EVALUATION OF A TWIN TRAWL SYSTEM USING TRAWLVISION SOFTWARE FOR THE VÓNIN COMPANY

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AcruxSoft SRL

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AcruxSoft is a Uruguayan company founded in 2008, specialized to provide technological solutions for the continuous improvement of fishing activity.

We work together with a multidisciplinary team formed by engineers and experts in fisheries, supported by scientific research by the Institute of Fluid Mechanics and Environmental Engineering - IMFIA, University of the Republic in Uruguay, with the objectives of improving the efficiency and sustainability of the fishing industry.

In these years we developed innovative computer tools, training workshops, fishing gear design and simulation laboratories for different companies and universities in the world.

The passion and quality of our work has led us to stand out in the area of research and the academic world, achieving different national and international awards. Our method is to work together with companies and universities in search of greater efficiency, profitability and sustainability of natural resources.

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Provide technological tools and professional services of excellent quality, which constantly help improving the fishing activity worldwide.

Vision

To become, by means of our technology products and professional services, a global example regarding to the knowledge contribution to the preservation of natural fishing resources.

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TECHNOLOGY FOR SUSTAINABLE FISHERIES

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EXECUTIVE SUMMARY

Trawl nets are essential tools in commercial fishing, designed to capture large quantities of marine organisms by towing a net through the water. The dynamics of trawl nets are complex, influenced by various factors such as the net's design, the speed and direction of towing, water currents, and the behavior of the targeted marine species. Understanding these dynamics is crucial for optimizing fishing efficiency, minimizing environmental impact, and ensuring the sustainability of fish stocks.

In the following work we are going to analyze the trawl rig of the ¨Northern Osprey III¨ fishing vessel by software, the structural and dynamic aspects.

a) Structural

The shape of the trawl, including the design of the mouth, body, and codend, plays a crucial role in its effectiveness. The net must be configured to maximize catch efficiency while minimizing drag and bycatch.

Dimensions of the trawl and evaluation of the design proportions, angles of attack of the panels, cuts of the panels, area of the twine, solid surface, area of the panels, ballast, flotation, angles of attack of the trawl system, codend filtration, type of doors and their hydrodynamic properties.

b) Dynamic

A trawl net is subjected to a variety of forces that influence its behavior and efficiency during fishing operations. These forces can be broadly categorized into hydrodynamic and mechanical forces.

Understanding and managing these forces is crucial for optimizing the performance of the trawl net and ensuring sustainable fishing practices.

Hydrodynamic Forces, drag is the resistance force exerted by the water against the trawl net as it moves through the water, it opposes the motion of the net.

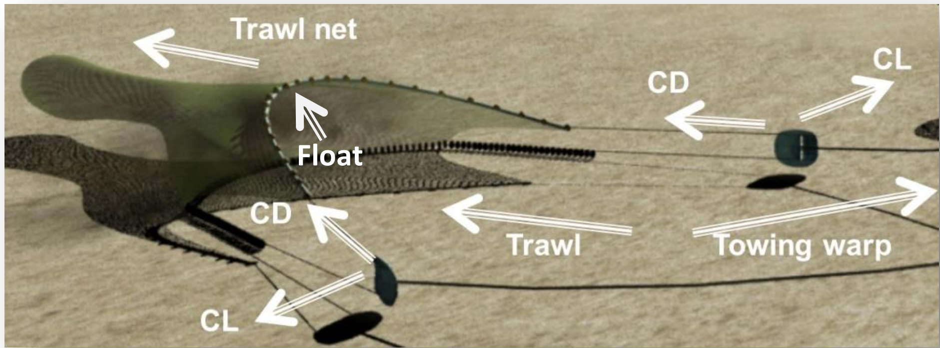
FACTORS INFLUENCING DRAG

Drag is influenced by several factors:

1) Speed of Towing: Higher towing speeds increase drag force.
2) Frontal area of the trawl: A larger frontal area results in greater drag.
3) Net's Shape: The overall shape and design of the net affect how water flows around it, impacting drag.
4) Trawl doors: The design and angle of the doors contribute to the net's drag.
5) Twine Diameter: Thicker twine increases drag due to greater water resistance.
6) Buoyancy Adjustments: The placement and amount of floats can alter the net's position and affect drag.
7) Seabed Type: Interaction with different seabed types (sand, mud, rocks) can increase or decrease drag.
8) Water Density and Viscosity: Higher density and viscosity of water increase the resistance against the net, thus increasing drag.

Understanding and optimizing these factors can help reduce drag and improve the efficiency of trawling operations.

Using TrawlVision software, we will analyze and evaluate the interaction of these forces.



Principal Forces in a Trawl System

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General characteristics of the trawler

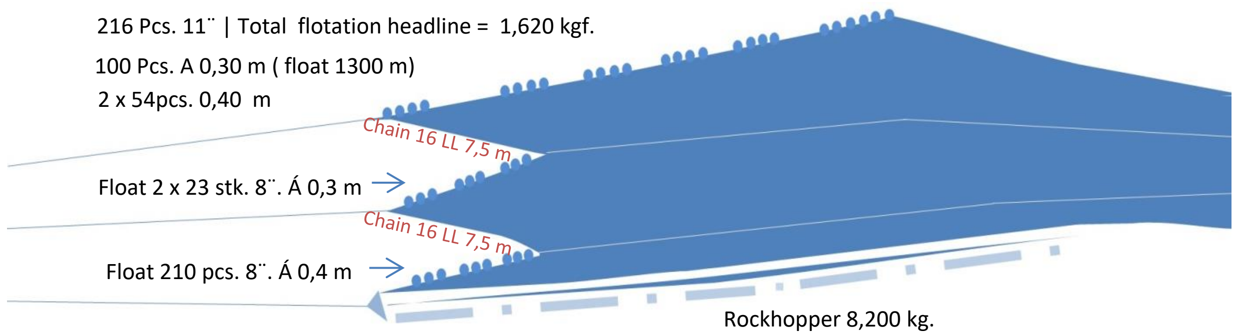
Name of trawler:	Northern Osprey III
Flag:	Canada
Rok budowy:	2017
Sygnał wywoławcz:	CFET
Type statku:	Twin Trawl
Length (OA):	79.5 m
Deadweight (DWT):	3,850
Total power:	8,100 HP
Total power:	5,958 kW

Northern Osprey III

DOORS VÓNIN | Type Storm

Weight	4,400 kg
Area	9 m²
Attack angle	39 °
CL	3,20
CD	0,91
Clump	6,600 kg

TRAWL VÓNIN 2014 | SCHEMATIC SIDE



TYPE: TWIN TRAWL

Trawl speed: 2,0 kts.
3 Bridle length : 30,0 m
Headrope Length: 79,0 m |24 mm Euroneema
Footrope Length: 82,5 m | 16 LL chain
Wing lines top and lower: 7,5 m | 16 LL chain
Fishing circle: 152,3 m
Trawl length (without the codend): 106,9 m
Codend length: 20 m
Twine Euroline premium

