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GIS for Monitoring the Operation on Inspection and Termination of Fishing Vessels in the Eastern Indonesian Waters

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----------**ABSTRACT**----------
The objective of this research is the creation of a spatial database from the operation of the termination and inspection of the fishing vessels (Henrikan). There are certainly a lot of multi-year fisheries data that can be used as an in-depth study. It is used Geographic Information Systems method, that is ArcView 3.3 software. In principle, the processing of data with geographic information systems (GIS) are data entry, data analysis and data display. Data entry associated with spatial data (location of fishing vessels) and tabular data (condition of the fishing vessels). Display the data could be maps of distribution of fishing vessel, graphs, and tables related with the activities of the operation on inspection and termination of fishing vessel.

Keywords *– GIS, Illegal fishing, Eastern Indonesian Waters.*

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I. INTRODUCTION

Illegal fishing activities most often occur in the Indonesian fishery management areas (WPP-RI). It is illegal fishing by foreign fishing vessels (FFV) coming from neighboring countries. Although they are difficult to map and estimate the level of illegal fishing, they are happening in the WPP-RI, but the results of monitoring conducted over the years, (2005-2010) concluded that illegal fishing by FFV mostly occurs in the EEZ (Exlusive Economic Zone) and also quite a lot going on in the archipelagic waters. In general, the type of fishing gear used by the former FFV illegally in Indonesian waters are productive tools such as purse seine fishing and illegal fishing trawl. The illegal fishing also conducted by Indonesian fishing vessel (IFV) [1].

From the operation of the termination and inspection of the fishing vessels (Henrikan), there are certainly a lot of multi -year fisheries data that can be used as a in-depth study. Those data can be used as a base in the development of a spatial database model in relation to illegal fishing in the eastern Indonesian waters. Because of the uniqueness of the existing data , where a party other than the Indonesian Navy certainly does not have these data.

As a first step (pilot project) in monitoring the availability of the spatial model for surveillance of fisheries to deter illegal fishing in the operation of termination and inspection of fishing vessels in the Eastern Indonesian waters. This study is important as an effort to provide information on the status and development of capture fisheries by developing a model for Monitoring Surveillance of Fisheries (MSF).

GIS is a computer system consisting of hardware , software , and brainware/ personal that is designed to efficiently enter , store , update , manipulate , analyze and present all types of geographically oriented information . GIS technology is developed and integrated from multiple concepts and techniques such as Geographical, Statistical, Cartography, Computer Science, Biology, Mathematics, Economics and geology. The GIS component devides into four sections , namely : input components (input) , the components of data management , manipulation and analysis of data components and component output [2] .

Definition of Geographic Information Systems (GIS) are now more frequently applied to geographic information -oriented understanding of computer technology . In the broader sense as well as an understanding of GIS include procedures used to store and manipulate geographycally references data. With these capabilities, GIS technology is very useful in the management of coastal and marine spatial [3].

Because of these reasons, efforts to develop a model -based monitoring surveillance of fisheries fishing in spatial operations to counter illegal fishing vessel decommissioning and inspection in Eastern Indonesian waters, can be done with a more integrated, so that the data and information obtained in the implementation can be organized and accessed quickly and easily by interested parties, so that the management of fisheries resources in the area of research can be conducted on an ongoing basis. The general objective of this research is to apply GIS in develop fisheries spatial database from the activities of termination and inspection of the fishing vessels in the Eastern Indonesian waters.

II. RESEARCH ELABORATIONS

This research is conducted for 10 months from March 2013 to December 2013 in the East Indonesian waters. (6° 48' N - 110° 36' E and 13° 85'S - 140° 92' E). Primary data used in this study is the result of cessation of fishing data and fishing vessel inspection in eastern Indonesian waters , among others : the number and type of fish , the number of fishing fleet , oceanographic conditions , Henrikan position , fishery management area maps , imagery of sea surface temperature and fishing ground. Secondary data is used fishery data obtained from the Ministry of Maritime Affairs and Fisheries (MMAF) and interview with stakeholders on policies and regulations that responsible management of fisheries resources.

The tools used in the manufacture and processing of databases: one unit of computer and software ArcView spatial data processing . Data spatial / spatial processed using ArcView 3.3 software. In principle, the processing of data with geographic information systems (GIS) are data entry, data analysis and data display. Data entry associated with spatial data (spatial) and tabular data (textual). Spatial data is put through the process of scanning , digitizing or import data from existing digital maps . Textual data entry will follow the spatial data. Once data is entered , the next step is to process spatial data in accordance with the needs , for example: overlay, buffering , counting area. The last stage is the data display. Display the data could be maps, graphs, tables, or storage in electronic media, such as multimedia. Some important spatial data processing operations used in this research is the process of digitizing the map , making the buffer ,the overlay, and processing and layouting the maps.

