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Determination of Potential Zones for Website-Based Small Pelagic Fish in Banten Bay Waters

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***Abstract*— The waters of Banten Bay have abundant resources of small pelagic fish. Anchovies, mackerel, Shortfin scad, goldstripe sardinella, selar fish, mullet, and lemuru are small types of pelagic fish that can be found all year round in the waters of Banten Bay. Based on its abundant potential, however, its utilization is still inefficient because most local fishermen still use traditional fishing methods, which result in low catches and incomes. The purpose of this study is to develop a website-based system to determine the Fishing Potential Zone (FPZ) in the waters of Banten Bay by utilizing sea surface temperature (SST) and chlorophyll-a data from Aqua MODIS satellite imagery in 2023. Data processing is carried out with SeaDAS and ArcGIS software to determine FPZ points that are implemented in the form of a website, namely FishZone Mapper. The FishZone Mapper website is designed to provide information that can be easily accessed by fishermen, researchers, and other stakeholders to improve fishing efficiency. The results showed that there was a significant difference in the number of FPZ points in the western and eastern seasons, which affected fishing strategies.**

Keywords— Small Pelagic Fish, Chlorophyll-a, Sea Surface Temperature, Banten Bay, Fishing Potential Zone, Website Based

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I. INTRODUCTION

The waters of Banten Bay are located in the Northern Waters of Java Island, which is known to have an abundant wealth of marine resources [1]. Small pelagic fish in the waters of Banten Bay are one of the abundant types of fish resources with a potential of up to 3.2 million tons per year [2]. The small pelagic fish group is a group of fish that has important economic value in a port. [3]. Based on the 2022 PPN Karangantu statistical annual report, the dominant types of fish produced are berber ponyfish, anchovies, squid, mackerel, silver goatfish, goldstripe sardinella, blue crabs, and other types of fish [4]. Fish that are included in the type of small pelagic fish that are commonly found throughout the Banten Bay Waters include anchovies, mackerel, Shortfin scad, goldstripe sardinella, selar fish, mullet, and lemuru [2]

The availability of abundant fish resources in the waters of Banten Bay encourages the people of Banten to seek income from the sea as fishermen [5] . For fishermen, fishing has become a daily routine [6]. However, in the process of fishing, some fishermen still use influence of sea surface e traditional methods, such as relying on natural signs or compasses [7]. The use of traditional methods requires more energy and time, which also affects the high operational costs of going to sea. Therefore, to optimize the fishing process and take advantage of the fisheries potential available in the waters of Banten Bay, a technological innovation is needed that can increase the efficiency of local fishermen's catches. According [8] to the Utilization of technology that continues to evolve today, it is used in various fields of life.

One of the technologies that can be used to realize efforts to improve the efficiency of fishermen's catches is to create a website to determine potential fishing zones in the waters of Banten Bay. The function of the website itself is broadly divided into 2 functions, namely as a source of information and interactive services [9]. The website has information can be applied to a fishing port [10]. The use of Aqua MODIS satellite imagery for sea surface temperature and chlorophyll-a data was used to analyze potential zones as a gathering place for fish that could be used as fishing zones [11] [12], [13]. The result

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of the analysis of the two parameters is in the form of estimated coordinate points of potential fishing zones [14] which are then implemented in the form of a website, namely FishZone Mapper.

The FishZone Mapper website is designed with the aim of providing a comprehensive overview of potentiaupwel fishing zones in the waters of Banten Bay. This website was also created to provide useful information to fishermen, research scientists, and parties with related interests so that they can better understand and utilize fishery resources in the waters of Banten Bay. The design of a website regarding the determination of potential fishing zones in the waters of Banten Bay is expected to provide significant benefits for various groups, especially fishermen. With access to information about potential fishing zones, fishermen can optimize their trips to waters that have high fishing success rates. In addition, knowledge of fishing potential zones allows fishermen to increase their catch by focusing on areas of water known to have fish abundance.