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OPERATIONAL DATA OF THE VESSEL ¨NORTHERN OSPREY III¨

HP - PS VESSEL Northern Osprey III	5,958 Kw – 8,100 HP
Doors Vónin - Type Storm Area (m²)	9,0 m²
Weight (kg.)	4,400 kg.
Backstrop length	14,0 m
Doors lift coefficient	3,20
Doors drag coefficient	0,91
Clump	6,600 kg
Trawl Speed	2,0 knots.
3 Bridles Length	30,0 m
Bridles diameter	24,0 mm (up) – 28,0 mm (botton)
TRAWL NET	"Vonin 2014" - Fishing circle: 152.3 m (572 # mesh 200 mm)
Headrope Length (m)	79,0 m
Fishingline Length (m)	82,5 m
Float headline (float for prof 1,300 m)	216 Pcs. 11¨ flotation total = 1,620 kgf
Float wing line	2 x 23 stk. 8¨. Á 0,3 m – flotation total = 161 kgf
Float fishingline	212 pcs. 18 center 0,20 m | 2x97 pcs. á 0,40 m | flotation total = 742 kgf
Total flotation of the trawl (kgf)	2,505 kgf
Spread between wings	38,3 m
Spread doors	104,0 m
Vertical opening	11,0 m
Rockhopper footgear (kg)	8,200 kg.
Average operating depth in meters	700 m
Warp Length in meters	1400 m (diameters 28 mm).

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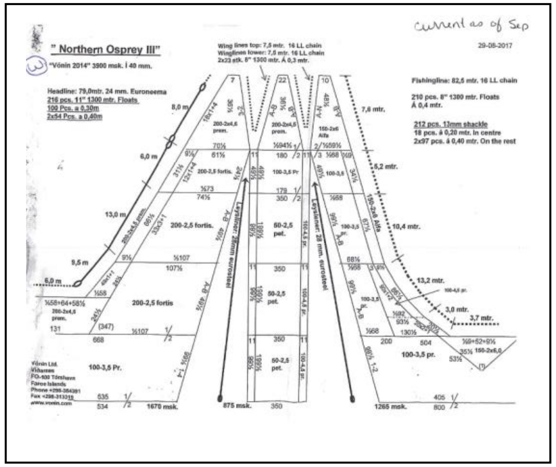
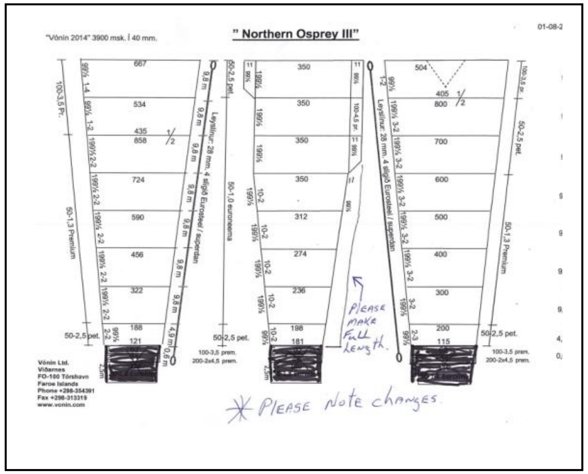
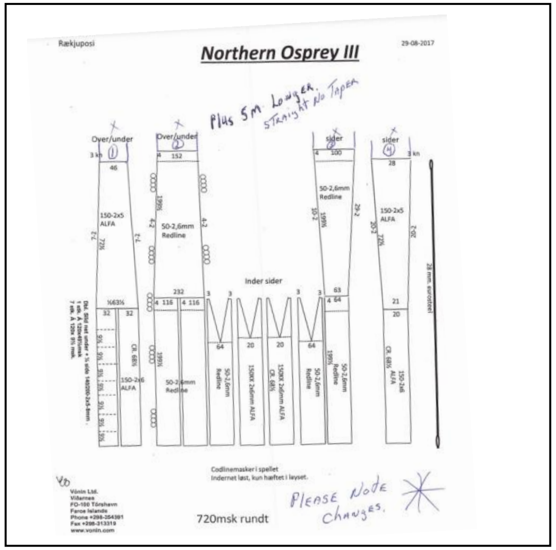
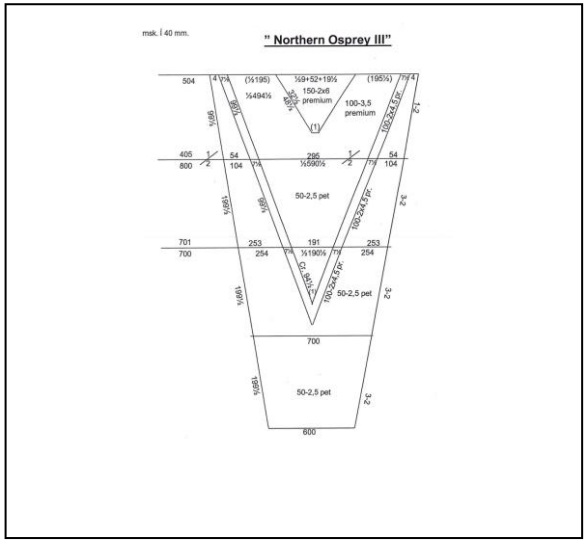
DATA PROVIDED BY THE COMPANY









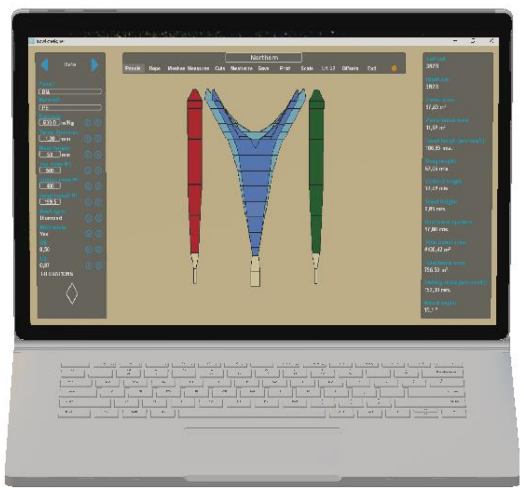
ORGANIZATION OF INFORMATION

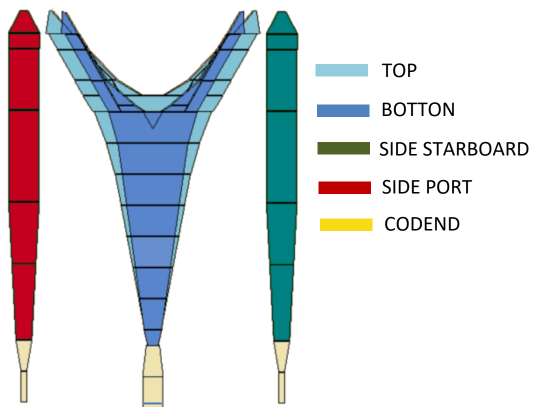
The initial phase involves organizing the information received from the company and digitizing the trawl Vónin2017. This step is crucial for assembling all sections of the trawl to scale, specifically at U1 = 0,50 and U2 = 0,87. Utilizing Trawl Vision software, we can visualize the trawl's structural and hydrodynamic properties. This advanced software allows us to simulate the entire trawl rig at various speeds, providing valuable insights into its performance.

