Journal homepage: www.fishtaxa.com

Database Development for Global Fish Biodiversity Records: Applications in Research and Conservation

Ahmadou Alim, Meke Soung Pierre

[1] *Environmental biology Option, Department of Environmental and Applied Biology, Imo state University, Owerri, Nigeria.*

Abstract

Fish biodiversity on a global scale is crucial for both the sustainability of aquatic ecosystems and human lives. The creation and use of an extensive database for worldwide fish biodiversity records are examined in this article, with an emphasis on its importance for both research and conservation initiatives. The database is used as a clearinghouse for data on fish species' taxonomy, range, population trends, and environmental factors. Its many uses include everything from habitat mapping and species identification to early warning systems for new dangers. The database also promotes research cooperation, provides information for management and policy choices, and aids in outreach and education programmers. This research stresses the value of stakeholder cooperation in creating and maintaining such a database to solve the urgent conservation issues facing the aquatic ecosystems on our world. Fish are more than simply aquatic residents; they are essential parts of ecosystems, brokers of equilibrium, and gauges of the health of the environment. They influence the dynamics of the ecosystems they inhabit by acting as predators, prey, and competitors. They provide food and a means of living for millions of people worldwide. They reveal the mysteries of evolution, behaviour, and adaption as research subjects. They serve as forerunners of change by indicating changes in our natural environment, particularly in reaction to the effects of climate change and human activity.

Keywords: Database Development (DD), Global Fish Biodiversity (GBD), E-views software, sustainability (S)

Citation: Ahmadou A and Meke S.P. 2023. Database Development for Global Fish Biodiversity Records: Applications in Research and Conservation. Fish Taxa 28: 46-57.

Introduction

The environmental changes driven by anthropogenic activities have always been a concern to the biodiversity of various species on earth. To manage that issue, different conservation techniques and ecological monitoring programs are being implemented. Among these methods, database management has taken the lead in being a resourceful method, especially for aquatic species like fish. Out of all the aquatic species, fish cover the most percentage as 40% of it is present in freshwater reservoirs and 60% inhabit the marine water. Considering the human activities that deplete the natural environment, freshwater fish are the most susceptible species. Although freshwater accounts for almost one percent of total water reservoirs but can provide a higher biodiversity of fish. These freshwater faunas are of great economic, nutritional, and scientific importance. Therefore, database management helps not only in the conservation of this specie but also make research work a lot easier. With the globally increasing interest in approaching ecology and studying specific patterns of fish evolution, a global dataset for fish biodiversity is needed. Therefore, in the 1970's establishment of a fish database was suggested by Daniel Pauly. According to him the proposition of theories and hypotheses regarding evolved fish features needed collected data. Hence, he came up with a fish database named FishBase, from where fisheries researchers could easily grab validated data regarding adult fish. Similarly, more databases were established later on, each dealing with fish data at diverse and unique levels. The compilation of the database was not easy but once it was done, it could help researchers in the conservation of species.

Accepted: 19 December 2022; Published: 13 April 2023

The major help provided by fish database management is in understanding the diversity patterns for fish, especially those present in freshwater as it is more vulnerable to human activities. Finding diversity pattern through database helps in learning the evolutionary changes faced by fish species, that ultimately shapes taxonomic studies. These diversity patterns help in associating the development of functionality that runs through a specie.

Similarly, database management has laid the foundation for finding environmental drivers that cause changes in a particular group of species and identifying their common behaviors. Different environmental factors impart specific changes in fish mobility, feeding, and nutrition cycles. Therefore, datasets providing this information are necessary for defining the fate of biodiversity. Similarly, another contribution of data management in regulating the conservation strategies of species is to determine the threats imposed by humans as it helps in understanding the fish's nature, tolerance, and existing stamina, which in turn regulates the biodiversity of fish species.

