ANALYSIS OF THE ACTIVITIES OF SUPPLY VESSELS IN THE INDIAN OCEAN FROM OBSERVERS DATA

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SUMMARY

The analysis of data related with the activities of the supply vessels as well as the purse seine vessels associated with and without them are conducted. A classification of the different types of supply vessels and purse seiners is done based on knowledge of the fishery and observers data. Also a description of the different types of vessels and their activities is carried out in order to see the importance of the effort of the supply vessels. Finally the yields of the purse seiners working with and without supplies is compared, and the possible effect of the supplies in this yield is discussed.

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INTRODUCTION

Supply vessels are auxiliary vessels that help purse seiners in several activities. We can find the origin of supply vessels in the "maciceros". These boats were also associated with the purse seiners working as FADs. In contrast, present supply vessels are continuously moving and only those associated with the seamount are anchored. Some of these activities are directly related with the fishing operations and some others are not, but even this last type of actions make the purse seiner have more time to invest on activities that are more directly related with the final yield.

The use of supply vessels has been developed in the last decade, and nor their activities nor their effects on catch rates are known.

During the 2000 Working Party on Tropical Tunas a ban of supply vessels was considered as an alternative measure to the different moratoria options in order to reduce the fishing mortality of juvenile bigeye tuna in the Indian Ocean (Anon., 2000), as the supply vessels were considered to be the probable cause of the difference in BET catch rates of the Spanish and French purse seiners since 1994, the year when a Spanish supply vessel first operated in the fishery (Anon. 2000). As a consequence, the Working Party recommended that more research be conducted on knowing the number of supplies operating in each year, the number of purse seiners using these vessels, and on which purse seiners were using supply vessels.

During the 1998-1999 moratorium on FADs for the western Indian Ocean, 10 Spanish associated supply vessels were operating in the purse seine fishery. Two of them remained anchored in de Coco de Mer seamount (25'N- 56º01´E), while the rest (8) were free navigating (we will refer to them as "Anchored supplies" and "Navigating supplies"). In 2000 this number increased to 11 to decrease until 7 in 2001. During all this period two of these vessels have kept anchored in seamounts.

The use of supply vessels is not exclusive of the Indian Ocean. Looking at the number of these boats that stopped in the port of Abidjan during 2000 and the first part of 2001 in the Eastern Atlantic, we can estimate that more than 8 supplies are operating. Regarding the Eastern Pacific, although some of these vessels started operating in the last 90s,their use was forbidden in that region in 1998.

In the period of the moratoria all the supply vessels had an observer onboard. This document analyses the data obtained by these observers, that were monitored by AZTI Foundation and funded by the Spanish Frozen Tuna Producer Organizations ANABAC and OPAGAC. The document also presents the results of one observer trip in a supply vessel as part of the ESTHER (efficiency of tuna purse seiners and real efforts) project activities. This project funded by the European Union and developed by the Instituto Español de Oceanografía (IEO – Spain) and the Institut de Recherche pour le Développement (IRD – France) has as a goal to analyse and quantify the change in the fishing power of the Spanish and French purse seiners fishing tropical tuna in the Atlantic and Indian Oceans due to the improvement of the onboard technical equipment.

The first objective of this work is to analyse the activities in which the different types of supplies did spend their time during that 1998-1999 two month period moratorium and during the ESTHER trip. The second objective is to compare the yields obtained by the purse seiners working with the different types of supply vessels during the mentioned periods of time in order to see whether the effort of the supplies could have affected the yield of the purse seiners or not.

SUPPLY DESCRIPTION

The **anchored supplies** act as fish aggregating devices and by means of the sonar and ecosounder periodically estimate the amount of fish aggregated under the vessel. Due to the aggregating behaviour of tunas around FADs, normally these estimations are done early in the morning, and the results are provided to the purse seiners (in this case, the anchored supplies were working for one and two purse seiners respectively), which will decide whether to make a fishing operation or not depending on the amount of fish and location of the purse seiner (distance to the supply).

The **navigating supplies** spend their time in activities conducted to help the purse seiner in their fishing operations.It is a common practice to share a supply between different purse seiners of the same company, sometimes they make use of it at the same time and some other times the supply works for a single purse seiner for a while and then works for another single purse seiner for another period of time.

During the 1998-1999 moratorium, 4 out of 8 navigating supply vessels were working with 2 purse seiners, 3 were working with a single purse seiner and the other navigating supply was working at least with one purse seiner, but could be working with more. In the ESTHER trip the supply worked associated with two purse seiners.
The activities of the supply vessel are targeted to increase the fishing efficiency of the purse seiner by increasing the catch rate and/or the economical yield. The increase in economical efficiency is mainly due to a reduction in costs of the purse seiner, specially the searching time cost. We can split these activities into two categories:

a things directly related with search and detection of schools.
b things related with the performance of fishing boats.

Under the first item the activities of the supply vessel are:

· Location of floating objects, including objects with or without and own or foreign objects. Once the object is located the supply vessel visits it to check if there are fishes aggregated or not and evaluates species, sizes and total amount. As the cost of sailing is much lower for this vessel than for the purse seiner this activity supposes an important reduction in costs.

- ·Increase the searching area of the purse seiner. The supply vessel can explore and detect schools in areas far from the purse seiner.
- ·Work as a floating object. In some cases the supply vessel is anchored in a particular place generally close to a seamount.
- ·Build and seed floating objects.
- ·Manipulate floating objects. The supply vessel can move objects from areas with high density of objects to other areas to allow bigger concentration of fishes under the object. Also the supply vessel can follow the behavior of the school aggregated under the object (movement direction, speed, etc.).

