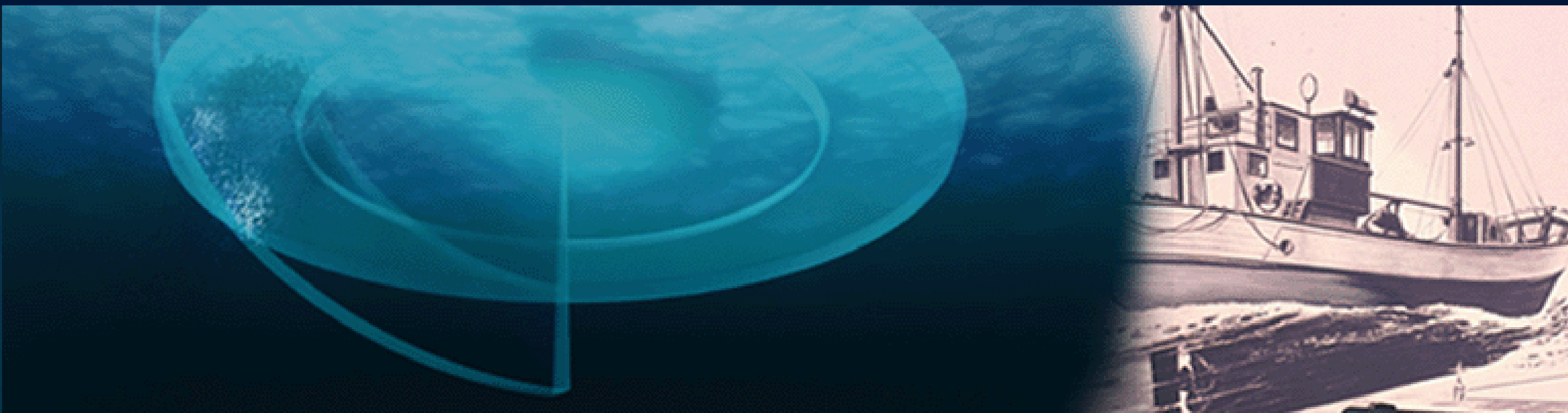




Improving energy efficiency and seabed impact in deep-sea shrimp trawl fishery

09/06/2023

Fishing gear resistance distribution

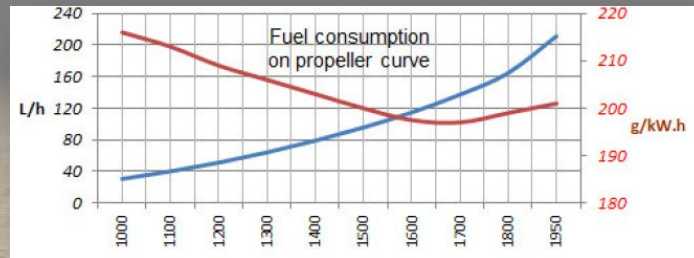


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The vessel's must be able to tow the whole system at desired trawl speed, using **80%** of its power as maximum

Fuel consumption is exponential against power use

(Graph extracted from Baudouin 12M26.2 engine datasheet)



Net
60/70%

Warps
10/15%

Trawl doors
10/20%

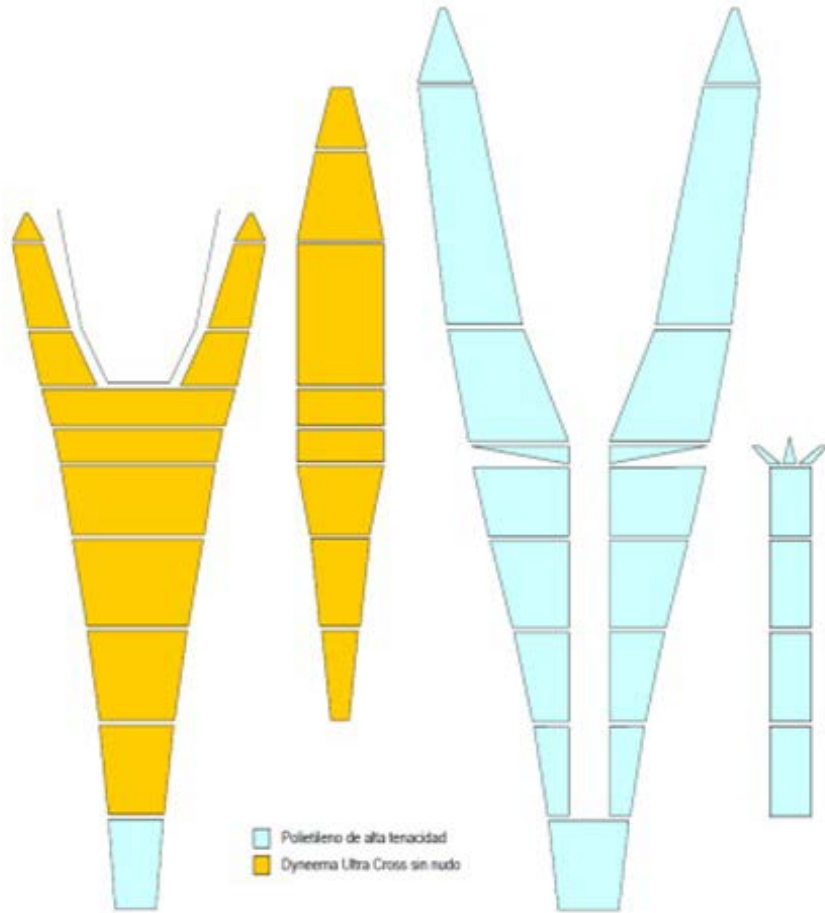
Ropes
5/10%

The net and the trawl doors are the potential areas to reduce resistance

Ecosistemic Trawl Gear



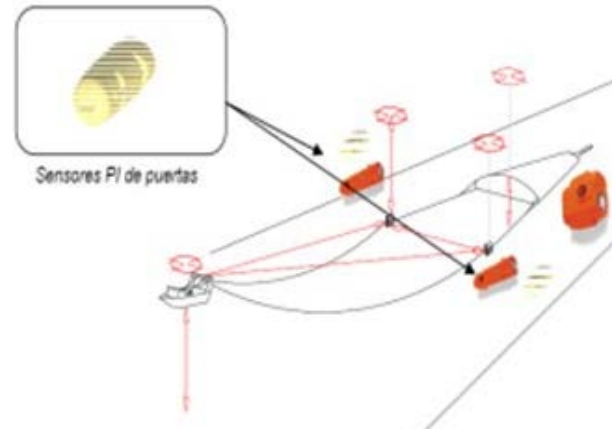
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New slight fibers



