Journal of Fish Health
Volume 4, Issue 4, November 2024
https://doi.org/10.29303/jfh.v4i4.5823

Mapping Potential Fishing Zones for Skipjack Tuna (*Katsuwonus pelamis*) Using Satellite Imagery

Angraeni[1*], Syeiqido Sora Datu[1], Nurfaidah[2], Rahmatang[3]

[1]Fisheries Science Study Program, Faculty of Science and Technology, Cahaya Prima University, Jl. Jend. Urip Sumoharjo, Watampone, Sulawesi Selatan
[2]Fishery Product Technology Study Program, Faculty of Fisheries and Marine Sciences, Mulawarman University, Jl. Gn. Kelua, Gn. Tabur, Samarinda Ulu, Kalimantan Timur
[3]Fishing Engineering Study Program, Fisheries Polytechnic, Jalan Jend. Soedirman, Kabupaten Bone, Sulawesi Selatan

***Correspondence**:
angraenidafiruddin@gmail.com

Received : 09-24-2024
Accepted : 10-24-2024

Keywords:
Chlorophyll-a, Salinity, Satellite Image, Sea Surface Temperature, Skipjack

ABSTRACT

Fisheries are an important economic sector for many countries, including Indonesia. Bone Bay has high potential for skipjack (*Katsuwonus pelamis*) fishing. This study aims to map potential skipjack fishing zones in Bone Bay and analyze the relationship between sea surface temperature, salinity, and chlorophyll-a concentration with the catch of these fish. Using quantitative methods and probability sampling techniques, primary data were obtained through direct observation of fishing activities using the pole and line method, while secondary data were obtained from satellite images downloaded from the Oceancolor website. The results showed that the potential zones for skipjack fishing are located at coordinates 3°0'0"LS-4°30'0"LS and 120°30'0"BT-121°0'0" BT. The findings are expected to help stakeholders make strategic decisions for more effective and susstainable fisheries management.

INTRODUCTION

Fisheries represent a crucial economic sector in Indonesia, especially for coastal communities that rely on marine resources for their livelihoods. Among the various fish species harvested, skipjack tuna (*Katsuwonus pelamis*) holds significant economic value and enjoys high market demand, both domestically and internationally (Amalia *et al*., 2023; Mustaqimah *et al*., 2023; Sumbu *et al*., 2023). One region renowned for its substantial potential in skipjack tuna fishing is Bone Bay (Pitcher *et al*., 2024). This potential must be optimally utilized to ensure the sustainability of marine resources and improve the well-being of coastal communities.

However, efforts to maximize catch yields often face challenges due to the dynamic variability of marine environmental conditions. Factors such as sea surface temperature, salinity, and chlorophyll-a concentration are key oceanographic parameters influencing the distribution and abundance of fish in a given area (Bharti *et al*., 2020; Retraubun *et al*., 2023). Therefore, mapping potential fishing zones based on oceanographic parameters can serve as an effective tool to assist fishermen in identifying optimal fishing locations, thereby enhancing the efficiency of fishing operations (Sivasankari *et al*., 2024).

With advancements in technology, the use of satellite imagery has become an increasingly common method for monitoring and managing fisheries resources. This technology enables more accurate and comprehensive analysis of relevant oceanographic parameters (Ali *et al*., 2022; Kamaruzzaman & Ahmad Mustapha, 2023; Syms, 2022). This study aims to analyze the relationships between sea surface temperature, salinity, and chlorophyll-a concentration with skipjack tuna catches in Bone Bay and to map potential fishing zones using satellite imagery. The findings of this research are expected to contribute significantly to decision-making for more efficient and sustainable fisheries resource management while supporting the sustainability of marine ecosystems.

METHODS

This study aims to map potential fishing zones for skipjack tuna (*Katsuwonus pelamis*) in Bone Bay based on oceanographic parameters, namely sea surface temperature, salinity, and chlorophyll-a concentration, using satellite imagery data. The research methodology employed is as follows:

Research Design

This study employs a quantitative method with a survey approach and secondary data analysis. Primary data were collected through direct field observations using standard oceanographic instruments, while secondary data were obtained from official sources providing satellite imagery with specific spatial and temporal resolutions.

Research Location and Duration

The research was conducted in the waters of Bone Bay, South Sulawesi, Indonesia, during June-July 2024, as this area has high potential for skipjack tuna fishing.