Under the second item we can consider the activities aimed at allowing the purse seine to keep fishing continuously in the same area during the hole trip, such as:

- ·Exchange of crew from and to port.
- ·Movement of persons in case of illness or accident.
- ·Get and distribute food, goods and oil.
- Being a platfo rm for at-sea repairs.

· In summary, we can consider that the association purse seiner-supply vessels increase the searching capacity (main activity in time of the purse seiner) and in consequence the location and fish of schools with a reduction in costs.

MATERIAL AND METHODS:

Part of the data used in this analysis was collected by the observers aboard purse seiners and supplies during the moratorium on FAD fishing in the western Indian Ocean, that took place from the 15th of November 1998 to 15th of January 1999. During that period, 40 observers went aboard 10 auxiliary boats and 30 purse seiners belonging to the Spanish organizations OPTUC-ANABAC and OPAGAC. More details on the real period observed are in Arrizabalaga & Artetxe (2000).

The formularies used for data collection on route parameters, catches and size distributions were adopted from the ones used in the research project UE 96/028 (Delgado de Molina et al. 1997). Data were collected periodically every hour or every time there was a change in the activities of the vessel.

In the case of the ESTHER trip the method used to get the observer data is described in the "Manual of observers on board of purse seiners fishing in the Atlantic and Indian Oceans" (Daniel Gaertner, 1999).

Data were obtained by an observer of the IEO during a trip of 45 days (from 7/2/2000 to 8/15/2000) in the Indian Ocean.

The data regarding activities of the vessels during the night are not considered clear enough, so for this analysis we have only considered information regarding activities during the day. Only in one case (ESTHER data) we considered the activity at night.

The 10 supply vessels were working with 15 purse seiners, 14 of which are observed. The rest 16 purse seiners observed belong to the category of "Purse Seiners working without supplies". From those 16 purse seiners, information from one of the vessels was not useful and was rejected for the analysis. Regarding the 14 vessels in the category "Purse Seiners working with supplies", there was not information on the catches for one of them, so the yield analysis was done with 13 vessels of this category. From the 8 navigating supply vessels observed, one of them was only observed for 4 days and another one did not have reliable information so both were eliminated for the analysis.

Fishing trips were mapped for all the available vessels in each vessel category.

Based on the knowledge of the fishery and supported on the fishing trip maps, we identified the following different groups of vessels for the present comparative analysis:

- Anchored supplies
- Navigating supplies
- Purse seiners working with anchored supplies
- Purse seiners working with navigating supplies
- Purse seiners working without supplies

The total miles covered and the miles covered per day were computed (the number of days at sea was computed resting the days at port to the total number of days). The number of total and average number of fishing days considered in this analysis is reflected in Table 1, showing that a similar amount of fishing days has being observed in each of the vessels, although there are logically more vessels of certain type than of others.

An analysis of the time employed in each activity for each type of vessel is carried out with an special focus on the activities that are more related with FAD searching, deploying or modifying. In the case of the hours spent by supplies in each activity, they have been divided by the total number of purse seiners working with them, in order to give an idea of how many hours they dedicate to each vessel in each activity, the amount of effort that a purse seiner is gaining because of the activities of the supply, or which is the relative daily advantage of a purse seiner working with a supply compared to one that is not working with it, in hours. Obviously we understand that this number of supply hours is not comparable and thus can not be added directly to the hours of the purse seiner without some kind of prior effort standardization between type of vessels (purse seiners and supplies).

The yields by species and by commercial categories for the different type of purse seiners are computed as total catch by number of days at sea. This information comes directly from the estimates of the skippers, as they have not been corrected with the length sample information.

RESULTS

Technical equipment of the supply vessel

In the case of the observed vessel during the ESTHER Project, the crew was of seven persons: a skipper, a captain, an engineer, two oil technicians, a cook and a sailor. However, the size of the crew can vary from a minimum of 5 to a maximum of 8 persons, this last case including one more sailor for searching with binoculars.

For the detection of tuna schools the boat is provided with different devices. In many cases the spare equipment is present to ensure the continuous availability of at least one of the two pieces of equipment. Those devices are:

- · - ARPA Radar: two, one for sailing and one for bird detecting.
- · -Radio Direction Founder (RDF): two, only one used at a time.
- · -Sonar: two, only one used at a time.
- · -Depth recorder: one, working between 0 and 125 meters.
- · -GPS: two, one for sailing and the other to get the spatial position of the SERPE buoys in a regular basis (each hour).
- · -Plotter: to follow the movement of SERPE buoys.
- · -Binoculars: one on the bridge.

Behaviour of the supply vessel observed in the ESTHER project

The activity of the supply can change along the year because of the seasonally of the fishery and the weather (specially in the Indian Ocean). During the observer trip the bad weather limited the activity of the supply to visiting its own floating objects. Rough seas difficult the sighting of other boats' floating objects. Nevertheless the skipper is always on the lookout to see any other object. Later in the year, during September-October, the weather improves and the supply vessel can spend more time searching its own objects as well as natural objects (without buoys) and objects from other boats. The fishing area is located in the northwest of Seychelles and catches come mainly from floating objects. During this season the bird radar and the binoculars are intensively used.

In general the activity of the supply vessel is defined by the skipper of the purse seiner. Only in a few cases does the fishing company define directly the strategy of this boat. We noticed that there is a high competition between skippers of purse seiners, even if they are from the same company, because they have a stake in the fishing revenues of their boats.

The communication between the skippers of the supply vessel and the purse seine vessels is permanent. In a regular basis the skipper of the supply vessel sends emails to the skipper of the purse seiner giving him all the information related to the different objects that the supply vessel has visited during the day (spatial location, amount of fish, species, sizes...). The skipper of the purse seiner continuously sends to the supply vessel instructions on what to do.

