



The spatial predictive ability of presence-only habitat suitability models: comparisons across macro-ecological scales

Tetley, M.J. (1) & Mitchelson-Jacob E.G. (2)

(1) School of Ocean Sciences, Bangor University, LL59 5AB, UK_m.j.tetley@bangor.ac.uk (2) Centre for Applied Marine Sciences, Menai Bridge, Anglesey, LL59 5AB, UK

BACKGROUND & ANALYSIS

1. Background

The use and availability of ecological niche models (ENMs) has become widespread throughout terrestrial and marine ecosystem studies. However, many techniques available still require rigorous testing before acceptable implementation into legislation and conservation action (Macleod *et al.*, 2008). This is also true for the spatial exportability of model predictions, both within and beyond surveyed areas and habitats.

2. Analysis

In this multi-site investigation, ranging across the North Atlantic (Canada, Iceland, Ireland & Scotland), we compared the predictive capabilities of a suite of ENM algorithm types (PCA, ENFA, Bioclim, Domain & Maxent) when applied to the niche modelling of the common minke whale (*Balaenoptera acutorostrata*). Models validated using a receiver operator characteristic (ROC) approach (of 100 optimal iterations after Phillips *et al.*, 2006) with comparisons conducted to ensure equal testing both within and between study sites.

3. Results

Study results showed that, whilst only considering one area of presence occurrence (e.g. Training=Scotland, Testing=Scotland), machine learning tools (Maxent $AUC=0.90$) outperformed other enveloping (Bioclim/Domain $AUC=0.80$) and ordination (PCA/ENFA $AUC=0.70$) techniques (Figures 1 & 2). When comparing predictive success between non-contiguous sites across the North Atlantic (e.g. Training=Canada, Testing=Scotland) simple ordination remained effective ($AUC=0.60$) whilst machine learning tools and enveloping techniques performed at or below random probabilities ($AUC=0.50$) (Figure 3).

4. Concluding Remarks

It is the opinion of the authors that, with respects to areas and spatial scales of species presence which are suitably sampled, machine learning tools (e.g. Maxent), being comparable to presence-absence techniques such as GAMs, are most suitable for use (Praca *et al.*, 2008). However should areas, being either distinct or adjacent to that of species presence, need to be assessed for potential habitat suitability then simple ordination statistics (e.g. PCA and ENFA) should be employed. These findings mirror other studies determining the predictive vs. descriptive capabilities of ENM techniques (Valavanis *et al.*, 2008) and is considered important if undertaking studies aimed at either species, population or macro-ecological scales.

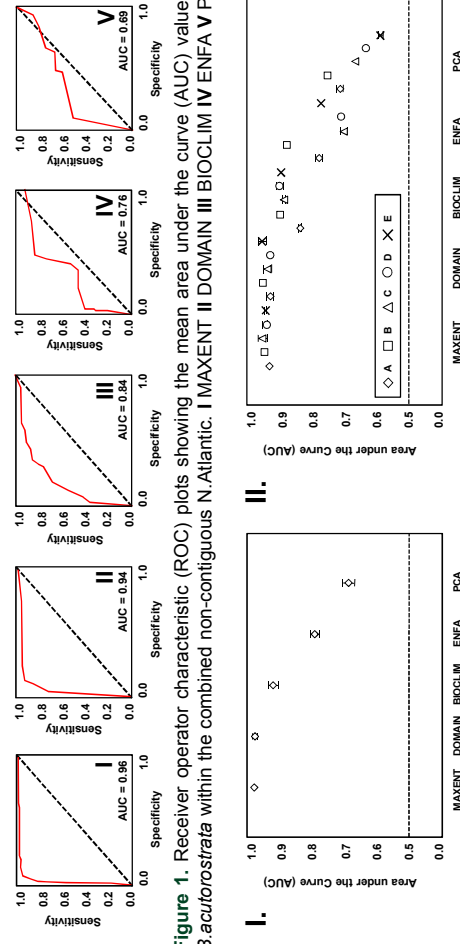


Figure 1. Receiver operator characteristic (ROC) plots showing the mean area under the curve (AUC) values for *B. acutorostrata* within the combined non-contiguous N-Atlantic. I MAXENT II DOMAIN III BIOCLIM IV ENFA V PCA.

Figure 2. Interval plots of mean AUC value produced for modelled *B. acutorostrata* presence, comparing ENM types tested, for both I. combined presence database and II. geographically distinct presence localities. A St. Lawrence Estuary, Quebec B Atlantic Coast, Nova Scotia C Skjalfandi Bay, Iceland D Blasket Islands, Ireland E Outer Moray Firth, Scotland). 95% confidence intervals and random probability ($AUC=0.5$) threshold (dashed-line) are shown.

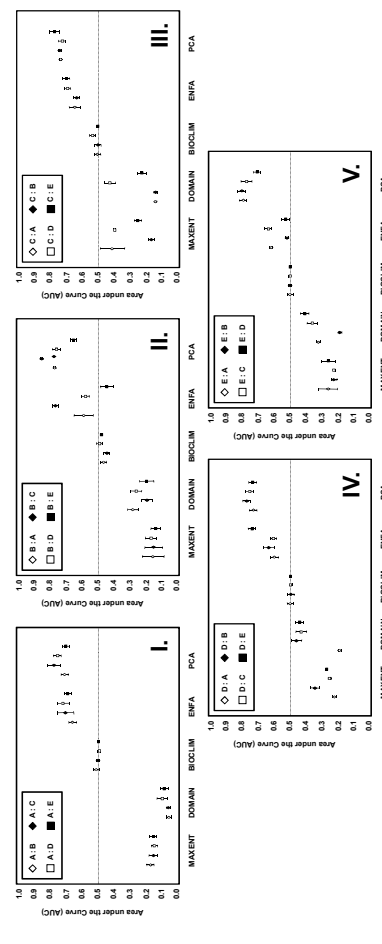


Figure 3. Interval plots of mean AUC values comparing model types tested between areas studied (I. Training A.II. Training B.III. Training C.IV. Training D.V. Training E) See Figure 2 for area codes. 95% confidence intervals and random probability ($AUC=0.5$) thresholds (dashed-line) are shown.

ACKNOWLEDGMENTS



REFERENCES

Macleod, C.D., Mandelberg, L., Schweder, C., Bamton, S.M. & Pierce, G.J. (2008) A comparison of approaches for modelling the occurrence of marine animals. *Hydrobiologia*, 612, 21-32
 Phillips, S.J., Anderson, R.P. & Schapire R.E. (2008) Maximum entropy modelling of species geographic distributions. *Ecol Model* 190: 231-259
 Praca, E., Ganner, A., Das, K. & Laran, S. (2009) Modelling the habitat suitability of cetaceans: Example of the sperm whale in the northwestern Mediterranean Sea. *Deep Sea Research Part I: Ocean Res Papers*, 55(4), 646-657
 Valavanis, V.D., Pierce, G.J., ... (2008) Modelling of essential fish habitat based on remote sensing, spatial analysis and GIS. *Hydrobiologia*, 612: 5-20