II. METHOD

The device used for the research consists of a set of computers that have an operating system and software with the following specifications:

1. Hardware: Intel 10th Gen Core i3 1005G1 Processor, 12 GB DDR4 Random Access Memory (RAM), NVIDIA Geforce MX330 GPU (GPU), Solid State Drive (SSD) 512GB + 32GB Optane, 24' LED Monitor, Mouse and Keyboard
2. Software: Windows 11 Operating System, ArcGIS 10.7.1, SeaDAS 8.4.1, Microsoft Excel 2019, XAMPP v3.3.0, Visual Studio Code, JavaScript Library.

This research uses research materials that include:

1. Primary Data: Field validation related to information about locations that are often fishing zones by local fishermen as well as data on strategic seasons for fishing activities, especially small pelagic fish.
2. Satellite Data: Aqua MODIS satellite imagery for sea surface temperature and chlorophyll-a parameters with 2023 footage in the waters of Banten Bay.
3. Literature Data: Literature data obtained through literature review, such as scientific journals, articles, books, and other relevant sources as reference material. The data used have been examined by experts and are information that has been used in many studies related to this study.

The data analysis methods used in this study include descriptive analysis and information system development. According [15] to Descriptive analysis is a method to analyze data by collecting, classifying, explaining, and analyzing the data. The goal is to get clear information and understand the picture of the problem being researched. In this study, the descriptive analysis method was used to provide an overview of the points of zones that have the potential to be small pelagic fishing grounds in the waters of Banten Bay based on 4 seasons, namely the western season (December – February), the transition season I (March – May), the eastern season (June – August), and the transition season II (September – November). The system development analysis method, in general, is a structured series of processes for the development of computer-based information systems [16]. The information system development analysis method is used to develop a website-based system as a medium to display the results of determining the potential zone for small pelagic fishing in the waters of Banten Bay which is designed in such a way to produce a responsive and user-friendly website so that it is easily accessible to users.

The data used to determine the potential zone points for small pelagic fishing in the waters of Banten Bay include Aqua MODIS satellite imagery data on sea surface temperature and chlorophyll-a in 2023, which can be downloaded through the www.Oceancolor.gsfc.nasa.gov website. Other data is in the form of supporting literature data obtained through literature review in the form of relevant scientific articles and journals as reference materials. The information data about locations that are often fishing zones, as well as strategic season data for fishing activities, especially small pelagic fish, was obtained through direct interviews with fishermen in the waters of Banten Bay.

Aqua MODIS satellite imagery data for sea surface temperature and chlorophyll-a parameters have been downloaded, then cropping is carried out using the exported SeaDAS 8.4.1 software to generate ASCII data from sea surface temperature and chlorophyll-a data. The ASCII data that has been obtained from these two parameters is then subjected out a NaN correction process to filter the empty values in the image extraction results. NaN data is the result of the reflection of an object that is not captured numerically by satellite imagery, so corrections must be made. NaN correction is carried out using Microsoft Excel, with the results of the NaN data filter from Microsoft Excel in Excel spreadsheet format (xls) that is ready to be further processed [17]. The next stage is IDW analysis and contouring using ArcGIS 10.7.1 software. Inverse Distance Weighted (IDW) is an interpolation technique that is commonly used for determining values based on data from a simple environment and is accurate enough to be used in the field of Geographic Information Systems [18]. In this study, the IDW method was used to interpolate the values of sea surface temperature distribution and chlorophyll-a. The sea surface temperature and chlorophyll-a data that have been successfully interpolated, then converted into contour form.

According [19] to the fishing potential zone it can be identified based on the contour distribution of sea surface temperature and chlorophyll-a that overlap with each other. The next stage is an overlay (intersect) and plotting process. The overlay process aims to combine the TTS contour with the chlorophyll-a contour, then from the confluence between the TTS and chlorophyll-a contours, intersecting points are identified and imported in a new formatted file (shp.). The points that have been identified will be plotted, where the plotting process is carried out to find out the position of longitude (BT) and latitude (LS) of the FPZ point. The SST value used in the plotting process ranges from 25°C – 32°C with a chlorophyll-a value of 0.2 mg/m³. The following is the

process flow of the analysis technique on sea surface temperature and chlorophyll-a image data in determining the potential zone for small pelagic fishing in the waters of Banten Bay (Figure 1).

