

# BFT Growth in farms study

ICCAT / GBYP 09/2019-d of the Atlantic- wide research programme of Bluefin tuna  
(GBYP Phase 9)

Pelagos-net farm d.o.o.

Final report

January 2020

**Contractor: PELAGOS NET FARM d.o.o. (PNF)**

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by the European Union

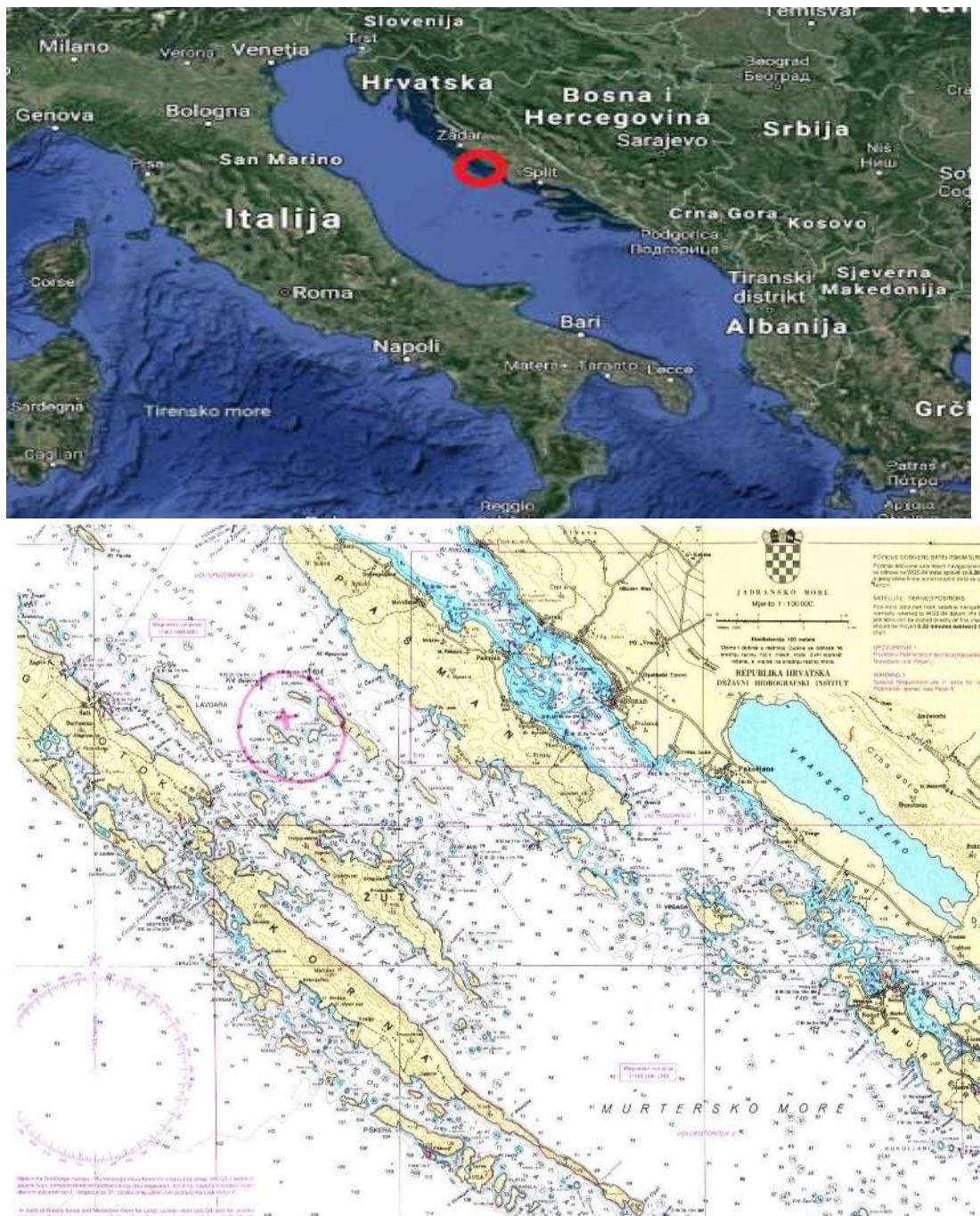
## **PLACE OF TAGGING BLUEFIN TUNA JUVENILES FOR INDIVIDUAL BASED GROWTH TRACKING**

TUNA FARM NEAR BALABRA ISLAND (position: 43° 56' 12.04 N    15° 16' 20.75 E)

The farm is located near Balabra island among the islands Žut and Sit in Šibenik area (Figure 1 and Figure 2). This location is well protected from winds and other unfavourable weather conditions. Capacity of the farm is 1500 tonnes in 14 cages and is registered under the ICCAT number ATEU1HRV00011. The farm is located about 9 Nm from company's headquarters in the main port of Zadar - Gaženica.



**Figure 1.** Pelagos-net farm near Balabra island



**Figure 2.** Surrounding area of Pelagos-net farm located in the central Eastern Adriatic

### **WORKING MULTIPURPOSE VESSEL INVOLVED IN TAGGING ACTIVITIES:**

Working vessel „Sestrica“ ATEU0HRV00236 is property of Pelagos-net farm d.o.o. It's a multipurpose supporting vessel that operates under variety conditions and needs (Figure 3). During tuna catching season it serves as a tug vessel, and the rest of the year its function is in tuna feeding as a vessel for mariculture purposes.



**Figure 3.** Working vessel „Sestrica“

### **TUNA FISHING FOR GROWTH IN FARM EXPERIMENT (Cage HRV.EU-001**

Group ebcd is HR19900165-G-LT01):

Purse seine fishing vessel (**PSFV**) **Tacoma ATEU0HRV00164**, is engaged from our sister firm Jadran tuna which takes part in the joint fishing operation (JFO). Date of catch was June 4 2019, when 833 specimens were caught that resulted in 7248,92 kg (ebcd number HR19900106). The fish was transferred to tug vessel Suport I transport cage HRV.EU-012 on June 5th 2019 with a mortality of 3 specimens/ 33 kg, so the remaining 830 specimens corresponded to 7215,92 kg, and then on June 11th 2019 to tug vessel Cezar transporting cage to the rearing site with no mortality recorded. (ROP observer: GAL-LA SERRANO CANALS # 571). After the stereoscopic camera system estimates 616 overcaught fish were released and 214 fish remain in the cage 1.

**Report obtained by SC video system on size structure of the tuna prior to distribution in cage # 1:**

**AQ1 Systems AM100 report**

**General Information**

Species: *T. thynnus* ICCAT nova2019

Site: Balabara

Cage: # 1

Recording date: 20/07/2019 11:01:58 AM

Comments:

Model formula weight =  $3.508 * (10^{-5}) * (FL * 100)^{2.883091788}$  ( $0.1 \leq FL < 2$ )

Recording folder: C:\AM100\20190720\_pelagos net farma cg10 u cg1

Project filename: IJ analiza.AQAM

**Counting Information**

Positive counts: 2

Negative counts: 0

Total count: 2

**Sizing statistical Information**

Mean weight (kg): 9.488

Minimum weight (kg): 7.779

Maximum weight (kg): 12.753

Weight S.D. (kg): 1.186

Weight CV (%): 12.502

Sample size (weight): 46

Samples out of formula range: 0

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Mean FL (m) : 0.764

Minimum FL (m) : 0.682

Maximum FL (m) : 0.849

FL S.D. (m) : 0.033

FL CV (%): 4.369

Sample size (FL): 46

Fish in the Cage **HRV.EU-005** (Group ebcd is HR19900216) is composed of five catches as follow:

**PSFV Kali ATEU0HRV00037** - date of catch was June 30, 2019 with 870 specimens/ 8700 kg, ebcd number HR19900196. This catch was transferred to tug vessel Pelagos III transporting cage HRV.EU-010 on June 30, 2019.

ROP observer: **RAFAEL MULET SOLIVELLAS # 561**

**PSFV Tacoma ATETOHRV00164** - date of catch was June 30, 2019 with 1150 specimens / 11500 kg, ebcd number HR19900197. This catch was transferred to tug vessel Pelagos III transporting cage HRV.EU-010 on 30.06.2019.

ROP observer: **GAL-LA SERRANO CANALS # 571**

**PSFV Pelagos II ATEU0HRV00017** - date of catch was July 01, 2019 with 337 specimens/ 6700 kg, ebcd number HR19900204. This catch was transferred to tug vessel Pelagos III transporting cage HRV.EU-010 on July 02, 2019, with the mortality of 5 individuals recorded, so remaining quantity of fish was 332 specimens/ 6580 kg.

ROP observer: **SUSANA CALLES GARCIA # 557**

**PSFV Pelagos II ATEU0HRV00017** - date of catch was July 02, 2019 with 165 specimens/ 3160 kg, ebcd number HR19900208. This catch was transferred to tug vessel Pelagos III transporting cage HRV.EU-010 on 02.07.2019.

ROP observer: **SUSANA CALLES GARCIA # 557**

**PSFV Tuljan Dva ATEU0HRV00155** - date of catch was July 02, 2019 with 64 specimens/ 9010,251 kg, ebcd number HR19900210. This catch was transferred to tug vessel Pelagos III transporting cage HRV.EU-010 on July 02, 2019, with the 1 dead fish, so remaining quantity was 463 specimens / 8986,251 kg.

ROP observer: **REBECA VAQUERIZO VELASCO # 487**

The caging operation took place on July 06, 2019 resulted in the total quantity of 2980 specimens and 38926,25 kg, average weight 13,062 kg. Fish were placed into a farming cage number HRV-EU.005 (Group ebcd is HR19900216).