Monitoring system



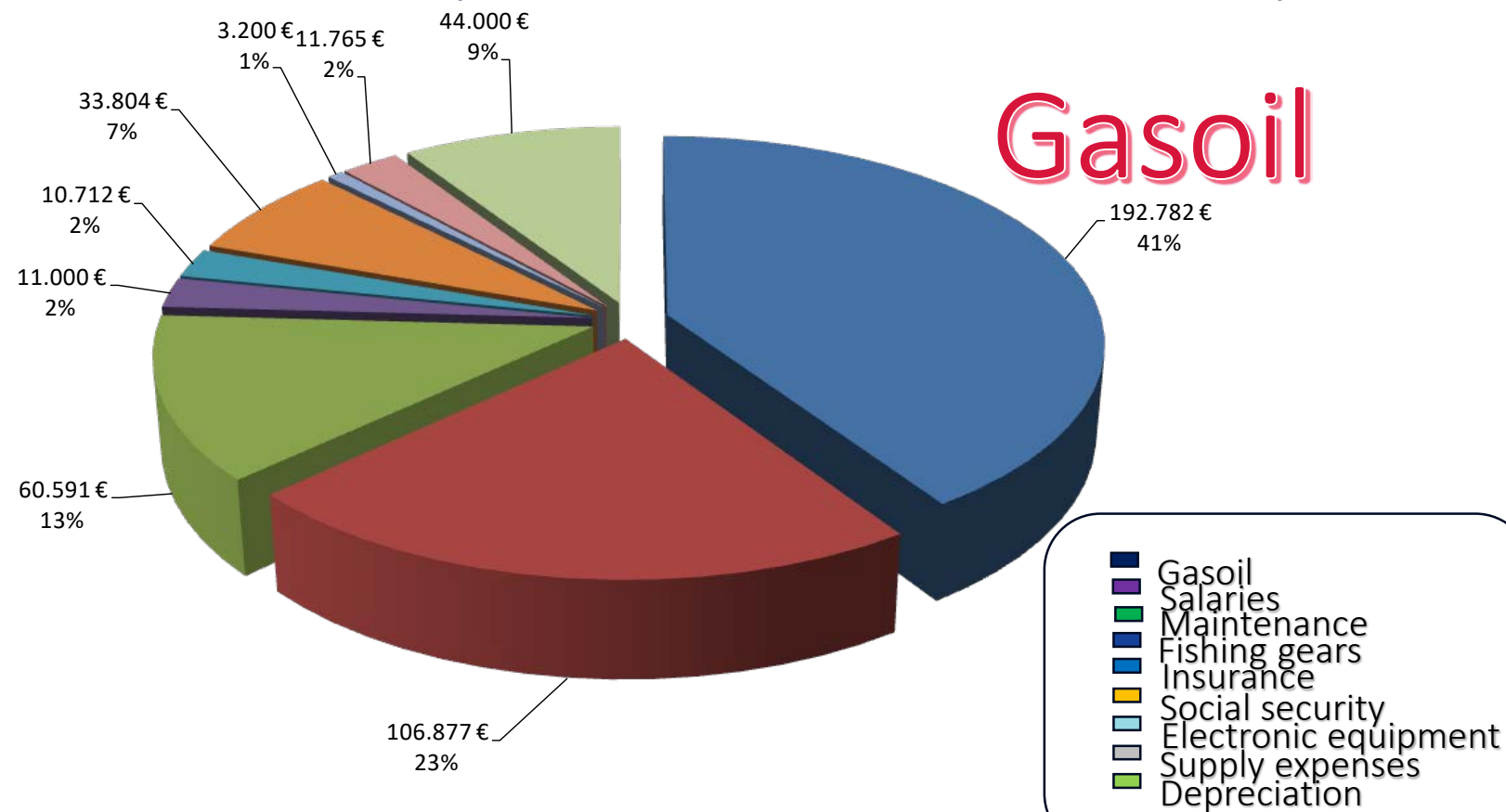
Mesh square panels

Methodology



KONGSBERG

- Financial analysis of two representative vessels from Santa Pola, Alicante & Joven Josefina, Mahón



