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Abstract

This paper summarizes the preliminary results obtained from tagging deepwater sharks in the Indian Ocean (SIOFA area). Nineteen sharks were tagged, twelve with electronic popup tags type Benthic survival (n=9) and MiniPATs (n=3). Analysis of the tags released provided information on the survival after release of three species Centrophorus squamosus, C. granulosus and Squalus mitsukurii. A priori the two Centrophoridae species did not survive while the three S. mitsukurii might have survived. All the tags were released (pop-up) in the proximity of the tagging area.

Findings show that benthic survival tags are not the most appropriate for survival studies on deepwater sharks. One of the tags did not report any data, and thus it is assumed lost. The rest four electronic tags attached are still recording data Not any recaptures have been reported from conventional tagging.

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PRELIMINARY RESULTS OF ELECTRONIC AND CONVENTIONAL TAGGING OF DEEPWATER SHARKS IN SIOFA AREA

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ABSTRACT

This paper summarizes the preliminary results obtained from tagging deepwater sharks in Indian Ocean (SIOFA area). Nineteen sharks were tagged, twelve with electronic popup tags type Benthic survival (n=9) and MiniPATs (n=3). Analysis of the tags released (n=7) provided information of the survival after release of three species *Centrophorus squamosus, C. granulosus* and *Squalus mitsukurii.* A priori the two Centrophoridae species (4 sharks) did not survive while the three *S. mitsukurii* might have survived. All the tags were released (pop-up) in the proximity of the tagging area. Findings show that benthic survival tags are not the most appropriate for survival studies on deepwater sharks. One of the tags did not report any data, and thus it is assumed lost. The rest four electronic tags attached are still recording data. Not any recaptures have been reported from conventional tagging.

1. INTRODUCTION

Deep-water sharks are considered highly vulnerable species due to their K-selected life-history characteristics and very low capacity for recovery from overfishing (Stevens *et al*., 2000). Limited information exists on some aspects of their biology and in particular about the survival capacity of these species when caught by different fishing gears and discarded, though survival capacity is assumed to be negligible.

The need for more research and dissemination of information about deep-water chondrichthyans has become imperative as fisheries worldwide continue to expand into deeper waters and exploit deep-water stocks, usually in the absence of data required for appropriate management (Morato *et al*., 2006; Kyne and Simpfendorfer, 2010). Due to the relative environmental homogeneity (temperature, salinity, light levels, pressure) of the deep ocean, boundaries to species distribution are less pronounced than for shallow water dwelling species. Therefore, many deep-water chondrichthyans have broad, often global, distributions, though species with limited geographic ranges, including endemics, are also commonly reported (Compagno, 1984).

Studies of population structure (Veríssimo *et al*., 2011, 2012) and species distributions (Moura *et al*., 2014) have demonstrated wide geographic ranges and high dispersal potential for some species. Such information can be used to inform fisheries management models as geographically limited fishing effort may have wide-ranging effects on deep-water species. In the absence of studies like these, it will be impossible to predict population growth trajectories or assess the full effect of fishing mortality on exploited species (Cotton and Grubss, 2015).

Extensive literature has been published on tagging pelagic sharks, both using conventional external tags (Kholer and Turner, 2001; Thorsteinsson, 2002) and using electronic tags (Arnold and Dewar, 2001; Hammerschlag *et al*., 2011). However, very few studies have been conducted on deepwater elasmobranchs. Most of these have been based on telemetry and acoustic tags (Yano and Tanaka, 1986; Nelson, 1990; Carey and Clark, 1995; Andrews *et al*., 2009; Grubbs and Kraus, 2010, Daley *et al*., 2015). Recent advances in satellite tagging technologies have provided scientists growing opportunities to resolve previously unknown spatial ecology of marine predators, including sharks. In particular, recent studies conducted on the deepwater shark *Centrophorus squamosus* have demonstrate that this shark is capable of making long migrations (Rodríguez-Cabello and Sánchez, 2014; Rodríguez-Cabello *et al*., 2016).

The EU project “Improving scientific advice on deep-water sharks in the SIOFA Area” has enabled us to carry out electronic and conventional tagging on board a Spanish longline commercial vessel with the purpose to analyse the population dynamic of these species and the survival rate. So far, there are no estimates for post-release mortality (PRM) of deep-water sharks in longline fleets in the Southern Indian Ocean Fisheries Agreement (SIOFA) area although these estimates are critical to understand total fishing mortality.

Note: the results presented here are preliminary as the vessel is still fishing and not all of the planned tagging has been completed.

2. MATERIAL AND METHODS

2.1. Study area

The geographical scope of this study covers the SIOFA area (Figure 1).

2.2. Tags

In this study two types of tags were used, conventional and electronic tags (Figure 2A-C). The majority of individuals were tagged using electronic data storage tags type Benthic sPAT tags and a few with MiniPAT tags both from WildLife Computers. Other few sharks were tagged with conventional tags (5 specimens per tonne caught). At-vessel mortality was estimated according to the protocol described and presented at SIOFA 2023 workshop held in Tenerife (WSDWS-2023-07) (Table 1). Only sharks in good condition were selected for electronic tagging.

Conventional Tags:

There are several types of plastic tags. However, for this study we are using T-bar tags which are widely used, suitable for a wide-ranging species and are used by the same fleet for teleost fish and are relatively easy to apply. T-bar tags were placed on the body musculature below dorsal fin with the help of the applicator Mark- II regular tagging gun. Each tag has a code number which was carefully noted down for each fish tagged together with the rest of the biological data recorded: species name, length, sex and the information of the fishing operation: haul number, location (latitude and longitude) where the shark was released.

Electronic tags:

Electronic tags (Benthic sPAT and or Mini PAT) were placed ahead of the first dorsal fin with the help of suitable pliers (Figure 2). Tags were previously programmed to automatically start once it is released in the water. Benthic sPATs were programmed for 30, 60 or 90 days (maximum interval) and the two Mini PATs attached were programmed for 105 and 120 days respectively.

2.3. Trips conducted on 2023

The shark tagging programme has been carried out on board the F/V "Ibsa Quinto", an EU-Spanish deep water longliner, which usually operates from Port Louis (Mauricio Island).

FIRST ANNUAL TRIP 2023 – M43:

After the start of the project, the first annual trip was planned from March to July 2023, but unfortunately tags (conventional and electronic) were not available at that time. The time between manufacture and delivery by the Wildlife Computer Inc. takes between 8-12 weeks, therefore the tags were not available for the first trip, so the scientific observer collected biological samples and data.

SECOND ANNUAL TRIP 2023 – M44:

The second trip was programmed to start in July, but due to vessel reparation due to sanitary and statutory inspections, the departure was delayed to September. The fishing vessel departed from Port Louis on 11th September 2023 and three days after departure, the vessel had a damage in the gasoil pump and went back to Port Louis for repair. On 25th September the breakdown was repaired, and the vessel started off again navigating to the fishing grounds where it arrived on 1st October and started to fish.

During this trip, the vessel was targeting Patagonian toothfish (*Dissostichus eleginoides*) to the South of the subareas 3b and 7. The vessel, in order to accomplish with the project objectives performed some sets in a neighbouring area with the aim to catch deep water sharks and therefore, proceed with the pop-up tagging.

During the trip, the scientific observer took 2000 conventional tags and 18 electronic tags previously programmed to be released in different periods (Table 2). Also, all tags were programmed to activate its release mechanism according to the following conditions:

1. Auto detection of mortality: if during 4 days, the tag is floating at the surface or is sitting at a constant depth.
2. It reaches a depth of 1500 m depth (option only available for MiniPAT tags).
3. More than four days at constant depth (option only available for MiniPAT tags).
4. Threshold settings for benthic tags were knockdown 0.5 and tilt -0.5.