In addition to these simulations, we conduct a comprehensive analysis of the fishing machine's behavior. This analysis covers several critical aspects, including the mechanical operations, efficiency of trawl deployment and retrieval processes, and overall effectiveness in catch target species. This process is vital for ensuring the longevity and reliability of the equipment, enhancing its operational efficiency, and maximizing its effectiveness in various fishing environments.

We will also integrate the hydrodynamic properties, weight and area of the Storm type doors from the Vónin Company into the software to interact with the analyzed trawl net. Overall, the combination of digitizing, simulation, performance analysis, and environmental assessment forms a robust approach to understanding and improving the fishing machine and trawl system.

This holistic approach not only enhances the functionality and productivity of the equipment but also contributes to more sustainable and responsible fishing practices.





The design is input into the software to observe and calculate the alignment and coincidence of various structural sections. This process includes analyzing the angles of attack, panel cuts, dimensions, solid surface, average vertical opening, horizontal opening, panel area, fishing circle, proportions and resistance. By simulating these factors, the software provides a comprehensive assessment of the trawl's performance, ensuring that all components function cohesively.

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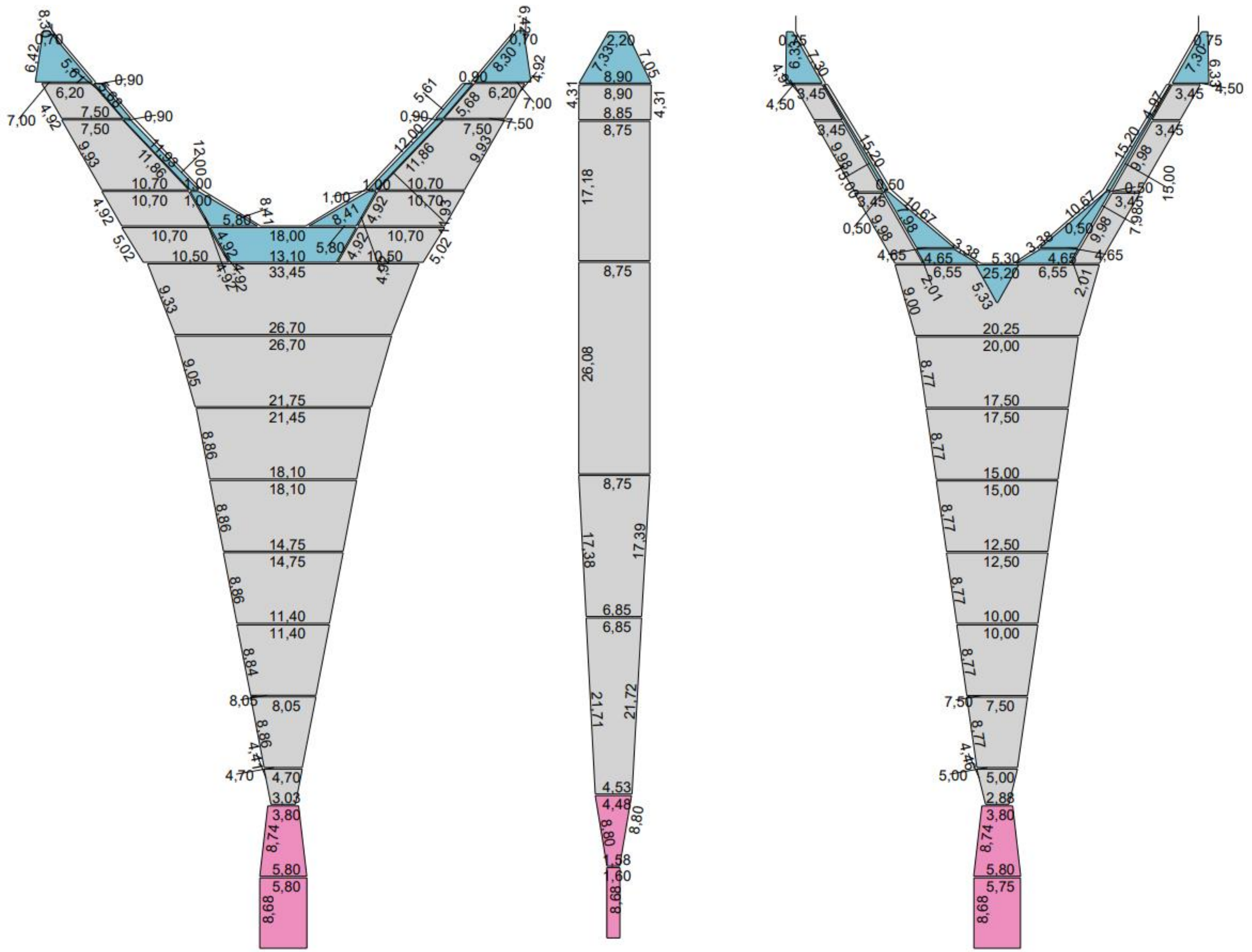
SCALE DRAWING OF THE TOWING TRAWL WITH LENGTHS IN METERS PER SECTION | U1 = 0.50 | U2 = 0.87