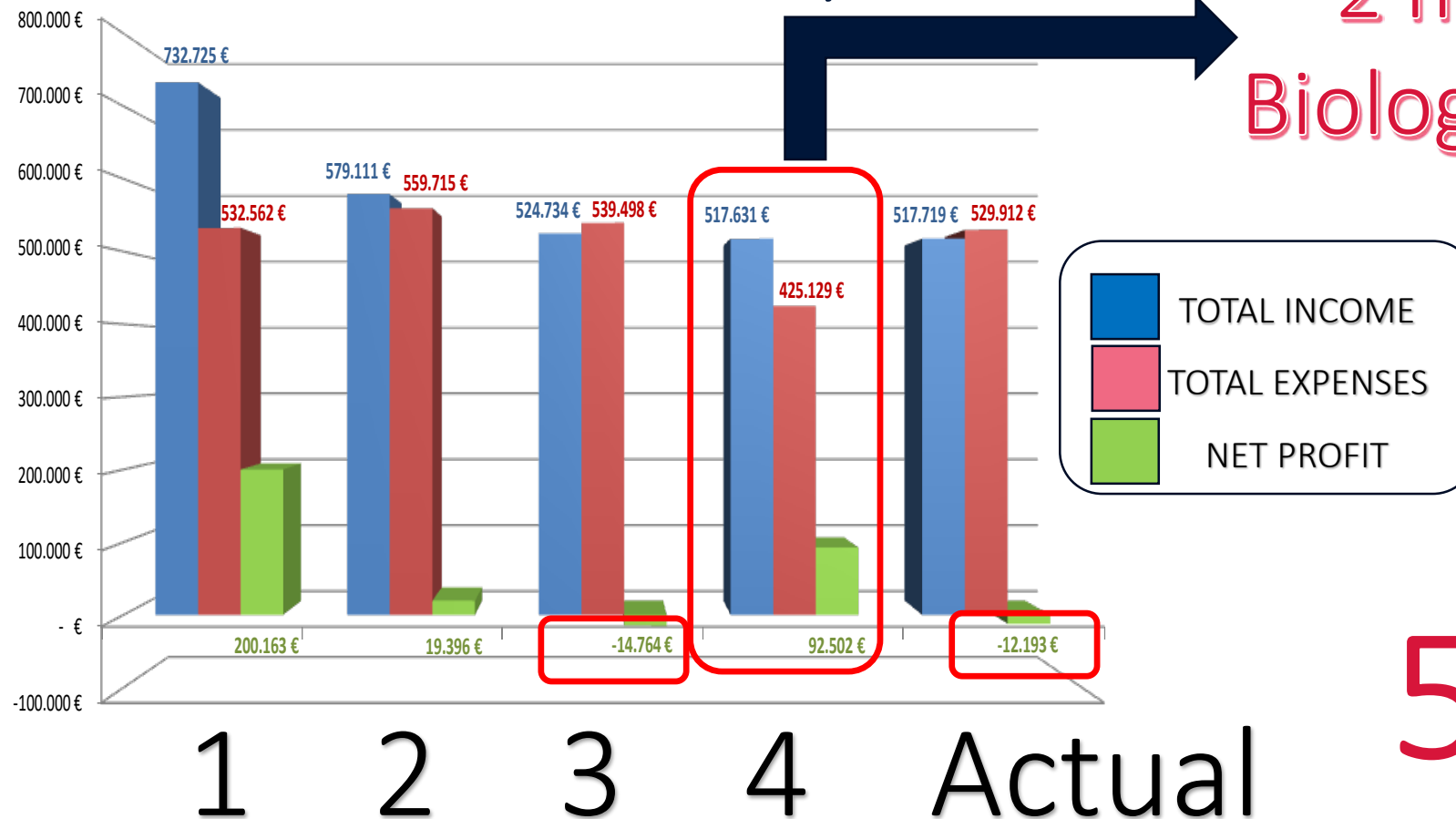
Methodology



KONGSBERG

- Financial analysis of Catamaran MAGÚ representative vessel from Santa Pola, Alicante

2 months
Biological stop



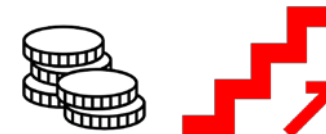
5 Years

Economics results



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Diesel oil going up



Economic result in current year	Annual expenditure	%
Diesel oil	€ 215,497.00	41%
Salaries	€ 113,900.00	22%
Maintenance	€ 74,557.00	14%
Fishing gears	€ 13,000.00	2%
Insurance	€ 18,000.00	3%
Social security	€ 25,473.00	5%
Electronic equipment	€ 2,931.00	1%
Supply expenses	€ 22,163.00	4%
Depreciation of the fishing boat	€ 44,211.00	8%
TOTAL EXPENSES	€ 529,732.00	100%
TOTAL INCOMES	€ 517,719.00	
PROFIT	€ 12,013.00	-2%
Fishing days	€ 205.00	
Fishing day expenses	€ 2,584.00	
Fishing day income	€ 2,403.00	
Fishing day profit	€ 181.55	

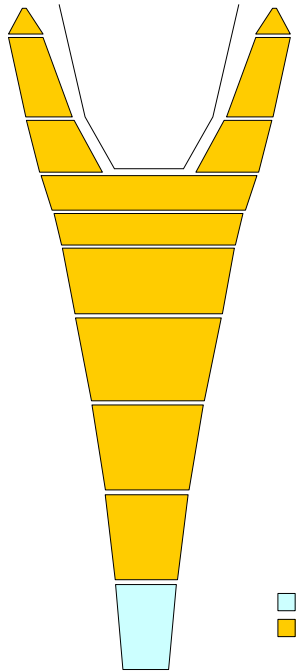
Economic trend prediction	Annual expenditure	%
Diesel oil	€ 255,479.00	45%
Salaries	€ 128,879.00	23%
Maintenance	€ 53,807.00	10%
Fishing gears	€ 13,000.00	2%
Insurance	€ 18,362.00	3%
Social security	€ 25,407.00	5%
Electronic equipment	€ 2,960.00	1%
Supply expenses	€ 21,882.00	4%
Depreciation of the fishing boat	€ 44,211.00	8%
TOTAL EXPENSES	€ 563,987.00	100%
TOTAL INCOMES	€ 511,465.00	
PROFIT	€ 52,522.00	-10%
Fishing days	€ 205.00	
Fishing day expenses	€ 2,751.00	
Fishing day income	€ 2,372.00	
Fishing day profit	€ 379.00	



