AgriCos e-Newsletter
ISSN: 2582-7049
AgriCos e-Newsletter
Open Access Multidisciplinary Monthly Online Magazine
Volume: 04 Issue: 11 November 2023 Article No: 28

Habitat Suitability for Marine Fish Distribution

M. Ponmani[1], S. Manickavasagam[2], P. Padmavathy[1] and D. Manimekalai[1]
[1]Department of Aquatic Environment Management, TNJFU - Fisheries College and Research Institute, Thoothukudi, Tamil Nadu
[2]Assistant Professor, TNJFU-DSA, Thanjavur Centre for Sustainable Aquaculture, Thanjavur, Tamil Nadu

SUMMARY

This abstract provides an overview of the critical concept of habitat suitability as it relates to the distribution of marine fish. Understanding the ecological preferences of different fish species and the factors that influence their habitat choices is of paramount importance in the field of marine ecology and fisheries management.Marine fish distribution is intricately linked to habitat suitability, which encompasses a range of environmental factors such as temperature, salinity, depth, substrate, and food availability. These factors collectively shape the spatial and temporal distribution of fish populations within aquatic ecosystems. The identification and quantification of suitable habitats are crucial for effective conservation and sustainable fisheries management. Various tools and methodologies, including remote sensing, GIS (Geographic Information Systems), and hydroacoustic technology, have been employed to assess habitat suitability. These techniques aid in mapping and modeling the spatial distribution of marine fish and the environmental variables that influence their presence. By exploring the dynamic relationship between marine fish and their preferred habitats, this research contributes to a deeper understanding of the ecological dynamics within marine ecosystems. Furthermore, it informs resource management strategies, conservation efforts, and sustainable fishing practices. The study of habitat suitability for marine fish distribution is an essential component in safeguarding the health and resilience of marine ecosystems and ensuring the long-term viability of commercial and recreational fisheries.

INTRODUCTION

Marine ecosystems are home to an astonishing array of fish species, each uniquely adapted to a specific set of environmental conditions. The distribution of these species within the vast expanse of the world's oceans is not random; it is intricately linked to the concept of habitat suitability. Understanding the factors that govern the selection and distribution of suitable habitats for marine fish is of paramount importance in the realms of ecology, conservation, and fisheries management. Habitat suitability refers to the compatibility between the environmental conditions of a given area and the ecological requirements of a particular fish species. These environmental conditions encompass a complex interplay of physical and biological factors, including temperature, salinity, depth, substrate, prey availability, and water quality. The dynamic nature of these factors results in a patchwork of habitats that vary in their suitability for different fish species. This research explores the fundamental question of why fish inhabit specific regions within marine environments, delving into the ecological preferences and behavior that drive their choices. By gaining insights into habitat suitability, we can unlock the mysteries of marine fish distribution, predict their movements, and make informed decisions regarding resource management and conservation. The study of habitat suitability for marine fish distribution is an essential component in safeguarding the health and resilience of marine ecosystems. It provides valuable information for the sustainable management of commercial and recreational fisheries, aids in the preservation of biodiversity, and contributes to our broader understanding of the intricate relationships that shape the underwater world. In this pursuit, we embark on a journey to unravel the factors that define where marine fish choose to call home.

Habitat suitablity models for marine fish distribution

Habitat suitability models, often referred to as habitat suitability assessments or habitat suitability modeling, are a set of analytical tools and approaches used in ecology and environmental science to predict and assess the suitability of specific habitats for various species or ecological communities. These models are essential for understanding species distribution, habitat quality, and ecosystem dynamics. They typically involve the following components:

Environmental Variables: Habitat suitability models rely on environmental data, including physical, chemical, and biological parameters, such as temperature, salinity, water depth, substrate type, food availability, and other habitat features. These variables are essential in characterizing the habitat conditions.

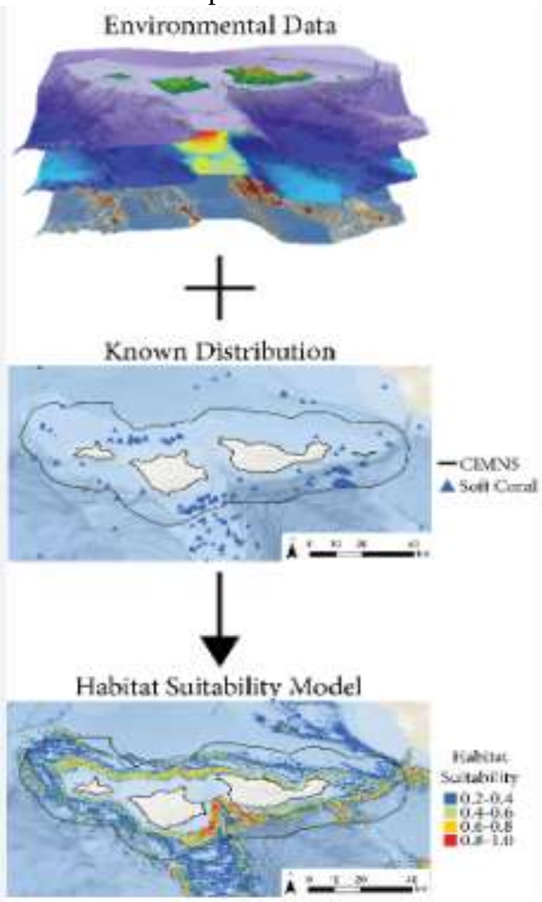
Species Data: These models use species-specific data, which can include the preferences, requirements, and limitations of a particular species. This information helps in identifying which environmental conditions are suitable for a given species.