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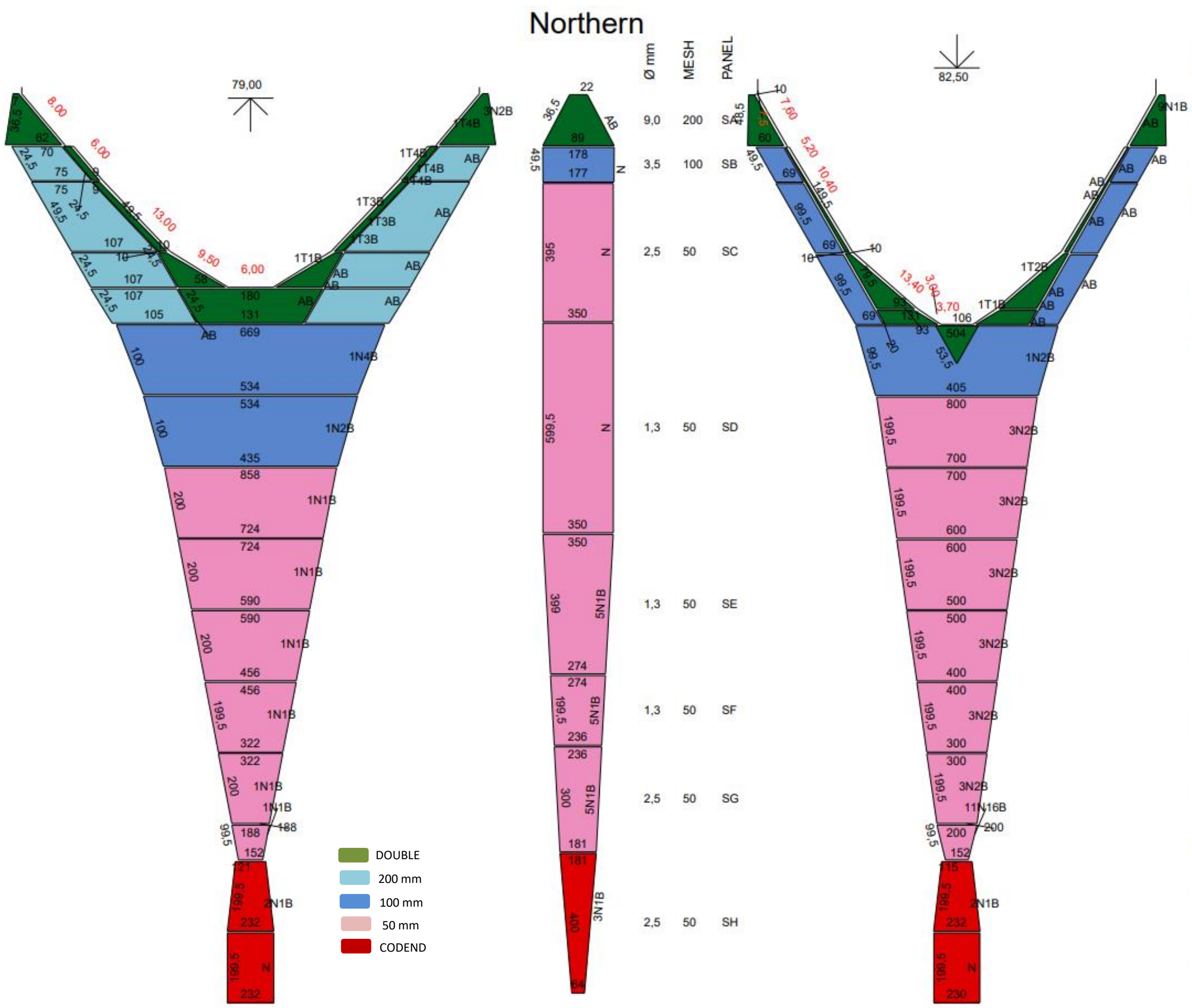
SCALE DRAWING PROVIDES GENERAL INFORMATION AND IDENTIFIES THE DOUBLE TWINE AND MESH BY COLOR

PANEL	MATERIAL	MESH mm	Ø mm	STR-m
TA	PE	200	9,0	7,30
TB	PE	200	2,5	4,90
TC	PE	200	9,0	4,90
TD	PE	200	2,5	9,90
TE	PE	200	9,0	9,90
TF	PE	200	2,5	4,90
TG	PE	200	9,0	4,90
TH	PE	200	9,0	4,90
TI	PE	200	2,5	4,90
TJ	PE	100	3,5	10,00
TK	PE	100	3,5	10,00
TL	PE	50	1,3	10,00
TM	PE	50	1,3	10,00
TN	PE	50	1,3	10,00
TO	PE	50	1,3	9,98
TP	PE	50	1,3	10,00
TQ	PE	50	2,5	4,98
TR	PE	50	2,6	9,98
TS	PE	50	5,5	9,98



Ø mm	MESH	PANEL
9,0	200	SA
3,5	100	SB
2,5	50	SC
1,3	50	SD
1,3	50	SE
1,3	50	SF
2,5	50	SG
2,5	50	SH

STR-m	Ø mm	MESH mm	MATERIAL	PANEL
7,28	12,0	150	PE	BA
4,95	3,5	100	PE	BB
14,95	4,5	100	PE	BC
9,95	3,5	100	PE	BD
7,95	4,5	100	PE	BE
9,95	3,5	100	PE	BF
2,00	4,5	100	PE	BG
5,35	4,5	100	PE	BH
9,95	3,5	100	PE	BI
9,98	2,5	50	PE	BJ
9,98	2,5	50	PE	BK
9,98	1,3	50	PE	BL
9,98	1,3	50	PE	BM
9,98	1,3	50	PE	BN
9,98	1,3	50	PE	BO
4,98	2,5	50	PE	BP
9,98	2,6	50	PE	BQ
9,98	5,0			

0 10

Company	**Vónin**	Panel Area	4456,7m²	Headrope	79,0m	Floatation	1600kgf	TWIN TRAWL - DOORS STORM 9 m2 - 4400 kg - 3 BRIDLE 30 m
Ship	Northern Osprey	Twine Area	817,6m²	Footrope	82,5m	Ballast	8200kg	Headline 79,0 m 24 mm Euroneema, 216 pcs 11´´ floats
HP	8100	Long. Net	106,9m	Extend Footrope	7,5m	Net Ap. H.	46m	
Net	VONIN 2014	Fishing circle	152,3m	Net ataque	15,1°	Net Ap. V.	11m	