Project targets & Phases

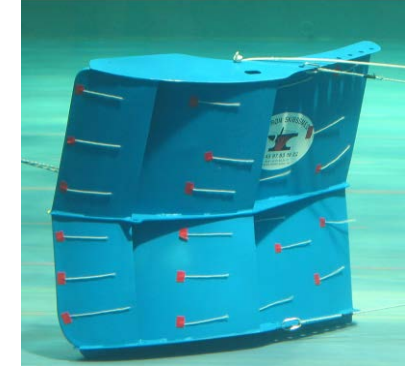


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Ph-2

- Reduce the fuel consumption **15-20%** by reduction of fishing gear resistance
- Reduce the fishing gear resistance without reducing the catch
- keeping the same fishing gear dimensions
- The return of the investments must be as short as possible
- **Phase 1**
 - Measure the current energy efficiency and design the changes
- **Phase 2**
 - Replace the fishing net with a new one with at least **20%** less resistance
- **Phase 3**
 - Replace the existing trawl doors with same type but at least **20%** less resistance
- **Phase 4**
 - Try a new type flying trawl door with at least **50%** less resistance



Ph-3



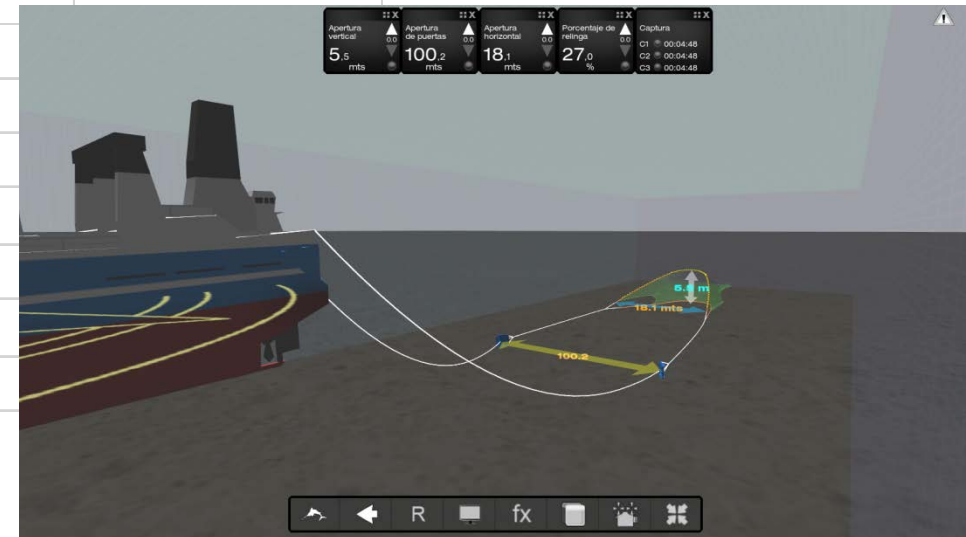
Ph-4

Phase 1 – Current fishing gear measurement



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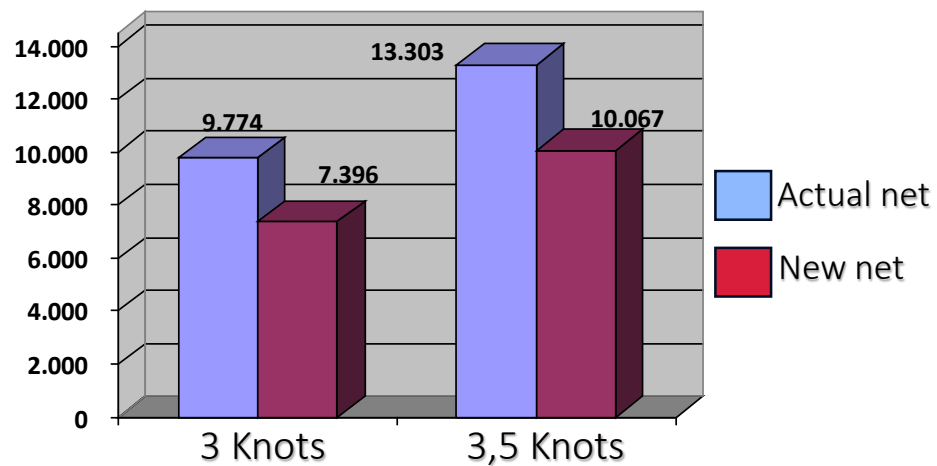
Hanging ratio 0,35 Results		Max. Traction Engine utility	
Total resistances	12242.26	17286.85	71%
Net resistance	9773.61	80%	
Trawl doors resistance	1471.43	12%	
Combination ropes resistance	591.00	5%	
Warp resistance	406.21	3%	
Trawl doors expansion (CI)	986.53		
Fishing circle	60.34		
Net length	125.47		
Stretched mesh length	143.85		
yarn average diameter	2.08		
Net heigth	6.26		
Wings spread	40.01		
Doors spread	131.88		



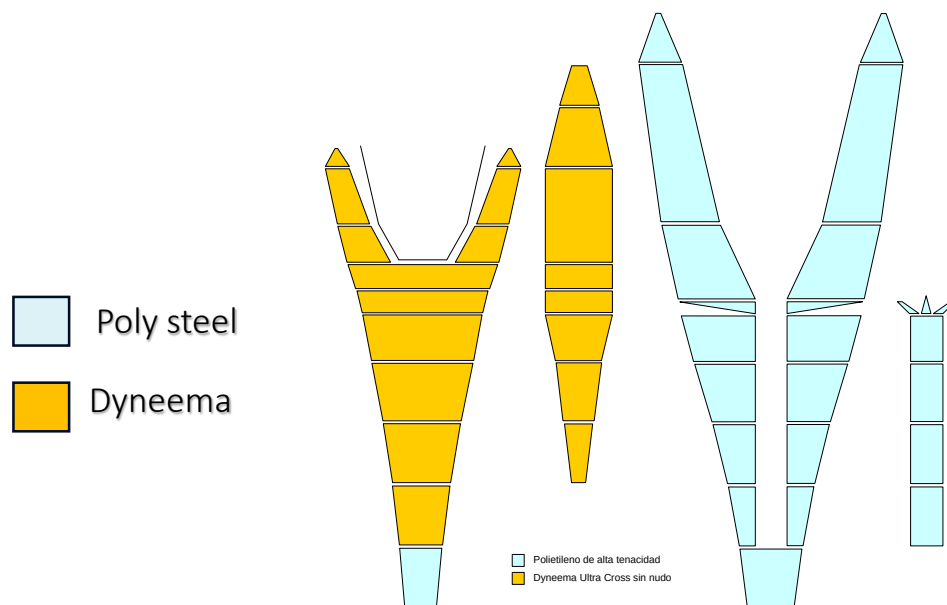
Phase 2 – Replacing the net



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- Reduced mesh size
- Reduced netting
- Use of knotless net
- Use of Dyneema U.C. net
- Replaced headrope material with Dyneema