At the system analysis stage, 2 components are divided into 2 components that will play a role in the website design, namely user and admin. The system on the website is designed to make it easier for users to access the website by various methods, either via smartphones or other hardware with internet access. Admins are given access to be able to update data which includes adding FPZ coordinate points, deleting FPZ points, adding, editing and deleting admin accounts, login and logout.

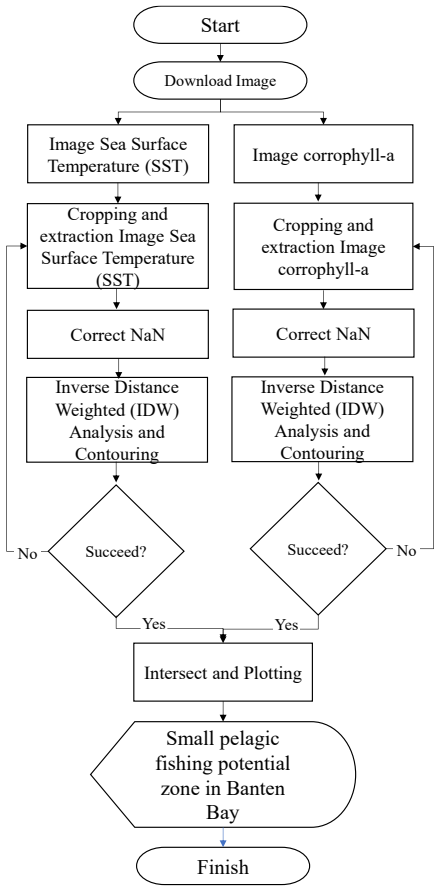


Figure 1. Image Data Analysis Flow Chart

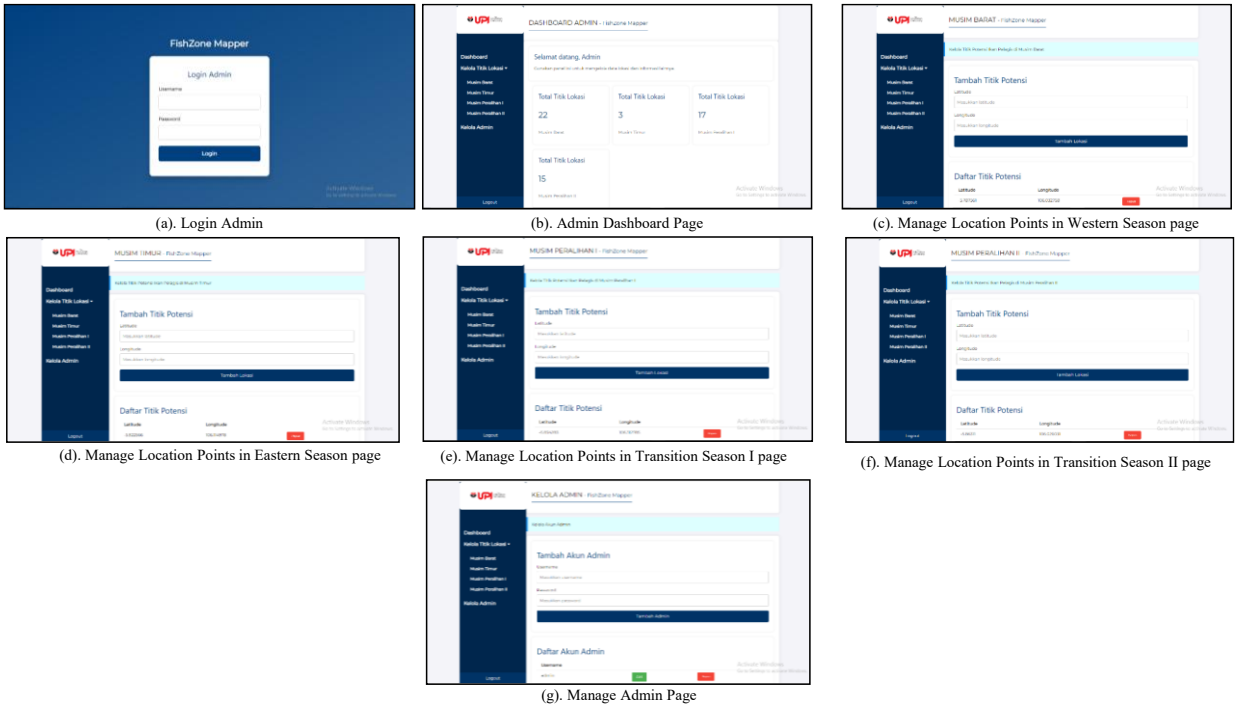
The FishZone Mapper website is designed using a native PHP programming language that integrates directly with the MySQL database. In addition, Leaflet Js which is an open-source Javascript library is also used to create interactive maps. Mapping is a map formation process that is carried out through several stages starting from data formation, data creation and presentation in map structure [20]. The interface design is made with Tailwind CSS and W3 CSS frameworks to produce an attractive user interface. The FPZ points that have been identified are then input into the website system through the admin page so that each point that has been input can be displayed on the main page that can be accessed by the user in the form of a location icon accompanied by coordinate point information which includes the position of longitude (BT) and latitude (LS) using units of degrees, minutes and seconds (DMS). The website system is designed to display the mapping of the potential zones of small pelagic fishing in the waters of Banten Bay based on the variability of 4 seasons, namely the western season (December – February), the intermediate season I (March – May), the eastern season (June – August), and the intermediate season II (September – November), thus allowing users to be able to see the small pelagic fishing zones throughout the year.

After the website is designed, then a test will be carried out on the website using the black box method and usability testing. Black box testing is a method of testing as well as evaluation of software that emphasizes on testing its functionality with the aim of identifying various errors such as malfunctions, interface issues, data structure mismatches, poor performance, as well as errors in the initialization and termination process [21].