More information about the tags used in this study is available at: Benthic sPAT - https://static.wildlifecomputers.com/Benthic-sPAT-User-Guidev22.pdf and MiniPAT - https://static.wildlifecomputers.com/MiniPAT-User-Guide-5.pdf

FINAL TRIP 2023/24:

The next fishing trip (M45) within the SIOFA area was expected to start in December 2023, but has been delayed, and is now expected to start in February 2024. The scientific observer will continue to collect information on the fishing operations and biological sampling and perform conventional and electronic tagging (remaining mini PATs).

Note: Complete information about the M45 won't be available for the SIOFA SC9 Meeting on March 2024, but final results will be presented during SIOFA SC10.

3. Preliminary Results

3.1. Tagging electronic and conventional tags

During the M44 trip (October to January2024), the first sets were directed to catch deep-water sharks to accomplish the tagging objectives, since this trip was targeting Patagonian toothfish. A total of 19 deep-water sharks were tagged following the tagging protocols (Annex 1 and Figures 3 and 4), of which 12 specimens were tagged with electronic tags (9 using survival benthic tags and 3 with MiniPAT tags).7 sharks were tagged with conventional plastic tags T-bar (Table 3).

Table 4 shows the time programmed for each shark according to the type of tag and the expected release date. Two tags, one attached to a *Centrophorus granulosus* and the other to a *C. squamosus*, were programmed to collect data until January 2024, however those tags were released prematurely. In the case of the first shark, the tag pop up after 18 days and in the second one, at 4 days following tagging. One of the benthic tags PTT 242619 attached to a *Squalus mitsukurii* was programmed to pop up and transmit the information on the 3rd of November but no data has been received so far (Table 4). Some of the hypotheses could be that the electronic failed, the shark sunk and exceed the limit depth that prevent the tag crash, the shark died and was eaten by a predator, etc. Table 5 shows the locations where the sharks were tagged and released according to the data transmitted.

3.2. Post-release survival of deep-water sharks caught in longline fisheries

Below, we detail the information and preliminary results of the electronic tags deployed and released up to date (Table 4) ordered by release time. At present there are no recaptures reported from conventional tags.

1) PTT 242597

This tag with serial number and code 23P0742 / PTT 242597 corresponded to an electronic tag type MiniPAT. It was attached to a leafscale gulper shark *Centrophorus squamosus,* a male of 116 cm total length on 3rd October (Table 4) in the location: 35.78 S - 53.56 E (Table 5). The tag was programmed to collect data during three and half months and then release and transmit the data. Nevertheless, on 8th October 2023 at 04:04:32 (UTC) the tag was at the surface and begun to transmit (Figure 5). This tag recorded information on depth and temperature every 5 minutes programmed. The data indicate that the shark died almost immediately after being tagged and released as the depth remains constant at 1563 m indicating that the shark was dead (Figure 6). When the shark was tagged and released it was noted down that the shark was in stage 2 (Table 4) that is with some vitality but not in very good condition. According to the tag specifications and programmed, after 4 days at constant depth, the tag detached and pops-up.

2) PTT 242617

This tag with serial number and code 23P0873 / PTT 242617 corresponded to an electronic tag type Benthic SPAT. It was attached in a *Centrophorus granulosus*, male of 119 cm total length on 3rd October 2023 at 35.78 S –53.60 E. The tag was programmed for 90 days but it detached prematurely after 20 days (Tables 4, 5). During tagging it was noted down that the shark was in good condition when released. The reason why the tag was released in advance is unknown since according to the messages sent by the tag via satellite, the pin was not broken. The data collected are difficult to interpret (Figure 7). Using the default threshold value of 0.5 (i.e. where a change in acceleration / deceleration of a knockdown event can be assessed) the number of knockdowns (Figure 7a) indicates that during the first day, there was some acceleration or change in tag orientation. However, the next day's knockdowns are almost zero, which indicates that there wasn't any activity and therefore potentially suggests mortality. Figure 7c includes both data and values of dry/wet sensor, which determines if the tag is on surface or not. According to this, the green line indicates that in the last 7 days the tag was on the surface. Deepwater sharks and particularly Centrophoridae species do not remain static on the sea floor but swim and can move long distances. Therefore 7 days without any activity is suspicious and suggest that the shark might have died. The activity on the following days could be the result of water currents. The amount of time the tag spends in upright position (Figure 7b) is almost 100% upright during all the period except the last 7 days. This might also suggest the shark died.

3) PTT 242618

This tag with serial number and code 23P0874 / PTT 242617 also corresponds to an electronic tag type Benthic SPAT. It was attached in another *Centrophorus granulosus*, the same day 3rd October 2023 and at the same position 35.78 S– 53.56 E. In this case, it was a female of 152 cm total length and as described previously it was in relatively good condition at release. The tag was programmed for 30 days, and it successfully completed the period (Table 4).

Data collected for this tag is shown on Figure 8. A similar situation to the previous tag is observed. After 3-4 days the activity is zero. It remains in this state during the following 15 days and in the last period, 12 days, there is new activity or knockdowns (Figure 8a). The position of the tags remains upright during the whole period (Figure 8b). The last figure (8c) indicates that during the last 12 days the tag was at surface or almost dry (50%). This pattern also suggests that the shark must have died during the first day after being caught, tagged and released. If the shark had been swimming, knockdowns would have been expected throughout the period as well as changes in the upright position.

4) PTT 242614

This tag with serial number and code 23P0870/PTT 242614 corresponds to an electronic tag type Benthic SPAT. It was attached to a *Squalus mitsukurii*, on 1st October 2023 and at the position 35.16 S –54.28 E. The shark, a female, measured 110 cm which was released alive and in good condition (Table 18, 19) although it had some injuries on the skin.

The tag was programmed for two months (60 days) and it accomplished the time period (Table 4). Data obtained are shown on Figure 14. According to the graphs, the tag remained in upright position and the number of knockdowns or acceleration activity although continues is very low, less than 7 per day. The dry/ wet sensors did not record any data and both display zero values. Assuming the sensors function correctly, the tag remained underwater during the whole period. We can therefore presume that the shark might have survived. Nevertheless, the activity of the shark based on the number of knockdowns has been very low, unless the shark moves very slowly. Other hypothesis could be that the shark died and the tag remained in the seafloor with low current and in upright position.

5) PTT 242615

This tag with serial number and code 23P0960 / PTT 242615 corresponds to an electronic tag type Benthic SPAT. It was attached to a *Centrophorus granulosus*, on 3rd October 2023 at the position 35.78 S –53.60 E (Tables 4, 5). The shark, a male of 118 cm total length was released in good condition (Table 4).

The tag was programmed for two months (60 days) and it accomplished the whole period. Data obtained are shown on Figure 10. During the first 12 days after tagging, the number of knockdowns or activity of the shark is zero (Figure 10a). This suggests that the shark might have died. Regarding the amount of time the tag spends in upright position in the first 12 days, there are some tilted variations but from the last period it remains all the time in upright position (Figure 10b). The combination of all data including information of the dry/wet sensor indicates that after 12 days the tag is almost dry suggesting it is on the surface (Figure 10c). As it is reported for tags PTT 242617 and PTT 242618 also attached to the same species, it is very contradictory that the shark did not show any movement or acceleration and after some period it shows high activity (Figure 10A). Considering this species actively swims probably the most likely explanation is that the shark died.

6) PTT 244240

This tag with serial number and code 23P0892 / PTT 244240 corresponds to an electronic tag type Benthic SPAT. It was attached to a *Squalus mitsukurii*, the 5th October 2023 at the position 35.95 S –53.23 E. The shark, a female of 109 cm total length, was released in good condition (Tables 4 and 5).

The tag was programmed for two months (60 days) and it accomplished the whole time period (Table 4). Figure 11 shows the data reported. Similar to the other *S. mitsukurii* (PTT 242614) the number of knockdowns or accelerometer metric is low although continuous along the whole deployment. Tag position remained almost in upright position during the whole period more evident in the first 20 days. The dry and wet sensors again did not report any values.