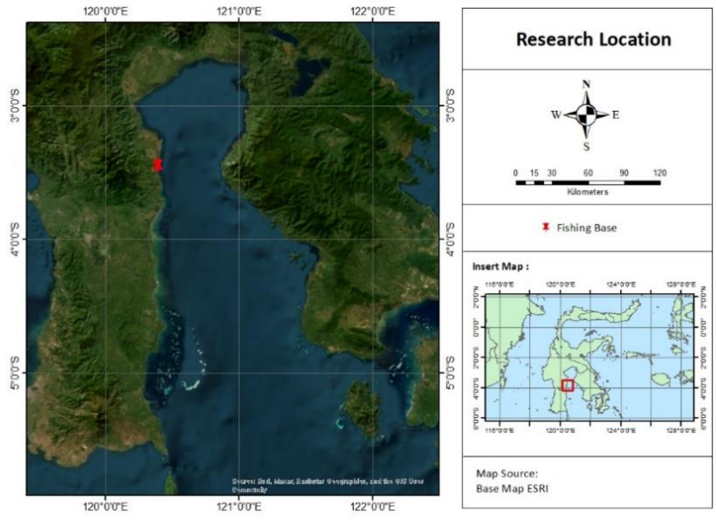

Figure 1. Research Location

Data Collection

a. Primary Data

Primary data were obtained through direct field observations by participating in fishing activities conducted by fishermen using the pole-and-line method. During these activities, data on catch volumes and local oceanographic conditions (temperature, salinity) were recorded during fishing operations.

b. Secondary Data

Secondary data included satellite imagery of sea surface temperature and chlorophyll-a concentration, downloaded from the OceanColor website at *https://oceandata.sci.gsfc.nasa.gov/*. Salinity data were obtained from the Copernicus website at *https://data.marine.copernicus.eu/products*. These datasets covered the same period as the primary data collection and were processed into appropriate formats for further analysis.

Data Analysis

a. Oceanographic Parameter Analysis

Satellite imagery data were analyzed to determine the distribution of sea surface temperature, salinity, and chlorophyll-a concentration using software such as SeaDAS, Ocean Data View, and ArcGIS.

b. Modeling Potential Fishing Zones

Based on the analyzed data, a model for skipjack tuna potential fishing zones was developed by correlating oceanographic parameters with locations and catch data from primary sources. This model was then visualized as a map of potential fishing zones.

c. Model Validation

The model's validity was tested by comparing the modeling results with field data not used in the modeling process. This was done to ensure the developed model could provide accurate predictions of potential skipjack tuna fishing zones.

RESULTS

Oceanographic Parameter Analysis

This study demonstrates a significant relationship between oceanographic parameters (sea surface temperature, salinity, and chlorophyll-a concentration) and skipjack tuna catch rates in Bone Bay.

Sea Surface Temperature (SST):

Sea surface temperature distribution ranges from 27°C to 30°C. The highest skipjack tuna catch rates were observed at temperatures between 28°C and 29°C. Temperatures higher or lower than this range tend to result in fewer catches.

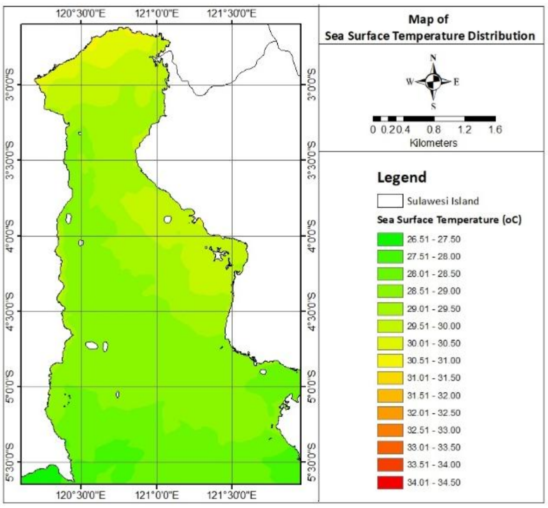

Figure 2. Sea Surface Temperature Distribution

Salinity

Salinity in Bone Bay waters ranges from 33 ‰ to 35 ‰. High skipjack tuna catches tend to occur in waters with salinity between 34 ‰ and 35 ‰, indicating that skipjack tuna prefer waters with higher salinity levels.