ROP observer: **RAMON ROMERO NAVARRO # 560**

**Report obtained by SC System on size structure of the tuna prior to distribution in cage # 5:**

#### **AQ1 Systems AM100 report**

##### **General Information**

Species: *T. thynnus* ICCAT nova2019

Site: Balabtra

Cage: # 5

Recording date: 6/07/2019 10:45:41 AM

Comments:

Model formula weight =  $3.508 * (10^{-5}) * (FL * 100)^{2.883091788}$  ( $0.1 \leq FL < 2$ )

Recording folder: C:\AM100\20190706\_Pelagosnetfarma 06072019 cg 10 u cg 5

Project filename: analiza.AQAM

##### **Sizing statistical Information**

Mean weight (kg): 13.746

Minimum weight (kg): 8.085  
Maximum weight (kg): 44.802  
Weight S.D. (kg): 5.841  
Weight CV (%): 42.496  
Sample size (weight): 764  
Samples out of formula range: 0

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Mean FL (m) : 0.856  
Minimum FL (m) : 0.724  
Maximum FL (m) : 1.312  
FL S.D. (m) : 0.114  
FL CV (%): 13.358  
Sample size (FL): 764



**Figure 4.** Position of two experiment cages #1 and #5 within Pelagos-net farm near Balabro island

#### **TAGGING ACTIVITY:**

#### **SAMPLING ACTIVITY FOR EXTERNAL TAGGING TRIAL ON JULY 12th**

The tagging team consisted of three scientist, two Pelagos net farm divers, assistant of coordinator farm worker, and a fishery expert supervising fishing operation in Pelagos-net farm. For this activity „Sestrica” was used as a working vessel.

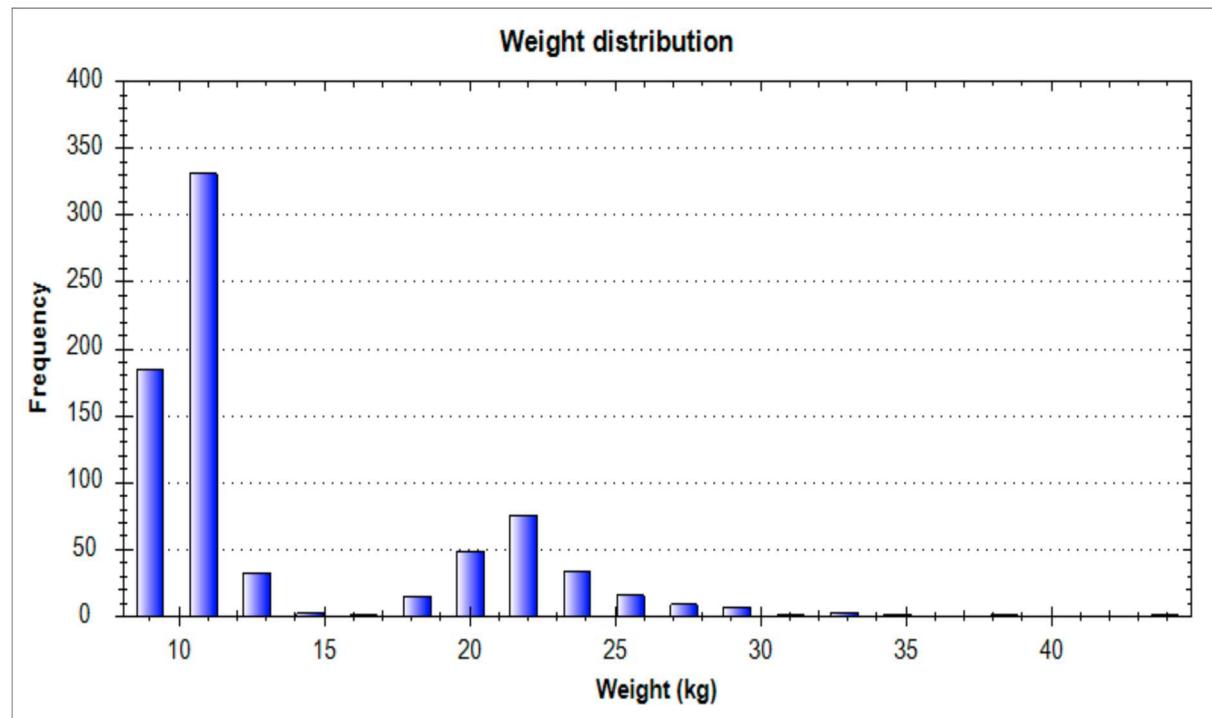
The sampling was made in cage #5 that was stocked with 1688 specimens (group EBCD HR19900216). In total, 12 bluefin tuna juveniles were tagged with external clips combined with the cutting of the second dorsal fin. During the tagging process there was mortality of 3 fishes. In the first week following tagging 2 fish died, both were examined and processed by the scientists involved.

**PIT TAGGING ACTIVITY:** July 26th, 27th, 29th, 30th and 31st

The tagging team consisted of three scientist, two Pelagos net farm divers, assistant of coordinator, farm worker, and a fishery expert. Vessel to support operation was „Sestrica”.

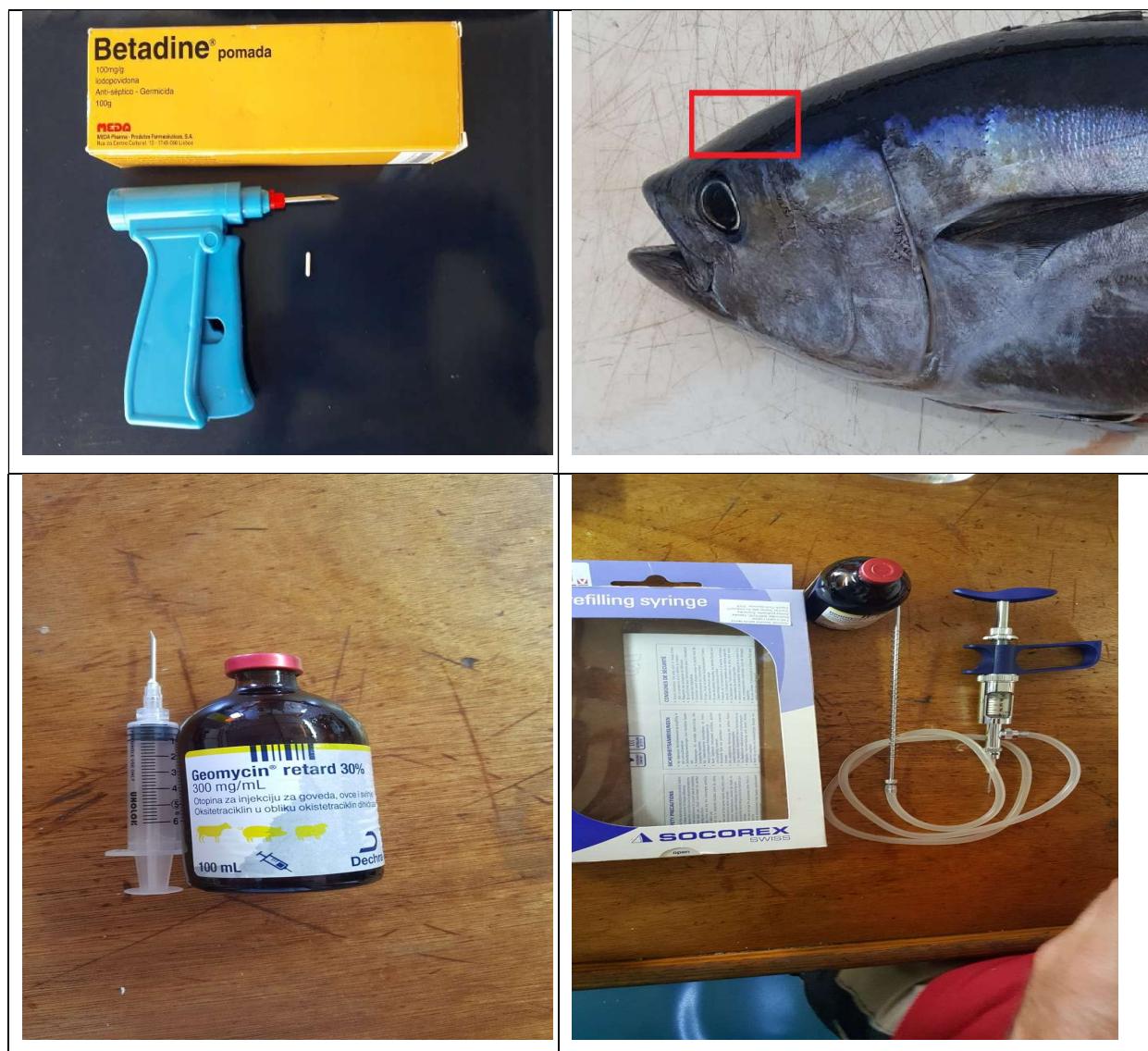
During five days, total of 206 bluefin tuna juveniles were marked by inserting PIT tag into a muscle on the top of the head. Age of tagged fish were estimated 2 years (approx. 160 ind.) and 3+ years (>40 individuals). Tagged fish were almost equally distributed into two experimental cages, one of this containing 1506 fish (cage #1, group EBCD HR19900165-G-LT01) and 1688 (cage #5, group EBCD HR19900216) respectively.

The initial size structure of the fish in the holding cage obtained by SCS is presented in Figure 5.



**Figure 5.** Weight distribution of fish estimated by Stereo camera video system and converted from fork length (FL cm) to round weight (RWT kg).

All tagged fish were measured in FL (nearest cm) and weight (RWT in kg). The PIT tag was introduced into the muscle at the top of the head, and Oxytetracycline was administered at the prescribed dose (Figure 6a-6d). The time needed to complete tagging operation is recorded (Table 1, Table 2).