III. Results and Discussion

Admin View

a. Login Admin



(a). Login Admin (b). Admin Dashboard Page (c). Manage Location Points in Western Season page

(d). Manage Location Points in Eastern Season page (e). Manage Location Points in Transition Season I page (f). Manage Location Points in Transition Season II page

(g). Manage Admin Page

Figure 2. Admin View; (a). Login Admin; (b)Admin Dasboard Page; (c). Mange Location Points in Western Season Page; (d). Mange Location Points in Eastern Season Page; (e). Mange Location Points in Transition Season I Page; (f). Mange Location Points in Transition Season II Page; (g). Manage Admin Page.

The admin login page is an access for the manager to manage the website, which includes the addition and removal of information related to the Fishing Potential Zone in the mapping of fishing locations. On the admin login page, managers can log in using the username and password that has been added in the database.

b. Admin Dashboard Page

The Admin Dashboard page is the main page that appears after the administrator successfully logs in. On this page, there is a summary of the accumulated number of location points in different seasons that include the western season, the eastern season, the transition season I, and the transition season II.

c. Manage Fish Potential Points in the Western Season

The list of potential fish points page displays all the coordinate points of fishing locations in the western season. On this page, the admin can update FPZ data such as adding or removing fishing coordinate point data to adjust the oceanographic conditions in each year in the western season.

d. Manage Fish Potential Points in the Eastern Season

The list of fish potential points page displays all the coordinate points of fishing locations in the eastern season. On this page, the admin can update FPZ data such as adding or removing fishing coordinate point data to adjust the oceanographic conditions in each year in the eastern season.