In general, the behaviour of the supply vessel during this trip was mainly to search for floating objects. Once the object was located the supply vessel verified and evaluated the availability of fish under the object. If the object found did not had a buoy or had someone else's buoy, the supply put its own, and if the object was not in good conditions it was repaired and sometimes the object is kept onboard if the seeding location is not considered of interest. During the trip the search was targeted exclusively towards schools associated with floating objects. After locating a school the supply vessel only notified the purse seiner if it was associated to a floating object. The reason for that is that the probability of a successful set is higher when the school is associated to a floating object than to a free school.

Once the supply vessel locates and evaluates the amount of fish under the object, its behavior depends on the location of other boats. If there are no purse seiners around or if they have not noticed that it has located the school it can continue searching. On the contrary, if it notices that other boats have noticed the presence of the school, the supply vessel maintains its position until its purse seiner arrives.

During this trip the type of buoys used were either SERPE buoys or conventional buoys. An important amount of time was used to take care of objects. Together with this activity the skipper followed the bird radar information taking note of all the appearances and controlling their behaviour (direction against or with the wind). The use of binoculars was not continuous because there was only one sailor in the crew and also because of the bad weather. With good weather the use of binocular is more continuous.

The behavior of the supply vessel in relation to its own floating objects is similar to that of the shepherd with his sheep. The supply takes care that other boats do not locate its objects but if that occurs the supply vessel will try to avoid that they can be fished. Even if the supply vessel is far from one object it can go back to it if the skipper thinks that another boat has located it. In the same sense the behaviour of the supply vessel around the objects is very cautious avoiding to give any clue to other boats about the presence of the object. On the contrary the supply vessel follows closely the behaviour of other boats in the radar in order to identify any sign of evidence of the presence of an object. All the objects coming from boats different of those associated with the supply vessel were considered as foreign even if they came from boats of the same company.

The "seeding" of objects is made along the year by setting 8 to 10 objects separated by about ten miles in a line. The first object put at sea generally has a SERPE buoy. As this type of buoys transmit its position each hour the supply can follow the direction of the movement of the objects and the current intensity. After some hours of observation the supply can decide if the movement of the buoys is appropriated or not. If it is, the supply proceeds to put at sea the rest of the objects. If it is not, the object is boarded and will be put at sea in another place. The rest of the objects have conventional buoys, alternated with some SERPE buoys in order to better follow the movement of the group of objects.

Activities of the supplies

Figures 1 to 5 show the fishing trips of all the vessels available for each one of the vessel categories identified. Under each trip there is information (if available) on the miles covered and trip days.

Obviously, there is a big difference between the anchored and navigating supply fishing trips, as the first ones just navigate from port to Coco de Mer Seamount and stay anchored there, while the navigating supplies have fishing trips that are more similar to the purse seiners'.

Regarding the fishing trips of the purse seiners, the main difference between the ones that work with supplies anchored in Coco de Mer Seamount and the others is that the first ones make, in general, several visits to that area. In the case of the navigating supplies, it is not possible to determine graphically when the purse seiner is in contact with it, as the time information is lacked in these maps. Further analyses on the contact points between purse seiners and navigating supplies could give a better idea of the type and success of the interaction between them.

There is not a significant difference between the fishing trips of purse seiners working with navigating supplies and the ones working without supplies.

The number of nautical miles per day for each vessel type is reflected in figure 6, showing that the purse seiners working with and without supplies cover the same number of miles per day, which is obviously much higher than the miles covered by the navigating supplies (which are smaller boats with less engine power) and anchored supplies (which only navigate from port to the seamount).

The time invested in each activity during the day is reflected in Figure 7 as a percentage of the total time employed by each vessel type. The general pattern of the time distribution along the different activities is similar to the one presented in other studies based on observers data (Ariz & Gaertner, 1999). Figure 8 is just a zoom in the activities that are directly related with FADs, such as "Searching exclusively for FADs", "Deployment or modification of FADs", "Taking on board owned FADs" or "Taking onboard someone else's FAD". Purse seiners and navigating supplies invest almost 60% of their time searching, while anchored supplies invest more than 90% of their time in the "Other activities" category, which includes being anchored in a seamount. There are no significant differences between the time distribution along the different activities of the purse seiners that work with and without supply vessels. On the other hand, the pattern of the navigating supply vessels is quite different from the purse seiners, as they invest more time (in percentage) in the activities that are related with FADs, and specially "Searching exclusively for FADs" (less than 10% of the time is invested by purse seiners and 18.65% by a supply vessel), The supply vessels also spend more time than purse seiners "Travelling without searching", which includes activities like transporting crew members or food from land to the purse seiners and vice versa.

In figure 9 the time distribution along the different activities is related to one single day at sea, with the particularity that for the case of the supplies, the hours invested in each activity have been divided by the number of purse seiners for which they work, as explained before. Again, Figure 10 is a zoom of figure 9 focusing on the activities that are directly related with FADs.

It is observed that 7.5 and 6.9 hours a day are invested in "General searching" by the purse seiners working with and without supplies respectively, and the navigating supply's work is reflected in 5.2 searching hours for each purse seiner working with them. In the same manner, and respectively for purse seiners working with and without supplies, 0.87 and 0.7 hours are invested daily in exclusively searching for FADs, and 1.6 hours a day is the contribution of the navigating supply to each purse seiner working with them; 0.18 and 0.3 hours are invested in "Setting up or modifying FADs", and 0.2 hours is the daily contribution of the supply vessels; 0.03 hours a day are spent "taking on board a foreign FAD", and the supply daily contribution is of 0.09 hours, and finally 0.04 and 0.01 hours are spent in "taking on board a self owned FAD", and the contribution of the supply is of 0.06 hours.