**Figure 6a, 6b, 6c, and 6d.** Place to insert the PIT tag by an applicator, and iodine based antiseptic - geramycin cream to prevent infection (upper). Oxytetracycline applied to each tagged fish in a prescribed dose (down)

After the tagging was done, the divers reported that tagged fish separated itself from the respective school and seemed quite dizzy. Due to this information, we expected higher mortality. Finally, there was only total of 2 mortality in the cage #5, which were examined and processed by the scientists engaged.

Eventually, ten days after tagging, on Jul 31st, the isolated tagged fish joined the rest of the school showing an usual behaviour.





**Figure 7a, 7b, 7c, and 7d.** Aluminum rigid cradle; rigid stainless steel platform fixed inside the cage frame. Procedure of fishing, tagging, measuring in length (FL cm) and round weight (RWT kg), and releasing back into a rearing cage

The fish has been monitored on the daily basis and so far, there is no sign of any deviation or irregularity in the behaviour or condition of tagged fish.

**Table 1.** The time (in seconds) needed to complete tagging operation with external clips attached to anal fin and combined with cutting of the second dorsal fin on July 12th. Tag number (TAGG); round weight (WT kg), straight fork length (SFL cm).

#5	TAGG	SFL (cm)	WT (kg)	TIME (sec)
1	199	78	7.5	80
2	198	82	8.5	90
3	197	72	7.3	75
4	195	80	8.5	95
5	194	77	8	42
6	193	82	9.6	55
7	192	75	9	60
8	191	83	9.5	56
9	188	81	10.5	58
10	177	81	8.5	65

**Table 2.** The time needed (in seconds) to complete tagging operation with PIT tag, oxytetracycline application, fork length (cm) and weight (kg) measurement, from July 26 to July 31 2019. Tag number (No); round weight (WT kg), straight fork length (SFL cm).

TAGGING ACTIVITY JUL 26th 2019				
#5				
No.	SFL (cm)	WT (kg)	TAGG	TIME (sec)
1	105	18.5	65705	?
2	86	9.65	60138	?
3	86	10.1	65582	?
4	83	8.6	63733	?
5	83	8.1	63626	?
6	106	13.2	63131	?
7	82	8.05	62099	?
8	87	10.1	66997	?
9	107	17.5	64929	?
10	107	18	62093	?
11	85	9.5	61236	?
12	83	8	63713	?
13	81	8.1	60930	?
14	87	9.5	59258	?
15	83	8	61370	?
16	84	10.5	66456	?
17	105	14	64404	54
18	106	16.1	65207	35
19	81	9.7	62585	41
20	82	8.1	65988	38
21	86	9.15	67606	38
22	103	16.5	61116	41
23	81	8.6	59508	22
24	82	8.45	65906	20
25	104	15	64982	?
26	83	9.55	61796	47
27	81	8	63275	34
28	83	9.55	59591	29
29	84	9	63657	39
30	78	8	64654	33
31	81	9.1	67235	34
32	82	8.1	59574	34
33	107	17.5	66065	51
34	121	25.2	60903	49
35	104	19	60862	56

36	105	19.15	61782	52
<b>TAGGING ACTIVITY ON JULY 27th 2019</b>				
#5				
No.	SFL (cm)	WT (kg)	TAGG	TIME (sec)
37	103	17.6	61541	41
38	84	10.15	63936	25
39	83	8.5	65655	36
40	104	17.3	67444	31
41	79	7.6	62732	29
42	81	8.3	59072	34
43	84	9	61371	50
44	97	14.8	64113	52
45	83	8.65	62139	34
46	80	8.1	60911	35
47	81	9	66207	35
48	80	8.15	63991	27
49	102	16	64884	46
50	81	9.2	65926	37
51	103	17.3	66100	52
52	81	9.5	59023	29
53	103	17.5	62119	43
54	102	17.3	65287	43
55	80	8.2	68366	36
56	104	18.1	61414	41
57	104	18.4	61535	29
58	100	15.8	60989	38
59	82	8.5	59794	22
60	103	18.2	63174	32
61	78	7.5	61375	49
62	81	8.4	63346	21
63	81	8.3	61920	
64	84	9.65	63702	21
65	102	17.3	62104	39
66	105	20.3	61935	31
67	88	9.5	64127	35
68	101	17.45	62713	39
69	102	19.4	61002	33
70	101	15.4	59773	28
71	101	17.5	62761	33
72	95	15.1	65819	48
73	78	7.5	67030	29
74	106	19.5	65029	36
75	104	17.3	64199	34

76	83	8.3	59861	36
<b>TAGGING ACTIVITY JULY 29TH 2019</b>				
#1				
No.	SFL (cm)	WT (kg)	TAGG	TIME (sec)
77	82	8.1	66954	
78	84	10.1	68495	50
79	79	7.5	64593	28
80	84	9.1	68776	27
81	78	8.1	61160	26
82	80	7.5	64366	28
83	81	8.1	68677	29
84	81	7.5	62665	24
85	81	8	63448	25
86	82	8.2	60015	28
87	80	7.3	65569	23
88	80	8.3	65522	21
89	77	7.2	68372	27
90	78	7.5	68480	28
91	79	8.1	59531	29
92	79	7.6	65023	33
93	80	9.2	68906	28
94	77	7.9	63182	25
95	76	7.6	62876	25
96	98	15.1	67796	34
97	78	7.5	60835	32
98	83	8.3	59807	27
99	79	7.5	66520	43
100	82	8.1	66798	28
101	79	7.5	67296	32
102	81	9	59334	27
103	81	8.1	64563	32
104	84	9.6	50511	31
105	80	8.45	63918	23
106	79	7.3	68479	23
107	76	7.55	63715	20
108	79	8.25	66231	39
109	80	8.1	61092	23
110	86	10	66555	29
111	83	8.5	66619	26
112	84	10.1	66279	27
113	82	9	63116	24
114	78	8.1	60509	30
115	84	10.25	44794	47

116	98	15.35	65183		35
117	81	9.1	60322		44
118	80	7.55	67081		39
119	78	8.45	63258		24
120	83	8	62181		29
121	81	7.35	62070		25

**TAGGING ACTIVITY JUL 30th 2019**

#1					
No.	SFL (cm)	WT (kg)	TAGG	TIME (sec)	
122	76	7.35	62187		24
123	75	7.15	65547		34
124	80	9.15	68718		23
125	80	9	68377		23
126	79	8.15	63544		29
127	81	7.55	63325		59
128	83	9.95	66091		31
129	83	9	63978		22
130	104	10.15	63598		31
131	100	15.45	68093		34
132	81	9.1	62413		27
133	78	8.15	63065		24
134	105	18.35	66593		50
135	83	10	64750		27
136	78	7.5	59105		26
137	79	8.15	66635		32
138	105	16.65	68371		39
139	81	9.45	68747		25
140	83	8.4	66146		26
141	78	7.4	60995		24
142	76	7.45	61628		27
143	80	9.1	63641		22
144	82	9.25	65410		25
145	77	7.65	62900		24
146	82	10	60873		26
147	81	9.4	65228		?
148	84	9.5	65833		?
149	81	9.65	62685		?
150	78	8.1	61096		?
151	81	9.1	60090		?
152	82	9.3	63256		?
153	82	9.5	65784		?
154	80	9.1	63384		19
155	79	8.1	65485		23

156	79	7.6	66520	24
157	79	7.5	66253	23
158	80	8.1	63835	22
159	85	10.1	65382	27
160	81	9.1	59317	24
161	80	8	64562	24
162	82	9.1	68110	27
163	81	9.25	61063	24
164	80	10.5	60893	17
165	81	9.45	62461	24
166	78	7.45	61143	22

**TAGGING ACTIVITY JULY 31st 2019**

#1				
No.	SFL (cm)	WT (kg)	TAGG	TIME (sec)
167	83	9.1	59153	20
168	88	10.1	60038	25
169	84	9.6	66117	31
170	82	8.55	65646	30
171	105	19.55	64409	51
172	88	12.1	60313	32
173	88	10.1	61385	?
174	78	8.1	62647	19
175	82	9.55	63038	23
176	75	7.55	64959	22
177	81	9.45	60945	24
178	83	8.55	64244	22
179	78	7.6	59692	24
180	75	7.8	61473	22
181	75	7.7	67772	45
182	78	7.6	64108	28
183	84	9.1	61454	36
184	82	9.5	60727	31
185	104	18.25	65088	32
186	78	7.7	60147	23
187	83	8.1	61362	22
188	79	7.2	66226	23
189	81	7.7	66442	22
190	78	7.6	63223	24
191	79	7.55	62337	37
192	81	8.8	64964	24
193	80	8.1	66970	21
194	83	8.6	66251	23
195	83	9.05	66074	30

196	78	7.6	62197	25
197	78	8.1	67407	37
198	81	9.1	62117	25
199	80	7.6	66220	21
200	79	8	68735	21
201	82	9	65530	27
202	82	9.55	66249	22
203	83	9.6	62747	21
204	75	7.65	65945	20
205	78	8.1	67733	?
206	83	9.1	67032	24

## **Recording cages 1 and 5 with AQ-1 AM 100 system**

Place: Island Balabara

Fish were recorded from FV "Sestrica" during feeding with AQ-1 stereoscopic camera system.