Both *Squalus mitsukurii* sharks show the same pattern. As there is not any reference about the swimming behavior of this species, it is difficult to draw any conclusion. It might have survived and the reason of this low activity is common in this shark.

7) PTT244245

This tag with serial number and code 23P0924 / PTT 244245 corresponds to a Benthic SPAT tag which was attached to a *Squalus mitsukurii*, on 5th October 2023 at the same position of previous one 35.95 S –53.23 E. The shark was a male of 91 cm total length and was released in good condition (Tables 4 and 5).

The tag was programmed for three months (90 days) and it accomplished the whole period (Table 4). Figure 12 shows the data reported. The same pattern as previously described for the other *Squalus mitsukurii* is observed. Dry and wet sensors report zero values; thus, we assume the tag was underwater all the period. Shark activity is continuous although not very high and the tag was almost all the time in upright position.

8) PTT 242619

This tag with serial number and code 23P0875 / PTT 242619 corresponds to an electronic tag type Benthic SPAT. It was attached to a *Squalus mitsukurii*, the 5th October 2023 and at the position 35.78 S– 53.56 E. The shark was a female of 105 cm total length (Tables 4 and 5). The tag was programmed for one month thus, it was expected to release and send the information from 9 of November onwards. However, no data has been received to date. Several hypotheses can be formulated, among these; electronics of the tag failed, problems with satellite transmission, shark swimming below 1800 m depth and loss of the tag, predation, etc.

4. Preliminary Conclusions

Preliminary findings show that benthic survival tags are not the most appropriate for survival studies on deepwater sharks. This type of tags was designed for benthic species that remained static on the sea floor or do not move continuously. Although designed for survival studies and are cheaper than MiniPAT tags lacking a depth sensor and therefore not depth data are recorded, does not allow to fully interpret the behavior of the deepwater sharks.

A priori none of the tags remained at surface after released, since the tag would have start releasing the information after 4 days as programmed, so this indicates that the sharks dive. Except the MiniPAT tag attached to a *C. squamosus* which clearly indicated that the shark died immediately, the benthic survival tags attached to *Centrophorus granulosus* suggest the sharks might not die immediately but after 12 days. With respect to *Squalus mitsuskurii* results suggest that it might have survived although the activity recorded is very low but swimming behavior of this shark is unknown.

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TABLES:

Table 1. Criteria used on board to assess at-vessel mortality. Sharks scored 1 or 2 were not tagged and released.

Score	Vitality	Description	Tagged & Released
1	DEAD	Shark is dead	No
2	WEAK	Shark is in very bad condition	No
3	MODERATE	Average condition: soft damage	Yes
4	STRONG	Excelent: without damage	Yes

Table 2. Quantities of conventional and electronic tags (type and time to release [days after **starting**]).

Type	Quantity	Time to release
Conventional	2000	recapture
Benthic survival PATs	12	30, 60 and 90
Mini PATs	6	105, 120, 140, 160, 180, 220

Table 3. Summary of species and number of sharks tagged.

Species	Sp. Code	Tag Type	Nº Tagged
Centrophorus granulosus	GUP	SPAT Benthic	3
Centrophorus squamosus	GUQ	MiniPAT	1
Centroscymnus coelolepis	CYO	Plastic Tag	3
Dalatias licha	SCK	SPAT Benthic	2
		MiniPAT	1
Deania calceus	DCA	Plastic Tag	3
Squalus mitsukurii	QUK	SPAT Benthic	4
		MiniPAT	1
Somniosus rostratus	SOR	Plastic Tag	1

Table 4. Summary of deep-water shark species tagged during the M44 with information about Species name, type of tag and code number, total length (cm), sex (M=male; F=female), maturity based on Stehmann key (2002), release condition: 1) Weak 2) Moderate and 3) Strong and dates of tagging and release according to the days programmed.

SET	SPECIES	FAO Code	Length (cm)	Sex	Maturity	Status before tagging	Release status	Tag Kind	Code	Tagging Date	Days Progr.	Release Date	Release Achieved
1	*Squalus mitsukurii*	QUK	110	F	4	3	3	SPAT Benthic	242614	01/10/2023 18:56	60	01/12/2023	On time
5	*Centrophorus granulosus*	GUP	118	M	3	3	3	SPAT Benthic	242615	03/10/2023 15:36	60	02/12/2023	On time
5	*Centrophorus granulosus*	GUP	119	M	3	3	3	SPAT Benthic	242617	03/10/2023 15:43	90	22/10/2023	Prematurely
5	*Centrophorus granulosus*	GUP	152	F	3	3	3	SPAT Benthic	242618	03/10/2023 17:10	30	02/11/2023	On time
5	*Centrophorus squamosus*	GUQ	116	M	2	2	2	MiniPAT	242597	03/10/2023 17:17	105	08/10/2023	Prematurely
10	*Squalus mitsukurii*	QUK	105	H	2	3	3	SPAT Benthic	242619	05/10/2023 16:40	30	-	Unknown
10	*Squalus mitsukurii*	QUK	91	M	3	3	3	SPAT Benthic	244245	05/10/2023 16:45	90	04/01/2024	On time
10	*Squalus mitsukurii*	QUK	106	H	2	3	3	MiniPAT	242598	05/10/2023 16:54	120	feb-24	Still Recording
10	*Squalus mitsukurii*	QUK	109	H	2	3	3	SPAT Benthic	244240	05/10/2023 16:58	60	05/12/2023	On time
181	*Dalatias licha*	SCK	109	M	2	3	3	SPAT Benthic	242623	21/01/2024 18:28	30	feb-24	Still Recording
181	*Dalatias licha*	SCK	94	M	2	3	3	SPAT Benthic	242624	21/01/2024 18:33	30	feb-24	Still Recording
181	*Dalatias licha*	SCK	111	M	2	3	3	MiniPAT	242599	21/01/2024 18:53	140	jun-24	Still Recording
11	*Centroscymnus coelolepis*	CYO	122	M	4	2	2	Plastic	0003 and 0004	06/10/2023 12:46			
11	*Deania calceus*	DCA	101	H	?	1	1	Plastic	0005 and 0006	06/10/2023 13:02			
11	*Somniosus rostratus*	SOR	134	H	?	2	2	Plastic	0007 and 0008	06/10/2023 16:41			
12	*Centroscymnus coelolepis*	CYO	91	M	3	1	1	Plastic	0010 and 0011	08/10/2023 9:33			
13	*Centroscymnus coelolepis*	CYO	92	M	3	2	2	Plastic	0012 and 0013	06/01/2024 8:30			
14	*Deania calceus*	DCA	93	H	2	2	2	Plastic	0014 and 0015	08/01/2024 10:50			
181	*Deania calceus*	DCA	67	M	1	3	3	Plastic	0016 and 0017	21/01/2024 18:15			

Table 5. Summary of the tagged and released location of the sharks tagged with electronic tags that emit the data up to date.