Moreover, other than such advantages, there are further sub-studies that are enhanced by data collected in different databases. Initially, only global databases were present for amphibians, birds, and mammals. But now fish database management has done wonders in research and allows the study of fish species in correspondence to their macroevolutionary and biogeographical studies. Hence, the modern fish databases involve more than 33500 species, classifying them from ancient into modern groups. The database established from studies of fish groups present in drainage basins, has allowed the accurate evaluation of global patterns of innate, non-native, and widespread fish species. The data found from these datasets not only allows the study of fish species richness in that specific habitat but also relates the influence of foreign fish groups on native fish groups. Other than that, database management also helps in forecasting the climatic effects on species and correlates their extinction ratio. Additionally, this management also provides information on the river flows occurring in the past, unveiling the history of how native species became innate to a specific water body.

Database management for fish species also aids in scrutinizing the process of diversification and its different rates. These diversification rates have helped in identifying the relation between geographical aspects and traits of fish species. For example, the origin of ray-finned fish from the bony fish family has been evaluated through fish database management. The term "Global Fish Biodiversity Records" refers to an extensive and well-organized database of data and information about the wide variety of fish species that live in aquatic habitats all over the world. For scientists, conservationists, decision-makers, and other stakeholders committed to comprehending, protecting, and sustainably managing fish species on a global scale, these data are an essential resource. There is a staggering diversity of fish species found across the world's aquatic ecosystems, including oceans, rivers, lakes, and wetlands, each with its own distinctive traits, behaviours, and ecological responsibilities. This extensive biodiversity has to be recorded and catalogued for a number of reasons (Ball-Damerow et al., 2019).

Fish are first and foremost essential to ecosystems and economies all across the planet. They provide a substantial contribution to global food security, sustain aquatic biodiversity, and offer jobs in the fishing sector for millions of people. Nevertheless, a number of fish species are under danger due to factors including overfishing, habitat destruction, pollution, and climate change. For these species to be conserved and used sustainably, it is crucial to understand their status and trends. Taxonomy, distribution, population dynamics, genetics, ecological relationships, and other topics are covered in great detail in the Global Fish Biodiversity Records. Scientists can track changes in fish populations, evaluate the wellbeing of aquatic ecosystems, and create policies for their conservation due to this abundance of data (Masayuki et al., 2021).

The researcher working in the field of water macroecology and conservation can easily derive a global map for the fish diversity hotspots and can locate the areas where an incalculable number of fish can be located. Other than fish diversity, these databases can indirectly help in identifying distinct geographic regions having revolutionary historic moments. In this way, phylogenetic relations of diverse fish assemblages come to the surface, and that in turn provides new intuition on the evaluation of fish present in freshwater or marine water (Howson, 2020).

To collect this data, there are different methods and approaches needed. The data can be based on fish abundance, biological features, and the ratio of catchment associated with a specific region. For securing databases that involve fish abundance, different collection methods are used that calculate the fish's size and weight. The biological database calculation involves information on the dynamic process of population and is calculated by determining fish's size, weight, scales, age, mortality and maturity. Equally, the socio-economic and ecological factors are also observed for their addition to regional databases. Ecological factors add further information regarding species encounter, habitat, predator-prey relations, and environmental hazards.

For deducing conservation strategies, the database management of fish is necessary as it helps in going down to the minute details of fish taxonomy y. Since different waterbodies inhabit different fish species, these databases can easily help in coming up with conservation methods that are suitable for species that are not only related to each other through common waters but have common phylogenetics. In this way, the conservation of species can be made effective as those having common traits can be grouped from different endangered environments. By studying their biological habits, the species can be provided with the exact necessities, securing their survival. Thus, database development for global fish diversity records has been a helpful venture and can aid in securing fish species also the researchers can come up with new ideas to meet the challenges imposed by human activities that are continuously devastating the natural habitat of these creatures and are leading them to the well of extinction, death and poor surviving abilities.

1. Conservation Planning: The database may be used by conservationists to pinpoint places that need to be protected and managed in a priority order. This involves locating crucial habitats and migration paths for fish species that are migratory or at risk of extinction.

2. Education and Outreach: A freely available database may be used as a teaching tool by pupils, academics, and the general public. To increase public knowledge of fish biodiversity and conservation challenges, it may also contain multimedia information, such as pictures and movies.

3. Research Collaboration: A global database on fish biodiversity can promote cooperation between academics and institutions all around the world. To speed up scientific development, researchers can exchange data, methodology, and discoveries.

