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REGIONAL POPULATION VIABILITY ANALYSIS PERFORMANCE FOR KEY BIRD SPECIES

PUFFINS

GUILLEMOTS

Background

The marine environment around Scotland offers considerable potential for offshore renewable development, providing sustainable energy solutions and reducing carbon emissions in Scotland. However, there is potential for offshore renewables to negatively impact populations of seabirds, either directly through mortality via collisions or indirectly, for example, via reduced breeding success through displacement or barrier effects. As such, seabird populations are assessed for predicted impacts, alone and in combination from renewable developments, commonly using Population Viability Analysis (PVA). PVA is a general term for demographic forecasting models which predict the robustness of a population to scenarios of risk comparative to an un-impacted baseline. There are a number of methods of PVA varying in process, complexity and data sensitivity. Consequently, there are concerns over model assumptions, associated uncertainty, model performance and user transparency. Currently there is a lack of evidence to inform guidance as to which PVA model is best suited to the specifics of the population being analysed. The Centre for Ecology and Hydrology (CEH) together with Biomathematics and Statistics Scotland (BioSS) were commissioned under the Scottish Government’s Contract Research Fund to evaluate performance of a range of PVA methods and provide recommendations on the appropriateness and limitations of these in order to facilitate method choice and appropriateness of application for assessment circumstance.

Approach

Data from colony counts, breeding success and where available, survival, across 10 different scales, ranging from local (i.e. site-level) to ‘global’ (i.e.British Isles) regions (Figure 1) were