**Figure 8. AQ-1 AM 100 system**

## **How the AQ-1 stereoscopic camera system was used**

The SC system was lowered into rearing cages. The camera mounting system included a 4.5 m long rectangular aluminium rod that was suspended into the water at a depth of 1,5 to 4,5 m, depending on light intensity and fish behaviour. Visibility during recording was estimated from 20 to 30 m. Pursuant to paragraph 83 of the ICCAT Recommendation 14-04, the SC system was deployed for size data covering a 20% sample of fish caged. It was assumed that 30 minutes of recording would be enough to attract most fish to move around the underwater camera, and to obtain a representative sample of the caged BFT, and three replicates were conducted at each cage. This implies that each fish from the population in the grow-out cages has an equal probability of being included in the sample. Only readable images from the 30-minute recordings were used to measure fork length. To stimulate fish to pass through the camera's field of vision, bite was distributed over the surface of the cages. BFT in the grow-out cage did not appear to be disturbed by the presence of the camera. Fish regularly approached the camera, though only those fish at a distance of greater than 3 m from the camera were measured. When the margin of error between doubled cameras exceed 3.5%, these fish were not registered.

Recorded images were stored directly onto a computer hard drive. To avoid errors, filmed BFT were only measured when the bodies were straight or near straight. Conversion of FL obtained by underwater SC to round weight (RW) was made by means of the L-W relationship integrated into the camera software, as:

$$RW = (2.3139 \times 10^{-5}) * FL^{2.9840}$$

### **OXYGEN MEASURING**

Besides the temperature, oxygen saturation is measured daily by Oxygen Handy polaris.



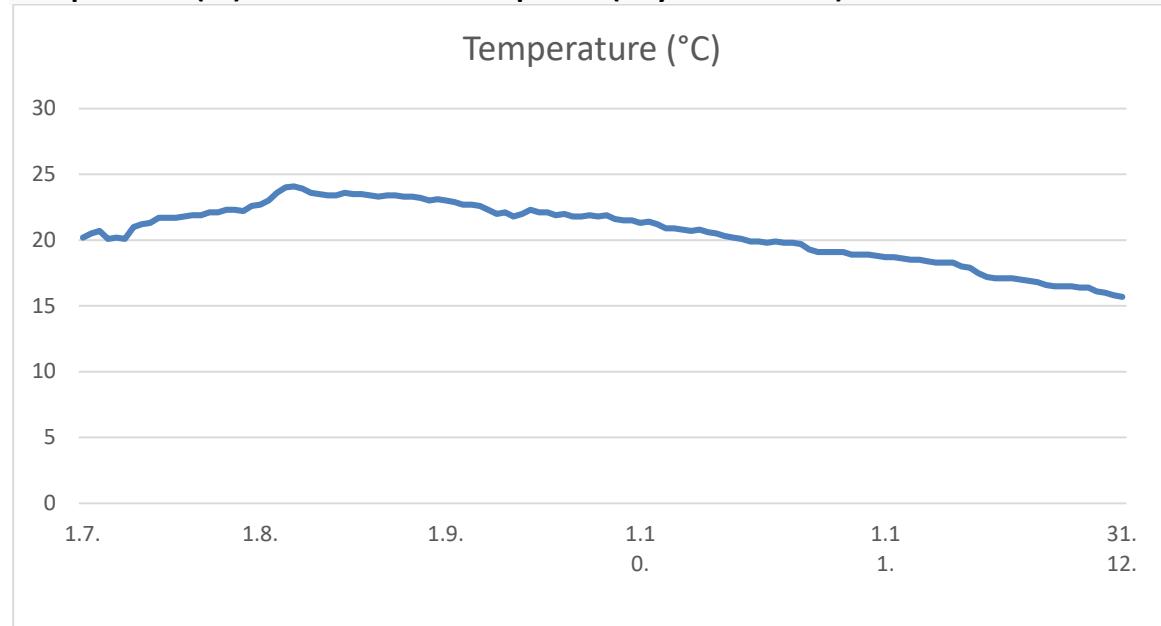
**Figure 9. OxyGuard Handy Polaris**

The Handy Polaris hand-held meter makes it easy to measure dissolved oxygen and temperature. The flat foil pushbuttons are easy to operate and the instrument is always ready to use, by pressing “on” button and measure. Dissolved oxygen values are shown both in mg/l (ppm) and % saturation – you can choose which parameter is shown in large figures. Measurements are compensated for changes in barometric pressure.

Response time: 90% of end value in less than 20 seconds in water.

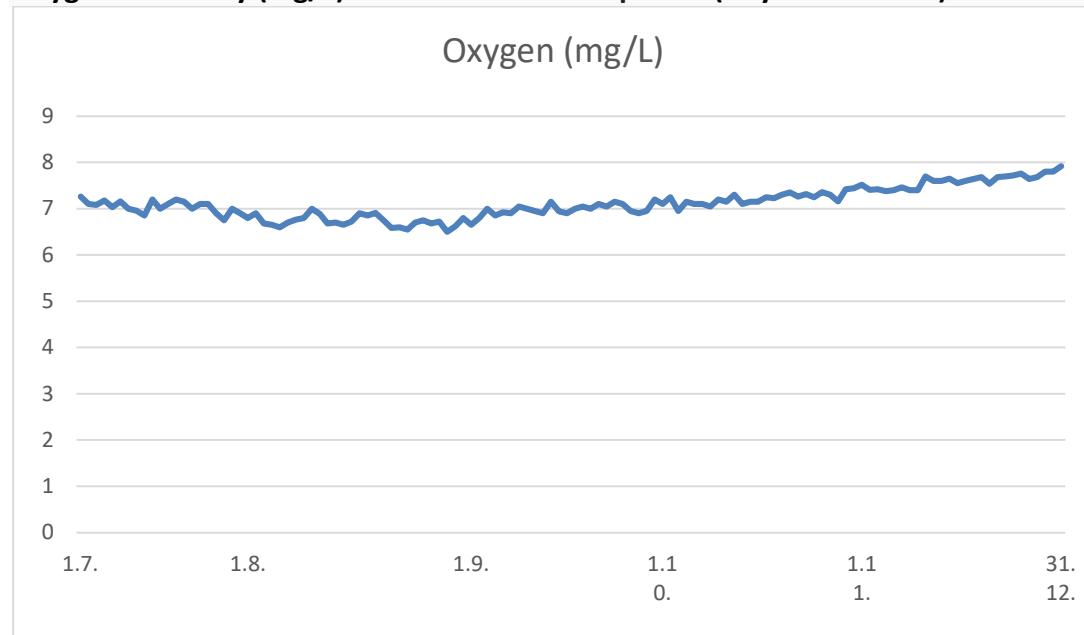
## **TEMPERATURE AND OXYGEN MEASURES SHOWN IN CHARTS**

**Temperature (°C) over observed time period (July 1 to Dec. 31)**



**Figure 10. Sea temperature in observed period**

**Oxygen solubility (mg/L) over observed time period (July 1 to Dec. 31)**



**Figure 11. Oxygen saturation in observed period**

**TEMPERATURE AND OXYGEN MEASURES SHOWN IN TABLES**

Cage #1	DATE	TEMP/OXYG.	DATE	TEMP/OXYG.	DATE	TEMP/OXYG.
	22.7.2019	21,7°C/7,20	1.8.2019	22,1°C/7,10	1.9.2019	/
	23.7.2019	21,7°C/7,00	2.8.2019	22,1°C/7,10	2.9.2019	23,3°C/6,75
	24.7.2019	/	3.8.2019	22,3°C/6,90	3.9.2019	23,3°C/6,58
	25.7.2019	/	4.8.2019	/	4.9.2019	23,2°C/6,60
	26.7.2019	21,7°C/7,10	5.8.2019	/	5.9.2019	23°C/6,55
	27.7.2019	/	6.8.2019	22,3°C/6,75	6.9.2019	23,1°C/6,70
	28.7.2019	/	7.8.2019	22,2°C/7,0	7.9.2019	23°C/6,75
	29.7.2019	21,8°C/7,20	8.8.2019	22,6°C/6,9	8.9.2019	/
	30.7.2019	21,9°C/7,15	9.8.2019	22,7°C/6,80	9.9.2019	22,9°C/6,68
	31.7.2019	21,9°C/7,00	10.8.2019	23°C/6,90	10.9.2019	22,7°C/6,72
		11.8.2019		/	11.9.2019	22,7°C/6,50
		12.8.2019		23,6°C/6,68	12.9.2019	22,6°C/6,62
		13.8.2019		24°C/6,65	13.9.2019	22,3°C/6,80
		14.8.2019		24,1°C/6,60	14.9.2019	/
		15.8.2019		/	15.9.2019	/
		16.8.2019		23,9°C/6,70	16.9.2019	/
		17.8.2019		/	17.9.2019	22°C/6,65
		18.8.2019		/	18.9.2019	22,1°C/6,80
		19.8.2019		23,6°C/6,76	19.9.2019	21,8°C/7,0
		20.8.2019		23,5°C/6,80	20.9.2019	22°C/6,85
		21.8.2019		23,4°C/7,0	21.9.2019	22,3°C /6, 92
		22.8.2019		23,4°C/6,89	22.9.2019	/
		23.8.2019		23,6°C/6,68	23.9.2019	22,1°C/ 6,90
		24.8.2019		23,5°C/6,70	24.9.2019	22,1°C/ 7,05
		25.8.2019		/	25.9.2019	21,9°C/ 7,00
		26.8.2019		23,5°C/6,65	26.9.2019	22,0°C/ 6,95
		27.8.2019		23,4°C/6,72	27.9.2019	21,8°C/ 6,90

		28.8.2019	23,3°C/6,90	28.9.2019	/
		29.8.2019	23,4°C/6,85	29.9.2019	/
		30.8.2019	/	30.9.2019	21,8°C/ 7.15
		31.8.2019	23,4°C/6,91		

