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14. ABSTRACT The object of this proposal was to characterize known beaked whale habitat and create a predictive beaked whale habitat model the Gulf of Mexico and east coast of the United States using available beaked whale sighting data in combination with bathymetry and remotely sensed oceanographic data. To accomplish this objective, three specific tasks were required: to establish a sighting and stranding database in a Geographic Information System (GIS) framework, create a database of oceanographic data on a corresponding spatial and temporal scale, and create/optimize a spatial statistical model for predicting beaked whale presence and absence.

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PRINCIPAL INVESTIGATOR: Jessica A. Ward

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OBJECTIVE: Development of a centralized database of beaked whale sighting and stranding data; incorporation of the database into a Geographic Information System (GIS); characterization of the relationship between beaked whale presence and oceanographic variables potentially representative of their habitat; and development of a statistical beaked whale habitat prediction model to provide Navy environmental planners with maps of known and predicted habitat.

APPROACH: The research and collection of beaked whale sighting and stranding data was primarily performed as a separate effort by our collaborators, Colin MacLeod and Angela D'Amico, at the University of Aberdeen and Space and Naval Warfare Systems Center, respectively. NUWC obtained data from the Northeast and Southeast Fisheries Science Centers as well as from several other sources in western North Atlantic. This data was input into a Microsoft Access database using a standard attribute format agreed upon by the three collaborators. Once the database was complete, the data was input into ESRI ArcGIS, a geographic information system.

Three study areas were chosen based upon the availability of survey data with effort: the Gulf of Mexico (GOM), South-East United States (SEUS), and North-East United States (NEUS). Known beaked whale distributions within each of three study areas were characterized using standard statistical methods. Statistical classification models were then developed using predictive linear discriminant analysis, a generalized linear model (logistic regression), and Environmental Niche Factor Analysis. Static models, using bathymetry and derived variables, as well as dynamic models using time-variant remotely sensed data in addition to the static variables, were developed. Each of the static models was assessed using a 5, 10 and 15 arc-minute spatial resolution. The dynamic model was evaluated using a 15 arc-minute spatial resolution. The classification effectiveness of each model using all combinations of available oceanographic variables was compared and an optimal model for each study area recommended.

ACCOMPLISHMENTS: Beaked whale habitat optimal classification rates varied from 73.3% to 81.3% for the static models and from 75.54% to 80.26% for the dynamic models of each study area (Table 1). The classification rate for correctly predicting a beaked whale present ranged from 79.3% to 100.0% for the static models and from 85.7% to 94.45% for the dynamic models. For all models, the ability to correctly classify habitat in which beaked whales were known to be present exceeded the classification rate of cells in which beaked whales were observed absent, an expected result given the difficulties inherent in collecting absolute presence/absence survey data.

Table 1. Summary of Beaked Whale Habitat Prediction Models with Optimal Classification Effectiveness

Study Area	Static Mean % Correct	Cell Resolution (minutes)	Observed Sighting Rate	Dynamic Mean % Correct	Cell Resolution (minutes)	Observed Sighting Rate
GOM	77.0 %	5	1.6 %	80.3 %	15	1.4 %
SEUS	81.3 %	5	0.3 %	n/a	15	n/a
NEUS	73.3 %	15	13.3 %	75.5 %	15	11.6 %

CONCLUSIONS: Beaked whale habitat prediction has been demonstrated as a promising and effective statistical technique for defining beaked whale habitat in regions where minimal or incomplete survey coverage exists. With input from our collaborators, a comprehensive database of beaked whale sightings and strandings was created. Maps of this data, in addition to predicted habitat maps for the three study areas, were developed in a GIS. While many GIS habitat models are limited to static, time invariant models, this study also assessed if the model could be improved by adding time variant oceanographic parameters derived from remotely sensed SST imagery and modeled SSH anomaly. The addition of these time-variant oceanographic parameters slightly improved the classification rates for the GOM and NEUS despite the decrease in observed sighting rate due to the addition of many absence cells using this methodology (Table 1). From this, one may conclude that while the predictive power of the dynamic model only increased slightly, the accuracy of the prediction was substantially increased using time variant oceanographic parameters.

SIGNIFICANCE: The beaked whale predicted habitat maps produced by this study are an excellent resource for environmental planners trying to develop a better understanding of beaked whale distribution. For long range planning, the static habitat prediction maps provide a broad assessment of predicted presence with no additional input required.

PATENT INFORMATION: No patent application was submitted.

AWARD INFORMATION: February 2002, University of Rhode Island Alumni Association Excellence Award in Science and Technology

PUBLICATIONS AND ABSTRACTS:

1. Ward, J. A., G. Mitchell, A. Farak, and E. Keane (2004) Beaked Whale Habitat Characterization and Prediction. NUWCNPT Technical Report 11,548. Naval Undersea Warfare Center Division, Newport. (in press)