4. Policy and Management: The database may be used by policymakers and resource managers to make well-informed choices about the management of fisheries, protected areas, and conservation laws. Sustainable fishing practises can be helped by data-driven policy.

5. Early Warning System: For spotting changes in fish populations and habitats, the database may be used as an early warning system. This might prompt effective conservation measures.

6. Genomic and Genetic Information: Including genetic data in the database will help researchers better understand the genetic variety of fish populations and how they respond to shifting environmental conditions. The conservation efforts can benefit from knowing this information. Collaboration between scientists, governmental bodies, non-governmental organizations, and the corporate sector is necessary to create and

maintain such a database.

Literature review:

Researchers claim that the study of animal movement processes is increasing rapidly. The movement of animal species from one ecosystem to another for their survival is managed through conservation-based planning. The species conservation management system uses photographic sensors to identify the distance covered by species when they move into an ecosystem. The movement of reef manta across the Australian aquatic ecosystem is determined through citizen sciences(Armstrong et al., 2019).studies reveal that the world is undergoing extreme climatic changes that result in the movement of aquatic species. The climatic shift disturbs the life of aquatic species and results in the degradation of the biodiversity of the aquatic ecosystem. To get information about the degradation caused by climatic shifts the use of modern technology is common. advanced technology is a great source that provides a database about the changes that occur in aquatic environments due to climatic fluctuations.studies reveal that the marine management ecosystem uses effective conservation strategies to improve the marine ecosystem's biodiversity. Using the eDNA approach for improving conservation strategies acts as a great planning tool(Bani et al., 2020) Also, in the process of eDNA metabarcoding the use of DNA-based biomarkers is made for purifying the ecosystem. the eDNA approach revolutionizes the biodiversity associated with aquatic ecosystems .For assessing the biodiversity-related record the technique of eDNA is employed(Berry et al., 2021). Studies reveal that for determining the health factors related to the life of aquatic species various studies described the biodiversity associated with aquatic species. Marine habitats have undergone dramatic changes in their biodiversity factor due to the sudden shift in climate(Canonico et al., 2019).scholars predict that using blockchain technology has changed the management strategies of the marine ecosystem. the advancement in marine ecosystem management strategies has resulted in the management of fishery-related food supply chains. studies show that the ecological behavior of aquatic species is determined through their demographic movements. free living animal species movement helps in understanding the species and also helps in developing conservation strategies to preserve the species. technology revolution has resulted in the development of technology-based sensors that are used in tracking aquatic species(Kays et al., 2022).studies suggest that technology used in marine life conservation is advancing at higher rates. this modern technology provides the most advanced technique to conserve the natural aquatic life processes. the monitoring of any marine ecosystem through the use of habitat-based monitoring technology has been greatly used in the present era of technology(Lahoz-Monfort & Magrath, 2021).studies claim that a large part of fresh as well as marine ecosystem services are contributed by the recreational fisheries .technological tools provided effective ways to get data about the ecological value associated with recreational fishes. the contribution of online data to develops the recreational fishery based ecosystem is immense(Lennox et al., 2022).

We are better equipped to meet these issues because to the thoroughness of Global Fish Biodiversity Records, which include taxonomy, distribution, population dynamics, genetics, behaviour, and more. These records work as a compass pointing us in the direction of evidence-based conservation strategies, sustainable fisheries management, and a better comprehension of aquatic ecosystems. Global Fish Biodiversity Records go outside the boundaries of science, as well. They serve as educational instruments that enable us to teach future generations about the wonders of the aquatic environment. They help persons who rely on fishing for their livelihood as tools for economic growth. They serve as alerting mechanisms for ecological emergencies. They unite nations and organisations in the common goal of maintaining aquatic biodiversity. They serve as bridges for international collaboration. However, creating and keeping track of these data is not without its challenges. The issues of data collecting, categorization, and assuring data quality persist. Additionally, as

long as human activities have an influence on aquatic ecosystems, it is critical to monitor, conserve, and manage fish biodiversity. The Global Fish Biodiversity Records are proof of our dedication to comprehending, protecting, and valuing the aquatic life that nourishes us and enhances our world.