Cage #1					
DATE	TEMP/OXYG.	DATE	TEMP/OXYG.	DATE	TEMP/OXYG.
1.10.2019	21,9°C/6,94	1.11.2019	/	1.12.2019	/
2.10.2019	21,8°C/6,90	2.11.2019	19,3°C/7,25	2.12.2019	/
3.10.2019	/	3.11.2019	/	3.12.2019	17,5°C/7,70
4.10.2019	21,9°C/7,00	4.11.2019	/	4.12.2019	17,2°C/7,60
5.10.2019	21,6°C/7,05	5.11.2019	/	5.12.2019	/
6.10.2019	/	6.11.2019	19,1°C/7,30	6.12.2019	17,1°C/7,60
7.10.2019	21,5°C/7,00	7.11.2019	19,1°C/7,35	7.12.2019	17,1°C/7,65
8.10.2019	/	8.11.2019	19,1°C/7,26	8.12.2019	/
9.10.2019	21,5°C/7,10	9.11.2019	/	9.12.2019	17,1°C/7,55
10.10.2019	21,3°C/7,05	10.11.2019	/	10.12.2019	17°C/7,60
11.10.2019	21,4°C/7,15	11.11.2019	18,9°C/7,32	11.12.2019	16,9°C/7,64
12.10.2019	21,2°C/7,10	12.11.2019	/	12.12.2019	16,8°C/7,68
13.10.2019	/	13.11.2019	18,9°C/7,25	13.12.2019	/
14.10.2019	20,9°C/6,95	14.11.2019	18,9°C/7,36	14.12.2019	16,6°C/7,54
15.10.2019	20,9°C/6,90	15.11.2019	/	15.12.2019	/
16.10.2019	20,8°C/6,95	16.11.2019	18,8°C/7,30	16.12.2019	16,5°C/7,68
17.10.2019	20,7°C/7,20	17.11.2019	/	17.12.2019	16,5°C/7,70
18.10.2019	20,8°C/7,10	18.11.2019	18,7°C/7,16	18.12.2019	16,5°C/7,72
19.10.2019	20,6°C/7,25	19.11.2019	18,7°C/7,42	19.12.2019	16,4°C/7,76
20.10.2019	/	20.11.2019	18,6°C/7,44	20.12.2019	16,4°C/7,64
21.10.2019	20,5°C/6,95	21.11.2019	18,5°C/7,52	21.12.2019	/
22.10.2019	20,3°C/7,15	22.11.2019	18,5°C/7,41	22.12.2019	/
23.10.2019	20,2°C/7,10	23.11.2019	18,4°C/7,42	23.12.2019	16,1°C/7,68
24.10.2019	20,1°C/7,10	24.11.2019	/	24.12.2019	16°C/7,80
25.10.2019	19,9°C/7,05	25.11.2019	18,3°C/7,38	25.12.2019	/
26.10.2019	19,9°C/7,20	26.11.2019	18,3°C/7,40	26.12.2019	/
27.10.2019	19,8°C/7,15	27.11.2019	18,3°C/7,46	27.12.2019	15,8°C/7,80
28.10.2019	19,9°C/7,30	28.11.2019	/	28.12.2019	15,7°C/7,92
29.10.2019	19,8°C/7,10	29.11.2019	18°C/7,40	29.12.2019	/

30.10.2019	19,8°C/7,15	30.11.2019	17,9°C/7,40	30.12.2019	/
31.10.2019	19,7°C/7,15			31.12.2019	/

Cage #5	DATE	TEMP/OXYG.	DATE	TEMP/OXYG.	DATE	TEMP/OXYG.
	6.7.2019	20,2°C/7,26	1.8.2019	22,1°C/7,10	1.9.2019	/
	7.7.2019	20,5°C/7,10	2.8.2019	22,1°C/7,10	2.9.2019	23,3°C/6,75
	8.7.2019	20,7°C/7,08	3.8.2019	22,3°C/6,90	3.9.2019	23,3°C/6,58
	9.7.2019	20,1°C/7,18	4.8.2019	/	4.9.2019	23,2°C/6,60
	10.7.2019	/	5.8.2019	/	5.9.2019	23°C/6,55
	11.7.2019	/	6.8.2019	22,3°C/6,75	6.9.2019	23,1°C/6,70
	12.7.2019	20,2°C/7,03	7.8.2019	22,2°C/7,0	7.9.2019	23°C/6,75
	13.7.2019	/	8.8.2019	22,6°C/6,90	8.9.2019	/
	14.7.2019	/	9.8.2019	22,7°C/6,80	9.9.2019	22,9°C/6,68
	15.7.2019	20,1°C/7,16	10.8.2019	23°C/6,90	10.9.2019	22,7°C/6,72
	16.7.2019	21°C/7,00	11.8.2019	/	11.9.2019	22,7°C/6,50
	17.7.2019	21,2°C/6,96	12.8.2019	23,6°C/6,68	12.9.2019	22,6°C/6,62
	18.7.2019	21,3°C/6,85	13.8.2019	24°C/6,65	13.9.2019	22,3°C/6,80
	19.7.2019	/	14.8.2019	24,1°C/6,60	14.9.2019	/
	20.7.2019	/	15.8.2019	/	15.9.2019	/
	21.7.2019	/	16.8.2019	23,9°C/6,70	16.9.2019	/
	22.7.2019	21,7°C/7,20	17.8.2019	/	17.9.2019	22°C/6,65
	23.7.2019	21,7°C/7,00	18.8.2019	/	18.9.2019	22,1°C/6,80
	24.7.2019	/	19.8.2019	23,6°C/6,76	19.9.2019	21,8°C/7,0
	25.7.2019	/	20.8.2019	23,5°C/6,80	20.9.2019	22°C/6,85
	26.7.2019	21,7°C/7,10	21.8.2019	23,4°C/7,0	21.9.2019	22,3°C /6, 92
	27.7.2019	/	22.8.2019	23,4°C/6,89	22.9.2019	/
	28.7.2019	/	23.8.2019	23,6°C/6,68	23.9.2019	22,1°C / 6,90
	29.7.2019	21,8°C/7,20	24.8.2019	23,5°C/6,70	24.9.2019	22,1°C / 7,05
	30.7.2019	21,9°C/7,15	25.8.2019	/	25.9.2019	21,9°C / 7,00

31.7.2019	21,9°C/7,00	26.8.2019	23,5°C/6,65	26.9.2019	22,0°C/ 6,95
		27.8.2019	23,4°C/6,72	27.9.2019	21,8°C/ 6,90
		28.8.2019	23,3°C/6,90	28.9.2019	/
		29.8.2019	23,4°C/6,85	29.9.2019	/
		30.8.2019	/	30.9.2019	21,8°C/ 7.15
		31.8.2019.	23,4°C/6,91		

DATE	TEMP/OXYG.	DATE	TEMP/OXYG.	DATE	TEMP/OXYG.
1.10.2019	21,9°C/6,94	1.11.2019	/	1.12.2019	/
2.10.2019	21,8°C/6,90	2.11.2019	19,3°C/7,25	2.12.2019	/
3.10.2019	/	3.11.2019	/	3.12.2019	17,5°C/7,70
4.10.2019	21,9°C/7,00	4.11.2019	19,1°C/7,23	4.12.2019	17,2°C/7,60
5.10.2019	21,6°C/7,05	5.11.2019	/	5.12.2019	/
6.10.2019	/	6.11.2019	19,1°C/7,30	6.12.2019	17,1°C/7,60
7.10.2019	21,5°C/7,00	7.11.2019	19,1°C/7,35	7.12.2019	17,1°C/7,65
8.10.2019	/	8.11.2019	19,1°C/7,26	8.12.2019	/
9.10.2019	21,5°C/7,10	9.11.2019	/	9.12.2019	17,1°C/7,55
10.10.2019	21,3°C/7,05	10.11.2019	/	10.12.2019	17°C/7,60
11.10.2019	21,4°C/7,15	11.11.2019	18,9°C/7,32	11.12.2019	16,9°C/7,64
12.10.2019	21,2°C/7,10	12.11.2019	/	12.12.2019	16,8°C/7,68
13.10.2019	/	13.11.2019	18,9°C/7,25	13.12.2019	/
14.10.2019	20,9°C/6,95	14.11.2019	18,9°C/7,36	14.12.2019	16,6°C/7,54
15.10.2019	20,9°C/6,90	15.11.2019	/	15.12.2019	/
16.10.2019	20,8°C/6,95	16.11.2019	18,8°C/7,30	16.12.2019	16,5°C/7,68
17.10.2019	20,7°C/7,20	17.11.2019	/	17.12.2019	16,5°C/7,70
18.10.2019	20,8°C/7,10	18.11.2019	18,7°C/7,16	18.12.2019	16,5°C/7,72
19.10.2019	20,6°C/7,25	19.11.2019	18,7°C/7,42	19.12.2019	16,4°C/7,76
20.10.2019	/	20.11.2019	18,6°C/7,44	20.12.2019	16,4°C/7,64
21.10.2019	20,5°C/6,95	21.11.2019	18,5°C/7,52	21.12.2019	/
22.10.2019	20,3°C/7,15	22.11.2019	18,5°C/7,41	22.12.2019	/
23.10.2019	20,2°C/7,10	23.11.2019	18,4°C/7,42	23.12.2019	16,1°C/7,68
24.10.2019	20,1°C/7,10	24.11.2019	/	24.12.2019	16°C/7,80
25.10.2019	19,9°C/7,05	25.11.2019	18,3°C/7,38	25.12.2019	/
26.10.2019	19,9°C/7,20	26.11.2019	18,3°C/7,40	26.12.2019	/
28.10.2019	19,9°C/7,30	28.11.2019	/	28.12.2019	15,7°C/7,92
29.10.2019	19,8°C/7,10	29.11.2019	18°C/7,40	29.12.2019	/
30.10.2019	19,8°C/7,15	30.11.2019	17,9°C/7,40	30.12.2019	/
31.10.2019	19,7°C/7,15			31.12.2019	/

## **FEEDING ACTIVITIES**

The fish are fed six times a week, early in the morning, by means of a small plastic boat filled with fish (herrings, sardines, anchovy, and mackerel). A shovel was used to deliver bite into the cages. Farmed tuna is fed to satiety (*ad libitum*). Thanks to the favourable position, the farm is well oxygenated, protected from winds and other unfavourable weather conditions.