III. RESULTS AND DISCUSSION

3.1. Fish Species in the Operation of Henrikan

Types of fish are scattered in the waters of eastern Indonesia are generally large and small pelagic fish, as well as an important economic value [4]. Groups / species of fish recorded in the years 2008-2012 henrikan operation is a mixture of fish groups and some types of fish include: Tuna, Indian Mackerel, Hairtails, Skipjack, Prawn, Spanish Mackerel, Tuna, Scad, Shark and Squid. In 2008, there were groups of mixed fish and 6 species of fish, in 2009 there were groups of mixed fish and 5 species of fish, in the year 2010, there were groups of mixed fish and 9 species of fish, in 2011 there were groups of mixed fish and 7 species of fish, while In in 2012 there were groups of mixed fish and 7 species of fish. Distribution of fish each year can be seen in Table (1) below:

Table 1. Distribution of group/type of fish in the operation of Henrikan in the years of 2008-2012.

Year		Group/type of fish (Indonesian Name)	Latin Name	International Name
2008	1.	Ikan campuran	--	*Mixed fish*
	2.	Kembung	*Rastreliger* sp	*Indian mackerel*
	3.	Layur	*Trichiurus* spp	*Hairtails*
	4.	Cakalang	*Katsuwonus pelamis*	*Skipjack tuna*
	5.	Udang	*Penaeus* sp	*Prawn*
	6.	Cumi cumi	*Loligo* sp	*Common squids*
	7.	Tuna	*Thunnus* sp	*Tuna*
2009	1.	Ikan campuran	--	*Mixed fish*
	2.	Tuna	*Thunnus* sp	*Tuna*
	3.	Tenggiri	*Scomberomoruscommerson*	*Spanish mackerel*
	4.	Cakalang	*Katsuwonus pelamis*	*Skipjack tuna*
	5.	Udang	*Penaeus* sp	*Prawn*
	6.	Cumi cumi	*Loligo* sp	*Common squids*
2010	1.	Ikan campuran	--	*Mixed fish*
	2.	Udang	*Penaeus* sp	*Prawn*
	3.	Cakalang	*Katsuwonus pelamis*	*Skipjack tuna*
	4.	Tongkol	*Euthynus* sp	*Little tuna*
	5.	Cumi cumi	*Loligo* sp	*Common squids*
	6.	Layang	*Decapterus* sp	*Shortfin scad*
	7.	Kembung	*Rastreliger* sp	*Indian mackerel*
	8.	Tenggiri	*Scomberomoruscommerson*	*Spanish mackerel*
	9.	Lemuru	*Sardinella* sp	*Bali sardinella*
	10.	Tuna	*Thunnus* sp	*Tuna*
2011	1.	Ikan campuran	--	*Mixed fish*
	2.	Udang	*Penaeus* sp	*Prawn*
	3.	Tuna	*Thunnus* sp	*Tuna*
	4.	Cumi cumi	*Loligo* sp	*Common squids*
	5.	Cakalang	*Katsuwonus pelamis*	*Skipjack tuna*
	6.	Tenggiri	*Scomberomoruscommerson*	*Spanish mackerel*
	7.	Cucut	*Charcharinus* sp	*Shark*
	8.	Layang	*Decapterus* sp	*Shortfin scad*
2012	1.	Ikan campuran	--	*Mixed fish*
	2.	Udang	*Penaeus* sp	*Prawn*
	3.	Cumi cumi	*Loligo* sp	*Common squids*
	4.	Cakalang	*Katsuwonus pelamis*	*Skipjack tuna*
	5.	Tuna	*Thunnus* sp	*Tuna*
	6.	Tenggiri	*Scomberomoruscommerson*	*Spanish mackerel*
	7.	Kembung	*Rastreliger* sp	*Indian mackerel*
	8.	Layang	*Decapterus* sp	*Shortfin scad*

3.2. Number of fish in the Payload Operations of Henrikan

Number of fish charge in 2008 of 20549.03 tons, in 2009 at 16697.221 tons, in the year 2010 amounted to 15715.331 tons, in 2011 at 11370.806 tons and in 2012 (data from January to June) of 7978.161 tonnes. The amount of charge in the operation in 2008-2012 were as follows Table (2):