As we see, the navigating supplies can contribute to the purse seiner with a significant amount of time spent in several activities such us general searching (the contribution in relative supply hours is 75% of the amount of hours spent by the purse seiner working with it), and specially in activities related with FAD handling, such us FAD searching (184%), setting up or modifying FADs (128%) and taking on board a foreign (300%) or self owned (150%) FAD.

Figure 11 and table 2 show the time distribution (in percentage) in each different activities taking into account both day and night activities, which has been obtained from one single observed navigating supply.

Most of the day time at sea has been spent searching (mainly for FADs). As the supply vessel is almost continuously visiting FADs, the time spent sailing towards an observed system is dominant (nevertheless, it has to be taken into account that while they are sailing toward an observed system they can also be searching for other schools or FADs). During the night, they spend most of the time sailing (approaching FADs) or drifting (near FADs).

During this single observed period, 28 tuna schools were directly observed. Looking at the behaviour of the school we verified that: -in any case the school was associated with the supply, - one school escape moving down, - three schools kept stable, - 24 schools escape towards the floating object.

From these 28 direct observations of schools, 9 of them were fished afterwards, resulting in 8 sets with tuna catch and 1 set with 20 t of bananas (Elagatis sp.) that were discarded. The estimation of total tuna catch from the logbooks was 324 t, 18% higher than the estimation of catch made by the supply (275 t). The catch by species was 145 t of YFT, 143 t of SKJ and 36 t of BET.

Figure 12 shows the movement of the supply and the position of the overall sets made by all the fleet by 11 day intervals (2/07 to 12/07, 13/07 to 23/07, 24/07 to 3/08 and 4/08 to 14/08).

Figure 13 shows the area where the supply worked with the objects (seeding and substituting buoys, following objects, estimating the size of schools, etc.) in the four periods considered. During this trip the supply visited objects 113 times and worked with 81 different buoys.

The drifting trajectories of some objects were obtained and are shown in figure 14.

In figure 15 the yield by species for each of the vessel types is represented. The difference between the yield for the purse seiners working with navigating supplies and the purse seiners working without supplies is very low (12139 kg/day and 11877 kg/day respectively), while the yield for the purse seiners working with anchored supplies is much higher (16170 kg/day).

Figure 16 shows the species and commercial categories composition of the total catch (including free school and log sets) of the purse seiners working with navigating supplies, anchored supplies and without supplies. It does not seem to be a significant difference between the small bigeye caught per day by each vessel type. On the other hand, the percentage of skipjack bigger than 1.8 kg in purse seiners working with anchored supplies is of 43%, compared with purse seiners working with navigating supplies (25%) and without supplies (36%), and the % of yellowfin bigger than 10 kg is 34%, 52% and 39% respectively.

DISCUSSION

Supply vessels seem to have a relatively important contribution to the time the purse seiner is dedicated to searching and/or handling with FADs. This points out that although almost the entire Spanish associated fleet has being sampled during the moratoria period, the two month period observed (15th October to 15th January) is not enough to make a clear idea of the activities of the supply vessels and their impacts in the yield of the purse seiners, in addiction the low coverage (only one supply) of observers outside this period does not allow to get any general conclusion on that. It would be interesting to carry out similar studies all along the year, and specially in seasons where the FAD fishery is more important. Moreover, it would be interesting to analyse yields separating log and free school sets in order to see whether there is a significant effect on the yield or not.

By means of the present analysis we have a better understanding of the types of vessels that operate in the Indian Ocean and the activities in which they spend their time. This supply effort could have an impact on the yield of the purse seiners for which they work. If we consider that the fishing unit is formed by the purse seiner and the supply vessel working for it (taking into account that some of the vessels work for more than one purse seiner), the catch of this fishing unit should be related to the effort of both the purse seiner and the supply, but the way in which the supply effort is taken into account at the time of computing the purse seiner effort must be handled carefully. The way of standardizing the effort so that it takes into account the supplies' effort should be further investigated in order to include it in the stock assessment of the tropical species in the Indian Ocean. The effect of the anchored supplies is more difficult to handle with at this step, as the activity they mostly do is not shared by the purse seiner but is completely different.

The yields computed in this analysis do not show differences between purse seiners working with navigating supplies and the ones working without supplies. Of course, this does not mean that the supply does not affect the yield of the purse seiner, because many other factors are affecting the yield of these vessels at the same time. The same conclusion could be valid for the purse seiners working with anchored supplies: they show an improved yield with respect to the other purse seiners, but it could be due to other factors not related to the supply.

Regarding the use of FADs, when we compare the times spent by purse seiners working with and without supplies, we can see that the ones working with supplies spend less time deploying FADs, the same amount of time taking on board someone else's FADs, and more time searching exclusively for FADs and taking onboard owned FADs. All this information seems to make sense if we assume that in general the purse seiners with supplies work with more FADs than the ones without supplies. If this was the case, the deployment of FADs would be done by the supply instead of the purse seiner working with it, this showing less time spent in deploying FADs than a purse seiner working without FADs (that would need to deploy them on its own). The probability of finding some other's FADs in the water would be the same for the two types of purse seiner, and the ones with supply would spend more time searching exclusively for FADs and taking onboard owned FADs because they are operating more FADs at a time. We consider that this hypothesis in which supplies would lead to a bigger amount of FADs deployed should be further tested in the future not counting the time invested in FAD related activities (as was intended in the present work) but counting the number of FADs operated by each type of purse seiner.