Therefore food given to fish remains in the cage until is consumed. The cages are being controlled daily above and under water. Our divers monitor feeding, and the condition of the fish on daily basis. In this observed period no mortality has been noted.

## **STEREOSCOPIC CAMERA RECORDINGS**

### **Recording cages #1 and #5 with AQ-1 AM 100 system**

Date: 28.08.2019

Place: Island Balabala

Aug 28th 2019. scientific team recorded tuna in cages #1\* and #5 with SC camera. Fish were recorded during feeding from FV "Sestrica" with AQ-1 stereoscopic camera system. They fed the fish with IQF- Scomber for approximately 90 minutes during which time three footages were made (30 minutes) for each cage. These videos are used for monitoring and analysing purposes of fish growth rate. Scientific team made graphical representation of mass and length distribution, as well as excel statistics. The charts are shown below and excel is in separate file.

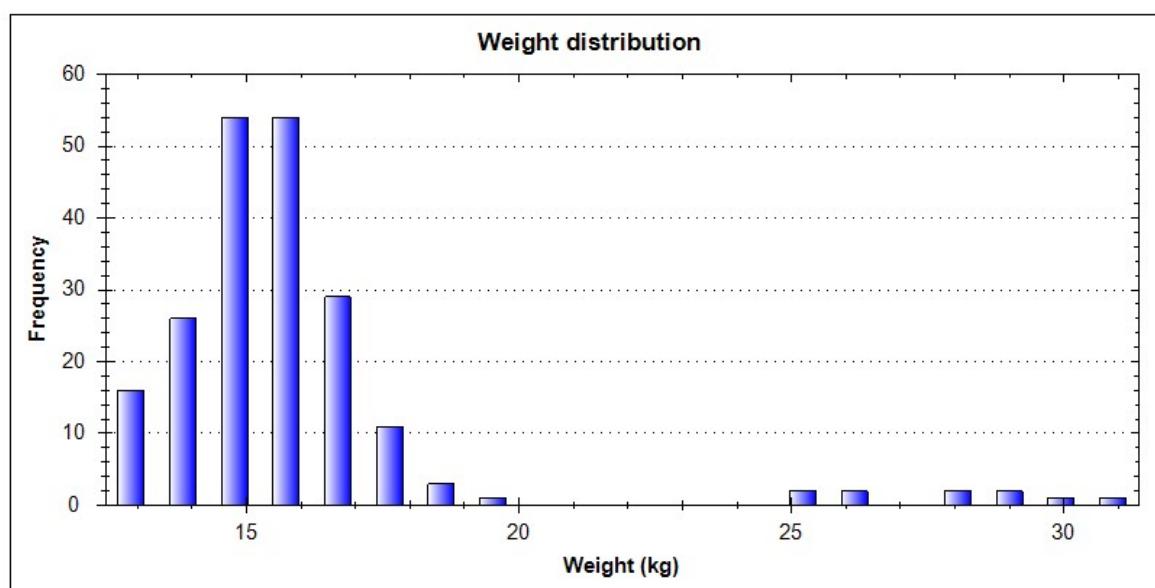
\*Recording of the third footage of the Cage #1 is missing due to the turbidity during the footage.

