J.J. De Leeuw, H.W. Van Der Veer and A.D. Rijnsdorp. 2008. Effects of climate change on growth of 0-group sole and plaice. *Marine Ecology Progress Series* 358:219-230.

Wiltshire K.H., A. Kraberg, I. Bartsch, M. Boersma, H.-D. Franke, J. Freund, C. Gebühr, G. Gerdts, K. Stockmann and A. Wichels. 2010. Helgoland Roads, North Sea: 45 years of change. *Estuar. Coasts* 33:295-310.