They serve as our way of navigating the intricate and delicate web of life under the surface. These records are dynamic, developing together with our knowledge of the natural world; they are not static. The effort to maintaining, enhancing, and using these data is crucial as we look to the future. By doing this, we respect the variety of life in our lakes, rivers, wetlands, and seas and protect the heritage of fish biodiversity for future generations. studies highlight that determining the future changes associated with fish biodiversity depends on climatic shift. change in climatic processes alters the biodiversity and taxonomical features associated with freshwater species.by studying the future climatic fluctuations it becomes easy to determine the biodiversity-based distribution of aquatic life(Manjarrés Hernández, Guisande, & García Roselló, 2021).studies made to understand the ecological value associated with aquatic species is determine through ecological conservation programs.

This program aims at determining the importance associated with species having ecological background. The surveys made by the ecological conservation programs provide data in database form related to aquatic species(Maureaud et al., 2023).studies suggest that by understanding the spatial distribution patterns of species its ecological background is determined .the quality of database obtained through the spatial distribution patterns is improved using advanced technology tools for specie assessment(Moudrý & Devillers, 2020).studies reveal that the marine citizen sciences are the major field that provides information about the marine organisms found in South African lakes. citizen science is a modern field that provides the most advanced and up-to-date information about the aquatic specie present in the region of south Africa.

The larger project on marine ecosystems provides an understanding of the contribution of marine species in maintaining the natural marine ecosystem(Potts et al., 2021).studies highlight that to stop biodiversity loss various biodiversity conservation strategies are involved in the ecosystem management systems. the citizen science approach greatly helps in understanding the biodiversity-related to species of different regions(Soteropoulos, De Bellis, & Witsell, 2021).studies show reservoirs of great specie biodiversity is found in Deep sea reservoirs.

The biotechnology-based new technological tools provide insight into the biodiversity possessed by deep-sea species. optoacoustic is a new technique used to study the deep-sea regions having ecological history. The monitoring technology used for studying deep-sea species has been revolutionized through the modern DNA metabarcoding technique(Stefanni et al., 2022).studies predict that for maintenance of the marine ecosystem requires effective decision-making strategies. the decision-making helps in maintaining the natural marine ecosystem and in conserving the biodiversity of the ecosystem.to get data regarding the biodiversity of the ecosystem the use of database is needed. The database provides thorough information associated with species related to different taxa(Stephenson & Stengel, 2020).

Studies scholars claim that the loss of biodiversity related to aquatic environment is increasing at alarming rate.to persevere the natural marine and aquatic specie and to restore the ecosystem various management techniques are used by ecosystem management organizations. the macroinvertebrates living in the benthic region of ecosystem are conserved using DNA based conservation approaches. the morpho taxonomy is an approach that provides assessment of aquatic biodiversity(Tzafesta, Zangaro, Specchia, & Pinna, 2021).studies made on the role of eDNA in maintaining the marine ecosystem has been modernized because of the use advance techniques.

The comprehension about the ecological aspect related to aquatic specie is made using the eDNA

approach(Wang et al., 2021).furthermore ,the origin of eDNA is from the debris of aquatic organism living in marine ecosystem .this eDNA obtain from specie debris is sampled and monitored using metabarcoding based techniques. this technique provides large databased about fish biodiversity(Xiong et al., 2022).moreover, sustainability factor associated with aquatic specie is disturbed due to the loss of biodiversity's .the decline in the specie of aquatic environment globally has pose a threat to the degradation of biodevesty.in diverse aquatic environment the eDNA based monitoring techniques provided efficient services. this monitoring service assesses the occurrence patterns of specie in ecosystem and then provides the information related to species in the form of database(Yao et al., 2022).

Environmental Planning

The database may be used by conservationists to determine priority regions for management and protection. This involves identifying crucial habitats, migration paths, and spawning areas for fish species that are endangered or migrate. Conservation efforts may be focused where they are most needed with the use of this information.