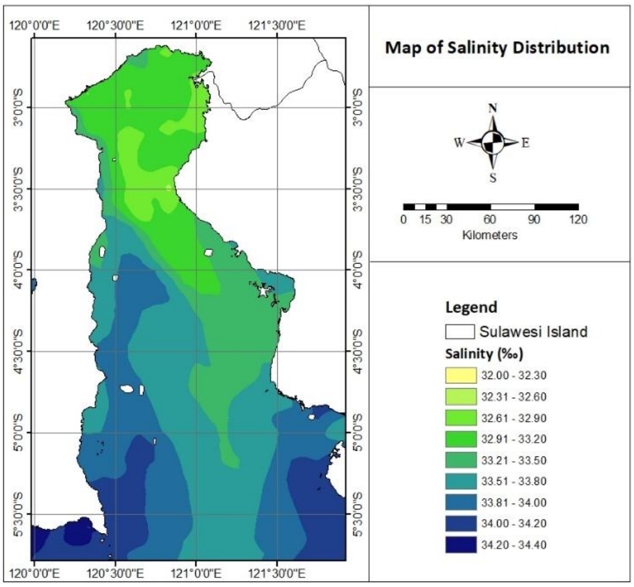

Figure 3. Salinity Distribution

Chlorophyll-a:

Chlorophyll-a concentrations measured in this study ranged from 0.2 mg/m³ to 0.8 mg/m³. Higher chlorophyll-a concentrations, particularly those above 0.5 mg/m³, were closely related to increased catch rates. This suggests that areas with higher primary productivity tend to support larger skipjack tuna populations.

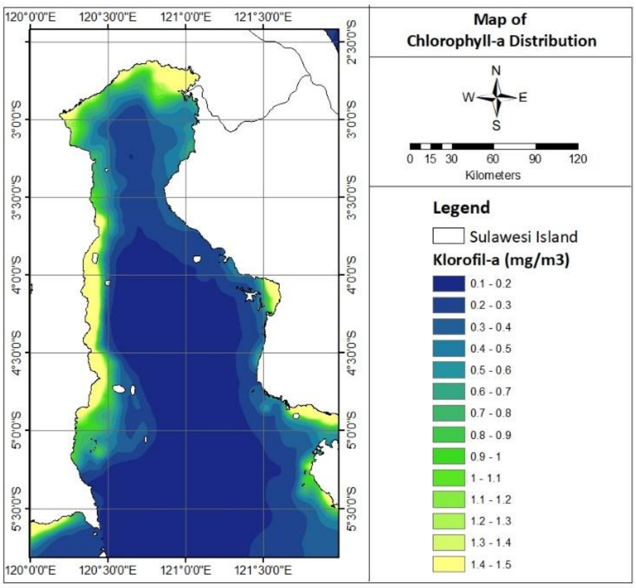

Figure 4. Chlorophyll-a Distribution

Mapping of Potential Skipjack Tuna Fishing Zones

Based on oceanographic data, mapping identified high potential zones in the southeastern part of Bone Bay, where sea surface temperature, salinity, and chlorophyll-a concentrations fall within optimal ranges.

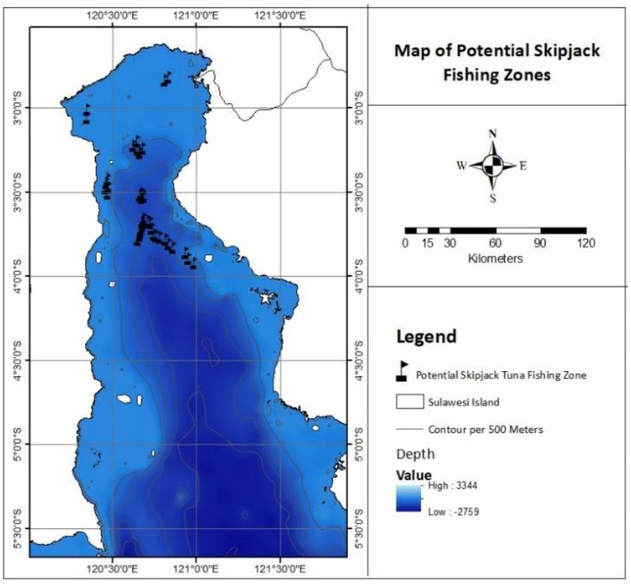

Figure 5. Potential Skipjack Tuna Fishing Zones

Model Validation

Model validation results showed high accuracy, with the predicted potential zones showing significant catch results in the field.