e. Manage Fish Potential Points in Transition Season I Page

The list of fish potential points page displays all the coordinate points of the fishing location in the transition season I. On this page, the admin can also update the FPZ data such as adding or removing the fishing coordinate point data to adjust the oceanographic conditions in each year in the transition season I.

f. Manage Fish Potential Points in Transition Season II Page

The list of potential fish points page displays all the coordinate points of the fishing location in the transition season II. On this page, the admin can update FPZ data such as adding or removing fishing coordinate point data to adjust oceanographic conditions in each year in the transition season II.

g. Manage Admin Account Page

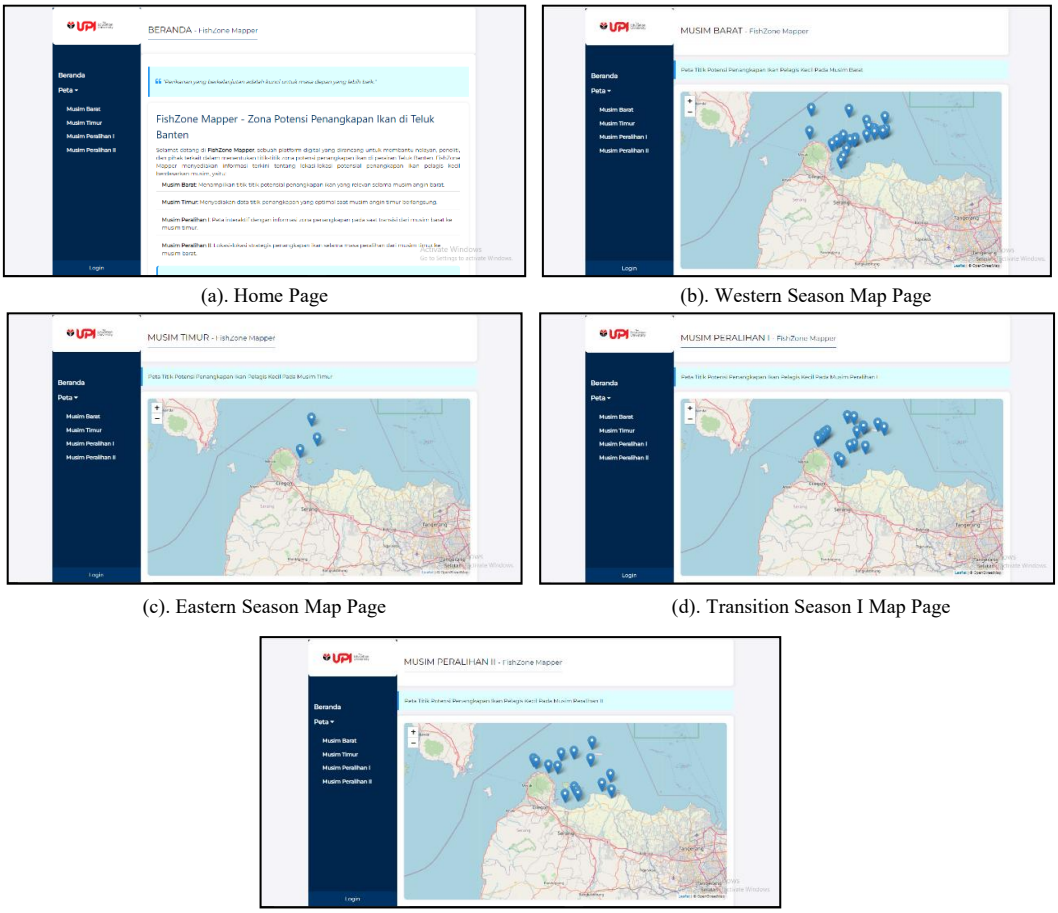
On this page, admins have the ability to add and remove other admin accounts. This feature allows other managers to gain the necessary access to add or remove the coordinate points of the fishing location. With this account management, admins can ensure that only authorized individuals have access to manage data.

