

RIVO-Netherlands Institute for Fisheries Research

P.O. Box 68
NL 1970 AB Ymuiden
The Netherlands
Phone: +31 255 564646
Fax: +31 255 564644
Internet: postmaster@rivo.wag-ur.nl

P.O. Box 77
NL 4400 AB Yerseke
The Netherlands
Phone: +31 113 672300
Fax: +31 113 573477

RIVO report

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Incidental catches of pelagic megafauna by the Dutch pelagic fleet in the Mauritanian Exclusive Economic Zone during the years 1999-2003.

R. ter Hofstede, J.J. Zeeberg, D. de Haan, B. Couperus, and I. Mantingh

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Drs. R.J.T. van Lint
Directeur Visserij
Postbus 20401
2500 EK DEN HAAG

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Approved by: E. Jagtman
Head Department Biology & Ecology

Signature: _____

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Table of Contents:

Table of Contents:.....	2
Summary.....	3
1 Introduction.....	4
2 Methods.....	5
2.1 Large species by-catch occurrence.....	5
2.2 Different missions and reliability of the observations.....	5
2.2.1 Scientific Observer Program.....	5
2.2.2 Remote Sensing missions.....	6
2.2.3 Other missions.....	6
2.3 Data analysis.....	6
3 Results.....	7
4 Discussion.....	8
4.1 Shortcomings in the sampling of pelagic megafauna.....	8
4.1.1 insufficient coverage.....	8
4.1.2 species identification.....	8
4.1.3 small-sized pelagic megafauna.....	8
5 Conclusions.....	9
6 Recommendations.....	9
References.....	10
Tables and Figures.....	11
Appendix 1.....	19
Appendix 2.....	20

Summary

This report presents all registered catches of pelagic megafauna by the Dutch pelagic fleet in the Mauritanian Exclusive Economic Zone during the years 1999-2003. 'By-catches' incidentally include large species, notably cetaceans, sea turtles, sharks, rays, and some large pelagic fish such as swordfish and ocean sunfish.

All observations were made in the framework of different projects of the Netherlands Institute for Fisheries Research (RIVO B.V.) in the area, financed by the Dutch Ministry of Agriculture, Nature Management, and Fisheries (LNV) and partly by the Redersvereniging voor Zeevisserij, part of the Pelagic Freezer-Trawler Association (PFA): "Assessment of Sardinella and other small pelagics in West Africa" (313-1230001), "Application of remote sensing data to analyse the distribution and recruitment of sardinella" (313-1230002), and "Preventing by-catches of protected or endangered species in the pelagic trawl fishery in West Africa" (313-1230003).

The sampling procedures of incidentally caught pelagic megafauna on board of Dutch pelagic freezer-trawlers in Mauritania throughout the period 1999-2003 are evaluated in this report. The collected raw data on this by-catch of large species is whenever possible validated with an observation factor, shortcomings are discussed, and recommendations for improvements are given. This report presents raw data and explicitly avoids extrapolations up to mission or even fleet level.

1 Introduction

The Dutch pelagic freezer-trawler fleet in Mauritania targets small pelagic species such as sardinella, pilchard, mackerel, and horse mackerel. Still, the unwanted by-catch of non-commercial large animals as sharks and dolphins is unwanted, but inevitable so far.

This report describes the observed catches of pelagic megafauna by the Dutch pelagic fleet in the Mauritanian Exclusive Economic Zone during the period 1999-2003. It presents all registrations of by-catch of large species throughout this period, made by observers on board the vessels. In this report, the incidentally caught large species will be defined as all marine mammals, sea turtles, sharks, rays, and the large pelagic fish swordfish and ocean sunfish.

All observations are made in the framework of three projects in Mauritania that are financed by the Dutch Ministry of Agriculture, Nature Management, and Fisheries (LNV) and partly by the Redersvereniging voor Zeevisserij, part of the Pelagic Freezer-Trawler Association (PFA): "Assessment of Sardinella and other small pelagics in West Africa" (313-1230001), "Application of remote sensing data to analyse the distribution and recruitment of sardinella" (313-1230002), and "Preventing by-catches of protected or endangered species in the pelagic trawl fishery in West Africa" (313-1230003).