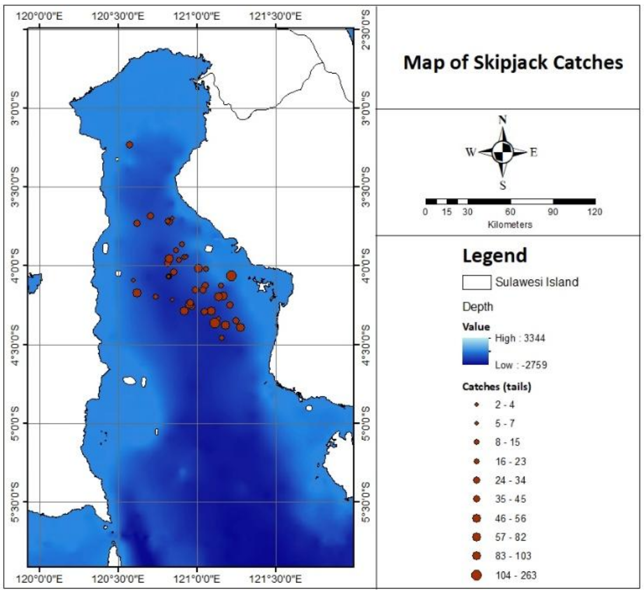

Figure 6. Skipjack Tuna Catch Results.

DISCUSSION

The results of this study indicate that sea surface temperature directly influences the distribution and abundance of skipjack tuna. The optimal temperature range found (28°C to 29°C) is consistent with previous findings, which suggest that skipjack tuna prefer warmer waters, typically associated with upwelling areas or ocean currents that bring nutrients from deeper layers to the surface (Clauson-Kaas *et al*., 2017; Handoco *et al*., 2022). Temperatures outside this range tend to cause the fish to migrate to areas that better align with their physiological preferences (Dahms & Killen, 2023a; Haesemeyer, 2020; Zillig, 2024). This finding underscores the importance of considering temperature in fisheries management, especially in the context of climate change, which may affect global sea surface temperature patterns. An increase in sea surface temperature due to global warming may shift the optimal fishing zones to higher or lower latitudes (Dahms & Killen, 2023b; Li & Convertino, n.d.; McClenachan *et al*., 2019), which in turn could impact the sustainability of local fisheries.

Salinity was also found to be an important factor in determining the presence of skipjack tuna. Higher salinity (34 PSU to 35 PSU) tends to support greater fish abundance, likely due to the correlation between salinity and food availability or optimal physiological conditions for skipjack tuna. Previous research has shown that salinity can affect osmoregulation in fish, and environments with stable salinity levels are more likely to support fish growth and reproduction (Su *et al*., 2022; Wang *et al*., 2022). Therefore, these findings highlight the need for regular monitoring of salinity conditions in fishing areas as part of a sustainable fisheries management strategy.

High chlorophyll-a concentrations were found to correlate with increased skipjack tuna catches. This is not surprising, as chlorophyll-a is an indicator of primary productivity, meaning areas with high chlorophyll-a concentrations have abundant phytoplankton, which in turn supports zooplankton populations and smaller fish, the primary food source for skipjack tuna. These results are consistent with other research showing that areas with high primary productivity tend to be hotspots for fisheries, as food webs starting from phytoplankton to apex predators like skipjack tuna are richer and more stable (Rana *et al*., 2022; Talib *et al*., 2022). The use of satellite imagery to map chlorophyll-a concentrations has proven to be an effective tool for predicting potential fishing locations (Riandi *et al*., 2023; Wang & Chen, 2024; Yailymov *et al*., 2024).

Using the analyzed oceanographic parameter data, potential skipjack tuna fishing zones in Bone Bay were mapped. The mapping results revealed several areas with high potential for skipjack tuna fishing. These areas are primarily located in the southeastern part of Bone Bay, where sea surface temperature, salinity, and chlorophyll-a concentrations fall within the identified optimal ranges. The model map indicates that high potential fishing zones remain relatively consistent throughout the fishing season, with minor variations caused by seasonal changes in oceanographic parameters. The potential fishing zone model developed in this study was validated using field data not included in the initial modeling process. Validation results showed that the model has high accuracy, with most of the predicted potential zones showing significant catches when tested in the field.

This indicates that the model can be used as an effective tool to support decision-making in skipjack tuna fishing operations in Bone Bay. This mapping can help fishermen optimize their fishing times and locations, thus improving efficiency and productivity. Mapping potential skipjack tuna fishing zones based on oceanographic parameters provides a useful tool for fisheries management in Bone Bay. By utilizing satellite data and environmental parameter analysis, fishermen can direct their efforts to more productive zones, reducing operational costs and increasing catch rates. Additionally, this finding emphasizes the importance of adapting fishing strategies in light of climate change and oceanic variability, which can affect oceanographic parameters. Sustainable management should consider the ever-changing environmental dynamics and integrate monitoring technologies like satellite imagery to provide accurate and timely information.