User Views

Home

This page is the initial view when the user accesses the FishZone Mapper Website. On the initial page of this system, there are two main menus, namely: Home and Maps. The home menu contains information about the description of the FishZone Mapper website which contains the purpose, benefits and a brief way to use the website.

a. Map Page of Potential Fish Points in the Western Season



(a). Home Page

(b). Western Season Map Page

(c). Eastern Season Map Page

(d). Transition Season I Map Page

(e). Transitional Season II Map Page

Figure 3. User Views; (a). Home Page; (b) Western Season Map Page; (c). Eastern Season Map Page; (d). Transition Season I Map Page; (e). Transition Season II Map Page

The map itself contains several pages, one of which is the Map Page of Fish Potential Points in the Western Season. This page displays a map that contains the coordinate points of fishing zones during the Western Season. On this page, users can see potential locations where fish tend to congregate during the Western Season.

b. Map Page of Fish Potential Points in the Eastern Season

This page displays a map that contains the coordinate points of fishing zones during the eastern season. On this page, users can view strategic locations that have been identified based on the pattern of fish migration that occurs in the eastern season to help fishermen and managers to plan fishing activities more efficiently and on target.

c. Fish Potential Point Map Page in Transitional Season I

This page presents a map that contains the coordinate points of potential fishing zones during the transition season I. This period marks the transition from the western season to the eastern season, where changes in sea conditions affect the distribution of fish so that fishermen can adjust fishing strategies based on available coordinate points.

d. Fish Potential Points Map Page in Transition Season II

This page maps the potential fishing points during the transition season II. This season is a transition period from the eastern season back to the western season, where weather patterns and ocean currents begin to change. The information displayed on this page helps fishermen and managers to remain effective in catching fish.

System Testing

The testing in this study uses the blackbox testing method. According to [22] blackbox testing, it is a test of a case that is carried out by running or executing all functions using software, then observing based on the suitability of the required specifications. The study also states that [23] blackbox testing is the testing of software systems based on functional specifications without testing the design or program code. The blackbox testing carried out on the FishZone Mapper website focuses on testing from the perspective of the admin and the user, the purpose of this test is to ensure that all features or systems have worked and are in accordance with the expected results. The following are the results of system testing on the FishZone Mapper website (Table 1).

Research states [24] that seasonal variability obeys the climate in the waters of the Java Sea. The fishing season in the Java Sea is influenced by the two main water masses that exist, namely those originating from the South China Sea and the Flores Sea. These two water masses will form a distribution pattern of oceanographic

parameters such as sea surface temperature and chlorophyll a, which in turn will affect the dynamics of fishing areas in the Java Sea [25]. The results of the FPZ mapping are in the form of optimal meeting zones between sea surface temperature and chlorophyll-a for the life of small pelagic fish in the waters of Banten Bay. In the western season, FPZ points were found, in the first transition season FPZ points were found, in the eastern season FPZ points were found, and in the second transition season FPZ points were found. Apart from that, the rivers that flow into the waters of Banten Bay affect the abundance of the waters, resulting in increased fishing potential zone [26].

Table 1. Systems Test Result

Input	Expected Results	Output	Conclusion
Click the login button	You can go to the admin dashboard page.	Go to the admin dashboard page.	Succeed
Click the add location button	You can add the location/point of the FPZ coordinates based on latitude and longitude positions.	The system stores the location/coordinate points of FPZ that have been added to the database and displays them on the fish potential map page according to the season added (input) as well as changes the accumulated number of FPZ location points on the admin dashboard.	Succeed
Click the delete button	It can delete the data of the location/coordinate point of the FPZ in question.	Location data/ The FPZ coordinate point in question has been deleted, both from the admin page and the Potential Fish (User) map page.	Succeed
Click the add admin button	You can add admin accounts based on username and password.	Increase the list of admin accounts authorized to manage data.	Succeed
Click the edit button on the manage admin page	Can edit/change username or password in the admin account data in question.	The username or password of the admin account in question is edited/changed.	Succeed
Click the delete button on the manage admin page	Can delete the admin list data in question.	The admin data in question is deleted.	Succeed

There is a significant difference between the FPZ points found in the eastern and western seasons. The western season has a greater distribution of FPZ points compared to other seasons. This is due to the accumulation of sea surface temperature and chlorophyll-a that can be tolerated by small pelagic fish [27] . During the western season, the sea surface temperature value in the waters of the western Java Sea is relatively lower than the waters of the eastern part of the Java Sea. In contrast to the western season, in the eastern season the sea surface temperature value in the waters of the eastern Java Sea is lower than in the waters of the western part of the Java Sea [24].