These projects are the result of joint activities between the Netherlands Institute for Fisheries Research (ASG-WUR) and the Mauritanian Institute for Oceanographic and Fisheries Research (IMROP) that started in 1998. This cooperation is aimed at strengthening Mauritania's capacity for pelagic research and stock assessment, thereby contributing to a rational exploitation of its pelagic resources.

2 Methods

2.1 Large species by-catch occurrence

The vessel searches for schools of small pelagic fish using sonar. When fish shoals are detected, the net is set and the ship starts a chase, again making use of the sonar. As soon as the amount of fish in the net seems large enough for processing, most of the net is taken on board; only the cod-end, the part where the fish have gathered, stays in the water. The crew connects a fish-pump to the tip of the cod-end, and the catch can be pumped directly from the net into the storage-tanks on board the ship.

Pelagic megafauna, such as sharks and dolphins are retained in a specific part of the net (the 'shark fyke'), which consists of large meshes that allow small(er) fish to pass, but prevent these large animals from entering the cod-end. As a result, the pelagic megafauna cannot block the fish pump when the catch is taken aboard the ship. Normally, the captured large species are released while the net is still in the water. However, during a voyage in which observers are on board the vessel, these animals are taken on deck in order to get biological information about them.

The objective of an observation mission is that observers inspect all hauls during a voyage for by-catch of pelagic megafauna. All megafauna is determined up to species level (according to FAO standards) and length measurements are taken.

2.2 Different missions and reliability of the observations

The information about the by-catch of large species by the Dutch pelagic fleet is collected through three different projects and therefore by various types of missions (see table 1).

2.2.1 *Scientific Observer Program*

Most of the results are derived from the Scientific Observer Program, which is meant to monitor the activities of the Dutch fishery for small pelagics in Mauritania. In the framework of the Scientific Observer Program, technicians and scientists from the IMROP join the Dutch pelagic trawlers in order to collect information about the amount and composition of the catches (both landings and discards), including the incidental by-catch of pelagic megafauna. These data combined with landing data obtained from the ship owners give detailed information about the total catches by the Dutch pelagic fleet in Mauritanian waters (Benjamins, 2002a,b; ter Hofstede 2002a, 2003a).

Due to work-related activities below deck, i.e. determining the catch composition, taking length measurements and performing biological analysis of target species, it appeared that the registration of large species on the afterdeck was very inconsistent. Since not all hauls were inspected for presence of large by-catch species, the total quantity of these captured animals during a mission remains unknown (ter Hofstede 2002b).

Special attention for the catch of pelagic megafauna was therefore introduced in the Scientific Observer Program beginning in June 2003 (mission no 4). Observers were tasked to note for each haul whether they had in fact *checked* for the presence of large species and whether these species were actually present in the catch (see appendix 1). This separates the Scientific Observer Program in two periods: old-style (1999 to 2003-mission 3) and new-style (2003-mission 4 onwards).

2.2.2 Remote Sensing missions

The objective of the remote sensing project is to stimulate the use of remote sensing information on board of the Dutch pelagic freezer-trawlers. Satellite images such as the Sea Surface Temperature (SST-) images reflect the dynamics of the ocean, which enables a vessel to predict and locate the physical boundaries that confine fish. This stimulates 'selective fishing', thereby reducing discards and the by-catch of pelagic megafauna. Furthermore, the remote sensing techniques are applied in biological and ecological research, in particular for distribution of pelagic fish related to environmental factors such as water temperature, food abundance, current direction and turbulence (Zeeberg, 2003; 2004).

During these missions, special attention is given to the presence of pelagic megafauna in the catches, to assess whether or not by-catch is related to the occurrence of specific water masses. As with the missions for the Scientific Observer Program (new style), the amount of checked hauls in relation to the total amount of hauls has been noted.

2.2.3 Other missions

A few other missions have been carried out by the Netherlands Institute for Fisheries Research (RIVO B.V.) in the Mauritanian EEZ during which information about catches of pelagic megafauna was collected. In April 2001, an exploring mission has been made on board a freezer-trawler in the Mauritanian EEZ in order to investigate the opportunities for monitoring the by-catch of large species by the pelagic freezer-trawlers in this area (Couperus, pers. com.). Two important missions concentrated on studies on gear modifications in order to reduce the by-catch of large species (de Haan, 2002a,b; 2003). One stomach-sampling mission was carried out in July 2003. During all these missions, the attention was highly focussed on the incidental catches of large species. Therefore these missions can be compared with the ones that are performed in the framework of the Scientific Observer Program (new style) and with the Remote Sensing missions.