Table 2. The amount of fish charge in the operation of Henrikan in 2008-2012

Year	Group/type of fish (Indonesian Name)	amount of fish charge (ton)
2008	1. Mixed Fish	15673.23
	2. Indian Mackerel	187
	3. Hartails	848
	4. Skipjack Tuna	1284.1
	5. Prawn	1377.96
	6. Common Squid	746.05
	7. Tuna	432.69
	Total of amount	20549.03
2009	1. Mixed Fish	12901.681
	2. Tuna	1302.69
	3. Spanish Mackarel	103.5
	4. Skipjack Tuna	1282.3
	5. Prawn	672.45
	6. Common Squid	434.6
	Total of amount	16697.221
2010	1. Mixed Fish	11627.276
	2. Prawn	1179.555
	3. Skipjack Tuna	1197.29
	4. Little Tuna	221
	5. Common Squid	310.2
	6. Shortfin scad	168.35
	7. Indian Mackerel	100
	8. Spanish Mackarel	30.2
	9. Bali sardinella	75
	10. Tuna	806.46
	Total of amount	15715.331
2011	1. Mixed Fish	9395.076
	2. Prawn	297.28
	3. Tuna	329
	4. Common Squid	64.2
	5. Skipjack Tuna	1245.25
	6. Spanish Mackarel	5
	7. Little Shark	15
	8. Shortfin scad	20
	Total of amount	11370.806
2012 (January-June)	1. Mixed Fish	6677.656
	2. Prawn	287
	3. Common Squid	116.5
	4. Skipjack Tuna	501.8
	5. Tuna	278.205
	6. Spanish Mackarel	12
	7. Indian Mackerel	100
	8. Shortfin scad	5
	Total of amount	7978.161

In Table (3) below shows that the number of fish cargo (tons) per group/type of fish from 2008-2012 was dominated by a mixed group of 56274,919 tons of fish, followed by the type of 18057,921 tons Tuna, Skipjack and shrimp at 5510.79 tonnes by 3814,245 ton.

Table 3. Number of loads of fish (tonnes) per species / groups of fish in Henrikan operation from 2008-2012.

Year	Number of loads of fish (tonnes)										
	Mixed Fish	Prawn	Tuna	Skipjack Tuna	Common Squid	Common Squid	Indian Mackerel	Hair tails	Short fin scad	Little Shark	Little Tuna
2008	15673.23	1377.96	432.69	1284.1	746.05	0	187	848	0	0	0
2009	12901.681	672.45	1302.69	1282.3	434.6	103.5	0	0	0	0	0
2010	11627.276	1179.555	15715.331	1197.29	310.2	30.2	100	0	168.35	0	221
2011	9395.076	297.28	329	1245.3	64.2	5	0	0	20	15	0
2012	6677.656	287	278.21	501.8	116.5	12	100	0	5	0	0
Totals	56274.919	3814.245	18057.921	5510.79	1671.55	150.7	387	848	193.35	15	221

3.3. State of Origin in the Operation of Henrikan

Registered fishing vessels in the operation of the year 2008 - 2012 are from several countries, among others: Philippines, Japan, Taiwan, Hong Kong, China, Panama, Malaysia, Kiribati, Thailand, Marshall Island and Indonesia. Of 11 (eleven) countries are examined in henrikan operation for 5 years, the highest number is the Indonesian -flagged fishing vessel some 862 units (in 2008) and 751 units (in 2010). In 2008 and 2010 listed Philippine -flagged fishing vessel some 14 units , followed by Malaysia some 10 units.

The data obtained in 2009, 2011 and 2012 is not like the data in 2008 and 2010, which clearly states the name listed . In 2009 , 2011 and 2012, the country of origin data is only indicated by the name of the fishing vessel registered in the henrikan process, so it was coded Ina panangkap for Indonesian-flagged vessels and non Ina for fishing vessels of other countries . The indicative distribution of the data obtained in three years as follows: 2009 fishing boat indication of another country number 11, number 19 in 2011 and in 2012 a number of 17. Meanwhile, Indonesian flagged vessel some 698 units (2009), 659 units (in 2011) and 349 units (in 2012).

Country of origin data is recorded in operations for 5 years henrikan seen of this type is dominated by boats catch fish from Indonesia catch fish mixed group, followed by shrimp (*Penaeus sp*). While fishing vessels from other countries the dominant group recorded catch fish mixture, followed by shrimp (*Penaeus sp*) and tuna (*Thunnus sp*).