## **WEIGHT DISTRIBUTION**

**Cage: #1**

**Date: 28.08.2019.**

**First footage**



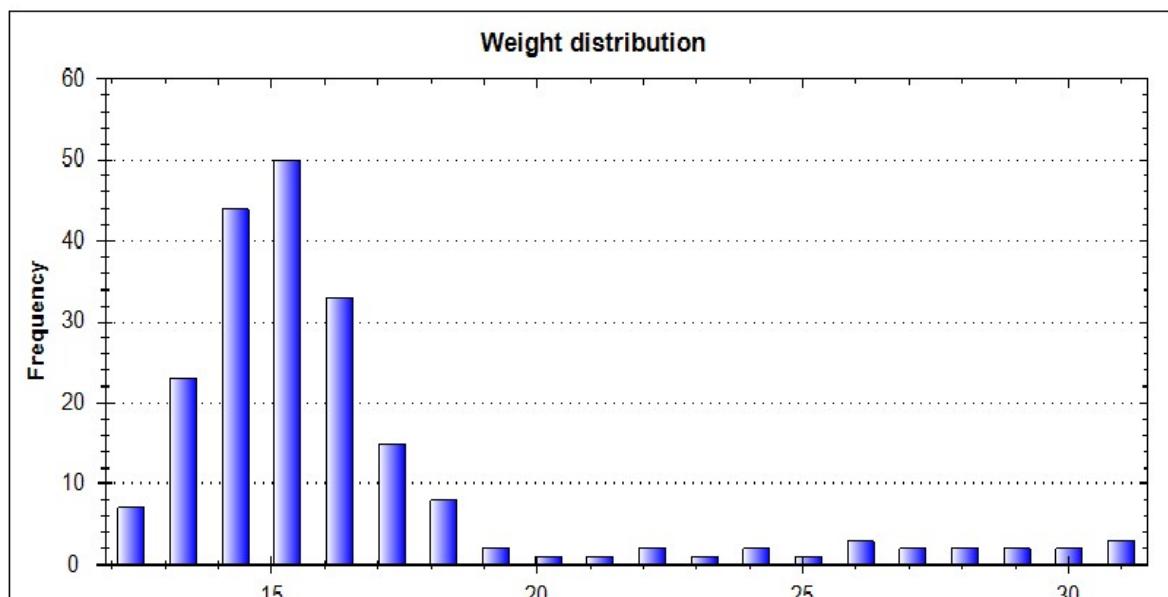
**Figure 12. Weight distribution**

## **WEIGHT DISTRIBUTION**

**Cage: #1**

**Date: 28.08.2019.**

**Second footage**



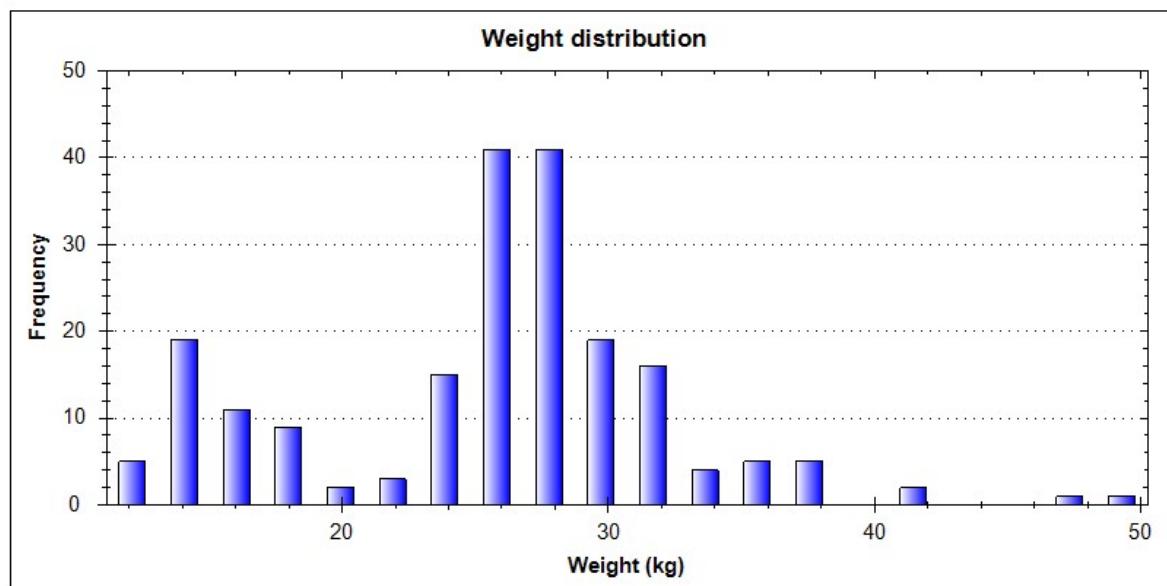
**Figure 13. Weight distribution**

## **WEIGHT DISTRIBUTION**

**Cage: #5**

**Date: 28.08.2019.**

**First footage**



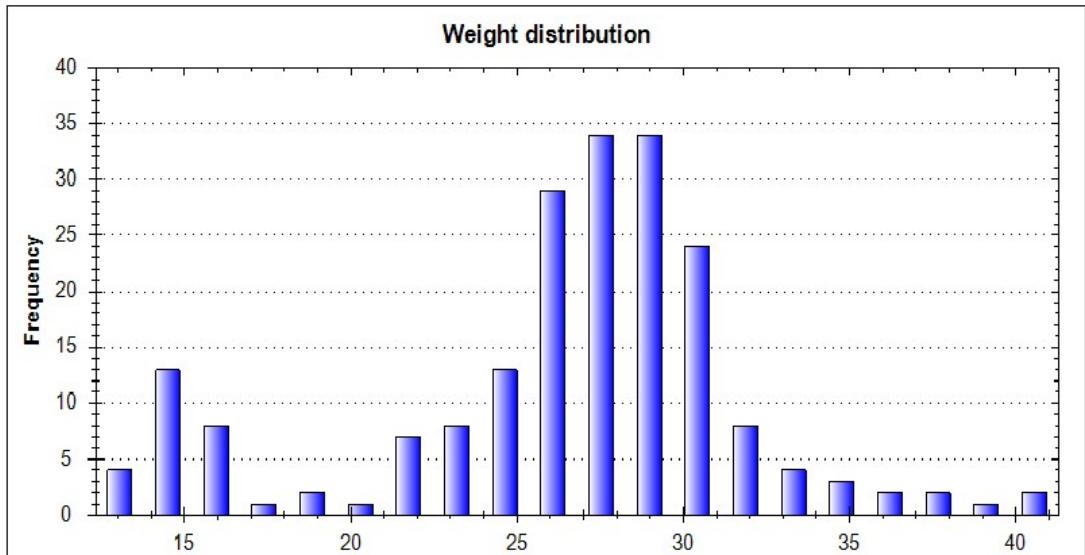
**Figure 14. Weight distribution**

## **WEIGHT DISTRIBUTION**

**Cage: #5**

**Date: 28.08.2019.**

**Second footage**



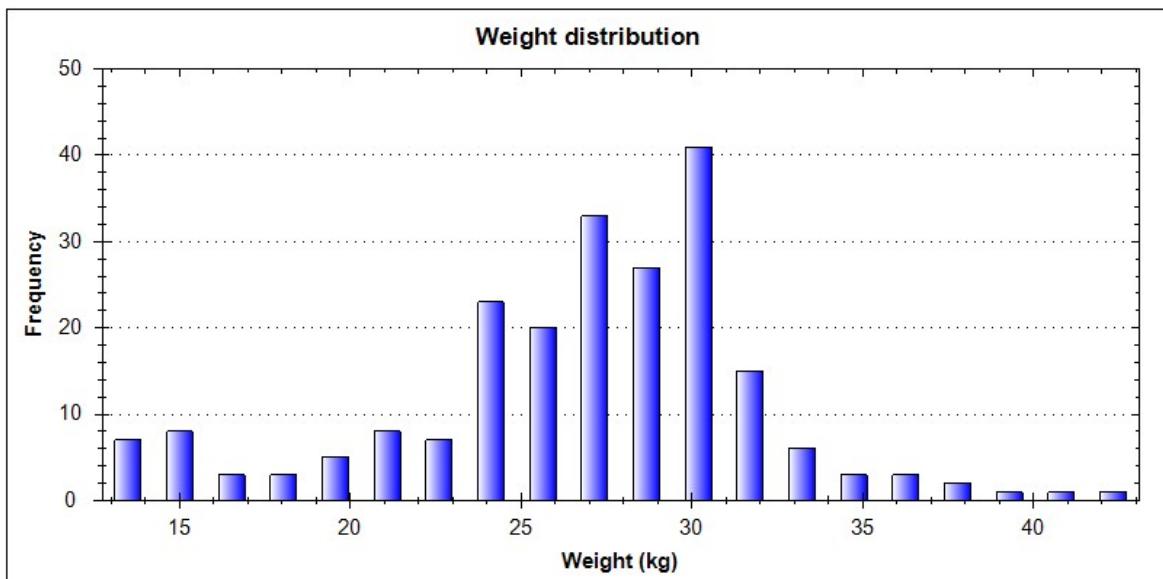
**Figure 15. Weight distribution**

## **WEIGHT DISTRIBUTION**

**Cage: #5**

**Date: 28.08.2019.**

**Third footage**



**Figure 16. Weight distribution**

## **Recording cages #1 and #5 with AQ-1 AM 100 system**

Date: 08.12.2019

Place: Island Balabara

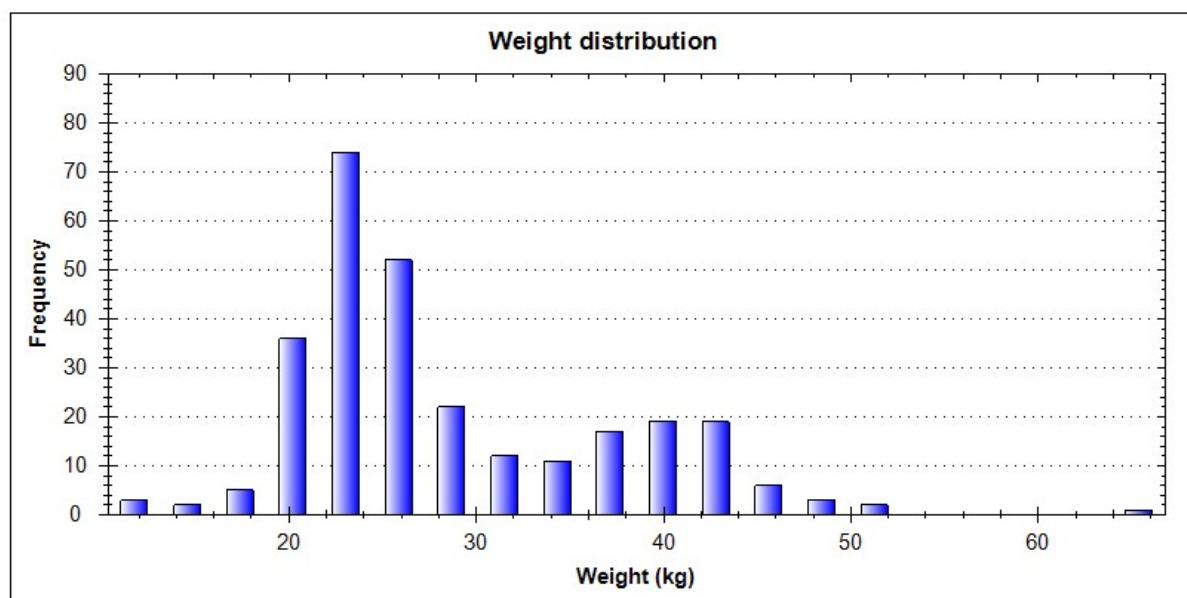
Dec 8th 2019. scientific team recorded tuna in cages #1 and #5 with SC camera. Fish were recorded during feeding from FV "Sestrica" with AQ-1 stereoscopic camera system. They fed the fish with IQF- Scomber for approximately 90 minutes during which time three videos were made for each cage. These videos are used for monitoring and analysing purposes of fish growth rate. Scientific team made graphical representation of mass and length distribution, as well as excel statistics. The charts are shown bellow and excel is in separate file.

