Silky shark (*Carcharhinus falciformis*) tagging project 2021

Update report:

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1. Background

This study was carried out on board an Echebastar fleet purse seiner operating in the Indian Ocean (Fig1), during a fishing trip between September 29 and October 17, 2021. The net cork line length was 1.647 meters and maximum depth 280 meters.

Fig 1. Echebastar fleet's purse seiner during a fishing operation. Photo: Iñigo Onandia

The survey area comprises the waters between the north of Seychelles up to 9 ˚ N latitude and between 53˚ E and 60˚ E longitude (see Fig 2).

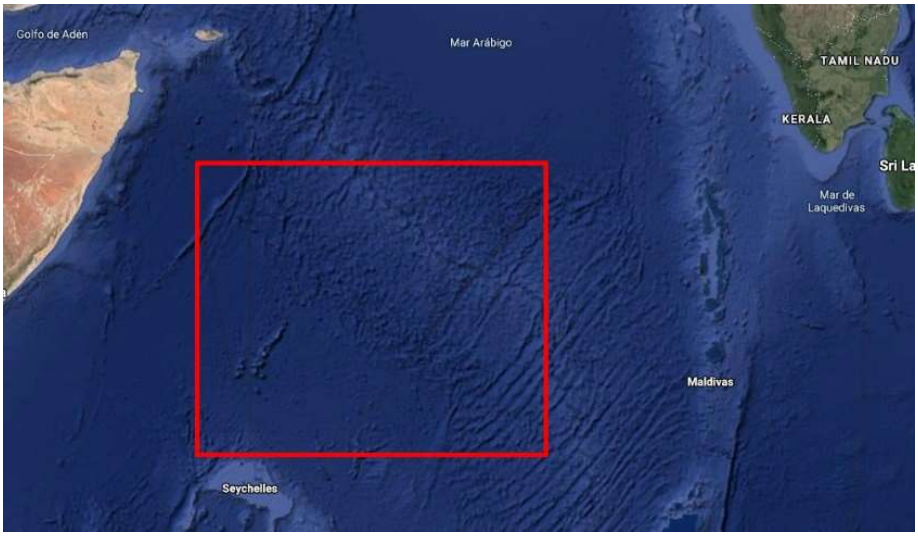

Fig 2. Tagging phase 2 survey area in the Indian Ocean

2. Objectives

This study funded by Echebastar aims to quantify post-release survival rates and overall mortality of incidentally caught silky sharks (*Carchahinus falciformis*) and evaluate how the location or the stage during the purse seine fishing operation at which the sharks are released affects to their survival rate.

Specific objectives

- Estimate the post-release survival rate of silky sharks through the application of best practices (BBPP) on purse seiners using sPAT and MiniPAT satellite tags.
- Identify the correlation between the number of silky sharks and the catch per set.
- Identify the relationship between the number of silky sharks caught per set and the geographic location of the set.
- Explore habitat use by examining horizontal and vertical migrations of silky sharks

3. Preliminary results

In this second tagging trip, 245 silky sharks (*Carcharhinus falciformis*) and 3 oceanic white tip sharks (*Carcharhinus longimanus)* were caught incidentally during 31 fishing sets around FADs. Of these, 32 silky sharks and 1 oceanic white tip shark were tagged with satellite tags (following good practice release methods) during two different stages: i) when releasing the shark before going down to the fish processing lower deck and ii) by releasing the shark through the second conveyor belt installed in the lower deck. Tagged specimens were also measured, sexed, and a blood sample was drawn to measure lactate (a blood parameter closely related to anoxia levels). Vitality categories were assigned to all individuals as proposed by Heuter and Manire (1994): 4 (perfect), 3 (good), 2 (poor), 1 (moribund) and 0 (death).

3.1. Satellite tagging

A total of 32 silky sharks with fork length ranging between 97 and 198 cm were successfully tagged with satellite tags (13 sPATs and 19 MiniPATs). The oceanic white tip (161 cm) was tagged with a SPAT tag. In the figure and table below (Fig 3, Table 1) we can see the geolocation and tag identification of the released sharks.