3.4. Number of Operations of Henrikan

Number henrikan operation for 5 years (2008-2012) for each month can be seen in table 5 and chart 5.1, where the number of operations in April henrikan highest number of 475 times in March followed by a number 443 times. Lowest number of operations in December henrikan some 170 times, caused by West season where the water conditions are not conducive to fishing. The average monthly number of operations henrikan 284 times. Analyzed in this section is that at the time of surgery henrikan successful implementation record / record cargo of fish from fishing vessels. Seen the average number of operations per year henrikan 682 times, which was the highest in 2008, lowest in 2012 due to the data obtained only through June.

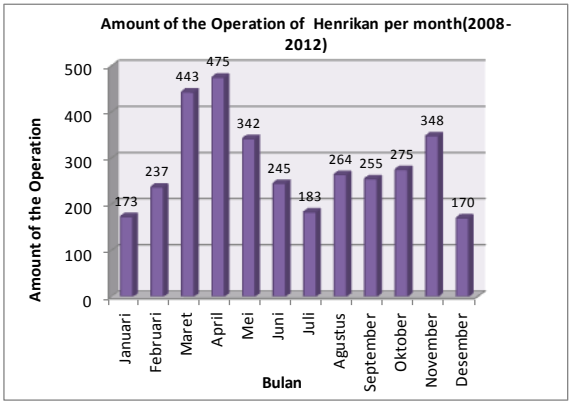


Fig 1 . Number of Operations Henrikan per Month (2008-2012)

3.5 Action on Operation Henrikan

On the implementation of the operations performed henrikan further action on fishing vessels stopped and checked. Data obtained by the mere act of recording the data in 2008 , while the 2009-2012 data is not available because the data is considered confidential . During 2008 , there were acts which recorded 154 cases of overall operations performed henrikan.

From the data obtained in 2008 to record some of the action taken by escorting the fishing vessel to (1) the Navy (Navy Main Base) Manado, Ambon, Kupang, Jayapura, Makassar, Surabaya, (2) Lanal (Naval Base) Sorong, Tahuna, Tual, Tarakan, Maumere, Behind the Blackboard, Merauke, Kendari, Aru , Kota Baru, Benoa Denpasar, Timika, Manokwari and Mataram. Distribution to 20 Lantamal escort action / Lanal can be seen in Table 4 below.

Table 4. Measures Escort Fishing Vessels to the Navy/Lanal in the eastern Indonesian waters on Operation of Henrikan

No	Name of Navy Port (Lantamal/Lanal)	Measures Escort Fishing Vessels
1	Lantamal Menado/Bitung	51
2	Lantamal Ambon	22
3	Lantamal Kupang	3
4	Lantamal Jayapura	2
5	Lantamal Makasar	4
6	Lantamal Surabaya	3
7	Lanal Merauke	13
8	Lanal Tarakan	9
9	Lanal Benoa	3
10	Lanal Maumere	8
11	Lanal Mataram	2
12	Lanal Sorong	16
13	Lanal Balikpapan	3
14	Lanal Tual	3
15	Lanal Kendari	1
16	Lanal Aru	1
17	Lanal Kota Baru	1
18	Lanal Tahuna	7
19	Lanal Timika	1
20	Lanal Manokwari	1
	Totals	154

In the above table it can be seen that the act of fishing vessels to escort the Navy / Lanal in the waters of eastern Indonesia on highest henrikan operations , the Navy is directed to Manado number of 51 units , followed by the Navy Ambon number of 22 units and 16 units Lanal shoves number.

Several modes / types of illegal activities are often carried out KII, among other things: fishing without a license (Fishery Permit (original) and a fishing permit (SIPI) or Ship Transportation Permit Fish (SIKPI)), has a license but violating the provisions as defined (offense fishing areas, gear violations, violations of compliance-based), fraud / manipulation of documents (document procurement, registration, and licensing ships), transshipment at sea, do not turn on the transmitter (special for vessels that are required to install the transmitter), and destructive fishing (destructive fishing) using chemical, biological, explosives, equipment and /or method, and /or buildings which endanger conserve fish resources [1].