CONCLUSION

The results of this study support previous findings that oceanographic parameters significantly influence the distribution of skipjack tuna. Specifically, the study highlights the importance of sea surface temperature, salinity, and chlorophyll-a concentration in determining potential fishing zones. The model's success in predicting potential zones also demonstrates that the use of satellite imagery technology and oceanographic parameter analysis is an effective and practical approach for fisheries resource management.

ACKNOWLEDGEMENT

The authors would like to express their deepest gratitude to the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia (Kemendikbudristek) for providing financial support through the Junior Researcher Scheme (PDP) with contract number 0459/E5/PG.02.00/2024. This assistance has played a crucial role in the smooth execution and success of this research. It is hoped that this support will continue in the effort to advance science and technology, particularly in the fields of fisheries and marine sciences.

REFERENCES

Ali, E. M., Zanaty, N., & El-Magd, I. A. (2022). Potential efficiency of earth observation for optimum fishing zone detection of the pelagic sardinella aurita species along the Mediterranean Coast of Egypt. *Fishes*, *7*(3). https://doi.org/10.3390/fishes7030097

Amalia, A., Aisa Liputo, S., Antuli, Z., Negeri Gorontalo, U., Studi Ilmu dan Teknologi Pangan Jl Ing Habibie, P. B., Bone Bolango, K., Gorontalo, P., & Pos, K. (2023). Uji efektifitas suhu fermentasi terhadap karakteristik mikrobiologi dan kimia bakasan ikan cakalang (*Katsuwonus pelamis*). In *Journal of Agritech Science* (Vol. 7, Issue 1).

Bharti, V., Jayasankar, J., Prakash Shukla, S., George, G., Ambrose, T. V., Koduveliparambil Augustine, S., Sathianandan, T. V., & Shafeeque, M. (2020). Study on sea surface temperature and chlorophyll-a concentration along the south-west coast of India. In *Indian Journal of Geo Marine Sciences* (Vol. 49, Issue 01).

Clauson-Kaas, S., Richardson, K., Rahbek, C., & Holt, B. G. (2017). Species-specific environmental preferences associated with a hump-shaped diversity/temperature relationship across tropical marine fish assemblages. *Journal of Biogeography*, *44*(10), 2343–2353. https://doi.org/10.1111/jbi.13044

Dahms, C., & Killen, S. S. (2023a). Temperature change effects on marine fish range shifts: A meta-analysis of ecological and methodological predictors. In *Global Change Biology* (Vol. 29, Issue 16, pp. 4459–4479). John Wiley and Sons Inc. https://doi.org/10.1111/gcb.16770

Dahms, C., & Killen, S. S. (2023b). Temperature change effects on marine fish range shifts: A meta-analysis of ecological and methodological predictors. In *Global Change Biology* (Vol. 29, Issue 16, pp. 4459–4479). John Wiley and Sons Inc. https://doi.org/10.1111/gcb.16770

Haesemeyer, M. (2020). Thermoregulation in fish. *Molecular and Cellular Endocrinology*, *518*, 110986. https://doi.org/10.1016/j.mce.2020.110986

Handoco, E., Retno Manik, R., & Arleston, J. (2022). Fish catch results related to temperature and chlorophyll in western waters of Sumatera. *Journal of Applied Geospatial*

Information, *6*(2), 652. http://jurnal.polibatam.ac.id/index.php/JAGI

Kamaruzzaman, Y. N., & Ahmad Mustapha, M. (2023). An overview assessment of the effectiveness of eatellite images and remote sensing in predicting potential fishing grounds and its applicability for *Rastrelliger kanagurta* in the Malaysian EEZ off the South China Sea. In *Reviews in Fisheries Science and Aquaculture* (Vol. 31, Issue 3, pp. 320–341). Taylor and Francis Ltd. https://doi.org/10.1080/23308249.2023.2183341

Li, J., & Convertino, M. (n.d.). *Temperature-driven organization of fish ecosystems and fishery implications-source link*. https://doi.org/10.1101/2021.01.18.427097

McClenachan, L., Grabowski, J. H., Marra, M., McKeon, C. S., Neal, B. P., Record, N. R., & Scyphers, S. B. (2019). Shifting perceptions of rapid temperature changes' effects on marine fisheries, 1945–2017. *Fish and Fisheries*, *20*(6), 1111–1123. https://doi.org/10.1111/faf.12400