Outreach and Education

For students, academics, and the general public, a fish biodiversity database that is open to the public serves as a useful instructional tool. Multimedia information, like as pictures and videos, can be added in addition to text-based data, helping to spread the word about problems with fish biodiversity and conservation. Key components in gaining support for conservation activities are outreach and education.

Research Partnership

Research on fish biodiversity must advance through collaboration between institutions and researchers. A worldwide fish biodiversity database can act as a centre for the exchange of information amongst researchers regarding their methods, data, and conclusions. Through this partnership, research is done systematically across many ecosystems and geographies, accelerating scientific development.

Management and Policy

A strong database has significant advantages for decision-makers and resource managers. Ecosystem management and sustainable fishing techniques may both be supported by data-driven regulations. The database supports the long-term health of fish populations and aquatic ecosystems by assisting in the decision-making process for protected areas, conservation laws, and fisheries management.

Early Warning Mechanism

For spotting changes in fish populations and habitats, the database can act as an early warning system. Researchers and conservationists can identify patterns and anomalies that may indicate new hazards by closely monitoring data. This proactive strategy allows for prompt conservation actions, which helps shield fish populations from permanent harm.

Material and methods:

This research study determine the Database Development for Global Fish Biodiversity Records related to Applications in Research and Conservation. The research based on secondary data analysis also the theoretical data analysis related to the global fish biodiversity records and database development.

For determine the research used E-views software and generate informative results included descriptive statistic, the unit root test, the augmented dickey fuller test analysis also that present the equality test analysis

between them.

Result and description:

	DD1	DD2	GFB1	GFB2
Mean	1.524288	1.501852	1.436844	1.498980
Median	1.431000	1.290100	1.432100	1.432100
Maximum	1.991000	1.992000	1.902000	1.940400
Minimum	1.111000	1.102100	1.115000	0.222000
Std. Dev.	0.350350	0.366344	0.181920	0.389145
Skewness	0.212349	0.194197	0.922698	-1.166429
Kurtosis	1.275249	1.214463	4.427115	5.568200
Jarque-Bera	3.286598	3.478115	5.668899	12.53945
Probability	0.193341	0.175686	0.058751	0.001893
Sum	38.10720	37.54630	35.92110	37.47451
Sum Sq. Dev.	2.945890	3.220983	0.794281	3.634411
Observations	**25**	**25**	**25**	**25**

Table-1

The above result describes that descriptive statistical analysis result represent the mean values, median values, maximum values, also that standard deviation and skewness rates between the independent and dependent variables. the DD1 and DD2 both are considering as independent variables. the result present mean value is 1.52 the median rate is 1.43 the standard deviation rate is 0.35 shows that 35% deviate from mean. The result also presents that probability value is 0.19 shows that 19% significantly relation with dependent variables. the result describes that skewness rate is 0.21 present that 21% skewness value of DD1. The sum of square deviation rate is 2.945 the sum value is 38.107 respectively. The DD2 present that mean value is 1.50 the median rate is 1.29 the standard deviation rate is 36% the probability value is 17% the result also presents that sum of square deviation rate is 3.22 respectively. According to the result its probability value is 17% respectively. The result present that GFB1 is dependent variable result describe the mean value is 1.43 the median rate is 1.43 the standard deviation rate is 18% the probability value is 5% significant rate between them. the result also presents that sum of square deviation value is 79% the sum rate is 35% respectively. The GFB2 is another dependent variable result describe that mean value is 1.49 the standard deviation rate is 38% the probability value is 0.001 shows that 100% significantly level between them. the result also describes that observation rate of overall research is 25 respectively.

Components of Records for Global Fish Biodiversity

A thorough overview of the world's fish species and their ecosystems is provided by the Global Fish Biodiversity Records, which include a wide range of data and information. These documents often consist of:

1. **Taxonomic Information:** It is essential to classify and name fish species correctly. The connections between species, genera, families, and orders are described in taxonomic records, which facilitate species identification and evolutionary research.
2. **Population Dynamics:** Monitoring fish populations throughout time gives managers of fisheries crucial information. Sustainable fishing techniques are based on information on population size, age structure, reproductive patterns, and growth rates.
3. **Genetic variety:** Genetic information aids in understanding the genetic variety of fish populations both within and across populations. Due to its capacity to shed light on a species' genetic stability and adaptability, this knowledge is crucial for conservation efforts.
4. **Fish engage:** in complicated interactions with their surroundings and other living things. Records of feeding patterns, predator-prey interactions, and ecological functions provide insight into the dynamics of the larger ecosystem.