### **WEIGHT DISTRIBUTION**

**Cage: #1**

**Date: 08.12.2019.**

**First footage**



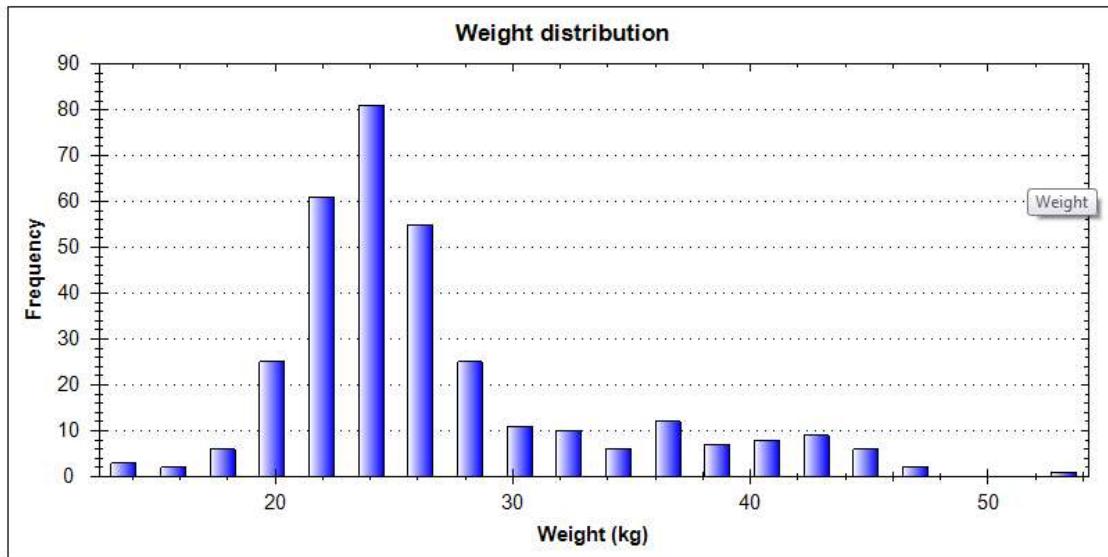
**Figure 17. Weight distribution**

## **WEIGHT DISTRIBUTION**

**Cage: #1**

**Date: 08.12.2019.**

**Second footage**



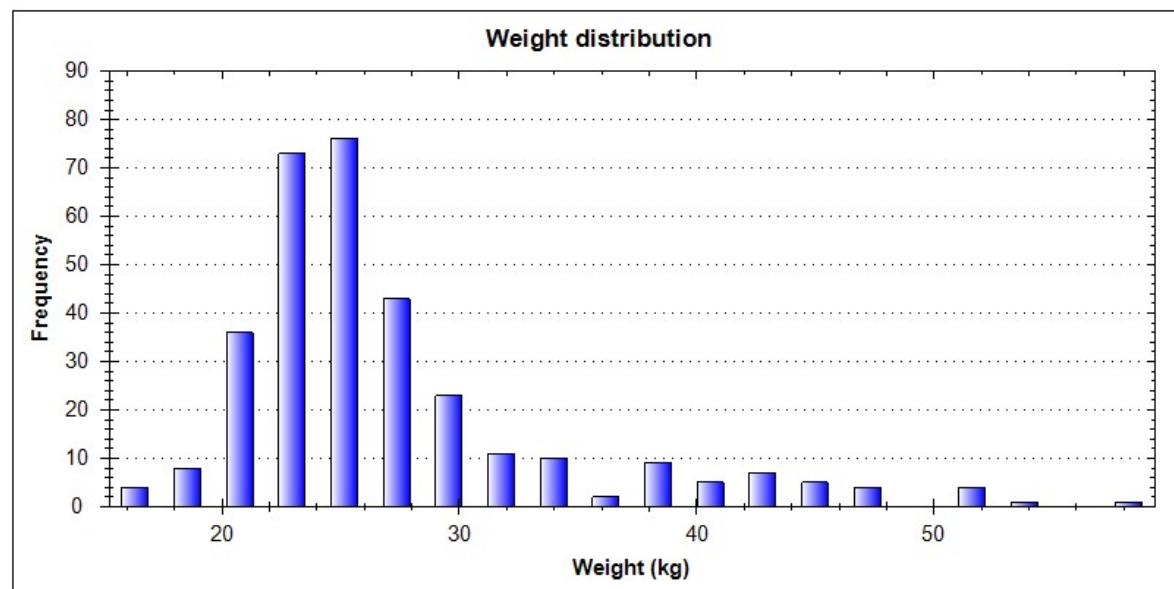
**Figure 18. Weight distribution**

## **WEIGHT DISTRIBUTION**

**Cage: #1**

**Date: 08.12.2019.**

**Third footage**



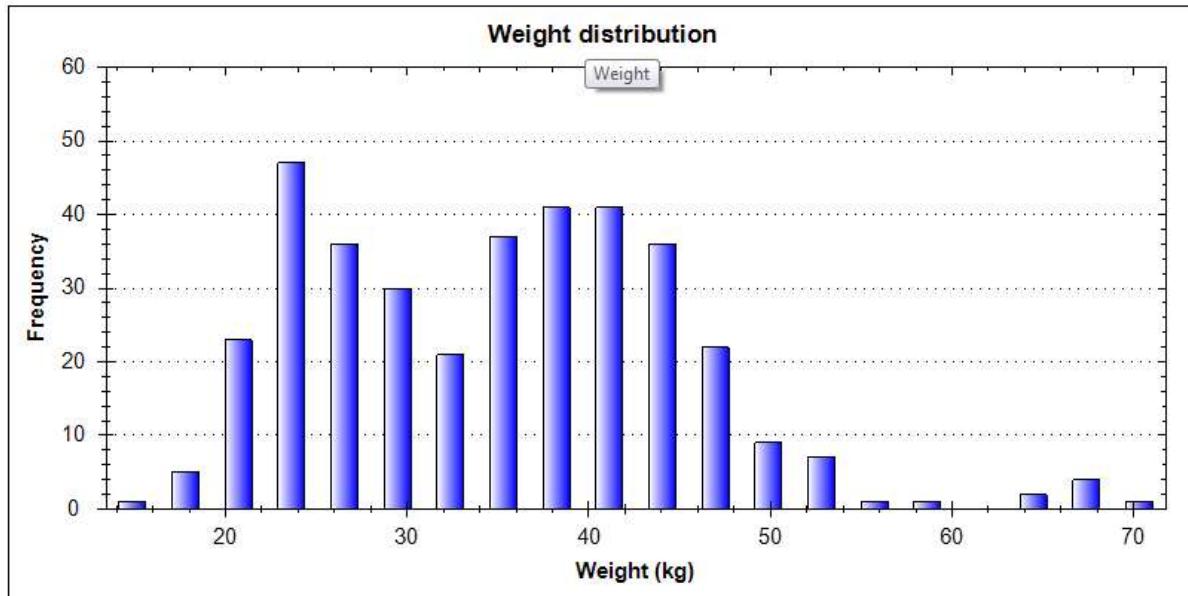
**Figure 19. Weight distribution**

## **WEIGHT DISTRIBUTION**

**Cage: #5**

**Date: 08.12.2019.**

**Frist footage**



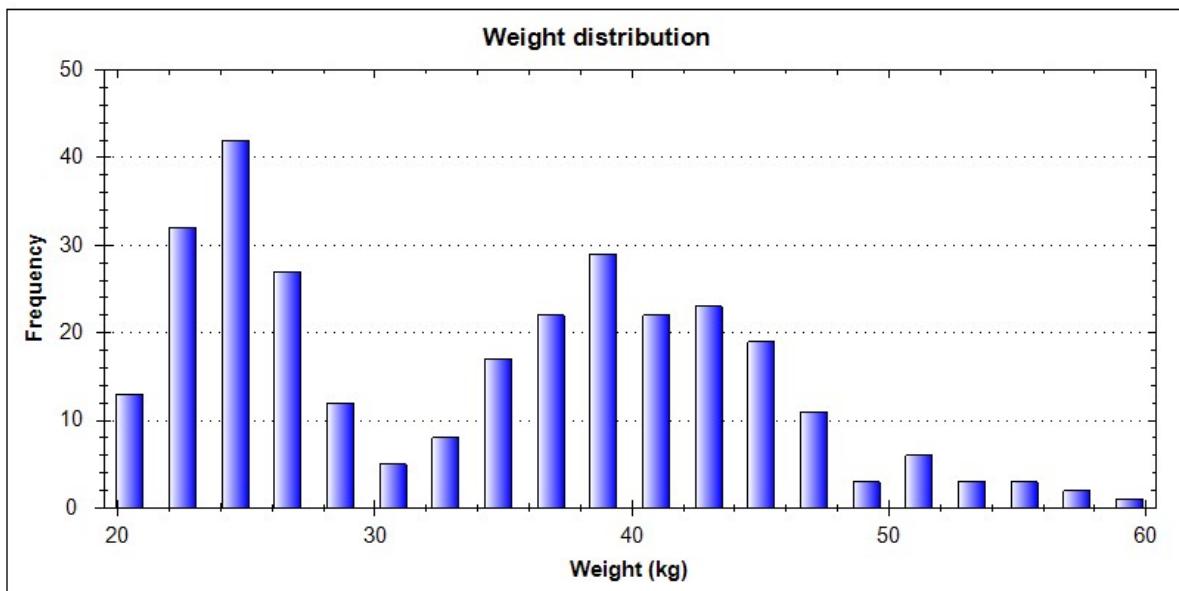
**Figure 20. Weight distribution**

## **WEIGHT DISTRIBUTION**

**Cage: #5**

**Date: 08.12.2019.**

**Second footage**



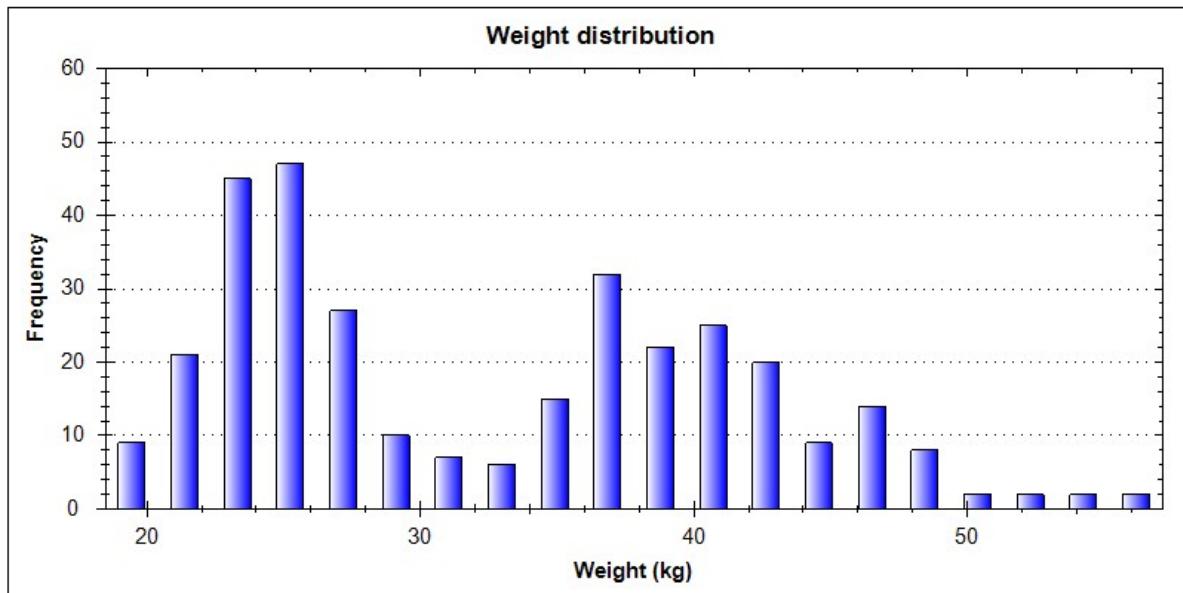
**Figure 21. Weight distribution**

## **WEIGHT DISTRIBUTION**

**Cage: #5**

**Date: 08.12.2019.**

**Third footage**



**Figure 22. Weight distribution**

## **SUMMARY**

The fish is monitored on daily basis and so far there is no sign of any deviation or irregularity in the behavior or condition of tagged fish. Stereoscopic camera video system was used every three months as to monitor growth rate of the fish in the experimental cages. Farming cyclus of the tagged fish is still ongoing and the harvest is expected to take place January or February of 2021. In the meantime we will keep sending reports of the SC camera.

## **ACKNOWLEDGEMENTS**

This work was carried out under the provision of the ICCAT Atlantic Wide Research Programme for Bluefin Tuna (GBYP), funded by the European Union, by several ICCAT CPCs, the ICCAT Secretariat and by other entities (see: <https://www.iccat.int/GBYP/en/Overview.asp>). The contents of this paper do not necessarily reflect the point of view of ICCAT or of the other funders, which have no responsibility about them, neither do they necessarily reflect the views of the funders and in no ways anticipate the Commission's future policy in this area.