DESCRIPTION AND RESULTS OF THE MATERIALS BY SECTION

PANEL	MATERIAL	RUNNAGE [m/Kg]	MESH [mm]	DIAMETER [mm]	TWINE LENGTH [m]	PANEL WEIGHT without KNOTS	TWINE AREA without KNOTS	PANEL WEIGHT with KNOTS [Kg]	TWINE AREA with KNOTS [m²]	WORK AREA [m²]
Upper view										
TA	PE	36	200	9,00	562	31,23	10,12	58,01	17,40	48,90
TB	PE	290	200	2,50	671	4,63	3,36	6,00	4,03	58,40
TC	PE	36	200	9,00	88	4,90	1,59	9,10	2,73	7,67
TD	PE	290	200	2,50	1802	12,43	9,01	16,10	10,81	156,76
TE	PE	36	200	9,00	188	10,45	3,39	19,41	5,82	16,36
TF	PE	290	200	2,50	1049	7,23	5,24	9,37	6,29	91,23
TG	PE	36	200	9,00	333	18,51	6,00	34,39	10,32	28,99
TH	PE	36	200	9,00	1524	42,33	13,72	78,63	23,59	66,29
TI	PE	290	200	2,50	1039	7,16	5,19	9,28	6,23	90,38
TJ	PE	200	100	3,50	12030	60,15	42,11	101,34	65,68	261,65
TK	PE	200	100	3,50	9690	48,45	33,92	81,63	52,91	210,76
TL	PE	830	50	1,30	15820	19,06	20,57	29,15	29,12	172,04
TM	PE	830	50	1,30	13140	15,83	17,08	24,21	24,19	142,90
TN	PE	830	50	1,30	10460	12,60	13,60	19,27	19,25	113,75
TO	PE	830	50	1,30	7761	9,35	10,09	14,30	14,29	84,40
TP	PE	830	50	1,30	5100	6,14	6,63	9,40	9,39	55,46
TQ	PE	290	50	2,50	1537	5,30	3,84	10,31	6,92	16,72
TR	PE	290	50	2,60	3830	13,21	9,96	26,13	18,24	41,66
TS	PE	81	50	5,50	4628	57,14	25,46	170,33	70,26	50,33
Lateral view										
SA	PE	36	200	9,00	810	45,02	14,59	83,62	25,09	70,50
SB	PR	200	100	3,50	1757	17,57	12,30	29,61	19,19	76,44
SC	PE	290	50	2,50	13825	95,34	69,13	185,35	124,43	300,69
SD	PE	830	50	1,30	20983	50,56	54,55	77,32	77,25	456,37
SE	PE	830	50	1,30	12449	30,00	32,37	45,87	45,83	270,76
SF	PE	830	50	1,30	5087	12,26	13,23	18,75	18,73	110,65
SG	PE	290	50	2,50	6255	43,14	31,28	83,86	56,30	136,05
SH	PE	290	50	2,50	4900	33,79	24,50	65,69	44,10	106,58
Lower view										
BA	PE	28	150	12,00	509	36,38	12,22	89,57	27,87	33,23
BB	PE	200	100	3,50	683	6,83	4,78	11,51	7,46	29,71
BC	PE	115	100	4,50	179	3,12	1,61	5,80	2,78	7,80
BD	PE	200	100	3,50	1373	13,73	9,61	23,13	14,99	59,73
BE	PE	115	100	4,50	819	14,24	7,37	26,45	12,68	35,62
BF	PE	200	100	3,50	1373	13,73	9,61	23,13	14,99	59,73
BG	PE	115	100	4,50	448	7,79	4,03	14,47	6,94	19,49
BH	PE	115	100	4,50	578	5,02	2,60	9,33	4,47	12,57
BI	PE	200	100	3,50	9045	45,22	31,66	76,19	49,38	196,72
BJ	PE	290	50	2,50	14963	51,59	37,41	100,30	67,33	162,72
BK	PE	290	50	2,50	12968	44,72	32,42	86,93	58,35	141,02
BL	PE	830	50	1,30	10973	13,22	14,26	20,22	20,20	119,33
BM	PE	830	50	1,30	8977	10,82	11,67	16,54	16,53	97,63
BN	PE	830	50	1,30	6983	8,41	9,08	12,87	12,85	75,93
BO	PE	830	50	1,30	4988	6,01	6,48	9,19	9,18	54,24
BP	PE	290	50	2,50	1567	5,40	3,92	10,51	7,05	17,04
BQ	PE	290	50	2,60	3830	13,21	9,96	26,13	18,24	41,66
BR	PE	60	50	5,00	4589	76,48	22,94	214,74	59,65	49,90

	SOLID SURFACE without KNOTS [m2]	WEIGHT without KNOTS
TOP PANELS	240,85	386,11
LATERAL PANELS	251,93	327,68
BOTTOM PANELS	231,64	375,92
TOTAL	724,42	1089,71

	SOLID SURFACE with KNOTS [m2]	PANEL WEIGHT with KNOTS [kg]
TOP PANELS	397,48	726,36
LATERAL PANELS	410,91	590,07
BOTTOM PANELS	410,95	777,01
TOTAL	1219,33	2093,45

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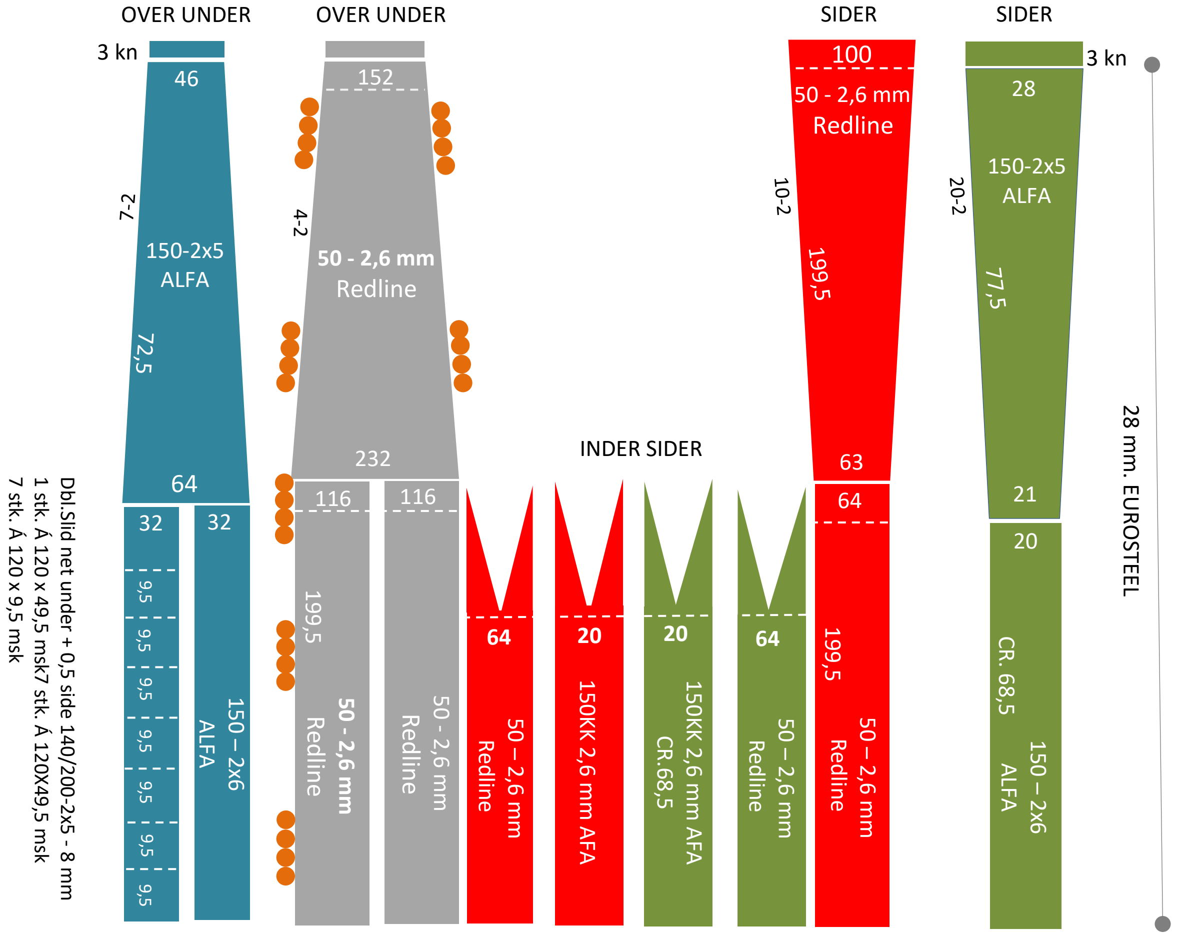
CODEND | NORTHERN OSPREY III | AcruxSoft Digitization