2.3 Data analysis

All data that has been collected by the observers are entered into a standard Microsoft Excel 97 spreadsheet for further processing with the statistical analysis system SAS for Windows, release 8.01.

During the missions in the framework of the Scientific Observer Program (new style), Remote Sensing and Other (stomach sampling, exploring and gear modification experiments), it is noted whether the hauls are checked for pelagic megafauna. Therefore, it is possible to validate the registration with an observation factor:

$$\text{Observation factor} = \frac{\text{number of hauls checked for pelagic megafauna}}{\text{total number of hauls}}$$

With this observation factor, clearly one has an idea about the part of the fishing effort of the vessel that has been examined for the presence of pelagic megafauna.

3 Results

Throughout the period 1999-2003 data about the incidental by-catch of pelagic megafauna has been collected during 58 missions (see table 1). Most of these missions were in the framework of the Scientific Observer Program (old style) (42 missions, see table 2). As mentioned in the previous chapter, these infrequent observations cannot be extrapolated with an observation factor, but they do provide indications of species involved in the by-catch by the Dutch pelagic freezer-trawlers in the Mauritanian Exclusive Economic Zone. However, the missions within the Scientific Observer program (new style) (5), Remote Sensing missions (7) and Other scientific missions (4) are actually validated with an observation factor, since the amount of observed hauls in relation to the total amount of hauls during a mission is known (see table 3). The observation factors are high, ranging from 0.75 up to 1.0, with a mean of 0.93.

A summary of the amount of incidentally captured pelagic megafauna is for each year given in table 4. A division has been made whether the registrations were done during missions of the Scientific Observer Program (old style) or during other missions. The animals are categorised by sunfishes, billfishes, rays, hammerhead sharks, all other sharks, turtles and cetaceans.

In table 5 the amount of by-catch during the Scientific Observer Program (old style) is given up to species level, as far as possible, for each year during the period 1999-2003. The total number of fishing days during which scientific observers were present on board the ship is given. Tables 6, 7 and 8 show the amount of by-catch for the missions in the framework of the Scientific Observer Program (new style), the Remote Sensing missions and all Other missions, respectively. Here, the data is given for each mission, up to species level. Furthermore, the total number of hauls, the total number of observed hauls and the observation factor are given for each mission.

4 Discussion

The objective of this report is to present all registrations of by-catch of pelagic megafauna during research missions by the Netherlands Institute of Fisheries Research (RIVO B.V.) on board the Dutch pelagic fleet in the Mauritanian Exclusive Economic Zone. Therefore, only the raw data is presented and whenever possible validated with an observation factor. Explicitly mentioned is that no extrapolations have been made up to mission or even fleet level.

4.1 Shortcomings in the sampling of pelagic megafauna

4.1.1 insufficient coverage

The monitoring of incidental by-catch of large species has appeared to be insufficient throughout the period 1999-2003, especially in the early years, due to a low coverage of the Dutch pelagic fleet with observers. For example by-catch of dolphins has not been registered within the framework of the Scientific Observer Program in the year 2001. However, from personal communications with the fishermen it appeared that catches of dolphins occurred regularly in 2001.

4.1.2 species identification

Another problem is the identification of the pelagic megafauna by the observers. There is a large variety in species and they appear often to be difficult to distinguish. The current determination up to species level is often limited to species that are described in handbooks that is available on board the vessels. Good and extensive identification guides should be present on board the ships during research missions.

In 2003 an identification guide has been developed for the large by-catch species that are likely to be caught in the Mauritanian EEZ, but it does not include rays (ter Hofstede, 2003b). Furthermore, it is recommended to make a collection of pictures of the pelagic megafauna, which will facilitate the identification of this incidental by-catch.