It is known that in the Atlantic ocean some cargo vessels also use to deploy FADs for the purse seiners. If this was the case also for the Indian Ocean, their effect on the purse seiner's yield should also be further studied.

AKNOWLEDGEMENTS

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Gala Moreno contributed with relevant knowledge of the fishery.

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Table 1. Total number of days at sea, total number of vessels and average number of days with the corresponding standard deviation of each vessel type.

	Purse seiner with supply	Purse seiner without supply	Navigating supply	Anchored supply
Total nº of days	828	840	296	139
Total nº of vessels	14	15	6	2
Average nº of days by vessel	**59.14 +/ - 8.41**	**56 +/- 6.25**	**56.67 +/- 13.7**	**69.5 +/- 9.2**

Table 2.- Quantification of the time spent in the different activities of the supply vessel.

CODE	ACTIVITY	%
1	Port	0.2
2	Sailing	34.0
3	Searching (general)	0.4
4	Searching for FAD	8.6
5	Sailing towards observed system	38.5
6	Approaching observed system	2.0
7	Drifting at night	11.2
8	Transshipment	0.4
9	Seeding and manipulating objects	0.5
10	Recovering foreign objects	0.1
11	Others	4.0

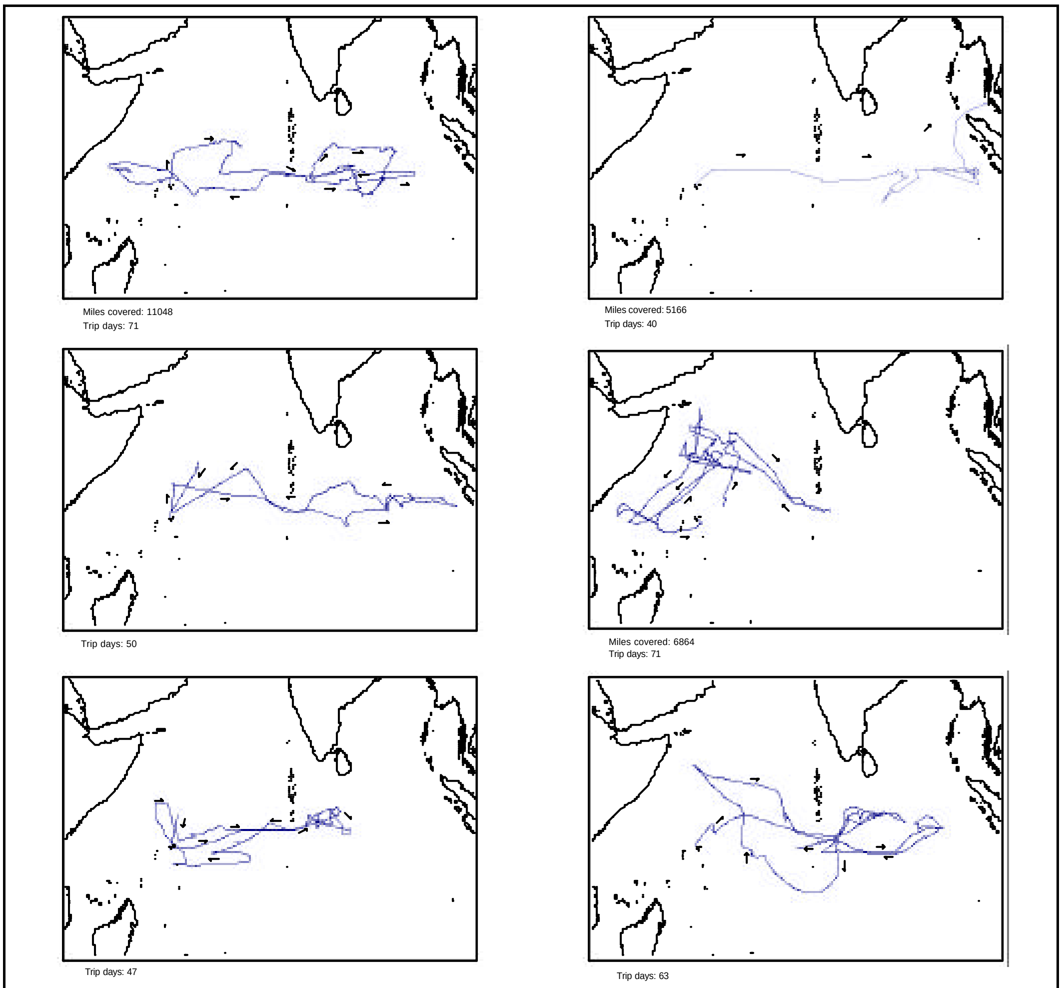


Fig 1a. Trips of Spanish navigating supplies during the 1998-1999 Indian Ocean Moratorium.