- 24%

Phase 3 - Door resistances



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Trawl speed in kn:	3.00	Manufacturer:	POLY-ICE
Surface in m ² :	4.41	Model:	CAZADOR

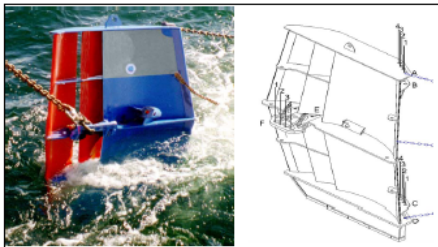
angle of attack	CL	CD	Expansion	Resistance
25	1.27	0.86	694	470
30	1.51	0.94	825	513
35	1.67	1.05	912	574
40	1.76	1.21	961	661
45	1.77	1.40	967	765
			-	-

Trawl speed in kn:	3.00	Manufacturer:	THYBORON
Surface in m ² :	3.73	Model:	T-4-88"

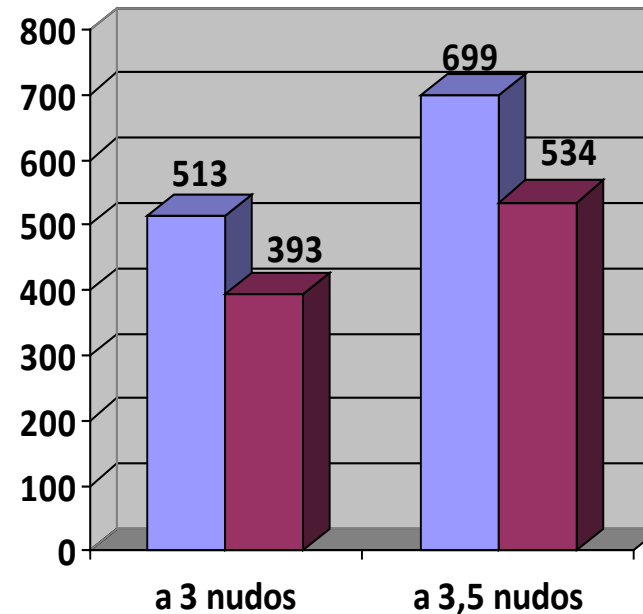
angle of attack	CL	CD	Expansion	Resistance
25	1.62	0.74	748	342
30	1.82	0.85	841	393
35	1.93	0.97	892	448
40	1.97	1.05	910	485
45	1.95	1.10	901	508
			-	-

Weight= 1.450 kg

POLY-ICE
El Cazador

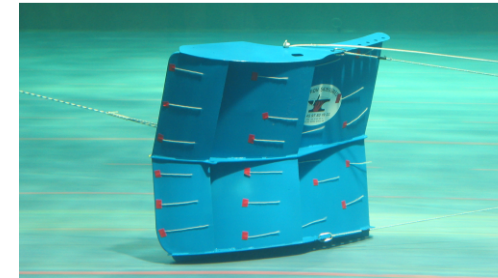


Model Specifications		Angle of Attack			
Length	0.515 mtr	25 deg	1.27	0.86	1.48
Height	0.890 mtr	30 deg	1.51	0.94	1.81
Projected Area	0.329 m ²	35 deg	1.67	1.05	1.99
Aspect Ratio	1.34	40 deg	1.76	1.21	1.45
Area Ratio	0.55	45 deg	1.77	1.40	1.26
Weight in Air	20.40 kg	Maximum CL at			
Weight in Water	17.70 kg	43 deg	1.77	1.32	1.34



Weight= 1.000 kg

Thyboron type 11
Demersal V-door with 2 slots



Model specifications	
Length	0.66m
Height	0.54m
Projected Area	0.350m ²
Aspect ratio	0.83
Area ratio	1.00
Weight in air	12.4kg
Weight in water	10.8kg

Angle of attack	CL	CD	CL/CD
30deg	1.62	0.74	2.19
35deg	1.82	0.85	2.14
40deg	1.93	0.97	1.99
45deg	1.95	1.10	1.78
49deg	1.90	1.20	1.58
Maximum CL at			
43deg	1.97	1.05	1.86