4.1.3 small-sized pelagic megafauna

The registration of the by-catch of small-sized pelagic megafauna, such as immature animals or smaller-sized species like certain rays, is difficult. The captured large animals (> ± 1 m) are retained in the shark fyke and thus can be put on the afterdeck, which makes it easy for the observers to register all information about these animals. The small-sized pelagic megafauna however goes along with the target species into the cod-end, so they will be pumped directly from the net into the storage-tanks. This catch is processed below deck and the small-sized pelagic megafauna will be discarded along with all other unwanted fish. Although depending on the magnitude of the catches, in general the processing of the catch takes place continuously, day and night, and therefore it is impossible for the observers to check the catches for presence of small-sized pelagic fauna. However, in good cooperation with the crew of the vessel, it might be possible to let the crew collect all small-sized megafauna straight from the conveyor belt, and subsequently the observers can perform their measurements at intervals.

5 Conclusions

The observations on board the Dutch pelagic freezer-trawlers in Mauritania during the period 1999-2003 were mainly focussed on the large animals ($\pm >1$ m). Sampling of small-sized pelagic megafauna was given too little attention.

Data about the by-catch of pelagic megafauna obtained in the framework of the Scientific Observer Program (old style) provides information on the temporal and spatial distributions of the large animals. Within this old style program registrations are however infrequent and the observation factor (hauls registered per total number of hauls) remains unknown.

Data about the by-catch of pelagic megafauna obtained in the framework of all other missions (Scientific Observer Program (new style), remote sensing, exploring, stomach sampling, and gear modification experiments) gives not only information about the temporal and spatial distributions of the animals, but also about the total amount of by-catch, since these missions have been validated with an observation factor. This data can be used to make a cautious estimation of the scale of by-catch of pelagic megafauna by the Dutch freezer-trawlers in the Mauritanian EEZ. Furthermore, the entire dataset should be explored for behavioural information about the pelagic megafauna species, such as daily activities and spatial and temporal distributions.

6 Recommendations

The following recommendations are given for the further development of the registration of pelagic megafauna in the framework of research missions on board the Dutch freezer-trawlers in the Mauritanian Exclusive Economic Zone.

- Observers should be sent out on trips throughout the entire year, with as even a distribution as possible.
- The sampling of small-sized pelagic megafauna should be introduced and performed consistently. Best method is to intercept them on the afterdeck before they are proceed into the storage tanks. The animals that continue to the factory should be collected on the working deck by the crew continuously and subsequently can be registered by the observers on a regular basis.
- Sampling of the large by-catch species takes place in narrow cooperation with the crew, both on the afterdeck and the working deck. The sampling forces the crewmembers to perform other and thus more work than in general. Therefore, the observers have to be able to motivate the crew to collect all animals for them and consequently only observers that have good communication skills with the crewmembers are suitable for these missions.
- Good identification guides should be available on board the ship during the research missions. It is worth developing a determination guide with photographs of all caught large by-catch species.
- In order to be able to make an estimation of the impact of the Dutch pelagic-trawler fleet on the pelagic megafauna in the Mauritanian EEZ, it is first priority to have an idea about the size of the populations. A research program should be designed to investigate the absolute abundance and the dynamics of the populations of the pelagic megafauna in the area.

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Tables and Figures

Table 1: Overview of various types of missions by the Netherlands Institute for Fisheries Research (RIVO B.V.) on board of Dutch pelagic freezer-trawlers in Mauritania.

project	missions	code	period	number
Assessment of Sardinella and other small pelagics in West Africa (313-1230001)	Scientific Observer Program - old style (Table 5)	OB	1999-2003	42
	Scientific Observer Program - new style (Table 6)	OB	2003	6
	Other – stomach sampling	OT	2003	1
Application of remote sensing data to analyse the distribution and recruitment of sardinella (313-1230002)	Remote Sensing (Table 7)	RE	2002-2003	7
Preventing by-catches of protected or endangered species in the pelagic trawl fishery in West Africa	Other – exploring mission	OT	2001	1
	Other - gear modification experiments (both in Table 8)	OT	2002	2

Table2: All missions in the framework of the Scientific Observer Program (old style) by the Netherlands Institute for Fisheries Research (RIVO B.V.) on board of Dutch pelagic freezer-trawlers in Mauritania.