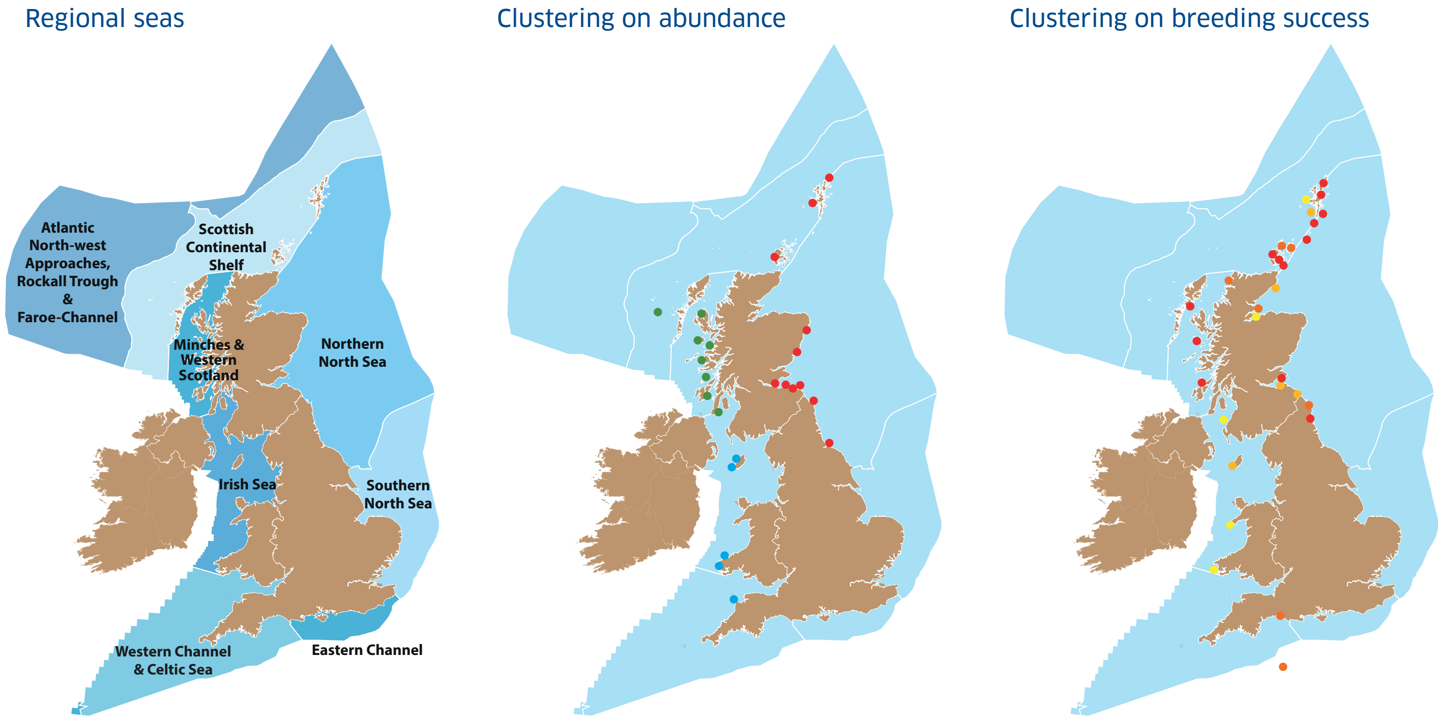

FIGURE 1.
EXAMPLE OF REGIONS USED FOR DATA POOLING WITHIN POPULATION MODELLING METHODS

gathered for 15 species of seabirds: (northern gannet, fulmar, great cormorant, European shag, Arctic skua, black-legged kittiwake, herring gull, lesser black-backed gull, great black-backed gull, common tern, sandwich tern, little tern, common guillemot, razorbill and Atlantic puffin). Seven methods for PVA were identified from literature and assessment and categorised based on the processes underpinning their forecasting, namely: time-series models, Leslie-matrix models and a semi-integrated population model (SIPM) (Table 1).

To assess model performance abundance data for each seabird species, at each scale was split into training and test data. Training data were data prior to the start of the test data that were available to estimate the test data: those abundance estimates for years post training period. The ability of each model to then estimate the abundance in the test years was used as an overall comparison of performance. In reality, some wildlife populations have more data collected than others, consequently models were assessed under different time periods of training and testing data. Four test periods were used for the time-series and Leslie matrix models:

- 5 years (2013 – 2017)
- 10 years (2008 – 2017)
- 15 years (2003 – 2017)
- and 20 years (1998 – 2017)

The SIPM model could only be assessed using the 5 year testing period as the data requirements for such an approach were only available for one year (2012) prior to the test period. Models were evaluated on seven criteria:

- the ability to run
- occurrence of highly implausible results
- lack of systematic bias
- low error in specific situations
- reliable quantification of uncertainty
- level of uncertainty
- and ease of computation

Method	Model type	Specific model	Type of data required	Minimum data requirements	Survival rates
ATG	Abundance time series models	Simple growth model	Abundance	10 years+ in TP for which abundance data are available in both current and previous year	Not relevant
ATR		Ricker	Abundance		
ATZ		Gompertz	Abundance		
LDN	Leslie matrix models	Deterministic	Demographic rates	1+ years breeding success data in TP, and 1+ years abundance data in TP	National
LDF					Forth-Tay
LMN		Stochastic – constrained productivity	Demographic rates	2+ years breeding success data in TP, and 1+ years abundance data in TP	National
LMF			Demographic rates		Forth-Tay
LUN		Stochastic – unconstrained productivity	Demographic rates		National
LUF			Demographic rates		Forth-Tay
IPM/ SIPM	Semi-integrated population model	Bayesian semi-integrated model	Abundance and demographic rates	All available data : demographic and abundance	Forth-Tay

TABLE 1.
SUMMARY OF PVA METHODS, AND MINIMUM DATA REQUIREMENTS FOR EACH METHOD. “TP” DENOTES THE TRAINING PERIOD

Not all methods could be applied in all situations and so additional evaluations on test period performance were made using those species and colonies for which it is possible to run all methods.

Findings

Results suggested model performance depended on a variety of factors with no obvious best performer under all circumstances. Integrated and semi-integrated population models are described as the gold standard of predictive population modelling, however these approaches often have data requirements that were not met frequently enough for commonplace use often because we lack demographic data on survival and breeding success. Leslie-matrix models were found to be less accurate in predictions than time-series models, likely to be due to the availability of abundance and count data comparative to demographic rate data, but were more appropriately applied in many situations, due to both their biological realism and their data requirements. Stochastic Leslie-matrix models using only demographic rates consistently underestimated uncertainty in the test periods. In contrast, time-series models though often simple and biologically unrealistic, often captured the observed abundance data during testing, however, they often produced large confidence intervals (uncertainty) within that estimate. Using the mean rather than the median to estimate abundance under some scenarios across all models but particularly time-series models often gave highly implausible results, because of sensitivity in the mean to extreme values.