In the eastern Indonesian waters on Operation of Henrikan, investigation on fishing vessels are laid off and examined, among others, regarding some of the following:

1 . Letter Worth completeness Operation (SLO)
2 . Permit completeness Screen (Sijil)
3 . Completeness VMS transmitter activation certificate (Vessel Monitoring System)
4 . Length of fish nets
5 . Mesh sizes of fish nets
6 . Arrests outside the area specified in the SIPI (fishing license)
7 . Results of testing the quality of the fish in the boat does not meet quality standards and are not worthy consumed
8 . ABK citizens in the absence of fishing vessels
9 . Make arrests without SIPI
10 . Barcode stickers and signs for the boat fishery redemption fees of up to 30 GT

11 . Sail the ship unseaworthy
12 . According to the number of crew members crew list
13 . Does not have a Business License (Business License Fisheries)
14 . Conformity in accordance with engine number SIKPI – OI
15 . SLO has not been properly socialized to fishermen / boat owners
16 . Certificate kelaiklautan fishing vessel , where the vessel nationality letters and measurement certificate in it
17 . The lack of existence in the boat captain

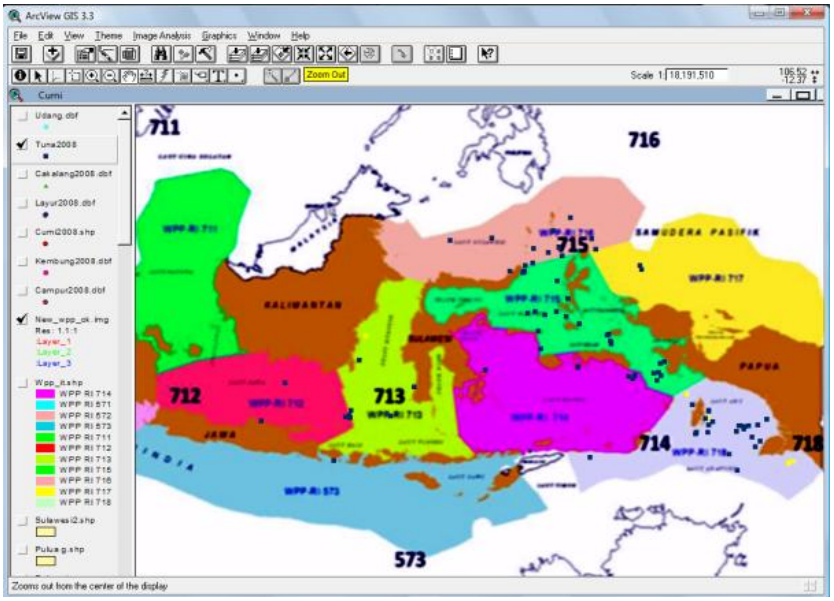
3.5. Spatial Data of Henrikan

Henrikan spatial data include : the results of the capture location data in the form of fishing vessels of data points (dots) and has a latitude and longitude position . Before the data is entered into the database , the necessary digitized map of Indonesia and fishery management area (WPP). Indonesia map is processed in the form of a line or polygon features.

Indonesia map digitised and displayed according to the island instead of the province while the map WPP in accordance with the provisions of the zoning fishery by the Ministry of Maritime Affairs and Fisheries . The digitized map WPP results are shown in Figure (2) . Maps are displayed in the form of polygon features .

Some fishing boats catching location data has been digitized by type of commodity, such as: shrimp, tuna, mackarel, squid, mackerel, fish mixture. Some of views of the location maps are shown in Figure (3) and Figure (4).

Fig 2. The digitized map Of WPP.



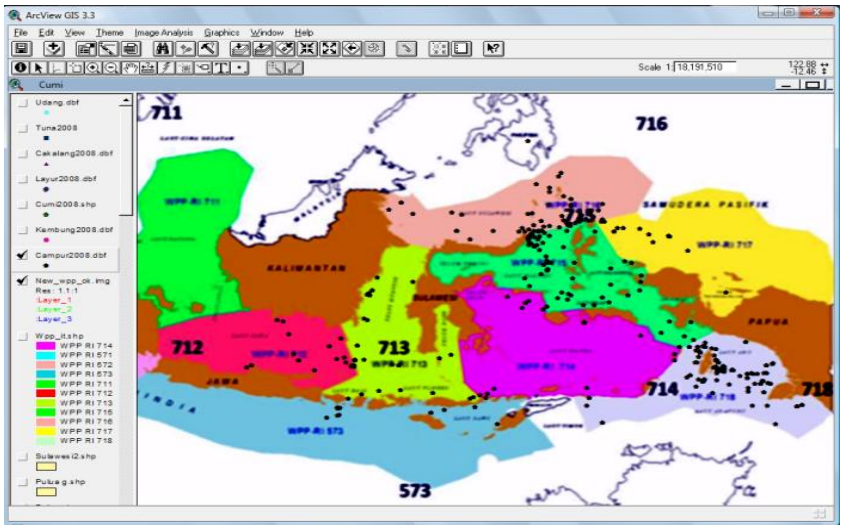


Fig 3. Results digitized map of the location of the mixed fish point features.