GIS and Spatial Analysis: Geographic Information Systems (GIS) play a central role in habitat suitability modeling. GIS software is used to map, analyze, and visualize spatial data, including environmental variables and species distributions. Spatial analysis tools are employed to create predictive maps and assess habitat suitability across geographic areas.

Modeling Techniques: Various modeling techniques are applied to assess habitat suitability. Common methods include logistic regression, MaxEnt (Maximum Entropy), species distribution modeling (SDM), and machine learning algorithms like Random Forest and support vector machines. These methods use environmental variables and species occurrence data to predict suitable habitat areas.

Validation and Evaluation: Models are evaluated and validated to ensure their accuracy and reliability. This often involves comparing model predictions to independent data or conducting statistical assessments to measure the model's performance.

Mapping and Visualization: The output of habitat suitability models is usually presented as maps, where different areas are color-coded to represent varying degrees of suitability. These maps help researchers and decision-makers visualize suitable habitat areas and plan conservation or management strategies.



Applications of Habitat suitability models:

Conservation: Assessing suitable habitats for endangered or threatened species to aid in conservation efforts.

Fisheries Management: Identifying areas where fish species are likely to thrive, which can inform sustainable fishing practices.

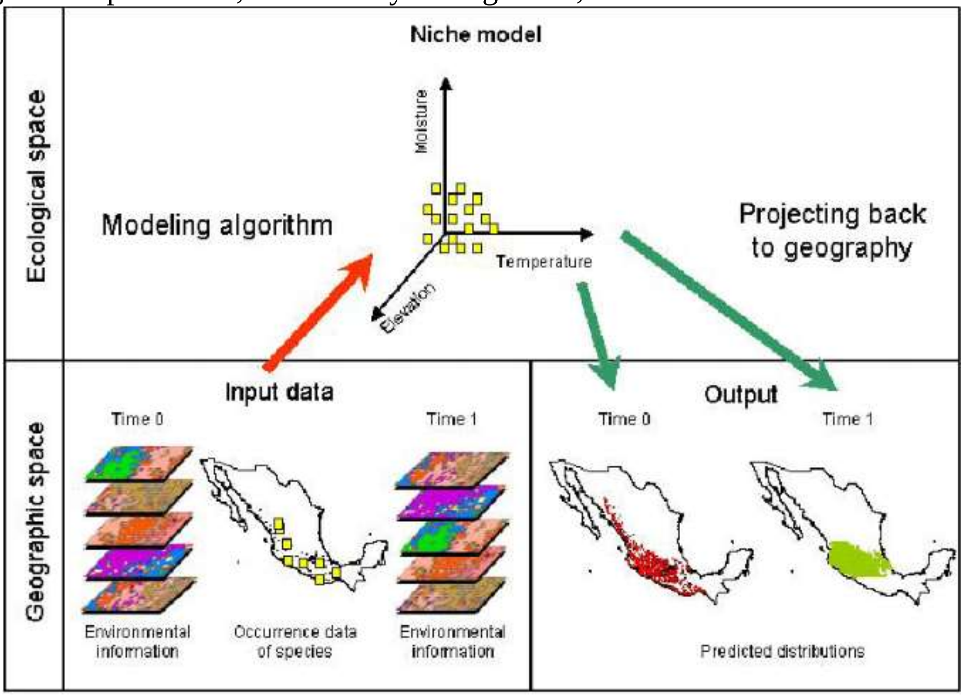
Land Use Planning: Assisting in land use decisions by considering the impact on wildlife habitats.

Climate Change Studies: Predicting how changing environmental conditions may affect the distribution of species in the future.

Invasive Species Management: Assessing areas vulnerable to invasive species establishment.

Ecological niche modeling (ENM):

It is a sophisticated computational tool used to predict the potential geographic distribution of species or ecological communities. It leverages environmental data, such as climate, topography, and land cover, in conjunction with species occurrence records to model the ecological requirements of organisms. ENM algorithms, including MaxEnt and machine learning techniques, establish statistical relationships between environmental conditions and species occurrences. This modeling approach is firmly rooted in the concept of ecological niches, representing the specific environmental factors necessary for a species to survive and reproduce. The resulting predictive maps illustrate areas where these conditions are met, with varying degrees of suitability. ENM finds applications in diverse fields, from species conservation and invasive species management to disease ecology and climate change impact assessment. It equips researchers, conservationists, and decision-makers with valuable insights into species distributions and their responses to changing environmental factors, facilitating informed decisions regarding habitat protection, biodiversity management, and resource conservation.