The lower sea surface temperature in the western season is caused by the position of the sun in the southern hemisphere which causes the air pressure over the Asian continent to be higher and the air pressure over the Australian continent to be lower, so that the wind blows from the direction of the Asian continent to the Australian continent or from west to east and then rotates in a southerly direction through the Ekman transport. Wind gusts result in friction between water masses at sea level, resulting in the appearance of empty water masses, which in turn causes the water mass in the lower layer to rise to sea level, thereby filling the empty water mass with lower temperatures, thus causing sea surface temperatures in the western season to drop [28] [29]. One of the characteristics of the western season is the relatively high intensity of rain in Indonesian waters, which has an impact on the abundance of nutrients from the land to the waters through rivers so that these waters contain high chlorophyll-a [30]. Chlorophyll a is a determinant of abundance in waters [31]. In addition, in the western season, the upwelling phenomenon will increase the concentration of nutrients at sea level [32] [33].

According to [34] chlorophyll-a describes the level of primary productivity of water. The distribution of chlorophyll-a is related to the abundance of phytoplankton so small pelagic fish tend to be more abundant in the region for food [28]. In line with research that states that in the eastern season, small pelagic fish tend to migrate from the Java Sea. This is because the highest value of chlorophyll-a in the eastern season begins to move towards the waters of southern Borneo Island and the waters of southern Sulawesi Island, so that in the eastern season small pelagic fish will tend to be found in these waters compared to the waters of the Java Sea.

The distribution of fish depends on the environmental conditions. The dynamics that occur in fish habitats will affect the migration patterns of fish in a water (Purwanto & Ramadhani, 2020). The existence of fish is greatly influenced by oceanographic conditions such as sea surface temperature and chlorophyll-a (Yunus et al., 2019). Sea surface temperature is an important factor for the survival of marine organisms which also affects fish habits such as spawning, fish development, larval resistance, metabolism, growth, abundance, migration and fish swarms [35]. Chlorophyll-a is an indicator to determine the existence of phytoplankton as primary producers in a water [30]. Phytoplankton is also a primary food source for several types of pelagic fish that are included in the type of plankton feeder [36], so that the abundance of fish, especially in small pelagic fish, can be identified by looking at the mechanism of the food chain cycle that occurs in these waters.

The environmental conditions in a body of water affect the organisms that live in it, each marine organism has a tolerance to live at various temperature levels [35]. The optimal temperature for the survival of small pelagic fish is between 27°C-31°C with a chlorophyll-a value between 0.5-1.2 mg/m³, so the classification can be declared as a water area that has the potential to be a fishing zone [36]. Some types of fish that belong to the small pelagic fish group include mackerel (*Rastrelliger* sp.), shortfin scad (*Decapterus* sp.), sardine (*Sardinella* sp.), and selar (*Selaroides* sp.) [37].

The design of the system built on the FishZone Mapper website and equipped with information about FPZ points for small pelagic fish in the waters of Banten Bay will be very useful for users as one of the navigation equipment used when going to sea, so that users will find it easier to determine fishing zones or access FPZ locations. Thus, efforts to optimize the use of fish resources, especially small pelagic fish in the waters of Banten Bay, can run sustainably and go hand in hand with technological advances.

IV. CONCLUSION

The results of the study show that a website-based system can be created and used by fishermen. There is a significant difference in the number of Fishing Potential Zones in the western and eastern seasons, which affects fishing strategies.

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