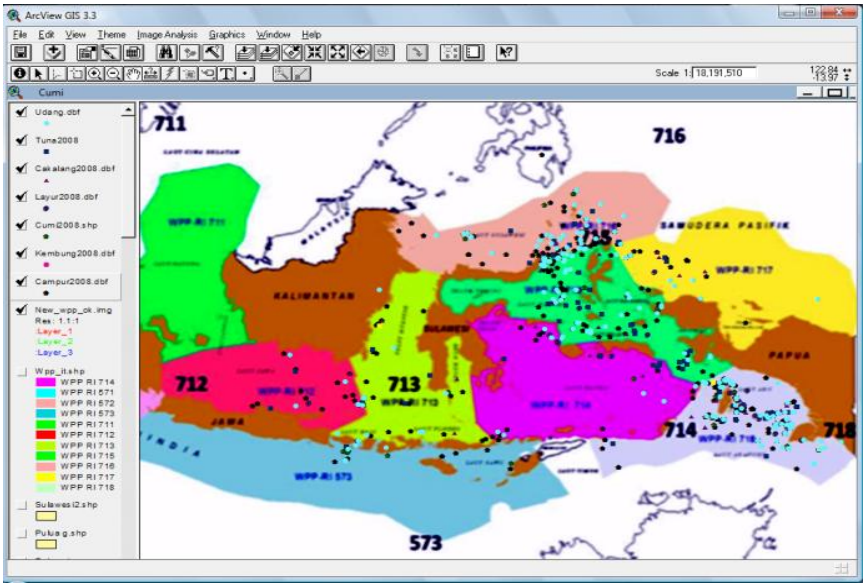


Fig 4. Results digitized map of the location of all fish point features.

The location data entry is the first step that must be done. Furthermore, the data is ready to be added to the data attributes as well as a more complete treatment, including the process of data search and query in the form of searching.

3.6. Attribute Data Processing

Once the spatial data henrikan entered into the database, then performed the data entry process attributes. Dimassukkan attribute data in accordance with the location of the arrest of the ship. The attribute data is the data description / condition at the time of capture fishing boat. An example is the following figure (5).

Attributes of Udang.dbf

Shape	Y	X	Kode	Bendera	Muatan
Point	-5.12472	115.19472	UD203	INA	200 KG UDANG
Point	3.02889	121.35833	UD204	INA	20 TON UDANG
Point	-3.68333	112.35000	UD205	INA	2,5 TON UDANG
Point	-0.59167	125.72722	UD206	INA	2,5 TON UDANG
Point	-0.59167	125.72722	UD207	INA	2 TON UDANG
Point	2.88611	119.79389	UD208	INA	2 TON UDANG
Point	2.84056	121.59722	UD209	INA	2 TON UDANG
Point	-3.78667	133.72000	UD210	INA	2 TON UDANG
Point	-3.78667	133.72000	UD211	INA	2 TON UDANG
Point	-3.78667	133.72000	UD212	INA	2 TON UDANG
Point	1.22278	125.28639	UD213	INA	2 TON UDANG
Point	3.00667	121.20333	UD214	INA	2 TON UDANG
Point	3.00667	121.20333	UD215	INA	2 TON UDANG
Point	3.00667	121.20333	UD216	INA	2 TON UDANG
Point	1.90528	126.23000	UD217	INA	17 TON UDANG
Point	-6.87333	137.15167	UD218	INA	16 TON UDANG
Point	-6.87333	137.15167	UD219	INA	16 TON UDANG
Point	-6.87333	137.15167	UD220	INA	16 TON UDANG
Point	-7.06333	136.92667	UD221	INA	15 TON UDANG
Point	-6.83500	135.06167	UD222	INA	120 KG UDANG
Point	-6.60167	135.30028	UD223	INA	11 TON UDANG
Point	-6.05833	135.05833	UD224	INA	10 TON UDANG
Point	-6.05833	135.05833	UD225	INA	10 TON UDANG
Point	-6.05833	135.05833	UD226	INA	10 TON UDANG
Point	-6.05833	135.05833	UD227	INA	10 TON UDANG
Point	-0.07861	126.88583	UD228	INA	1,5 TON UDANG
Point	1.51639	125.35028	UD229	INA	1,5 TON UDANG
Point	1.54056	125.35972	UD230	INA	1,5 TON UDANG

Fig5. Examples of data capture location aribut for commodity shrimp fishing vessels.