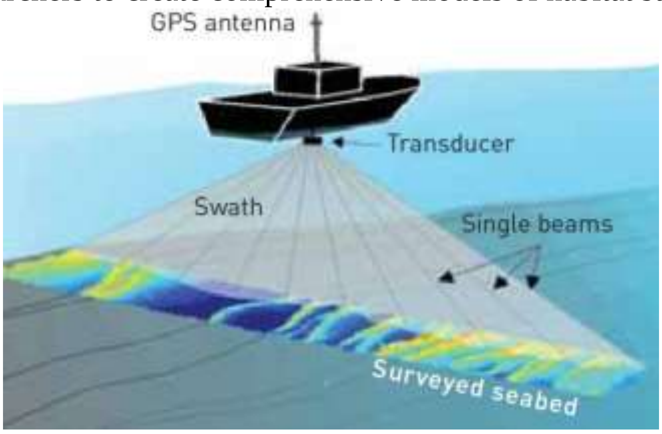


Habitat suitability for marine fishes using presence-only modeling

- Assessing habitat suitability for marine fishes through presence-only modeling is a valuable method that relies on species occurrence data, typically obtained from sources like fisheries records, bycatch observations, or citizen science initiatives. Unlike traditional abundance data, presence-only modeling works with the knowledge of where a species has been observed or captured, without quantifying the absence of the species in other locations. This approach offers several advantages, such as its capacity to incorporate historical data and its suitability for species that are challenging to sample comprehensively.
- Presence-only modeling integrates these species occurrence records with environmental data, which can encompass variables like water temperature, salinity, substrate type, and oceanographic features. By analyzing the association between species occurrences and environmental conditions, these models generate predictive maps of habitat suitability. These maps indicate where the environmental conditions are likely to be favorable for the species, which is crucial for conservation and fisheries management.
- Presence-only modeling has proven to be especially beneficial in marine fisheries research, as it allows for the assessment of habitat suitability for multiple species in a cost-effective and data-efficient manner. This approach aids in identifying critical habitats for various fish species, informing spatial management strategies, and contributing to a more comprehensive understanding of the complex interactions between marine fishes and their environments. Moreover, it offers insights into the potential impacts of environmental changes on fish distributions, making it a valuable tool for adapting to and mitigating the effects of climate change in marine ecosystems.

Habitat suitability for marine fishes using multibeam sonar

Assessing habitat suitability for marine fishes has seen significant advancements with the integration of cutting-edge technology like multibeam sonar. This innovative approach utilizes multibeam sonar, which provides high-resolution bathymetric and substrate information of the seafloor, to enhance our understanding of the underwater environment. Multibeam sonar technology employs sound waves to measure the depths and contours of the seafloor with remarkable precision, offering detailed insights into the underwater landscape. It not only reveals the topography but also helps identify the composition and texture of the substrate. These data, when combined with information on species occurrences and environmental variables like water temperature and salinity, enable researchers to create comprehensive models of habitat suitability for marine fishes.



By fusing multibeam sonar data with species distribution information and environmental factors, these models offer a more holistic perspective on the ecological preferences and requirements of fish species. They can identify suitable habitats, spawning grounds, and foraging areas, contributing to more effective fisheries management and conservation efforts. Moreover, they help in understanding the impacts of habitat changes and human activities on fish populations, making multibeam sonar a valuable asset in the endeavor to safeguard marine biodiversity and ensure sustainable marine resource management.

CONCLUSION:

The assessment of habitat suitability for marine fish distribution is a critical undertaking with far-reaching implications for marine ecology, fisheries management, and conservation efforts. By incorporating various data sources and advanced modeling techniques, we gain valuable insights into the ecological preferences and habitat requirements of marine fish species. Habitat suitability models, often driven by environmental data and species occurrence records, provide a predictive framework to understand where fish species are likely to thrive within the complex marine environment. These models are instrumental in multiple aspects, including sustainable fisheries management, the conservation of endangered or threatened species, and the assessment of the impacts of climate change on marine ecosystems. Moreover, the integration of innovative technologies like multibeam sonar has greatly enhanced our ability to characterize the underwater landscape and substrate composition, adding a new dimension to our understanding of marine habitats. This technology has revolutionized our capacity to map and model marine habitats with remarkable precision, ultimately contributing to more effective habitat suitability assessments.

REFERENCES:

Guisan, A., & Thuiller, W. (2005). Predicting species distribution: offering more than simple habitat models. Ecology Letters, 8(9), 993-1009.

Elith, J., & Leathwick, J. R. (2009). Species distribution models: ecological explanation and prediction across space and time. Annual Review of Ecology, Evolution, and Systematics, 40, 677-697.

Kearney, M., & Porter, W. (2004). Mapping the fundamental niche: physiology, climate, and the distribution of a nocturnal lizard. Ecology, 85(11), 3119-3131.

Marmion, M., Parviainen, M., Luoto, M., Heikkinen, R. K., & Thuiller, W. (2009). Evaluation of consensus methods in predictive species distribution modelling. Diversity and Distributions, 15(1), 59-69.

Wenger, S. J., Olden, J. D., & Jackson, D. A. (2018). Predictive accuracy of species distribution models made with presence-only data for the submersed aquatic macrophyte Vallisneria americana. Ecological Modelling, 385, 21-30.