- 24%

Phase 4 – Replacing Flying trawl door

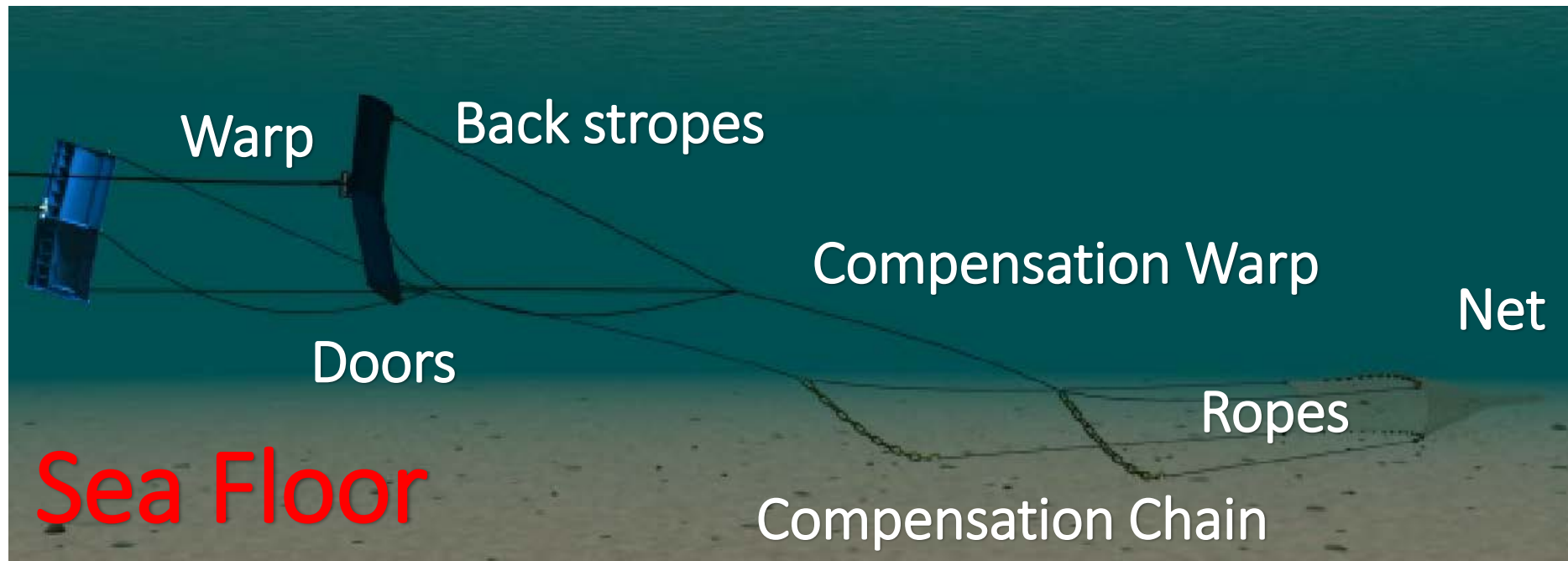


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Model Specifications		
Length	0,515	mtr
Height	0,690	mtr
Projected Area	0,329	m²
Aspect Ratio	1,34	
Area Ratio	0,93	
Weight In Air	20,40	kg
Weight In Water	17,70	kg

Angle of Attack	CL	CD	CL/CD
25 deg	1,27	0,86	1,48
30 deg	1,51	0,94	1,61
35 deg	1,67	1,05	1,59
40 deg	1,76	1,21	1,45
45 deg	1,77	1,40	1,26
Maximum CL at			
43 deg	1,77	1,32	1,34

Model specifications		Angle of attack	C_L	C_D	C_L/C_D
Length	0,490 m	27,6	2,27	0,49	4,676
Height	1,225 m	30,0	2,35	0,53	4,430
Projected area	0,600 m²	33,6	2,50	0,68	3,668
Aspect ratio	2,500	36,8	2,56	0,78	3,285
Area ratio	1,000	39,2	2,41	0,86	2,801
Weight in air	kg	Maximum C_L			
Weight in water	kg	36,8	2,56	0,78	3,285



Door resistances



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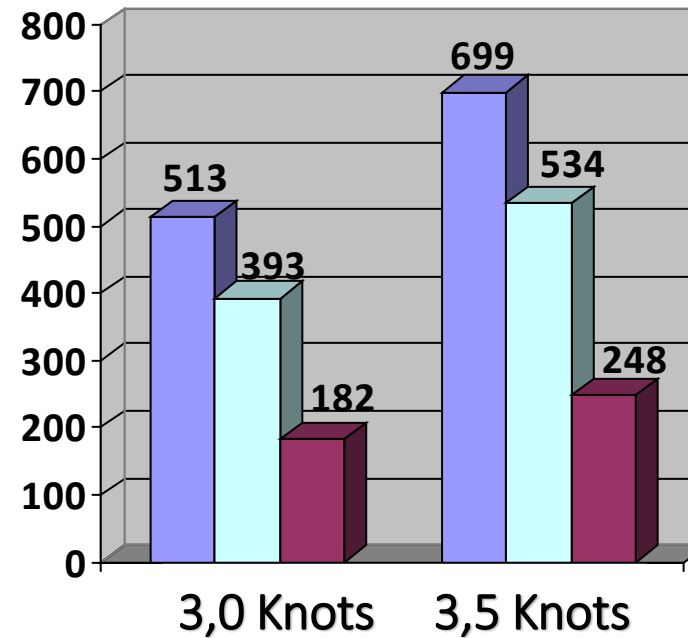
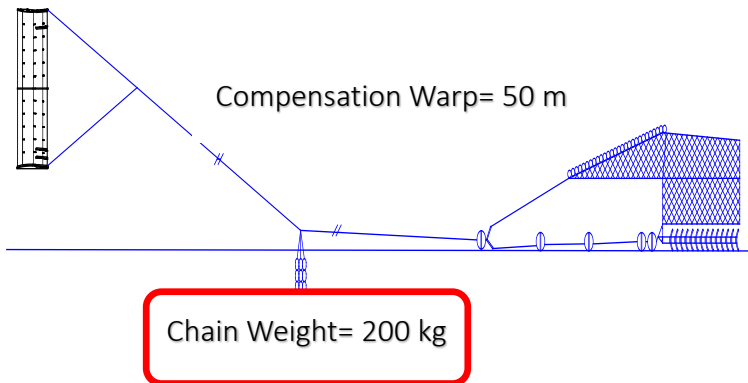
Trawl speed in kn:		3.00	Manufacturer:	POLY-ICE		
Surface in m ² :		4.41		Model:	CAZADOR	
angle of attack		CL	CD		Expansion	
25		1.27	0.86	694		470
30		1.51	0.94	825		513
35		1.67	1.05	912		574
40		1.76	1.21	961		661
45		1.77	1.40	967		765
				-		-