Codlinemasker i spellet | 720 msk | Vónin

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PRELIMINARY DIAGNOSIS

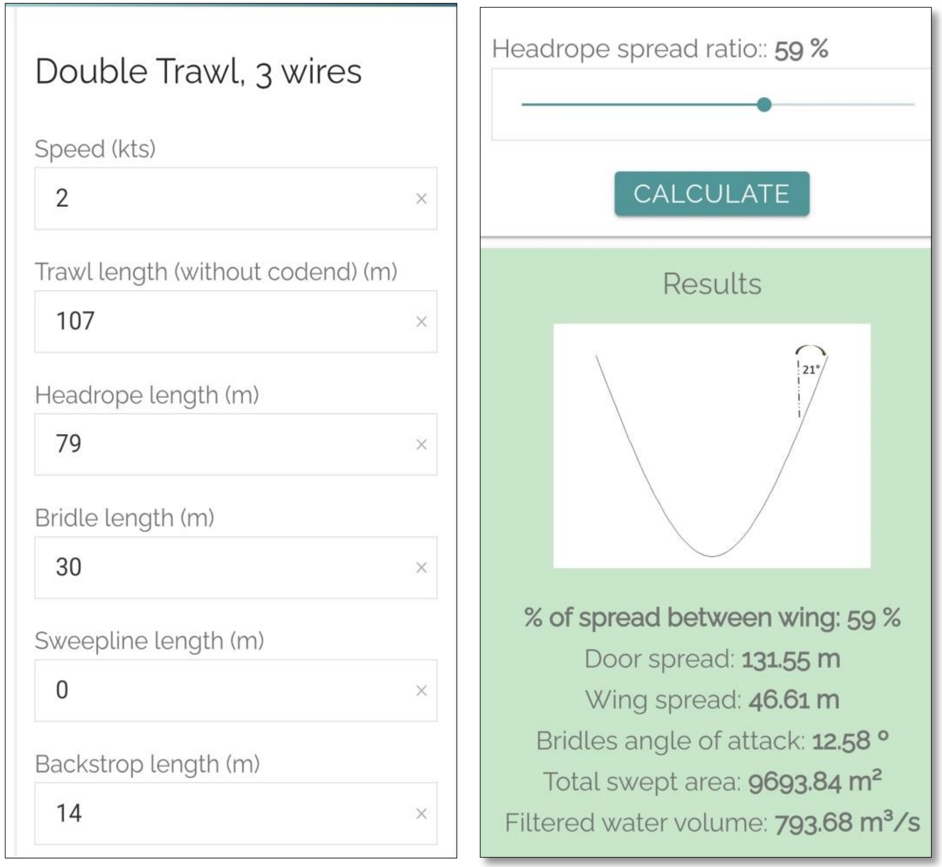


Image SoftwareTrawl Vision Movile

We observed a trawl net constructed from high-quality materials, featuring a well-proportioned design as indicated by the software diagnosis, and demonstrating versatility in its deployment.

The net maintains correct bottom contact and achieves optimal flotation for demersal nets, with a buoyancy of 20 kgf per meter and a substantial rockhopper weight of 8,200 kg.

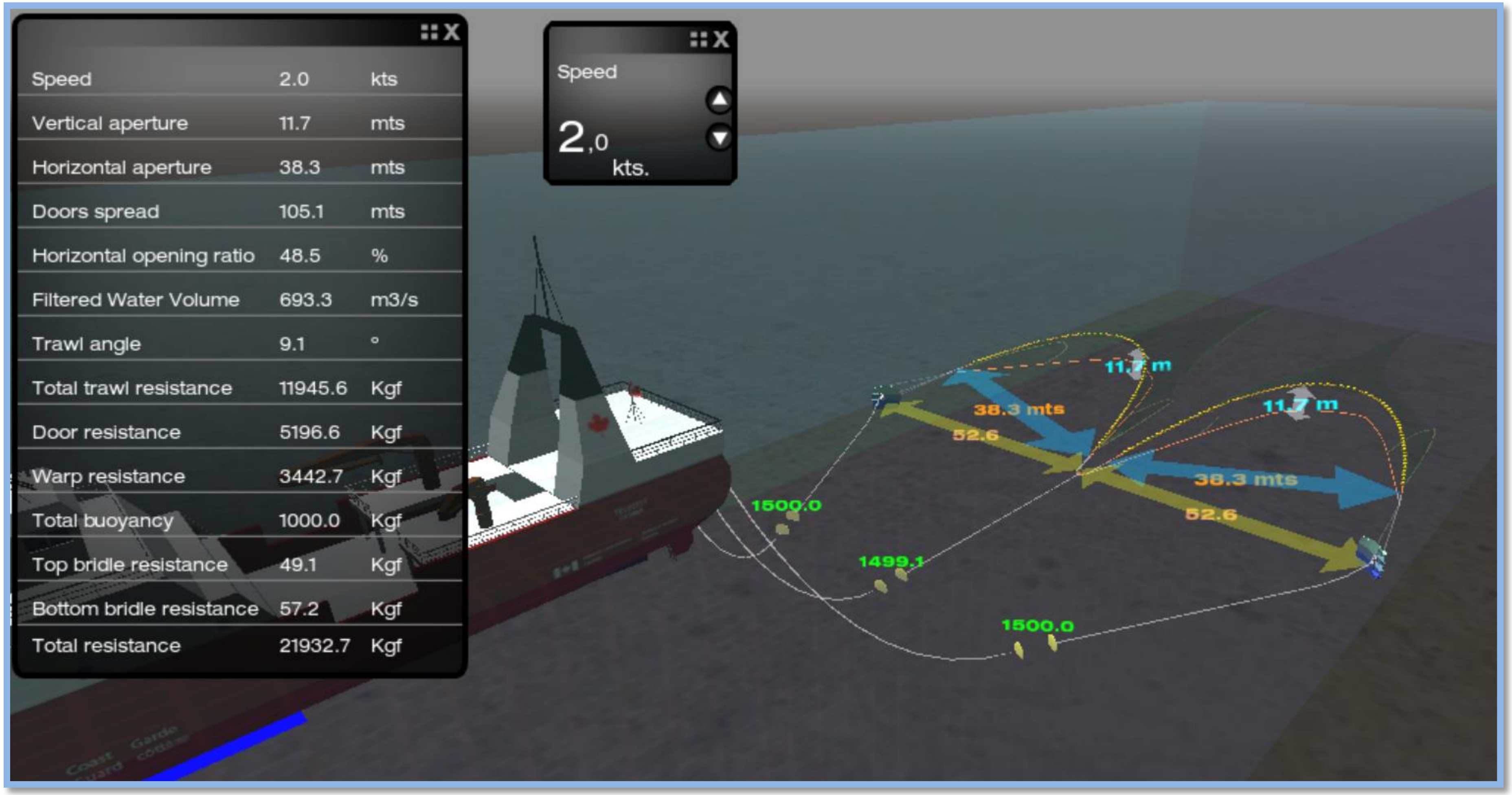
The analysis presents an optimum: angles of attack, net openings, spread wing and optimal headrope deployments.