TAG Nº		TAGGED DATA			RELEASE DATA		
PTT	TYPE	Date	Latitude	Longitude	Date	Latitude	Longitude
242614	Benthic	01/10/2023	-35.1667	54.2833	01/12/2023	-35.1507	54.3022
242615	Benthic	03/10/2023	-35.7834	53.6000	02/10/2023	-32.7251	52.3595
242617	Benthic	03/10/2023	-35.7835	53.6000	22/10/2023	-35.7785	53.5697
242618	Benthic	03/10/2023	-35.7836	53.5667	02/11/2023	-34.1948	51.7150

242597	MiniPAT	03/10/2023	-35.7838	53.5667	08/10/2023	-35.7790	53.5552
244240	Benthic	05/10/2023	-35.9500	53.2333	05/12/2023	-35.9493	53.2424
244245	Benthic	05/10/2023	-35.9500	53.2333	04/01/2024	-35.9463	53.2421

FIGURES:

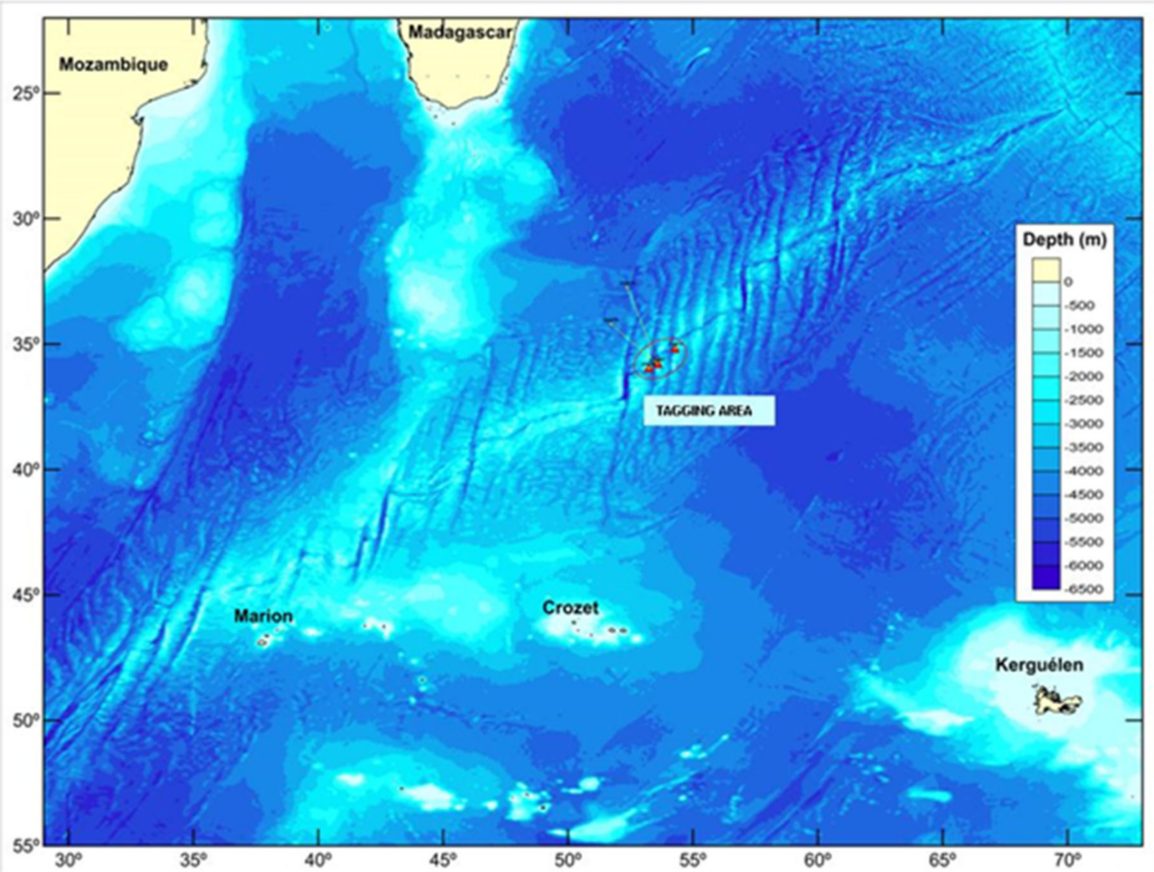


Figure 1. Location of the tagging area and site where tags were released.

Figure 2. A. T-bar Tags; B. Electronic satellite tag (PAT); C. Anchor designed and used in this study.

Figure 3. On board work during the second trip (Oct-Dec 2023). A-B. Removing hooks *Squalus mitsukurii*; C. Preparing a birdbeak dogfish (*Deania calceus*) to checkup its live status; D-E. Checking the birdbeak dogfish's live status; F. A *Somniosus rostratus* shark tagged with two conventional tags.

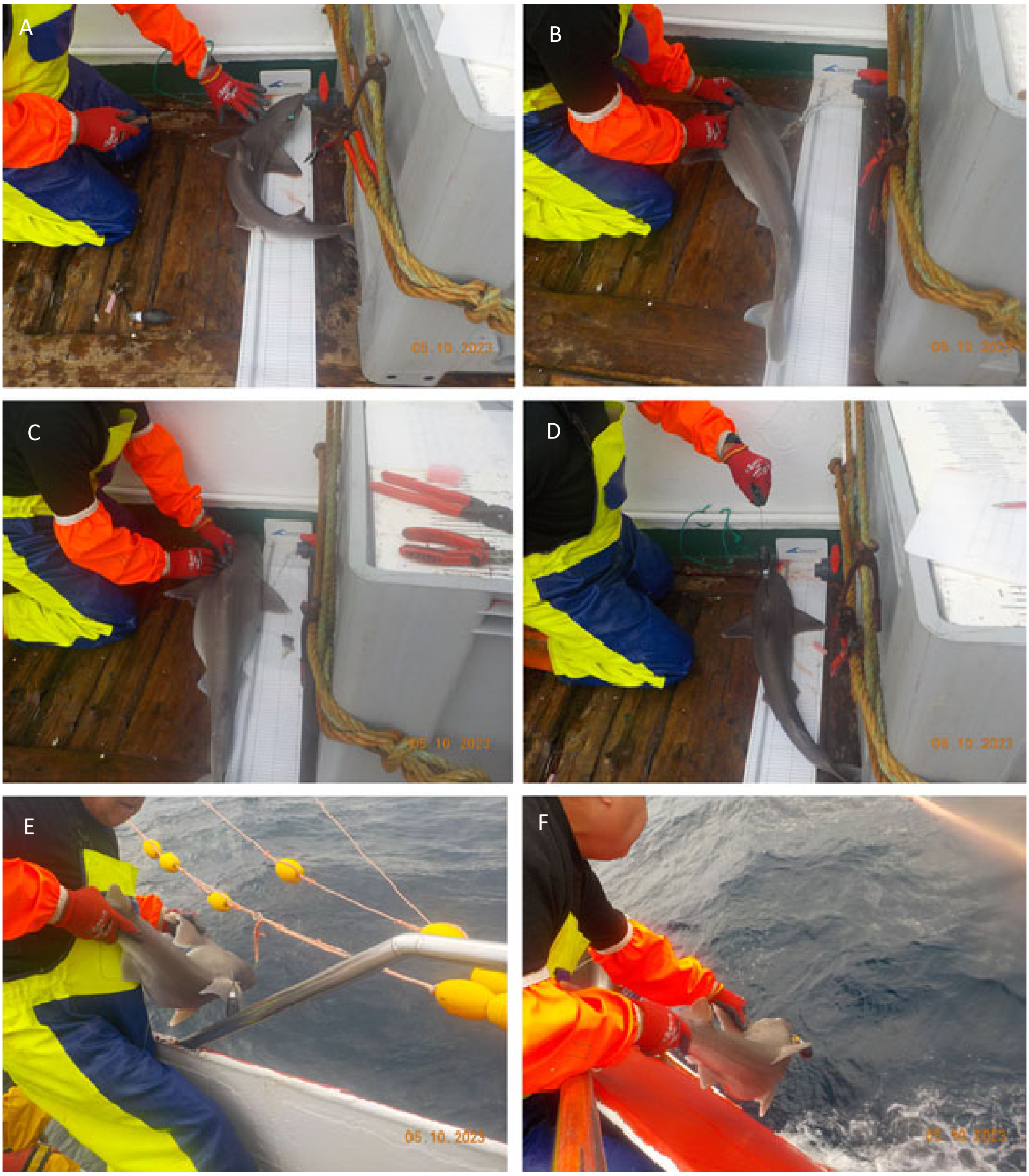


Figure 4. Tagging some *Squalus mitsukurii* specimens with electronic tags (A-D) and releasing them later (E-F).