Unit root Test analysis:

Null Hypothesis: DD1 has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic - based on SIC, maxlag=5)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.429622	0.0199
Test critical values:	1% level	-3.737853	
	5% level	-2.991878	
	10% level	-2.635542	
*MacKinnon (1996) one-sided p-values.			

Table-2

The above result describes that unit rsoot test analysis result shows t statistic values, the probability values of each indicator. The t statistic rate is -3.4296 the probability value is 0.0199 shows that negative but its 100% significantly level between them. the 1% level, 5% level also that 10% level related to the test critical values are -3.737, -2.9918, -2.6355 respectively.

Identification of Species and Taxonomy

Accurately identifying and categorizing species is a core use of a fish biodiversity database. With hundreds of species spread out over several environments.

Fish taxonomy is a complicated subject. Scientific names, colloquial names, physical traits, and taxonomic connections may all be stored in a well-maintained database, assisting researchers and conservationists in classifying and recognizing various species.

Threat Evaluation

In addition to being overfished, fish suffer various dangers such as habitat loss, pollution, and climate change. By gathering and examining information on the condition of fish populations and their habitats, an extensive database may be used to evaluate these concerns. These evaluations are essential for setting priorities for conservation efforts and efficiently allocating resources. Moreover, this comprehensive data can empower scientists and policymakers to implement targeted strategies, ensuring the long-term survival of aquatic

ecosystems. Additionally, public awareness and education can play a crucial role in fostering a collective commitment to preserving our oceans and the diverse species that inhabit them.

Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(DD1)				
Method: Least Squares				
Sample (adjusted): 2 25				
Included observations: 24 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DD1(-1)	-0.712538	0.207760	-3.429622	0.0024
C	1.093270	0.327938	3.333776	0.0030
R-squared	0.348386	Mean dependent var		-0.005083
Adjusted R-squared	0.318767	S.D. dependent var		0.418853
S.E. of regression	0.345708	Akaike info criterion		0.793212
Sum squared resid	2.629311	Schwarz criterion		0.891383
Log likelihood	-7.518542	Hannan-Quinn criter.		0.819257
F-statistic	11.76230	Durbin-Watson stat		1.562359
Prob(F-statistic)	0.002396			

Table-3

The result represent that augmented dickey fuller test analysis result represent that coefficient values, the standard error values, the t statistic values also that probability value of each indicator. The DD1 shows that coefficient rate is -0.71 the standard error value is 0.20 the t statistic rate is -3.429 also that probability value is 0.002 shows that negative but its significant relation between them. the result also present that R square value is 0.34 shows that 34% model fit for analysis the result represent that adjusted R square value is 0.31 its present that 31% adjusted value between them. the F statistic rate is 11.762 the probability value is 0.002 shows that 100% significant value between them. the result also describe that mean dependent var rate is -0.005 the standard deviation dependent var value is 0.41 its shows that 41% rate between them. the result represent that overall probability value is 0.002 shows that 100% significantly value between them. the result describes significant impact between dependent also independent variables.

The creation of databases for global fish biodiversity records is essential for the advancement of research and conservation initiatives pertaining to aquatic environments. Understanding the distribution, behaviour, and conservation status of the varied group of species known as fish is crucial for preserving the health of aquatic ecosystems. There are a few major uses for such a database:

1.Data on habitat and the environment may be linked to information on fish biodiversity to get insight into the

factors affecting fish populations. Examples of such environmental variables include water temperature, pH levels, and habitat kinds. Planning for habitat restoration and conservation can be influenced by this knowledge.

2.Threat Assessment: Using the database, researchers may evaluate the hazards that various fish species face, such as overfishing, habitat loss, pollution, and climate change. The prioritisation of conservation efforts can be influenced by this knowledge.