Recommendations

Support is given to the continued use of SIPMs and IPMs where circumstances allow. In general, Leslie-matrix models are recommended as the most biologically realistic and adaptable for use in assessments (Figure 2), with the added marinescotland

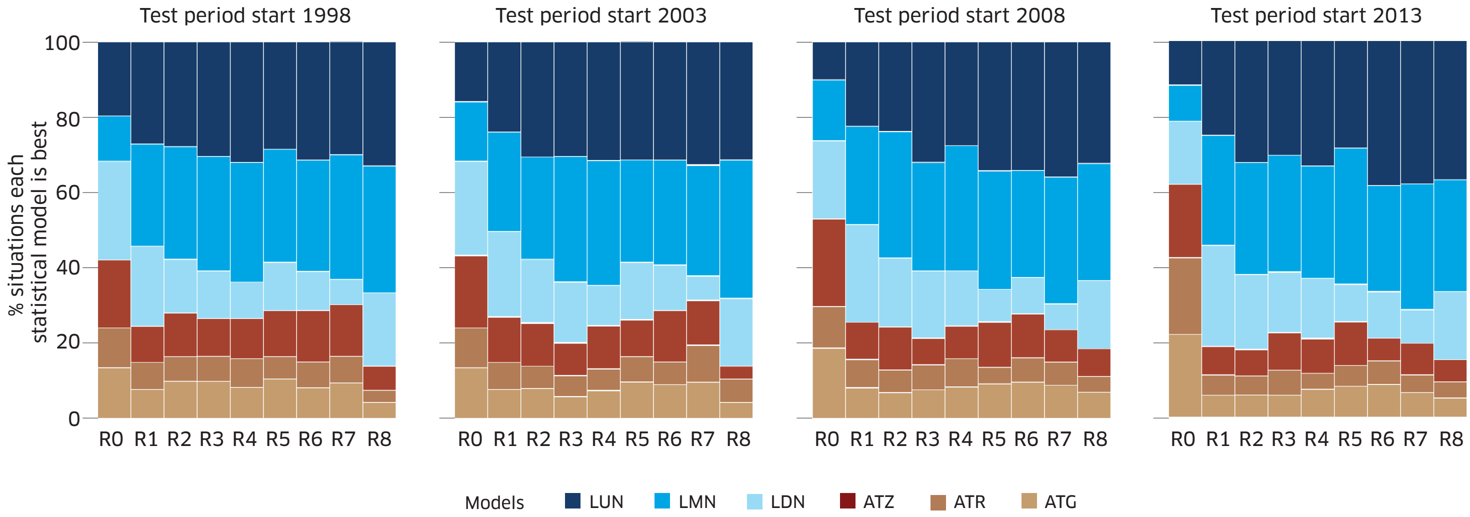

FIGURE 2.
PERCENTAGE OF SPECIES-COLONY-YEAR COMBINATIONS FOR WHICH EACH STATISTICAL METHOD HAS THE BEST PERFORMANCE, CALCULATED SEPARATELY FOR EACH POOLING METHOD AND EACH TEST PERIOD DEFINITION. PERCENTAGES WERE CALCULATED USING ALL SPECIES, COLONY, YEAR COMBINATIONS.

Reporting regions were: R0: site level; R1: SMP regions; R2: ICES regions; R3: JNCC regional seas; R4: Cook & Robinson Abundance; R5: Cook & Robinson Breeding Success; R6: MSFD; R7: OSPAR; R8: Global (all colonies in England, Northern Ireland, Scotland, Wales, Channel Islands and Isle of Man).

recommendation that where adequate abundance data are available, the demographic rates are adjusted (tuned) to relate to the abundance data, reducing uncertainty in forecasting. Where abundance data are minimal, the study highlights again the systematic underestimation of uncertainty in untuned, standard Leslie-matrix approaches and cautions that current estimates derived from such method should be considered underestimated. Further research into estimating correlations in demographic data are recommended to help resolve this issue.

The full report is available to view follow the link below.

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