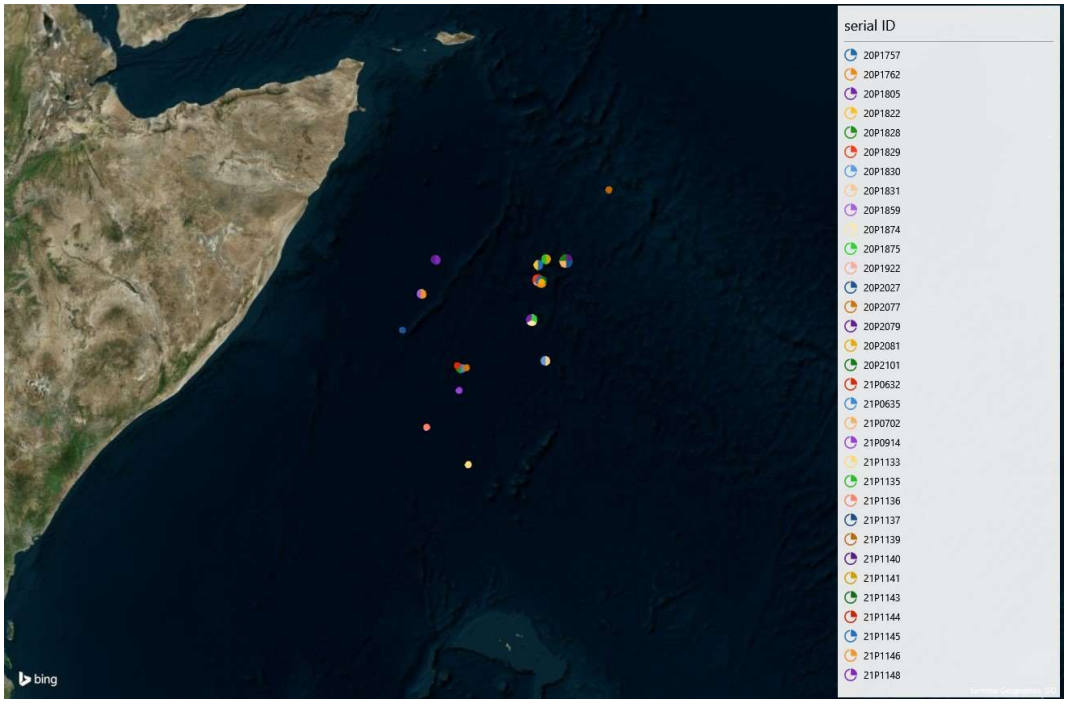

Fig 3. Map showing location of phase 2 released sharks.

Table 1. Tagged released sharks geolocation and size information.