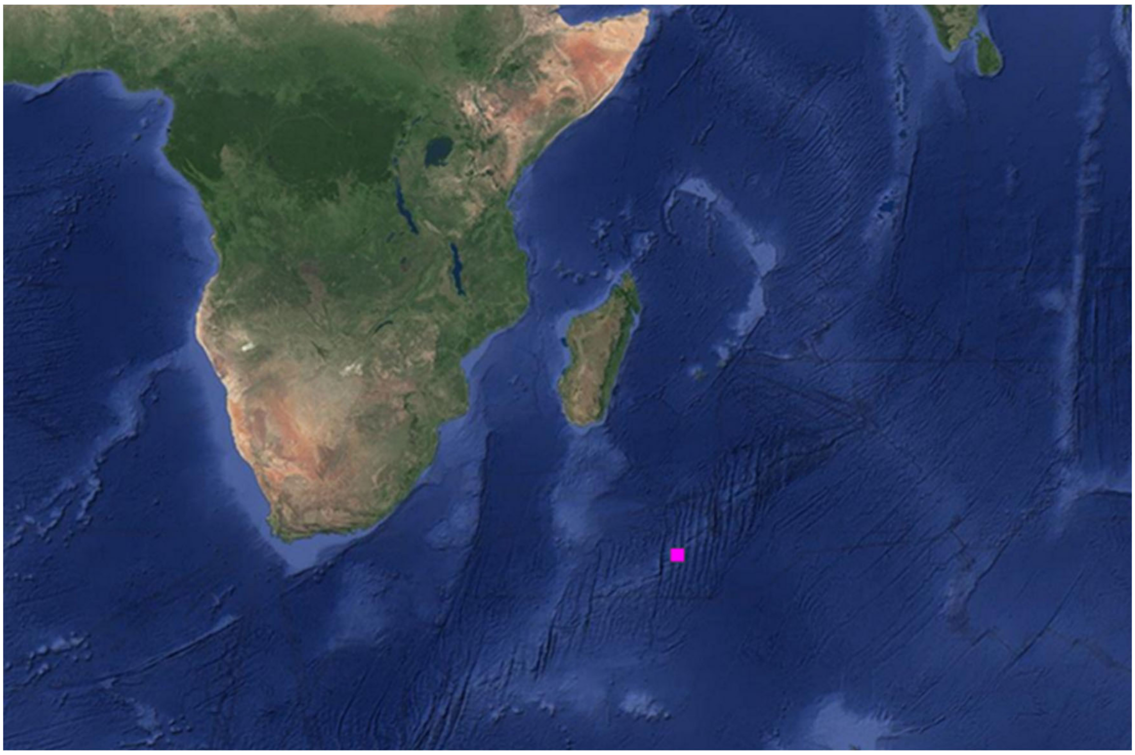


Figure **5**. Location of the tag PTT 242597 at surface transmitting the data (09/10/2023).

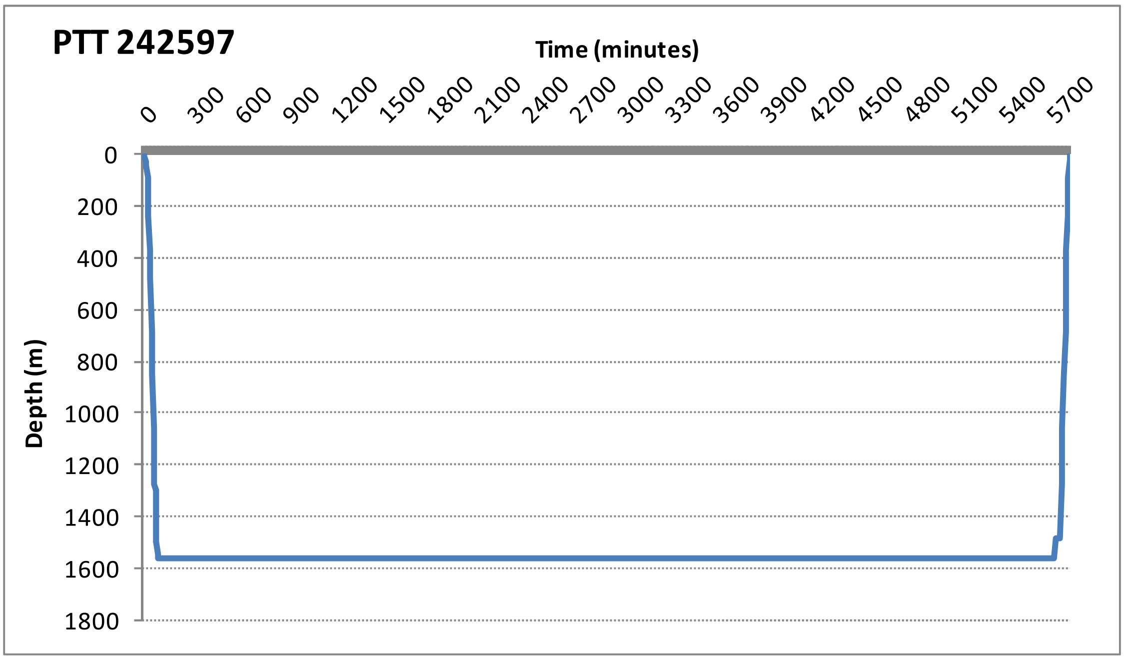


Figure 6. Behaviour of the shark *Centrophorus squamosus* (PTT 242597) during the 4 days that the tag was collecting data.