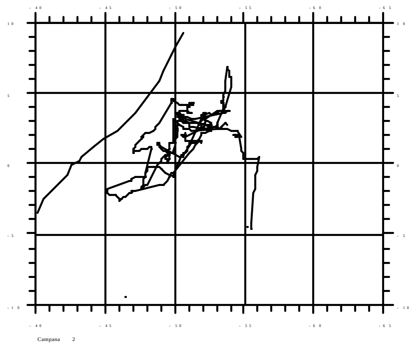


Fig 1b. Trip of the navegating supply observed in the ESTHER project during the period 07/02/2000-08/15/2000

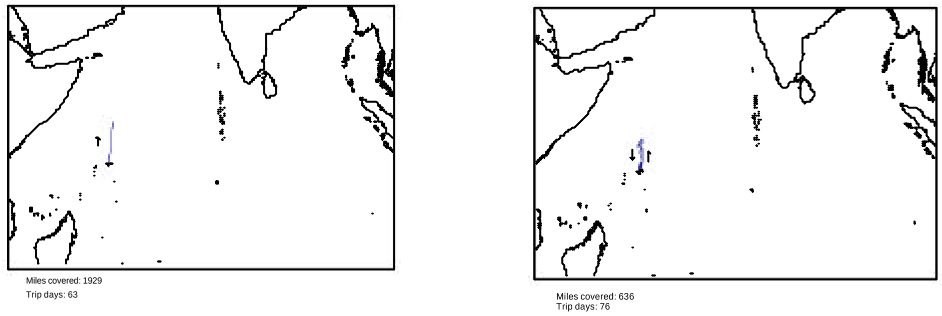


Fig 2. Trips of Spanish anchored supplies during the 1998-1999 Indian Ocean Moratorium.

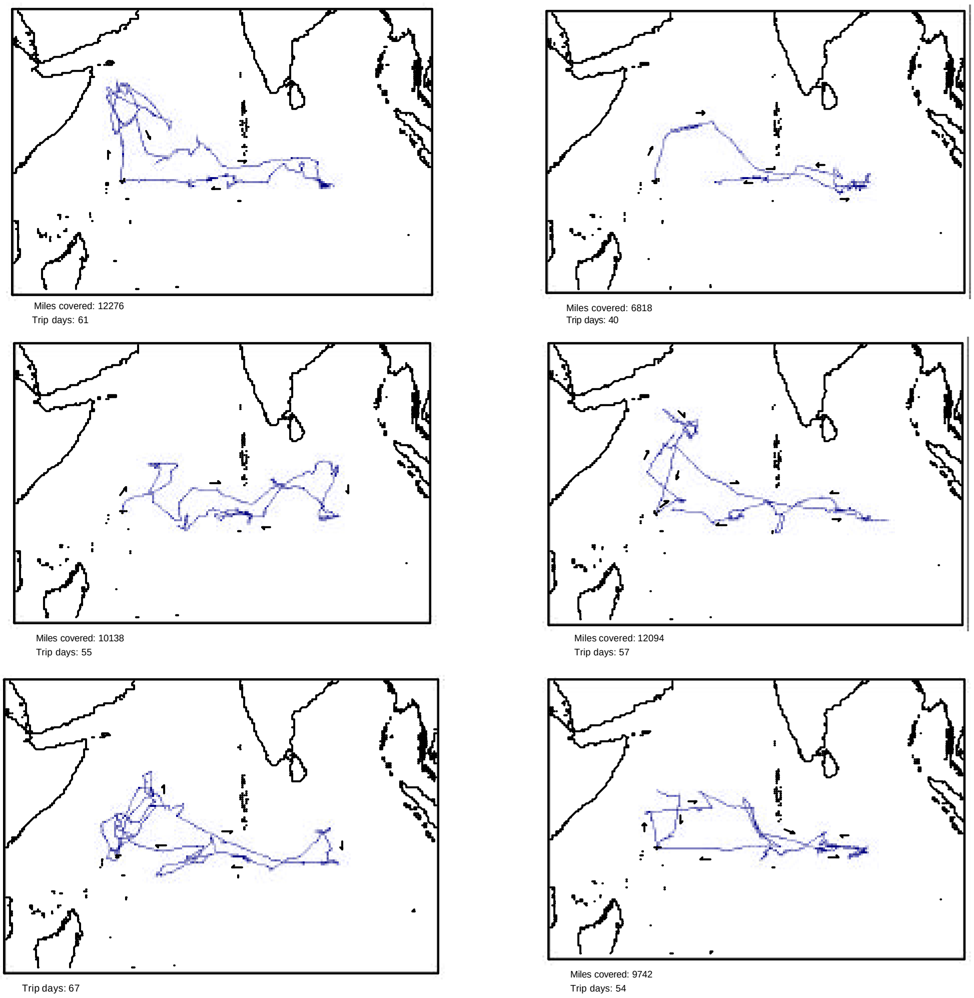
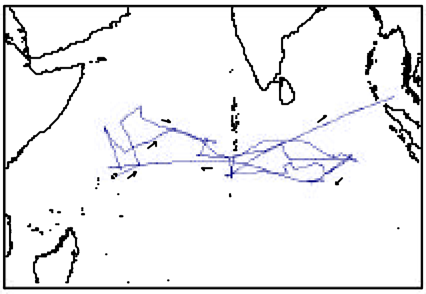
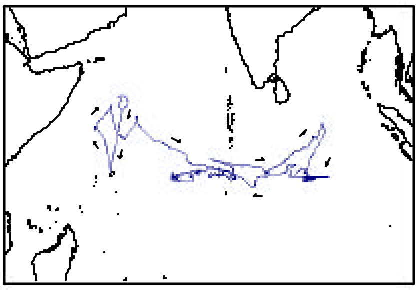


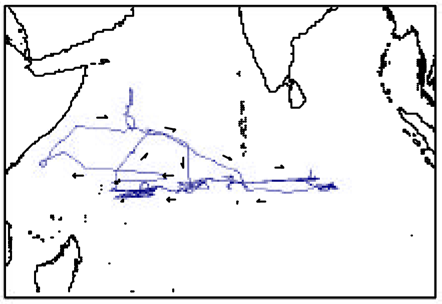
Fig 3a. Fishing trips of Spanish purse seiners working with navigating supplies during the 1998-1999 Indian Ocean Moratorium.