mission code	ship	date of departure	date of return	number of hauls	number of observed hauls	total number of fishing days
OB99_01	SCH118	6-2-1999	8-3-1999	?	?	26
OB99_02	SCH54	18-2-1999	27-3-1999	?	?	33
OB99_03	SCH118	13-3-1999	16-4-1999	?	?	31
OB99_04	SCH81	7-4-1999	6-5-1999	?	?	26
OB99_05	SCH72	24-4-1999	15-5-1999	?	?	17
OB99_06	SCH72	23-5-1999	15-6-1999	?	?	19
OB99_07	ROS785	23-5-1999	15-6-1999	?	?	15
OB99_08	ROS785	17-6-1999	6-7-1999	?	?	15
OB99_09	SCH24	13-7-1999	2-8-1999	?	?	16
OB99_10	SCH22	5-8-1999	5-9-1999	?	?	28
OB99_11	SCH54	7-8-1999	9-9-1999	?	?	26
OB99_12	SCH24	16-9-1999	18-10-1999	?	?	28
OB99_13	SCH72	18-10-1999	14-11-1999	?	?	23
OB00_01	SCH120	20-3-2000	7-4-2000	?	?	11
OB00_02	SCH118	3-4-2000	21-4-2000	?	?	14
OB00_03	SCH81	3-4-2000	25-4-2000	?	?	18
OB00_04	SCH118	27-4-2000	16-5-2000	?	?	15
OB00_05	SCH81	1-5-2000	24-5-2000	?	?	19
OB00_06	SCH118	20-5-2000	7-6-2000	?	?	14
OB00_07	KW174	16-6-2000	29-6-2000	?	?	11
OB00_08	SCH72	18-6-2000	22-8-2000	?	?	54
OB00_09	KW174	23-7-2000	4-8-2000	?	?	9
OB00_10	SCH72	30-8-2000	3-10-2000	?	?	28
OB01_01	SCH54	9-1-2001	30-1-2001	?	?	21
OB01_02	KW171	15-2-2001	4-3-2001	?	?	17
OB01_03	SCH81	22-4-2001	12-5-2001	?	?	20
OB01_04	SCH24	28-5-2001	9-6-2001	?	?	12
OB01_05	SCH302	13-6-2001	28-6-2001	?	?	15
OB01_06	SCH302	7-7-2001	24-7-2001	?	?	17
OB01_07	SCH72	19-8-2001	24-9-2001	?	?	36
OB01_08	KW171	6-10-2001	6-11-2001	?	?	31
OB02_01	SCH302	8-1-2002	12-2-2002	?	?	30
OB02_02	KW171	3-3-2002	1-4-2002	?	?	29
OB02_03	SCH81	6-5-2002	9-6-2002	?	?	34
OB02_04	SCH302	20-6-2002	27-7-2002	?	?	37
OB02_05	KW171	11-8-2002	20-8-2002	?	?	9
OB02_06	SCH81	4-9-2002	5-10-2002	?	?	31
OB02_07	SCH54	13-10-2002	1-11-2002	?	?	19
OB02_08	SCH30	14-11-2002	1-12-2002	?	?	17

	2					
OB03_01	SCH30 2	23-1-2003	10-2-2003	?	?	18
OB03_02	SCH81	15-3-2003	16-4-2003	?	?	32
OB03_03	KW171	13-5-2003	28-5-2003	?	?	15

Table 3: All missions in the framework of the Scientific Observer Program (new style) (OB), Remote Sensing (RE) and Other missions (OT) by the Netherlands Institute for Fisheries Research (RIVO B.V.) on board of Dutch pelagic freezer-trawlers in Mauritania. (Mission RE03-03 was also a mission in the framework of the Scientific Observer Program (new style) (no. OB03_09), but is in this report presented as a Remote Sensing mission.)