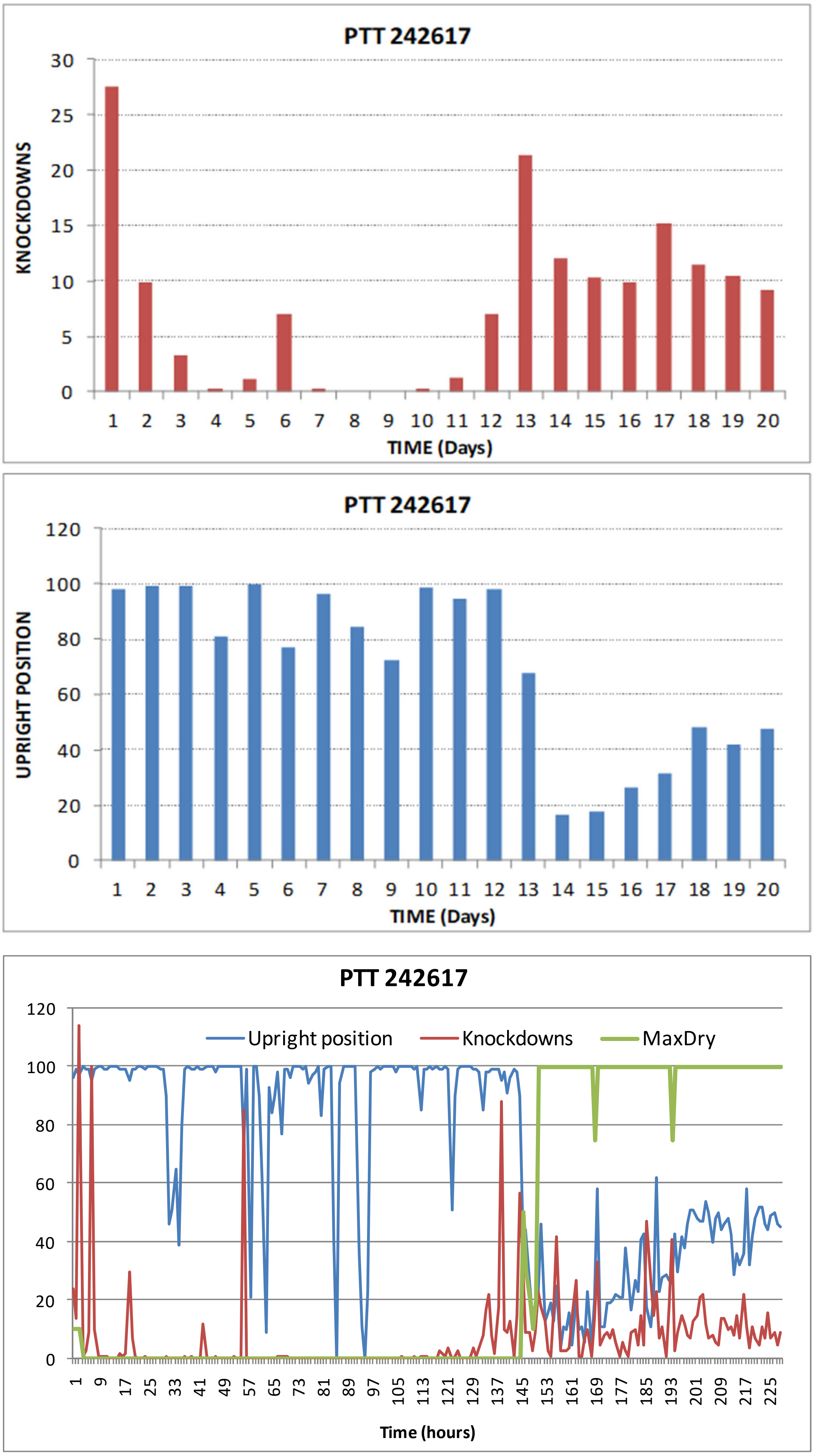
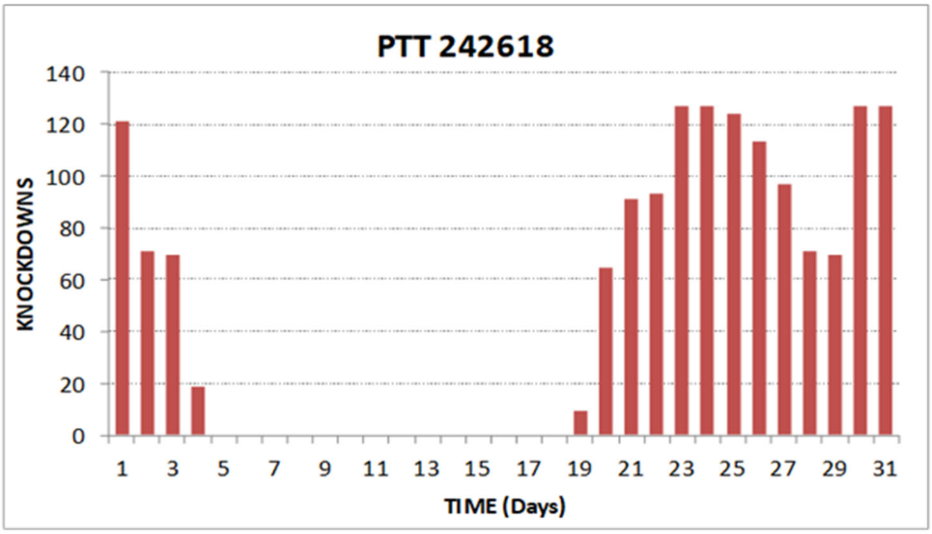
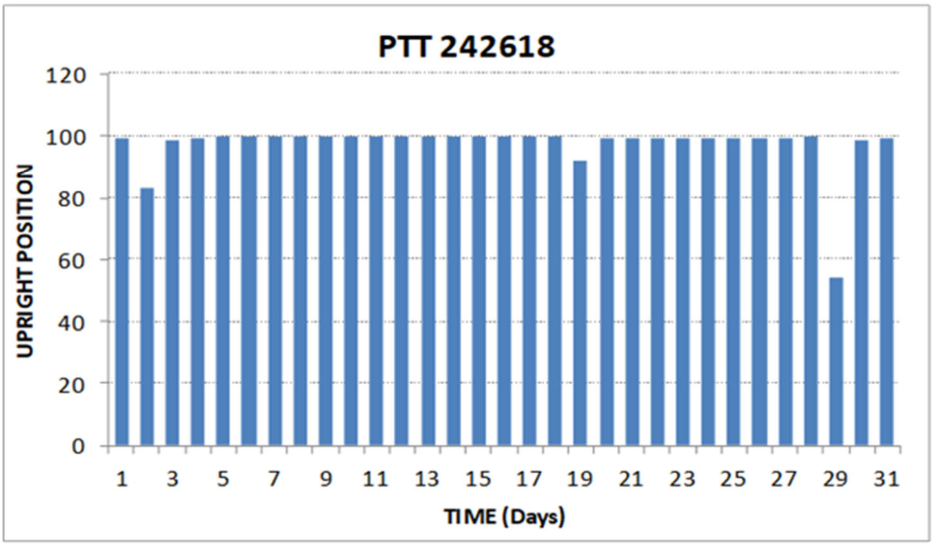


Figure7. Data of tag PTT 242617 attached to *Centrophorus granulosus*. From top to bottom: Top: Number of knockdowns per day; Middle: Amount of time the tag spends in upright position versus tilted; Down: All data including dry/wet sensor.





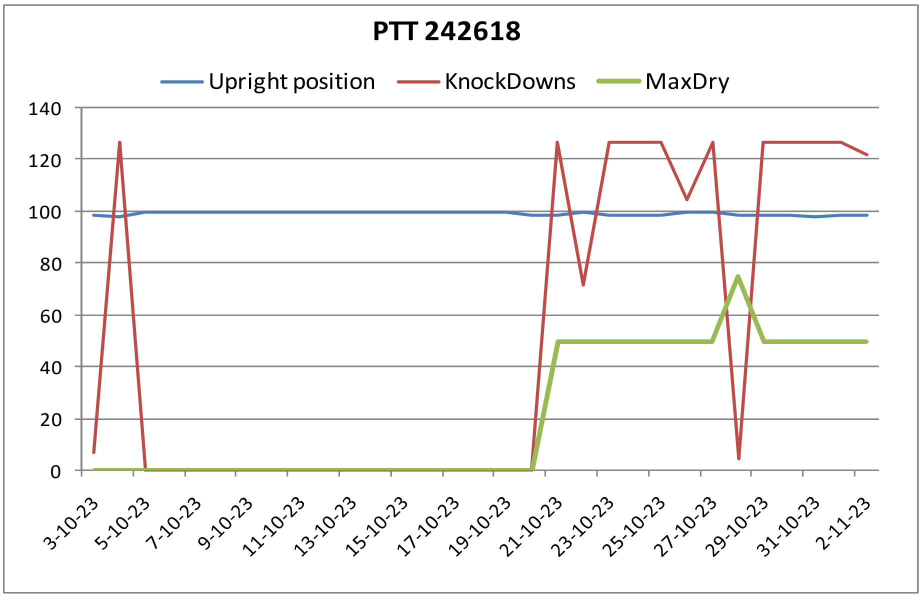


Figure 8. Data PTT 242618 attached to a *Centrophorus granulosus*. From top to bottom: Top: Number of knockdowns per day; Middle: Amount of time the tag spends in upright position versus tilted; Down: All data including dry/wet sensor.