ID set	Date_Set	SST	ID specimen	Species	Sex	Length (cm)	PTT ID	Serial ID
1	01/10/2021	27,6	1	FAL	Female	144	225276	21P1133
4	03/10/2021	27.1	2	FAL	male	198	225278	21P1136
5	04/10/2021	27,1	3	FAL	Female	171	225376	21P0914
8	05/10/2021	27	4	FAL	Female	140	221596	21P0635
8	05/10/2021	27	5	FAL	Female	137	208252	20P1828
9	05/10/2021	27,2	6	OCS	Male	161	221595	21P0632
12	06/10/2021	27,8	7	FAL	Male	102	208254	20P1831
12	06/10/2021	27,8	8	FAL	Female	107	208253	20P1830
13	07/10/2021	27,6	9	FAL	Male	143	209073	20P1805
13	07/10/2021	27,6	10	FAL	Female	180	208255	20P1874
13	07/10/2021	27,6	11	FAL	Male	160	208256	20P1875
14	08/10/2021	27,5	12	FAL	Male	164	210668	20P2101
14	08/10/2021	27,5	13	FAL	Male	180	221663	21P0702
14	08/10/2021	27,5	14	FAL	Female	193	225279	21P1137
14	08/10/2021	27,5	15	FAL	Female	190	225281	21P1140
15	08/10/2021	27,5	16	FAL	Female	169	225277	21P1135
15	08/10/2021	27,5	17	FAL	Male	190	225282	21P1141
16	09/10/2021	27	18	FAL	Male	104	225280	21P1139
18	10/10/2021	27,5	19	FAL	Female	183	225283	21P1143
18	10/10/2021	27,5	20	FAL	Female	170	208321	20P1762
18	10/10/2021	27,5	21	FAL	Female	168	208320	20P1757
19	10/10/2021	27,5	22	FAL	Male	140	225284	21P1144
19	10/10/2021	27,5	23	FAL	Female	97	209077	20P1922
19	10/10/2021	27,5	24	FAL	Male	130	209075	20P1829
20	10/10/2021	27,6	25	FAL	Female	154	225285	21P1145
20	10/10/2021	27,6	26	FAL	Male	136	209074	20P1822
21	10/10/2021	27,9	27	FAL	Male	113	209081	20P2081
22	11/10/2021	26,9	28	FAL	Male	100	225286	21P1146
22	11/10/2021	26,9	29	FAL	Male	100	209076	20P1859
23	11/10/2021	27,2	30	FAL	Female	113	225287	21P1148
23	11/10/2021	27,2	31	FAL	Female	140	209080	20P2079
26	12/10/2021	27,3	32	FAL	Male	154	209078	20P2027
27	13/10/2021	27,6	33	FAL	Male	143	209079	20P2077

Sharks with more than 10 days at liberty after tagging were considered survivors. There were 5 sharks showing immediate mortality within the first 24 hours after release and another 2 died

after 4 and 7 days (highlighted in red in Table 2). Three tags popped of prematurely after 26, 33 and 38 days for no clear reason (highlighted in orange in table 2), one of them transmitted from the inland coast of Somalia, probably due to local fishing. Two tags have been recaptured recently by a French purse seiner, as reported by observers onboard, and physically recovered (highlighted in green in table 2). The remaining 20 tags still appear to continue to be attached to the sharks.

Table 2. Satellite tags deployment and release time information

PTT	Serial	Tag Type	Deploy Date	Release Date	Release Reason	First Data to Release
225285	21P1145	MiniPAT	10/10/2021 8:54	17/11/2021 9:00	Too Deep. Pin was intact at the time of release	38d 1h
208254	20P1831	MiniPAT	06/10/2021 7:12	01/11/2021 10:00	Too Deep. Pin was intact at the time of release	26d 10h
225276	21P1133	MiniPAT	01/10/2021 8:03	30/10/2021 9:00	Recaptured	29d 1h
225281	21P1140	MiniPAT	08/10/2021 3:54	15/10/2021 14:00	Too Deep. Pin was intact at the time of release	7d 14h
209077	20P1922	sPAT	10/10/2021 6:58	12/11/2021 18:00	Premature.Local fishing coast of Somalia?	33d 12h
225282	21P1141	MiniPAT	08/10/2021 9:16	08/10/2021 11:00	Too Deep. Pin was intact at the time of release	3h
221663	21P0702	MiniPAT	08/10/2021 3:50	08/10/2021 5:00	Too Deep. Pin was intact at the time of release	1h 10m
225376	21P0914	sPAT	04/10/2021 3:43	29/10/2021 10:00	Recaptured	25d 7h
209081	20P2081	sPAT	10/10/2021 12:18	15/10/2021 5:40	Too Deep. Pin was intact at the time of release	4d 17h 40m
209078	20P2027	sPAT	12/10/2021 12:37	12/10/2021 14:05	Too Deep. Pin was intact at the time of release	2h 5m
209074	20P1822	sPAT	10/10/2021 9:31	10/10/2021 16:32	Too Deep. Pin was intact at the time of release	7h 32m
208321	20P1762	sPAT	10/10/2021 3:58	10/10/2021 5:43	Too Deep. Pin was intact at the time of release	5h 43m
208320	20P1757	sPAT	10/10/2021 4:03	10/10/2021 5:36	Too Deep. Pin was intact at the time of release	5h 36m