Mustaqimah, N., Usman, N. F., Pagalla, D. B., & Nurhayati, N. (2023). Pemanfaatan hasil tangkapan ikan dengan pelatihan pembuatan sossis ikan di Desa Bilungala Kecamatan Bonepantai Kabupaten Bone Bolango. *Jurnal Sibermas (Sinergi Pemberdayaan Masyarakat)*, *12*(3), 301–310. https://doi.org/10.37905/sibermas.v12i3.17910

Pitcher, C. R., Hiddink, J. G., Jennings, S., Collie, J., Parma, A. M., Amoroso, R., Mazor, T., Sciberras, M., Mcconnaughey, R. A., Rijnsdorp, A. D., Kaiser, M. J., Suuronen, P., Hilborn, R., & Hastings, A. (2024). Trawl impacts on the relative status of biotic communities of seabed sedimentary habitats in 24 regions worldwide. https://doi.org/10.1073/pnas.2109449119/-/DCSupplemental

Rana, S., Bhattacharya, S., & Samanta, S. (2022). Complex dynamics of a three-species food chain model with fear and allee effect. *International Journal of Bifurcation and Chaos*, *32*(06). https://doi.org/10.1142/S0218127422500845

Retraubun, A. S. W., Tubalawony, S., Masrikat, J. A. N., & Hukubun, R. D. (2023). Analysis of sea surface temperature and chlorophyll-a and its relationship with catch results flying fish eggs in the Waters of the Kei Islands. *Jurnal Penelitian Pendidikan IPA*, *9*(12), 11311–11324. https://doi.org/10.29303/jppipa.v9i12.6240

Riandi, M., Irham, M., Rusdi, M., Deli, A., Abdullah, F., & Miswar, E. (2023). The analysis of chlorophyll-a distribution in fishing areas of Aceh Waters. *Depik*, *12*(2), 137–142. https://doi.org/10.13170/depik.12.2.31405

Sivasankari, M., Anandan, R., & Rajesh, G. (2024). Application of machine learning techniques on multivariate ocean parameters. *Journal of Scientific and Industrial Research*, *83*(2), 174–182. https://doi.org/10.56042/jsir.v83i2.3684

Su, M., Liu, N., Zhang, Z., & Zhang, J. (2022). Osmoregulatory strategies of estuarine fish Scatophagus argus in response to environmental salinity changes. *BMC Genomics*, *23*(1). https://doi.org/10.1186/s12864-022-08784-2

Sumbu, T., Rumokoy, D. A., & Frederik, W. A. P. G. (2023). Existence of consumer protection in the *Katsuwonus Pelamis* process as a safe culinary. *Substantive Justice International Journal of Law*, *6*(1), 28. https://doi.org/10.56087/substantivejustice.v6i1.224

Syms, C. (2022). Satellite ocean data can inform precision fishing. *Nordic Machine Intelligence*, *2*(2). https://doi.org/10.5617/nmi.9945

Talib, R. H., Helal, M. M., & Naji, R. K. (2022). The dynamics of the aquatic food chain system in the contaminated environment. *Iraqi Journal of Science*, *63*(5), 2173–2193. https://doi.org/10.24996/ijs.2022.63.5.31

Wang, J., & Chen, X. (2024). A new approach to quantify chlorophyll-a over inland water targets based on multi-source remote sensing data. *Science of The Total Environment*, *906*, 167631. https://doi.org/10.1016/j.scitotenv.2023.167631

Wang, J., Zhu, X., Sun, Y., Gu, L., Wu, Y., Chen, Y., & Yang, Z. (2022). Changes in transcriptome and ultrastructure reveal salinity tolerance of obscure puffer Takifugu obscurus. *Frontiers in Marine Science*, *9*. https://doi.org/10.3389/fmars.2022.854140

Yailymov, B., Kussul, N., Henitsoi, P., & Shelestov, A. (2024). Improving spatial resolution of chlorophyll-a in the Mediterranean sea based on machine learning. *Radioelectronic and Computer Systems*, *2024*(2), 52–65. https://doi.org/10.32620/reks.2024.2.05

Zillig, K. W. (2024). Temperature and fish biology: Insights from metabolism. In *Encyclopedia of Fish Physiology* (pp. 47–61). Elsevier. https://doi.org/10.1016/B978-0-323-90801-6.00175-0