mission code	ship	date of departure	date of return	number of hauls	number of observed hauls	observation factor
OB03_04	SCH24	25-6-2003	13-7-2003	67	64	0.96
OB03_05	SCH24	23-7-2003	15-8-2003	75	69	0.92
OB03_06	SCH54	22-8-2003	25-9-2003	77	59	0.77
OB03_07	KW174	3-10-2003	17-10-2003	38	35	0.92
OB03_08	SCH30 2	20-10-2003	5-11-2003	58	57	0.98
RE02_01	SCH11 8	4-7-2002	11-7-2002	16	12	0.75
RE02_02	KW171	23-8-2002	23-8-2002	22	?	?
RE02_03	SCH54	13-10-2002	1-11-2002	22	22	1.00
RE02_04	SCH30 2	14-11-2002	22-11-2002	24	24	1.00
RE03_01	KW171	18-6-2003	27-6-2003	31	31	1.00
RE03_02	SCH30 2	20-9-2003	29-9-2003	28	25	0.89
RE03_03	SCH81	19-11-2003	7-12-2003	80	68	0.85
OT01_01	SCH11 8	24-3-2001	15-4-2001	51	45	0.88
OT02_01	SCH30 2	10-7-2002	29-7-2002	73	73	1.00
OT02_02	SCH30 2	10-9-2002	30-9-2002	87	87	1.00
OT03_01	SCH30 2	14-7-2003	20-7-2003	24	24	1.00

Table 4: Total number of registered pelagic megafauna (categorised by group) per year for the period 1999-2003, divided into missions of the Scientific Observer Program (old style) and all other missions.

group	Observer Program (old style)					total	All other missions			
	1999	2000	2001	2002	2003		2001	2002	2003	total
sunfishes	4	2	7	28		41	6	102	14	122
billfishes	4	5		4		13	1	9	13	23
rays	2	21	2	2		27	3	10	21	34
sharks	88	18	19	20	1	146	11	26	73	110
hammerheads	4		42	221	5	272	4	146	96	246
turtles	4					4	1	1	2	4
cetacea	95			30		125		77	1	78

Table 5: Total number of registered pelagic megafauna (up to species level) per year during the period 1999-2003 during missions of the Scientific Observer Program (old style).

			year	1999	2000	2001	2002	2003
			Number fishing days	303	193	169	206	65
			Number of hauls observed	?	?	?	?	?
			Observation factor	?	?	?	?	?
group	family	species						
sunfishes	<i>Molidae</i>	<i>Mola mola</i>	4	2	7	28		
billfishes	<i>Istiophoridae</i>	<i>Istiophorus albicans</i>		5		2		
		<i>Istiophorus spec.</i>				1		
		<i>Xiphias gladius</i>	4			1		
rays	<i>Myliobatidae</i>	<i>Manta birostitus</i>				1		
		<i>Rhinoptera marginata</i>	2	21	1			
	<i>Rajidae</i>	<i>Raja miraletus</i>			1			
		<i>Raja spec.</i>				1		
sharks	<i>Carcharhinidae</i>	<i>Carcharhinidae</i>				1	1	
		<i>Carcharhinus limbatus</i>	12		1			
		<i>Carcharhinus obscurus</i>					1	
		<i>Prionace glauca</i>					2	
		<i>Rhizoprionodron acutus</i>	6	6			3	
	<i>Leptocharidae</i>	<i>Leptocharias smithii</i>		1	6	6	1	
	<i>Triakidae</i>	<i>Mustelus mustelus</i>	1		4	3		
	<i>Hexanchiformes</i>	<i>Heptranchias perlo</i>				3		
	<i>Alopiidae</i>	<i>Alopias spec.</i>					1	
		<i>Alopias vulpinus</i>				4		
	<i>Lamnidae</i>	<i>Isurus oxyrinchus</i>				2		
<i>Squaliformes</i>	<i>Scymnodon obscurus</i>	68						
	<i>unidentified shark</i>	<i>unidentified shark</i>	1	11	1			
hammerheads	<i>Sphyrnidae</i>	<i>Sphyrna lewini</i>				211	2	
		<i>Sphyrna spec.</i>	4			2		
		<i>Sphyrna zygaena</i>			42	8	3	
turtles	<i>turtle</i>	<i>turtle</i>	4					
cetacea	<i>Delphinidae</i>	<i>Delphinidae</i>	95					
		<i>Delphinus delphis</i>				30		

Table 6: Total number of registered pelagic megafauna (up to species level) per mission during missions of the Scientific Observer Program (new style).