The advantages of tri-wing tips are significant as they provide a much more stable shrimp trawl by transferring more tension to the selvage lines.

Due to the characteristics of the design, a trawl with great height is observed that allows greater catching power for the shrimp.

The preliminary results enable us to calculate the technical efficiency of the twin trawl and determine its optimal deployment.

SIMULATION RESULTS AT 2 KNOTS AT A DEPTH OF 500 METERS



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SIMULATION RESULTS AT 2,0 KNOTS | TVS

Average mesh length	77,65 mm
Average twine diameter	3,19 mm
Overall trawl filtration index	**0,041**
Fishing Circle of net	152,3 m
Trawl net length	106,9 m
Total twine area	817,6 m²
Total panel area	4456,7 m²
Attack net for designer	15,1° (By netting design)
Trawl angle attack	7,7° (simulator)
Estimated total weight of net panel + codend	2093,66 kg (The total estimate of the weight of the twine is based on the ¨**runnage**¨ of the Euroline Premium tables based on the diameter of the twine per section of trawl net and codend).
RESISTANCE |	**SPEED 2,0 kts.**
Trawl	11945,6 kgf
Doors	5196,6 kgf
Warp	3442,7 kgf
Floaters	1000,0 kgf
Bridle	351,0 kgf
Total	21932,7 kgf

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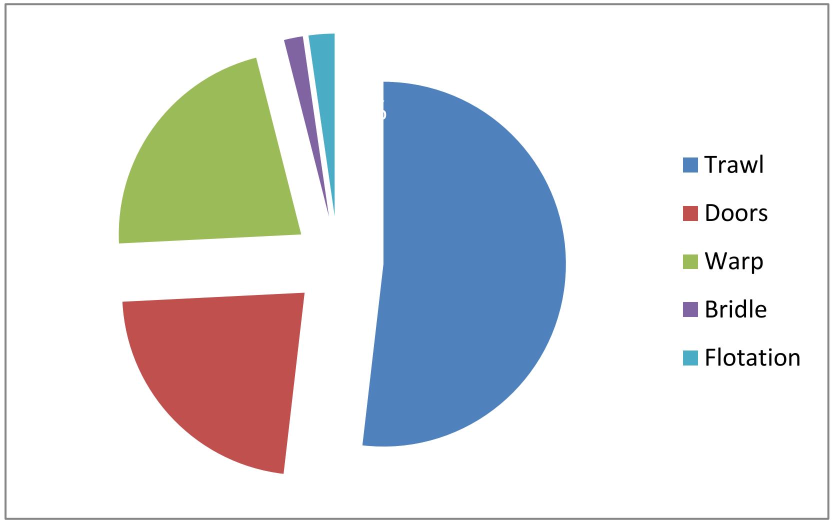
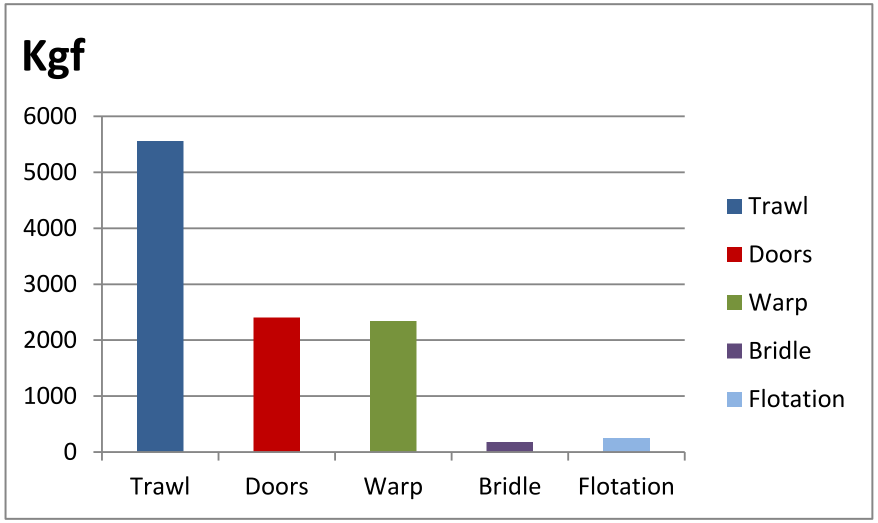
RESISTANCE ANALYSIS

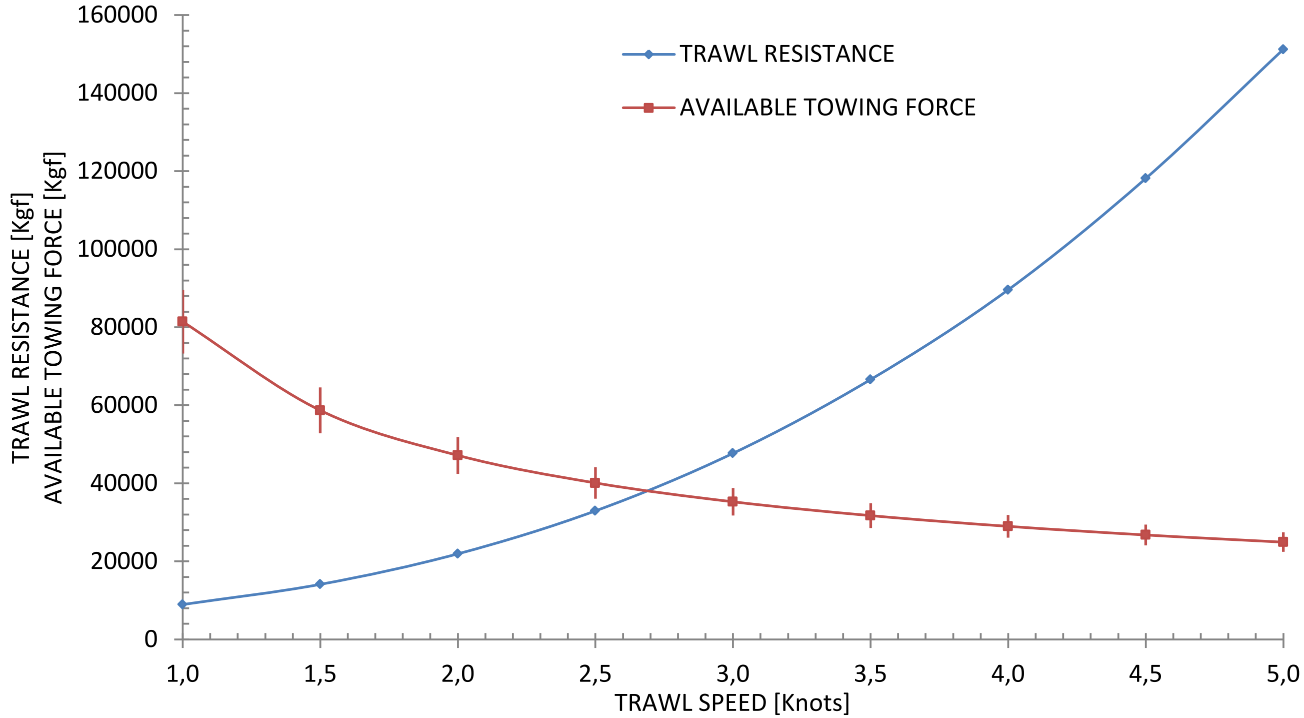
Distribution of resistance among the elements comprising the trawl system.