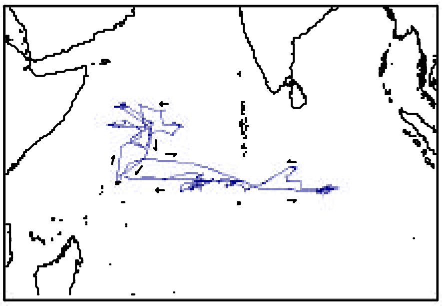
Miles covered: 12584
Trip days: 54



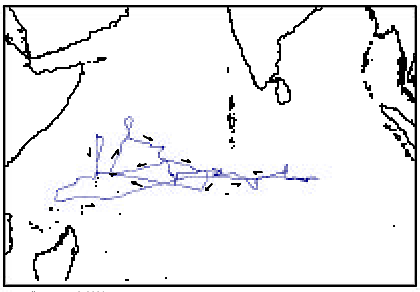
Miles covered: 12466
Trip days: 64



Trip days: 73

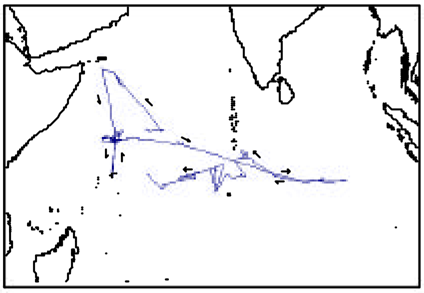


Trip days: 71

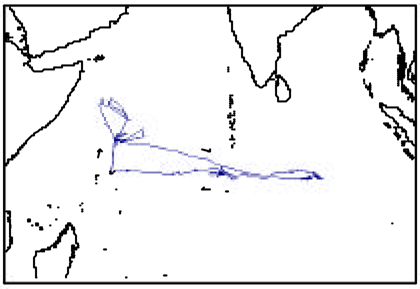


Miles covered: 8336
Trip days: 63

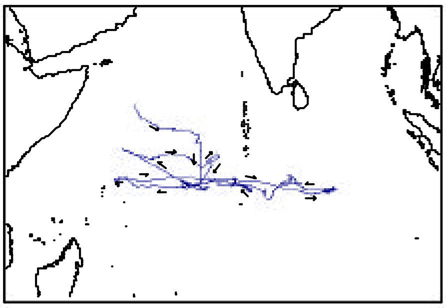
Figure 3b. Fishing trips of Spanish purse seiners working with navigating supplies during the 1998-1999 Indian Ocean Moratorium



Miles covered: 11538
Trip days: 59



Miles covered: 10279
Trip days: 53



Trip days: 57

Fig 4. Fishing trips of Spanish purse seiners working with anchored supplies during 1998-1999 Indian Ocean Moratorium.

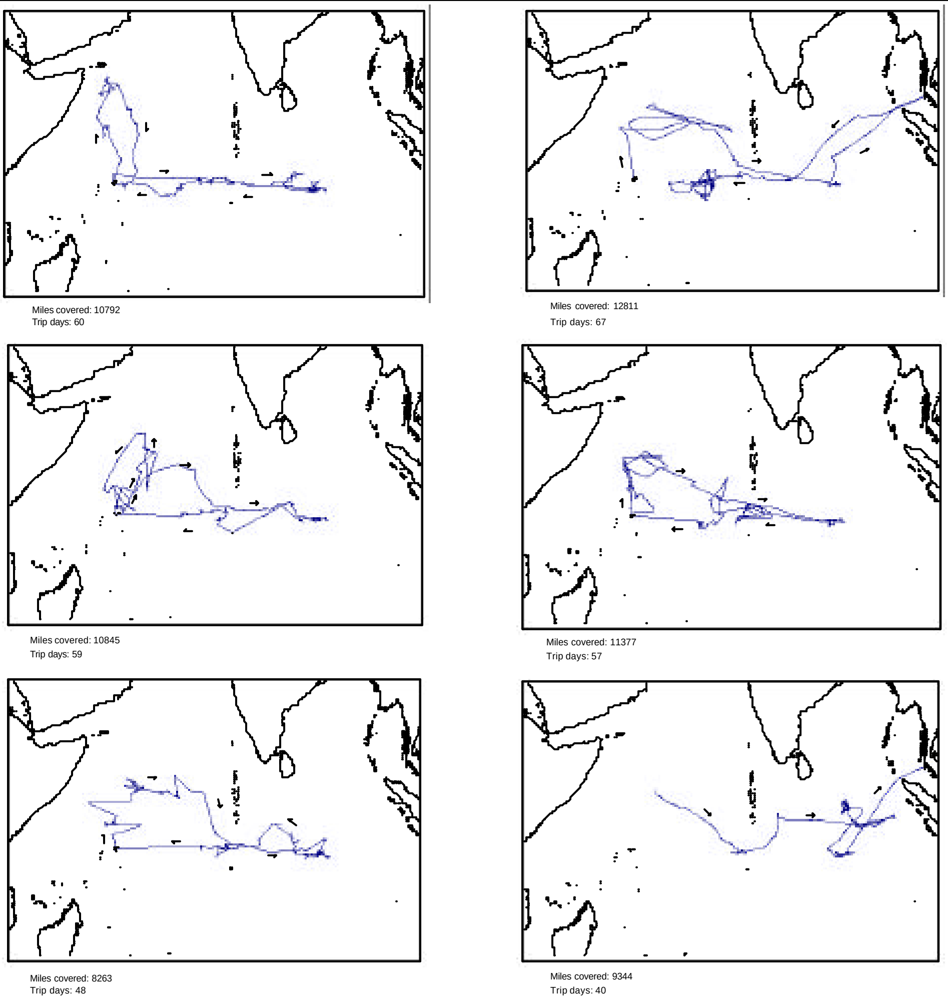
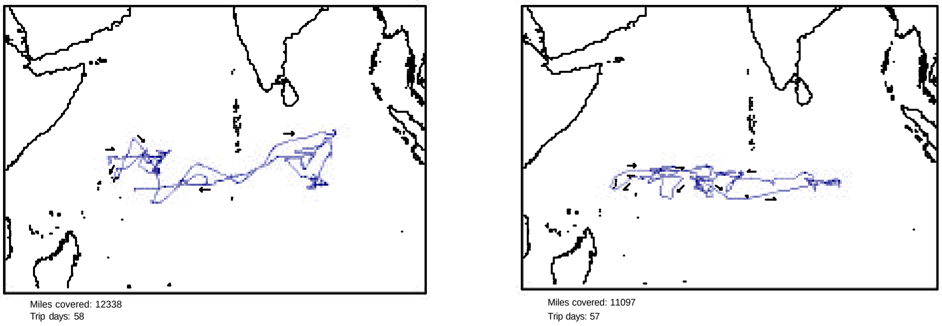