Trawl speed in kn:	3.00	Manufacturer: THYBORON	Model: Type 15VFB - 3,0
Surface in m ² :	3.00		

angle of attack	CL	CD	Expansion	Resistance
27.6	2.27	0.49	843	182
30	2.35	0.53	873	197
33.6	2.50	0.68	929	253
36.8	2.56	0.78	951	290
39.2	2.41	0.86	895	320
-	-	-	-	-

Weight= 1.450 kg

Surface= 3m² – Weight= 500 kg



Weight= 500 kg

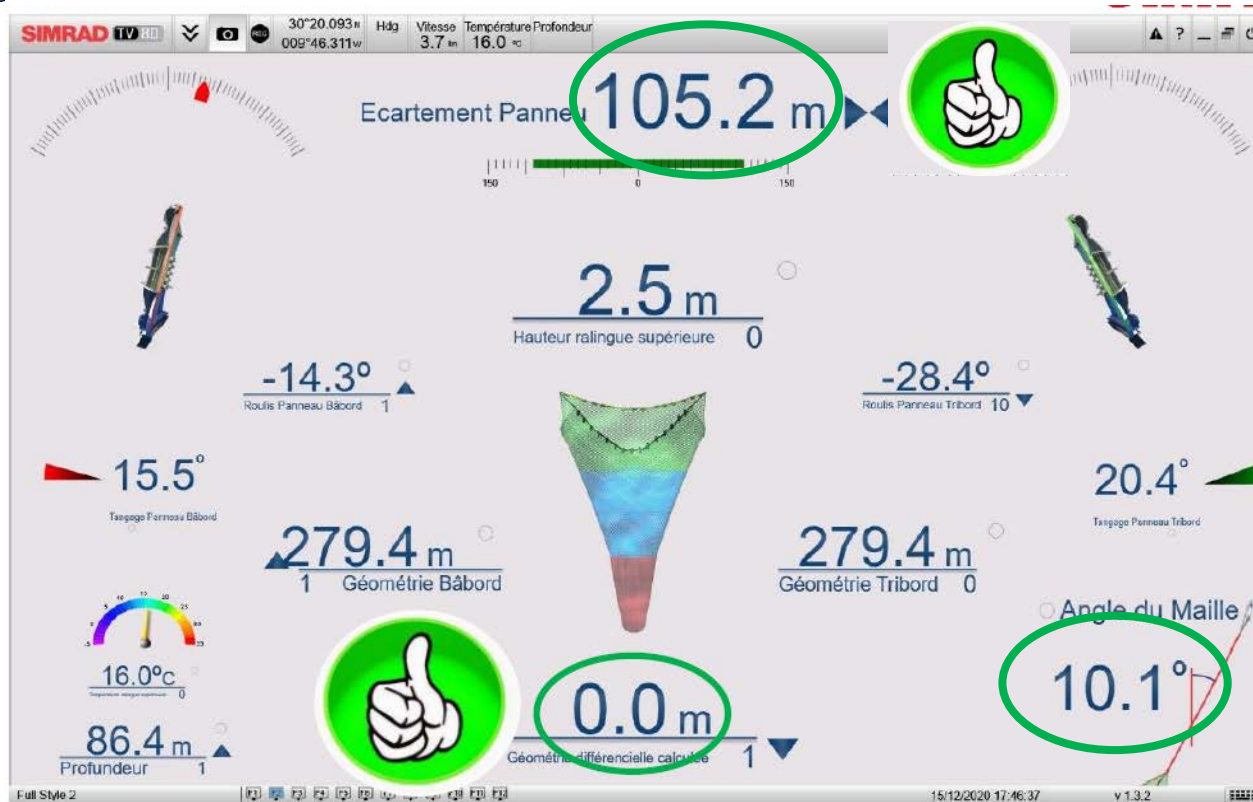
- CAZADOR Trawl door
- THYBORON T-4 Trawl door
- THYBORON T-15VF Trawl door

- 64%



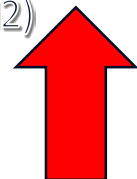
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Geometry SPUTNIK



OPENINGS CALCULATIONS		
Headline length	84	meters
Hanging Ratio (Ch)	0.33	
Trawl net opening	27.72	meters
Combination rope length	210	meters
Bridles length	10	meters
Back strops length	6	meters
chain length	0	meters
Combination+bridles+backstrops	226	meters
Calculus of "X"	37.29	meters
Calculus of "2 X"	74.58	meters
Trawl doors spread	102.3	meters
α Combination ropes angle	9.50	degrees

Bottom trawl 2 faces trawls (OTM2)



Perfect Octopus Geometry

Summary



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COMPARISON OF RESISTANCES						
DATA	R _{total}		R _{net+floats}		R _{trawl doors}	
START	12213.00	Kg	9774.00	Kg	1442.00	Kg
PHASE 2	9421.00	Kg	7397.00	Kg	1027.00	Kg
Advantage	-22.9%		-24.3%		0.0%	
DATA	R _{total}		R _{net+floats}		R _{trawl doors}	
PHASE 3	9179.00	Kg	7397.00	Kg	785.00	Kg
Comparison PHASE 2	-2.56%		0%		-23.52%	
START	12213.00	Kg	9774.00	Kg	1442.00	Kg
Advantage	-24.8%		-24.3%		0.0%	
DATA	R _{total}		R _{net+floats}		R _{trawl doors}	
PHASE 4	8829.00	Kg	7397.00	Kg	364.00	Kg
Comparison PHASE 3	-3.81%		0%		12.04%	
START	12213.00	Kg	9774.00	Kg	1442.00	Kg
Advantage	-27.7%		-24.3%		12.0%	

Project result – F/V “Magú”