3.7. Query and Henrikan Data Search

Query is a question and answer facility between the user (user) to the computer after all the required data has been entered into the database system. One of the query shown in Figure 6. In the example of the query is to ask the captured ship with china flag. Then the query results are shown on a map or chart. On the map marked in yellow on the corresponding point on the chart while also shown with a yellow background on his writing. Query results in the table shown in Figure (6).

In addition to the query process, the identification process can also be done. The identification process is shown in Figure (7). By identifying the point at which the active features in the map, then the computer will show the results of the identification.

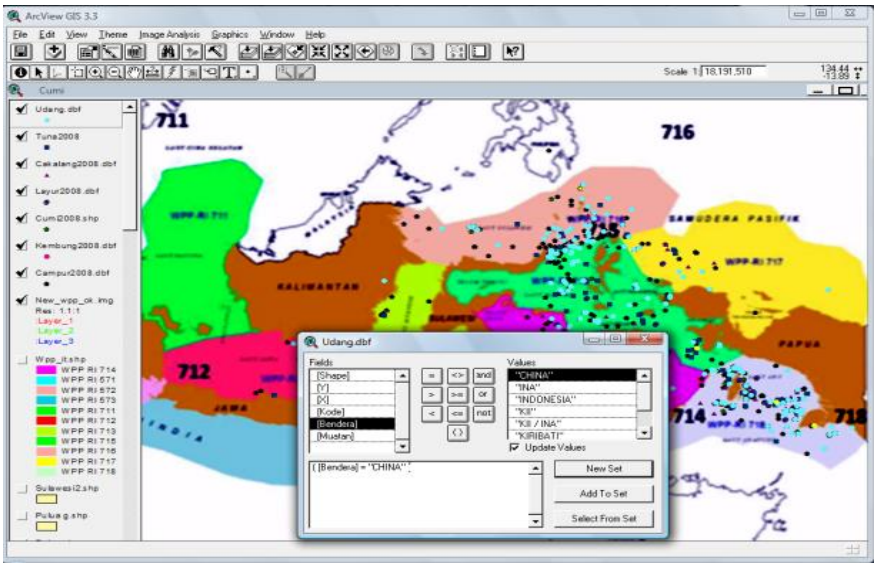


Fig 6. Query Result

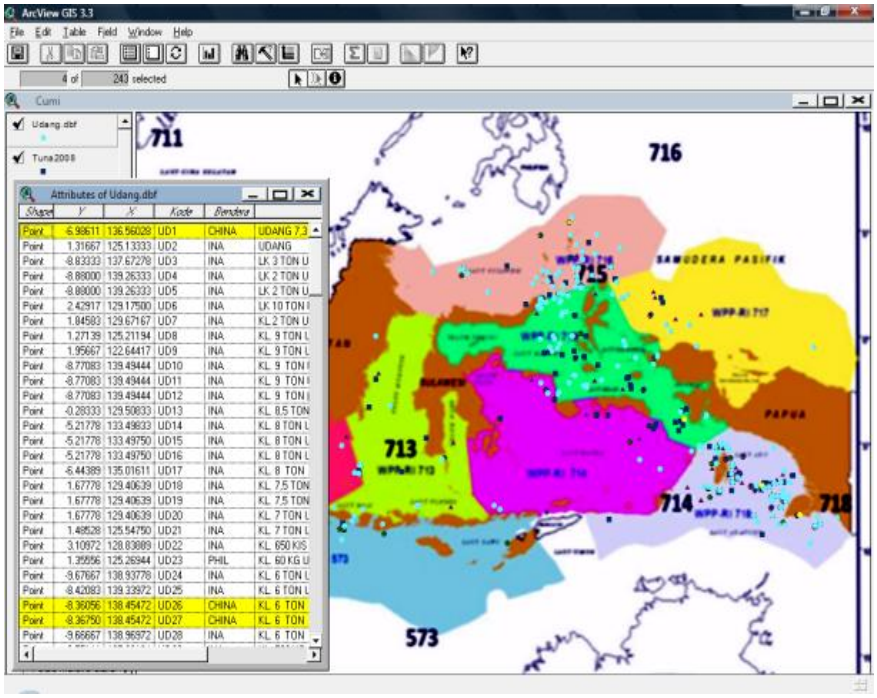


Fig 7. Result Identification

3.8. Data Reporting Henrikan

Preparing reports henrikan shown in the form of data map with the location of the background fishery management area. One form of the report displays is shown in Figure (8).