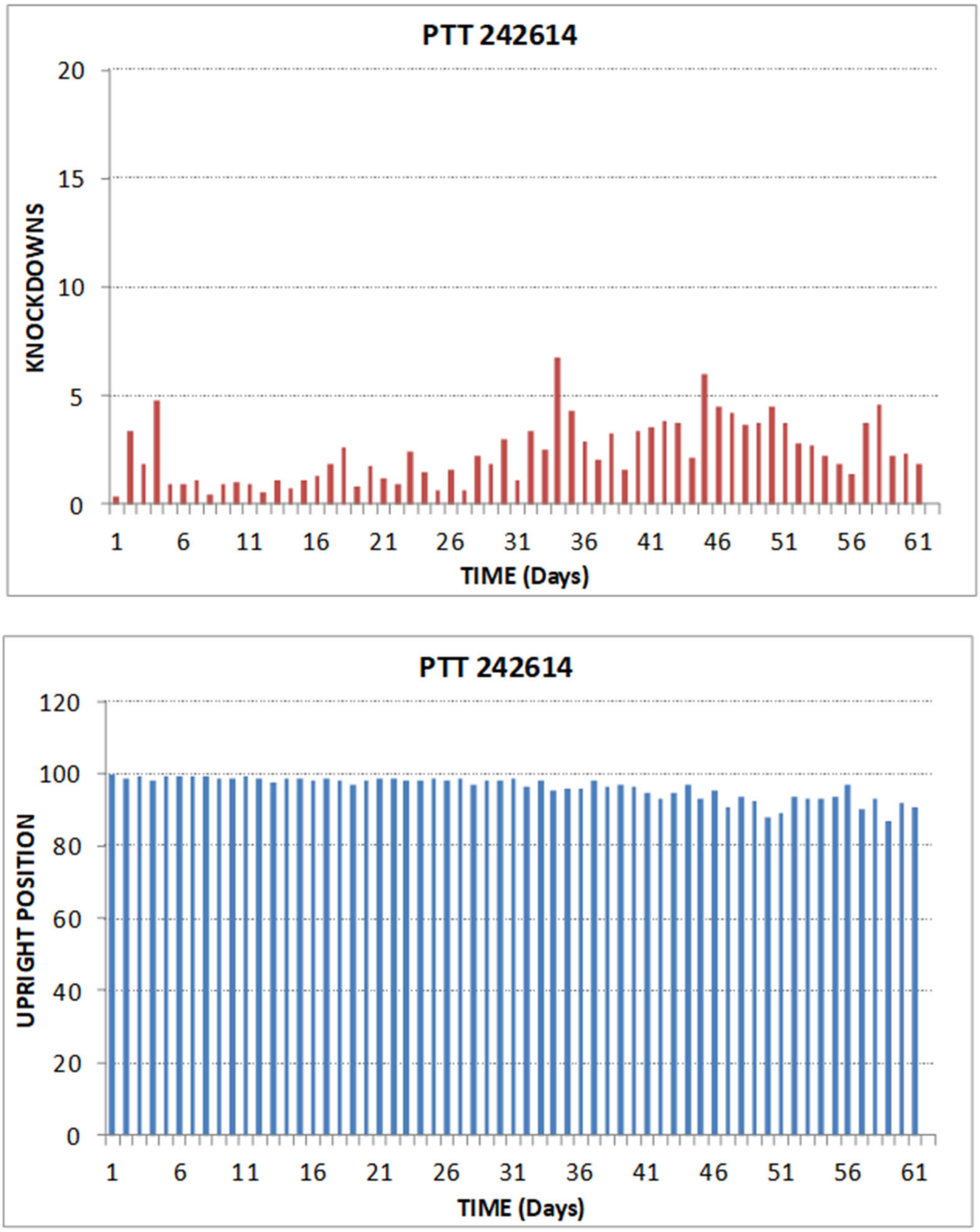


Figure 9. Data PTT 242614 attached to a *Squalus mitsukurii*. Top: Number of knockdowns per day; Down: Amount of time the tag spends in upright position versus tilted.

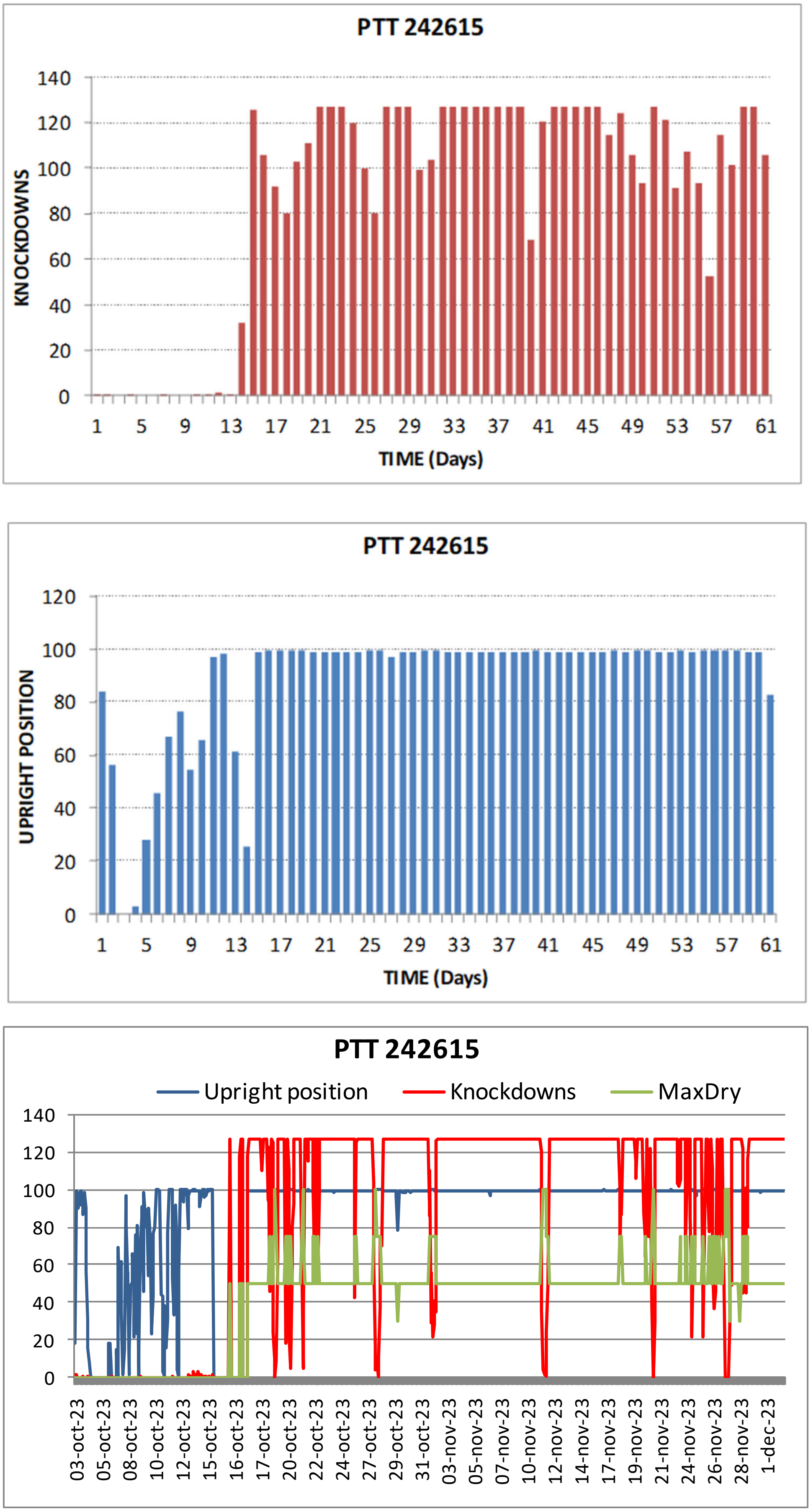
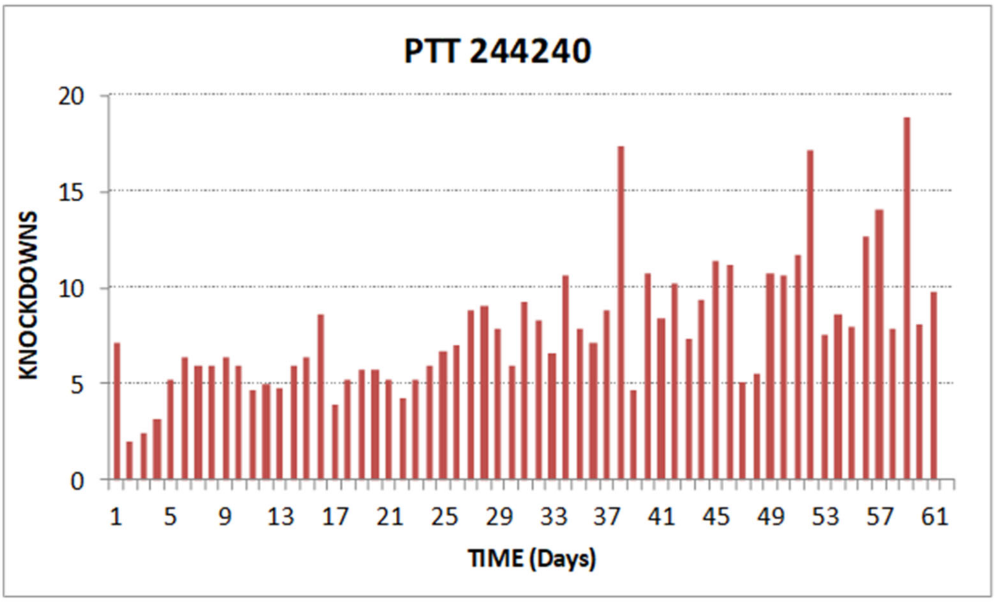