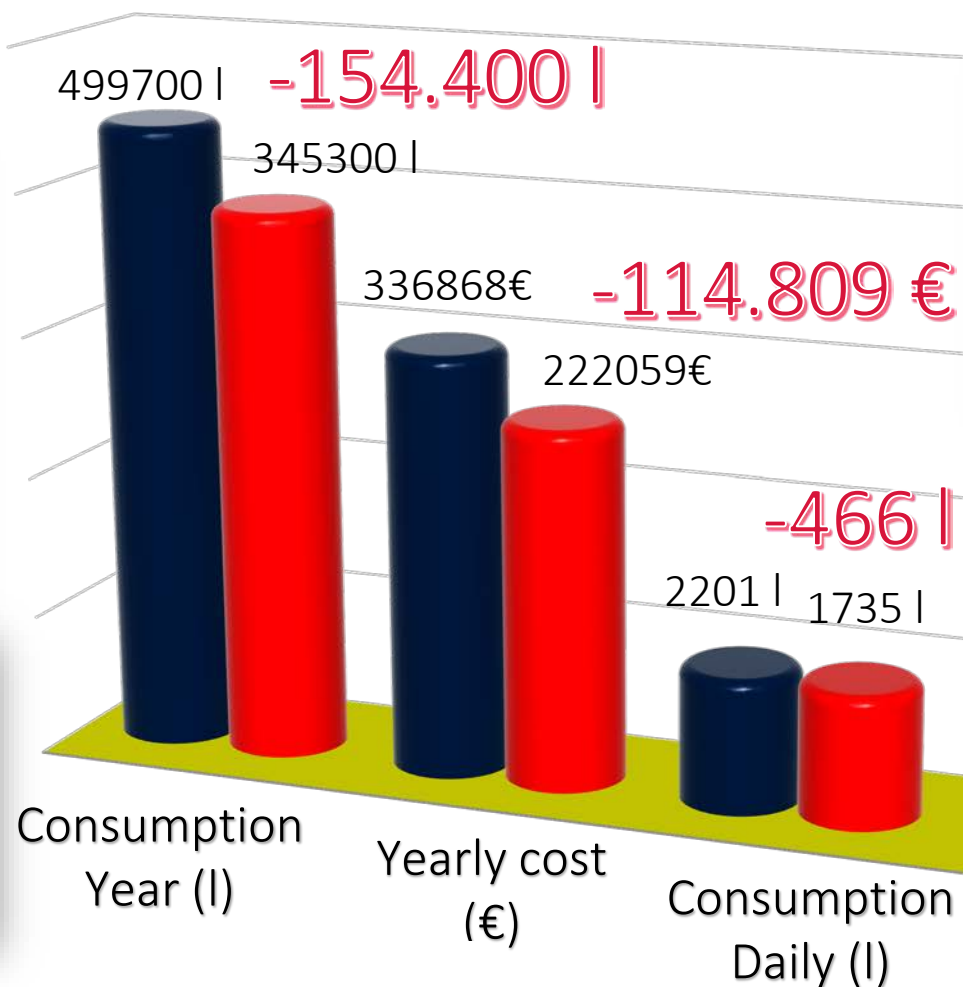


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■ Current

■ Economic Result after 1 year



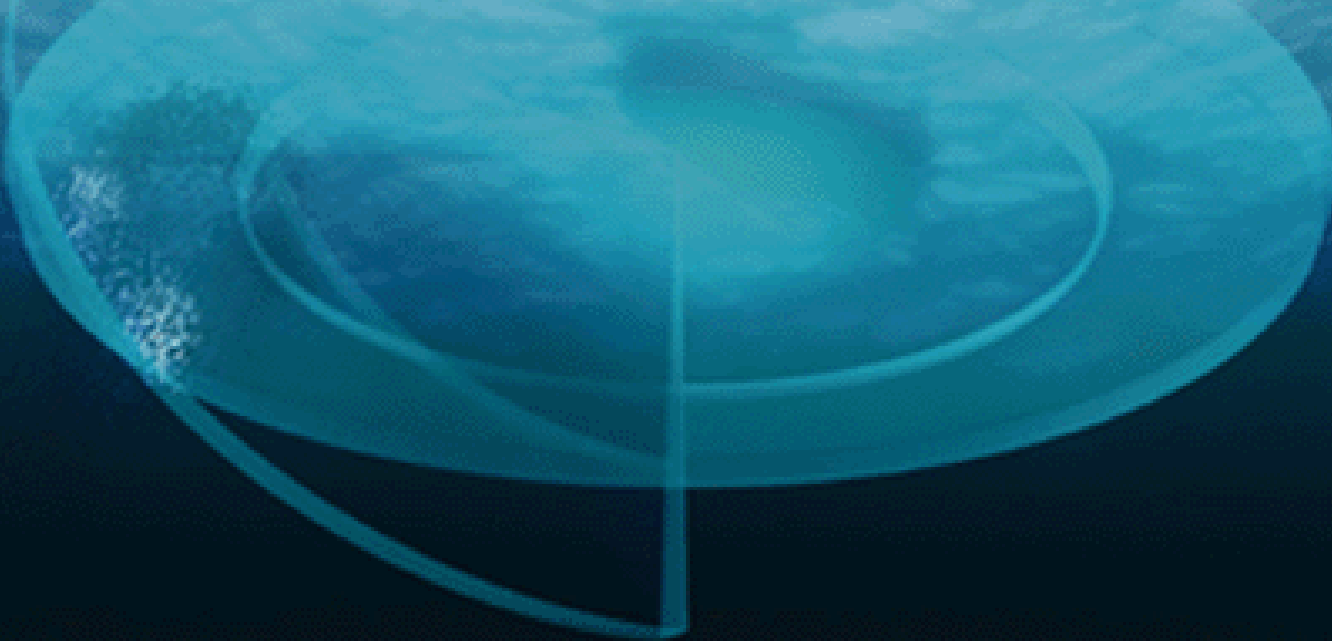
Project result – F/V “Magú”



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1,34 m





Food and Agriculture
Organization of the
United Nations

ICES/FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB23)

and

Symposium on Innovations in Fishing Technologies for Sustainable and Resilient Fisheries

13-17 February 2023 | Taj Gateway Hotel, Kochi, India

Ignacio J. Soler Martínez