			mission	OBO	OBO	OBO	OBO	OBO
				3-4	3-5	3-6	3-7	3-8
			number of hauls	67	75	77	38	58
			number of hauls observed	64	69	59	35	57
			observation factor	0.9 6	0.9 2	0.7 7	0.9 2	0.9 8
group	family	species						
sunfishes	<i>Molidae</i>	<i>Mola mola</i>	3			2		3
billfishes	<i>Istiophoridae</i>	<i>Istiophoridae</i>				2		
		<i>Istiophorus albicans</i>	3					
		<i>Xiphias gladius</i>					5	
rays	<i>Dasyatidae</i>	<i>Dasyatis centroura</i>					5	
	<i>Myliobatidae</i>	<i>Rhinoptera marginata</i>						2
	<i>Rajidae</i>	<i>Rajidae</i>			1			
	<i>Torpediniformes</i>	<i>Torpinidae</i>					1	
sharks	<i>Carcharhinidae</i>	<i>Carcharhinus limbatus</i>						1
	<i>Triakidae</i>	<i>Mustelus mustelus</i>						
	<i>Hexanchiformes</i>	<i>Heptranchias perlo</i>				4		
	<i>Alopiidae</i>	<i>Alopias spec.</i>					1	
	<i>unidentified shark</i>	<i>unidentified shark</i>					1	
hammerheads	<i>Sphyrnidae</i>	<i>Sphyrna lewini</i>	1					
		<i>Sphyrna spec.</i>			2			
		<i>Sphyrna zygaena</i>	3	1			10	
turtles	<i>turtle</i>	<i>turtle</i>					1	
cetacea	<i>Delphinidae</i>	<i>Stenella clymene</i>					1	

Table 7: Total number of registered pelagic megafauna (up to species level) per mission during Remote Sensing missions.

			mission	RE02	RE02	RE02	RE02	RE03	RE03	RE
				-1	-2	-3	-4	-1	-2	-3
			number of hauls	16	22	22	24	31	28	8
			number of hauls observed	12	?	22	24	31	25	6
			observation factor	0.75	?	1	1	1	0.89	0.8
group	family	species								
sunfishes	<i>Molidae</i>	<i>Mola mola</i>	13	1	4	3	1	1		
billfishes	<i>Istiophoridae</i>	<i>Istiophoridae</i>	1	1						
		<i>Istiophorus albicans</i>			2					
		<i>Xiphias gladius</i>					1	2		
rays	<i>Dasyatidae</i>	<i>Dasyatis centroura</i>					2			
	<i>Myliobatidae</i>	<i>Mobula spec.</i>		4	1					
		<i>Rhinoptera marginata</i>					1			
	<i>Rajidae</i>	<i>Rajidae</i>	1							
	<i>Torpediniformes</i>	<i>Torpedo torpedo</i>			1					
sharks	<i>Carcharhinidae</i>	<i>Carcharhinus obscurus</i>	1					1		
		<i>Rhizoprionodron acutus</i>			5					
	<i>Triakidae</i>	<i>Mustelus mustelus</i>								
	<i>Hexanchiformes</i>	<i>Heptranchias perlo</i>							70	
		<i>Hexanchus griseus</i>				2				
	<i>Alopiidae</i>	<i>Alopias profundus</i>				2				
<i>Alopias spec.</i>		1	1				1			
	<i>unidentified shark</i>	<i>unidentified shark</i>	1					3		
hammerheads	<i>Sphyrnidae</i>	<i>Sphyrna lewini</i>			2			2		
		<i>Sphyrna spec.</i>	27	12	3				50	
		<i>Sphyrna zygaena</i>			10			2		
turtles	<i>turtle</i>	<i>turtle</i>			1					
cetacea	<i>Delphinidae</i>	<i>Delphinidae</i>	15		4	1				

Table 8: Total number of registered pelagic megafauna (up to species level) per mission during Other missions.