3.2 Vitality assessment

The vitality state at time of release was recorded for every captured individual. Entangled individuals showed the best vitality score while the ones that came on board after the second brail showed a higher rate of immediate mortality. With survival rates obtained from tagged individuals and vitality scores determined by the observer on board, the estimated overall survival rate was 40%.

Table 3. Silky shark vitality scores and estimated survival rates at each phase of the fishing operation

Zone	Dead (0)	Poor (1)	Fair (2)	Good (3)	Excellent (4)	Total	Estimated survival N	Estimated survival %
Tangled	0	2	1	6	7	16	**13**	86.88
1st_brail	7	19	38	10	3	77	**44**	58.27
2nd_brail	18	17	24	2	0	61	**24**	39.56
3rd_brail	49	41	4	0	0	94	**16**	17.48
(all)	74	79	67	18	10	248	**99**	40.05
Pred. survival (%)	*0*	*33.33*	*69.23*	*92.31*	*100*			
Survivors	**0**	**26**	**46**	**17**	**10**			

3.3. Blood sampling. Lactate levels

Blood samples were taken from the caudal peduncle of tagged silky sharks (Fig.3) and immediately measured with a lactate meter. With the survival rates obtained from tagged individual and the lactate levels a survival probability curve was developed which was then applied to those individuals sampled for lactate levels (79 out of 248). (Table 4). Due to the objectives of phase 2 of the project (i.e., tracking shark migratory patterns) sampling was skewed towards individuals in better condition more suitable for tagging with more expensive MiniPAT tags. In the case of this subsample of sharks, the overall survival rate was estimated at 60%.

Fig 3: Shark blood sample extraction for lactate analysis

Table 4. Lactate levels and estimated survival rates at each phase of the fishing operation

	Lactate<7.94	N measured	Pred. survival (%)	Total	Survivors
Tangled	17	17	100.00	16	**16**
1st brail	21	26	80.77	77	**62**
2nd brail	11	14	78.57	61	**48**
3rd brail	9	22	40.91	94	**38**
(all)	58	79	66.13	248	**164**

4. Preliminary Conclusions

As observed in previous works on tuna purse seiners, the post-release mortality of sharks is at its lowest when individuals are in good condition, such as when they are swimming in the net. Shark mortality starts to increase from the moment the sac is formed and with the number of brails, which in parallel decreases the vitality index observed. In this study the survival rate estimated differed depending on the indicator used for estimation of overall survival rates, yielding 40% when the vitality index was applied or 60% when lactate levels were employed). These differences, as explained previously, could be caused by the selection of the healthier specimens for lactate sampling. However, these are preliminary results which should be further explored. Nevertheless, the estimates obtained in this tagging campaign are both higher than the ratios estimated in previous works like Hutchinson 2015. The difference could rely on the fishing operation itself and the time elapsed from the catch to release which can be influenced for example by set size, brail size or environmental conditions, or shark biological characteristics (e.g., size, age). In addition, crew experienced in the application of best releasing practices since it was implemented almost a decade ago and the adaptation of the vessel through the installation of the bycatch release conveyor belt in the lower deck has a positive influence on the increment of shark survival.

These findings suggest that if best handling and release practices are consistently applied and fauna handling/release devices are incorporated on board, a significant increase in post-release survival of sharks could be achieved in tuna purse seiners.

The data obtained in this phase 2 tagging campaign will be used to further study the biology of silky sharks by exploring their habitat use and investigating the migration pattern of this species, which could help in the design and development of future alternative mitigation approaches.