Figure 10. Data PTT 242615 attached to a *Centrophorus granulosus*.From top to bottom: Top: Number of knockdowns per day; Middle: Amount of time the tag spends in upright position versus tilted; Down: All data including dry/wet sensor.



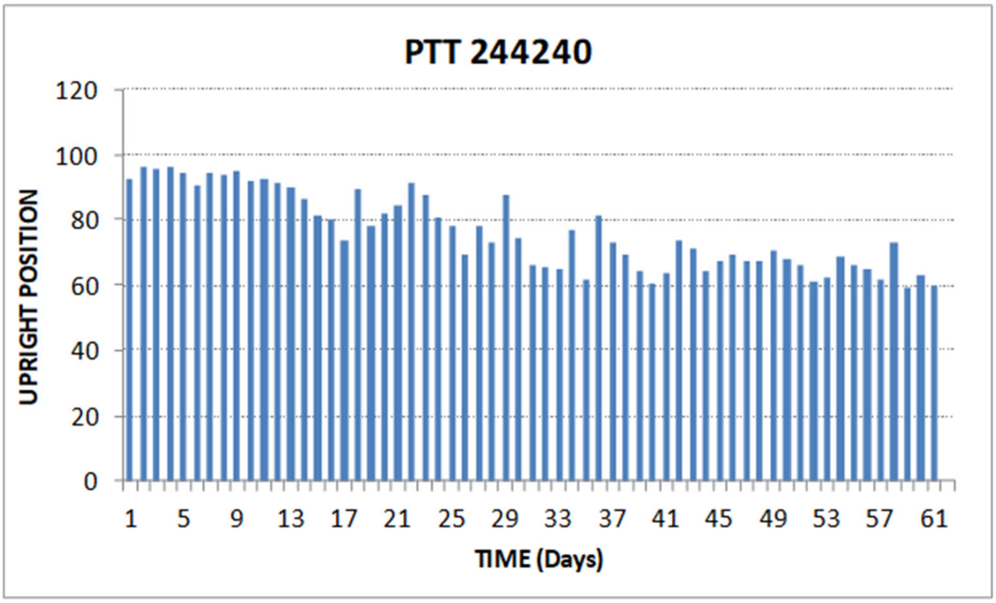
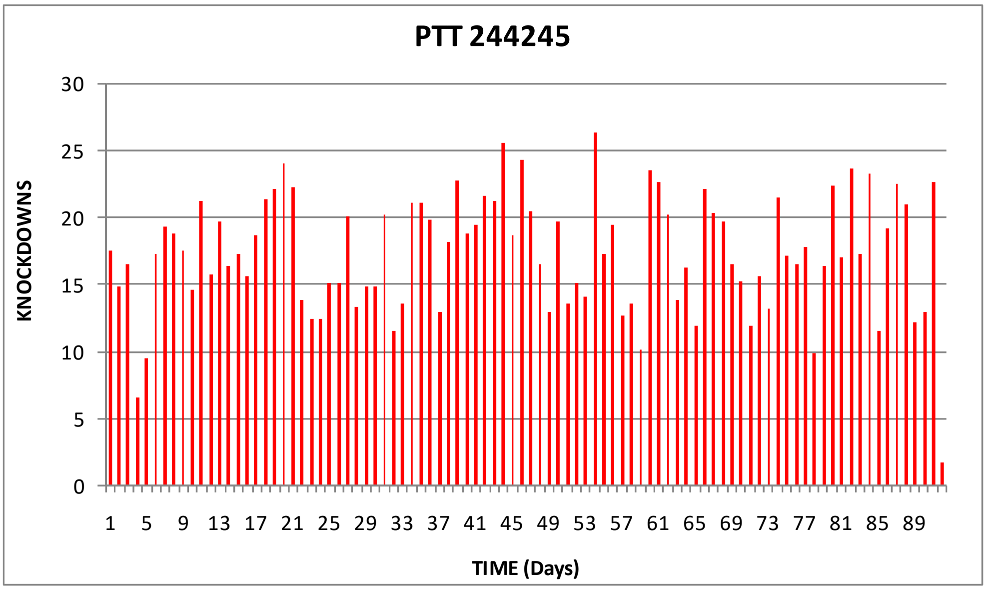


Figure 11. Data PTT 244240 attached to a *Squalus mitsukurii*. Top: Number of knockdowns per day; Down: Amount of time the tag spends in upright position versus tilted.



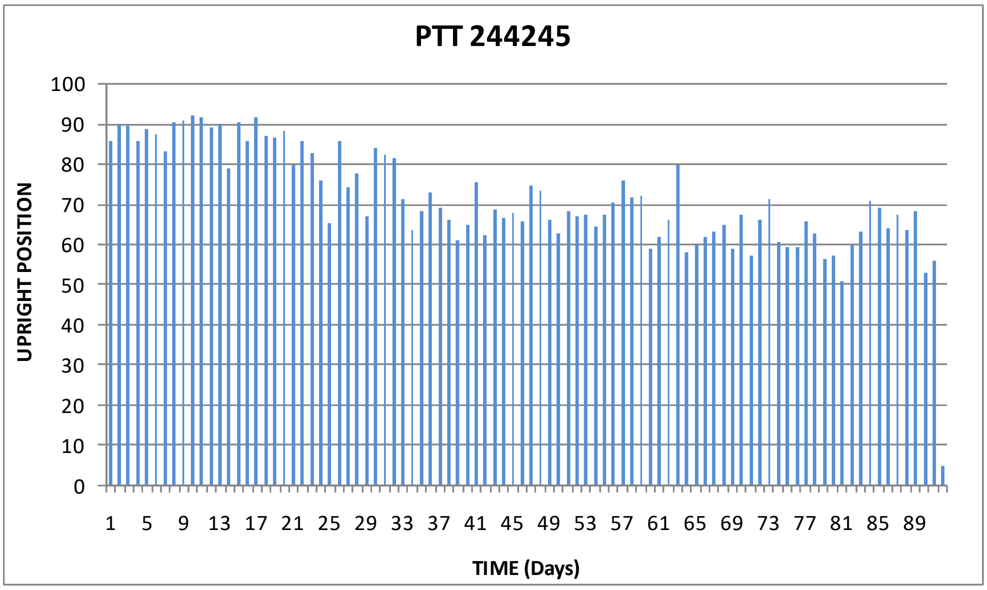


Figure 12. Data PTT 244245 attached to a *Squalus mitsukurii*. Top: Number of knockdowns per day; Down: Amount of time the tag spends in upright position versus tilted.