		mission	OT01-1	OT02-1	OT02-2	OT03-1
		number of hauls	51	73	87	24
		number of hauls observed	45	73	87	24
		observation factor	0.88	1	1	1
group	family	species				
sunfishes	<i>Molidae</i>	<i>Mola mola</i>	6	63	18	4
billfishes	<i>Istiophoridae</i>	<i>Maikara nigricans</i>			1	
		<i>Xiphias gladius</i>	1	4		
rays	<i>Myliobatidae</i>	<i>Manta birostitus</i>			1	
		<i>Mobula spec.</i>	2			8
		<i>Myliobatidae</i>			2	
	<i>Rajidae</i>	<i>Raja spec.</i>	1			
sharks	<i>Carcharhinidae</i>	<i>Carcharhinidae</i>		2	3	
		<i>Carcharhinus obscurus</i>	9			
		<i>Prionace glauca</i>				4
	<i>Triakidae</i>	<i>Mustelus mustelus</i>	2			
	<i>Hexanchiformes</i>	<i>Heptranchias perlo</i>			3	
	<i>Alopiidae</i>	<i>Alopias spec.</i>			5	
hammer-heads	<i>Sphyrnidae</i>	<i>Sphyrna lewini</i>				3
		<i>Sphyrna mokarran</i>		33	44	
		<i>Sphyrna spec.</i>	4	15		2
		<i>Sphyrna zygaena</i>				19
turtles	<i>turtle</i>	<i>turtle</i>	1			
cetacea	<i>Delphinidae</i>	<i>Delphinus delphis</i>			38	
		<i>Globicephala spec.</i>		8	1	
		<i>Stenella coeruleoalba</i>			5	
		<i>Tursiops truncates</i>		5		

Appendix 1

Table 9: Species list.

group	family	species name (scientific)	species name (english)
sunfishes	<i>Molidae</i>	<i>Mola mola</i>	Ocean sunfish
billfishes	<i>Istiophoridae</i>	<i>Istiophoridae</i>	billfish
		<i>Istiophorus albicans</i>	Atlantic sailfish
		<i>Istiophorus spec.</i>	sailfish
		<i>Maikara nigricans</i>	Atlantic blue marlin
		<i>Xiphias gladius</i>	Swordfish
rays	<i>Dasyatidae</i>	<i>Dasyatis centroura</i>	Roughtail stingray
		<i>Myliobatidae</i>	Atlantic manta
	<i>Myliobatidae</i>	<i>Mobula spec.</i>	devil ray
		<i>Myliobatidae</i>	manta
		<i>Rhinoptera marginata</i>	Lusitanian cownose ray
	<i>Rajidae</i>	<i>Raja miraletus</i>	Brown ray
		<i>Raja spec.</i>	skates
		<i>Rajidae</i>	skates
	<i>Torpediniformes</i>	<i>Torpedo torpedo</i>	Common torpedo
		<i>Torpinidae</i>	electric ray
sharks	<i>Carcharhinidae</i>	<i>Carcharhinidae</i>	requiem shark
		<i>Carcharhinus limbatus</i>	Blacktip shark
		<i>Carcharhinus obscurus</i>	Dusky shark
		<i>Prionace glauca</i>	Blue shark
		<i>Rhizoprionodron acutus</i>	Milk shark
	<i>Leptocharidae</i>	<i>Leptocharias smithii</i>	Barbeled houndshark
	<i>Triakidae</i>	<i>Mustelus mustelus</i>	Smooth-hound
	<i>Hexanchiformes</i>	<i>Heptranchias perlo</i>	Sharpnose sevengill shark
		<i>Heptranchias spec.</i>	sevengill shark
		<i>Hexancheus griseus</i>	Bluntnose sixgill shark
	<i>Alopiidae</i>	<i>Alopias profundus</i>	Bigeye tresher
		<i>Alopias spec.</i>	tresher
		<i>Alopias vulpinus</i>	Tresher shark
	<i>Lamnidae</i>	<i>Isurus oxyrinchus</i>	Shorfin mako
	<i>Squaliformes</i>	<i>Scymnodon obscurus</i>	Smallmouth velvet dogfish
	<i>unidentified shark</i>	<i>unidentified shark</i>	shark
hammerheads	<i>Sphyrnidae</i>	<i>Sphyrna lewini</i>	Scalloped hammerhead
		<i>Sphyrna mokarran</i>	Great hammerhead
		<i>Sphyrna spec.</i>	hammerhead shark
		<i>Sphyrna zygaena</i>	Smooth hammerhead
turtles	<i>turtle</i>	<i>turtle</i>	turtle
cetacea	<i>Delphinidae</i>	<i>Delphinidae</i>	dolphin
		<i>Delphinus delphis</i>	Common dolphin
		<i>Globicephala spec.</i>	pilot whale
		<i>Stenella clymene</i>	Clymene dolphin
		<i>Stenella coeruleoalba</i>	Striped dolphin
		<i>Tursiops truncatus</i>	Bottlenose dolphin