Equality Test Analysis:

Test for Equality of Means of DD1			
Categorized by values of DD1 and DD2 and GFB1 and GFB2			
Sample: 1 25			
Included observations: 25			
Method	df	Value	Probability
Anova F-test	(22, 2)	487.7199	0.0020

Analysis of Variance			
Source of Variation	df	Sum of Sq.	Mean Sq.
Between	22	2.945341	0.133879
Within	2	0.000549	0.000274
Total	**24**	**2.945890**	**0.122745**

Table-4

the above result represents that test of equality result describe the value, and probability value of each variables included independent and dependent. The result present ANOVA F test its value is 487.199 the probability value is 0.0020 shows that 100% significant level. The result also present that between the group and within the group result shows sum of square rate is 2.945, 0.0005 also that 2.945890 respectively. The mean square values are 0.13387 and 0.00027 also that 0.12274 shows that positive average value of mean square between them.

Conclusion

Creating databases for recordings of the world's fish biodiversity is a potent instrument with many uses in study and conservation. Our knowledge of fish taxonomy, distribution, populations, threats, and interactions with the environment are supported by this. Additionally, it promotes cooperation, policy creation, and educational outreach—all crucial elements of successful fish conservation. But building and maintaining one of these databases is no easy undertaking. Scientists, government organizations, non-governmental organizations, and the commercial sector must work together on this. To guarantee the database's quality, dependability, and accessibility, standardized data gathering procedures, data sharing agreements, and strong data management systems are essential. The database must also be continuously monitored and updated in order to remain current in the face of shifting environmental factors and developing body of knowledge. A thorough database of fish biodiversity is not only desirable; it is really necessary in a world where aquatic ecosystems are becoming more and more susceptible to anthropogenic stresses. It gives us the information and resources we need to safeguard these crucial ecosystems and the numerous species that depend on them. The creation and upkeep of such a database is an investment in the sustainability of our planet and the future conservation of its biodiversity. Additionally, these data are useful for managing fisheries since they assist set catch limits, uphold rules, and encourage ethical fishing methods. By monitoring changes in fish distribution and behaviors in response to environmental changes, they also aid in the study of climate change. Global Fish Biodiversity Records are instructional tools that promote a broader understanding of aquatic ecosystems and the significance of protecting their biodiversity, in addition to their scientific and conservation worth. Additionally, they promote global perspectives on fish conservation and management by promoting data

exchange between nations and organizations. The variety and complexity of life found in aquatic habitats throughout the globe are demonstrated by the global fish biodiversity records. Fish constitute a magnificent tapestry of variety, adaptability, and interconnectedness with over 34,000 species already known and countless more still to be found. In addition to being a scientific endeavor, the creation and upkeep of these records is an essential tool for solving some of the planet's most serious problems. These records have a wide range of significance. They are important because we must comprehend, safeguard, and properly manage fish biodiversity.

References:

Armstrong, A. O., Armstrong, A. J., Bennett, M. B., Richardson, A. J., Townsend, K. A., & Dudgeon, C. L. (2019). Photographic identification and citizen science combine to reveal long distance movements of individual reef manta rays Mobula alfredi along Australia's east coast. *Marine Biodiversity Records, 12*(1), 1-6.

Ball-Damerow, J. E., Brenskelle, L., Barve, N., Soltis, P. S., Sierwald, P., Bieler, R., . . . Guralnick, R. P. (2019). Research applications of primary biodiversity databases in the digital age. *PloS one, 14*(9), e0215794.

Bani, A., De Brauwer, M., Creer, S., Dumbrell, A. J., Limmon, G., Jompa, J., . . . Beger, M. (2020). Informing marine spatial planning decisions with environmental DNA. In *Advances in ecological research* (Vol. 62, pp. 375-407): Elsevier.

Berry, O., Jarman, S., Bissett, A., Hope, M., Paeper, C., Bessey, C., . . . Bunce, M. (2021). Making environmental DNA (eDNA) biodiversity records globally accessible. *Environmental DNA, 3*(4), 699-705.