Fig 5a: Fishing trips of Spanish purse seiners working without supplies during the 1998-1999 Indian Ocean Moratorium.



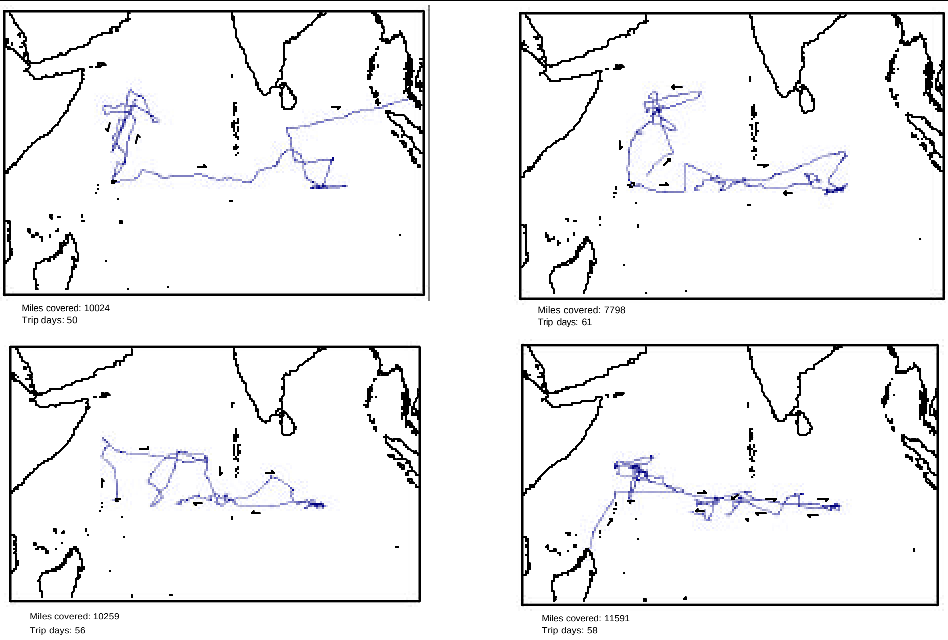
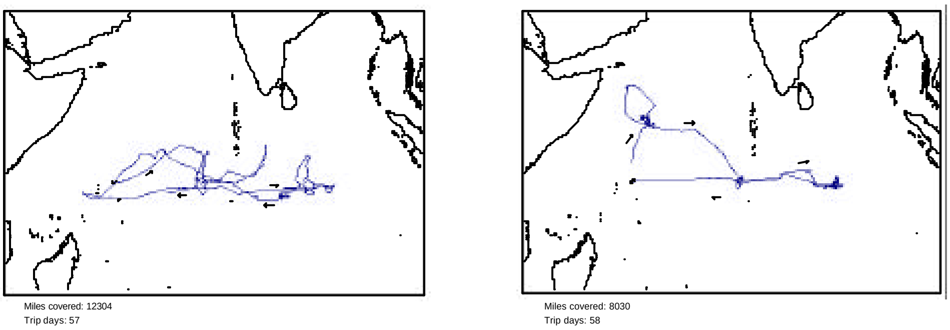


Fig 5b: Fishing trips of Spanish purse seiners working without supplies during the 1998-1999 Indian Ocean Moratorium.



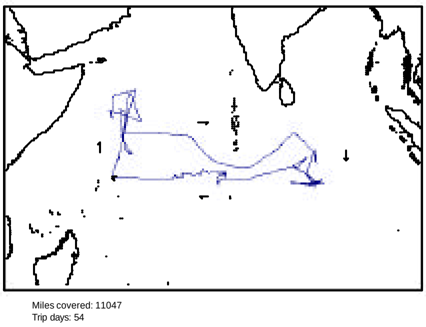


Fig 5c: Fishing trips of Spanish purse seiners working without supplies during the 1998-1999 Indian Ocean Moratorium.

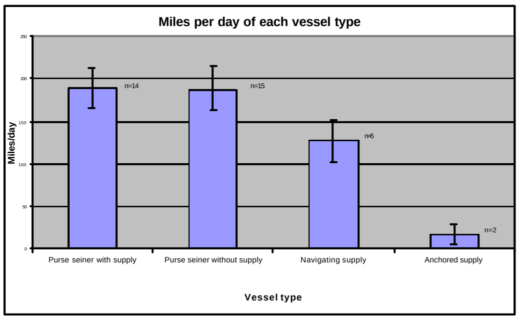


Fig 6: Miles per day (mean and standard deviation) covered by each vessel type.