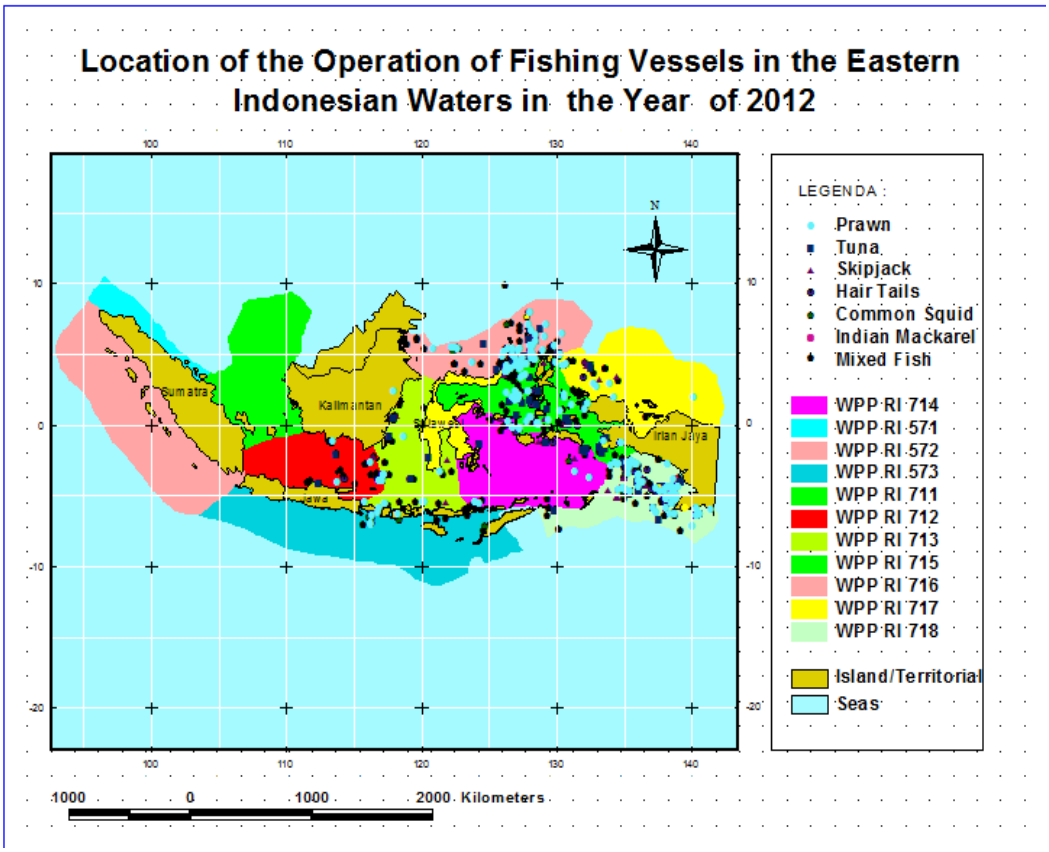


Fig 8. Report Display

IV. CONCLUSION

From this research, it can be concluded and recommended, as follows: (1) Data capture fisheries in the eastern waters of Indonesia, in particular relating to the termination and inspection of fishing vessels made by the parties involved , namely the Navy is very important data to be known and communicated to the public in general and in particular fisheries observers. (2) Data recorded Fishing Conditions in the process of becoming Henrikan be processed spatial data base using ArcView soft ware. (3) Groups and species of fish recorded in Henrikan process is a mixture of fish, bloated, tuna, mackerel, hairtail, calamari squid, shrimp, skipjack, and frigate, lemuru and overpasses. (4) Countries that are processed in Henrikan operations include Indonesia, Malaysia , Philippines , Thailand , China , and Hong Kong , Japan and Panama. (5) Escort the fishing vessel which stopped and checked dominant brought to Lantamal Bitung / Manado and Ambon Lantamal the most dominant case is about the completeness of unseaworthy. (6) Number of fish charge in 2008 of 20549.03 tons , in 2009 at 16697.221 tons , in the year 2010 amounted to 15715.331 tons , in 2011 at 11370.806 tons and in 2012 (data from January to June) of 7978.161 tonnes

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