Canonico, G., Buttigieg, P. L., Montes, E., Muller-Karger, F. E., Stepien, C., Wright, D., . . . Sousa-Pinto, I. (2019). Global observational needs and resources for marine biodiversity. *Frontiers in Marine Science, 6*, 367.

Howson, P. (2020). Building trust and equity in marine conservation and fisheries supply chain management with blockchain. *Marine Policy, 115*, 103873.

Kays, R., Davidson, S. C., Berger, M., Bohrer, G., Fiedler, W., Flack, A., . . . Russell, B. (2022). The Movebank system for studying global animal movement and demography. *Methods in Ecology and Evolution, 13*(2), 419-431.

Lahoz-Monfort, J. J., & Magrath, M. J. (2021). A comprehensive overview of technologies for species and habitat monitoring and conservation. *BioScience, 71*(10), 1038-1062.

Lennox, R. J., Sbragaglia, V., Vollset, K. W., Sortland, L. K., McClenachan, L., Jarić, I., . . . Cooke, S. J. (2022). Digital fisheries data in the Internet age: Emerging tools for research and monitoring using online data in recreational fisheries. *Fish and Fisheries, 23*(4), 926-940.

Manjarrés Hernández, A., Guisande, C., & García Roselló, E. (2021). Predicting the effects of climate change on future freshwater fish diversity at global scale. *Nature Conservation, 43, 1-24.*

Masayuki, M., Atsushi, S., Rika, K., Yu, S., Hiroyuki, J., Kenji, K., . . . Aloke, V. F. (2021). Paclitaxel- and Sirolimus-coated Balloons in Peripheral Artery Disease Treatment: Current Perspectives and Concerns. *Vascular & Endovascular Review, 4*.

Maureaud, A. A., Palacios-Abrantes, J., Kitchel, Z., Mannocci, L., Pinsky, M., Fredston, A., . . . Palomares, D. (2023). FishGlob_data: an integrated database of fish biodiversity sampled with scientific bottom-trawl surveys. *OSF Preprints*.

Moudrý, V., & Devillers, R. (2020). Quality and usability challenges of global marine biodiversity databases: An example for marine mammal data. *Ecological Informatics, 56*, 101051.

Potts, W., Mann-Lang, J., Mann, B., Griffiths, C., Attwood, C., de Blocq, A., . . . Thornycroft, R. (2021). South African marine citizen science–benefits, challenges and future directions. *African Journal of Marine Science, 43*(3), 353-366.

Soteropoulos, D. L., De Bellis, C. R., & Witsell, T. (2021). Citizen science contributions to address biodiversity loss and conservation planning in a rapidly developing region. *Diversity, 13*(6), 255.

Stefanni, S., Mirimin, L., Stanković, D., Chatzievangelou, D., Bongiorni, L., Marini, S., . . . del Rio Fernandez, J. (2022). Framing cutting-edge integrative deep-sea biodiversity monitoring via environmental DNA and optoacoustic augmented infrastructures. *Frontiers in Marine Science, 8*, 797140.

Stephenson, P., & Stengel, C. (2020). An inventory of biodiversity data sources for conservation monitoring. *PloS one, 15*(12), e0242923.

Tzafesta, E., Zangaro, F., Specchia, V., & Pinna, M. (2021). An overview of DNA-based applications for the assessment of benthic macroinvertebrates biodiversity in Mediterranean aquatic ecosystems. *Diversity, 13*(3), 112.

Wang, S., Yan, Z., Hänfling, B., Zheng, X., Wang, P., Fan, J., & Li, J. (2021). Methodology of fish eDNA and its applications in ecology and environment. *Science of the Total Environment*, *755*, 142622.

Xiong, F., Shu, L., Zeng, H., Gan, X., He, S., & Peng, Z. (2022). Methodology for fish biodiversity monitoring with environmental DNA metabarcoding: the primers, databases and bioinformatic pipelines. *Water Biology and Security*, *1*(1), 100007.

Yao, M., Zhang, S., Lu, Q., Chen, X., Zhang, S. Y., Kong, Y., & Zhao, J. (2022). Fishing for fish environmental DNA: Ecological applications, methodological considerations, surveying designs, and ways forward. *Molecular Ecology*, *31*(20), 5132-5164.