The following analysis presents the percentage distribution of forces within the trawling system of the Northern Osprey III fishing vessel. The data reveals a balanced resistance profile, with a notable distinction between the low resistance of the doors and the high trawl net.

ANALYSIS OF THE AVAILABLE TOWING FORCE OF THE NORTHERN OSPREY III IN RELATION TO SPEED AND TWIN TRAWL



According to the results processed by the software and the observation of the intersection between the towing force lines of the Northern Osprey III vessel (HP 8100, estimate 85% performance + nozzle) and the twin trawl resistance, the vessel can tow the trawl up to a speed of 2.7 knots.

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DYNAMIC PERFORMANCE

The Trawl Vision Simulator® (TVS® v.1.3.11.2023) displays simulations within the speed range of 1.0 to 5.0 knots, as recommended by ICES (1982). The simulator screen allows for the evaluation and modification of 28 different variables, enabling users to maximize the efficiency of the trawl according to the fishing gear configuration provided by the company.

For this evaluation, only the registration of 9 variables was sufficient.

To catch shrimp based on the deployment of the fishing gear and behavior of the target species, the performance marked in green is recommended.

Speed kts.	Vertical Trawl	Wing Spread	Doors Spread	Headrope wing ratio	Filtered Water volume m^3/s	Trawl angle	Resistance total
1,0	14,1 m	18,7 m	51,3 m	23,7 %	203,6 m^3/s	4,4°	8942,2 Kgf
1,5	12,9 m	29,6 m	81,4 m	37,5 %	441,9 m^3/s	7,0°	14119,2 Kgf
2,0	11,7 m	38,3 m	105,1 m	48,5 %	693, 3 m^3/s	9,1°	21932,6Kgf
2,5	11,0 m	44,8 m	123,0 m	56,7 %	951,0 m^3/s	10,7°	32947,0 Kgf
3,0	10,0 m	49,8 m	136,6 m	63,0 %	1154,0 m^3/s	11,9°	47693,4kgf
3,5	9,1 m	53,7 m	147,5 m	68,0 %	1316,5 m^3/s	12,9°	66595,0 kgf
4,0	7,5 m	57,0 m	156, 6 m	72,2 %	1328,7 m^3/s	13,7°	89987,0 kgf
4,5	6,0 m	60,0 m	164, 6 m	75,9 %	1255,7 m^3/s	14,9°	118130,0kgf
5,0	4,5 m	62,6 m	172,0 m	79,3%	1092,5 m^3/s	15,0°	151215,7kgf

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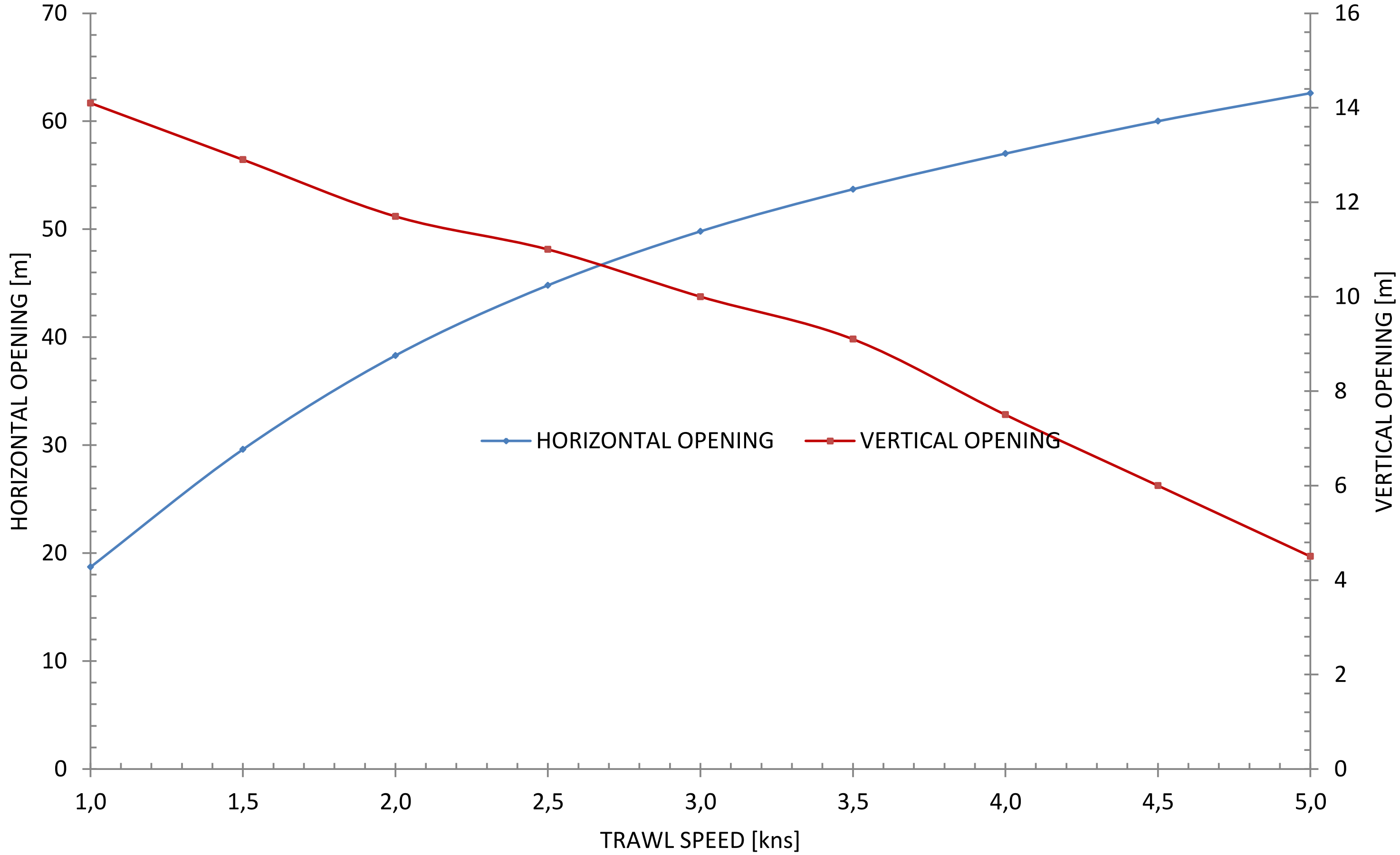
DYNAMIC PERFORMANCE



We observe in the graph that at a speed of 2.6 kns. its optimal vertical opening is reached based on the horizontal wing spread.

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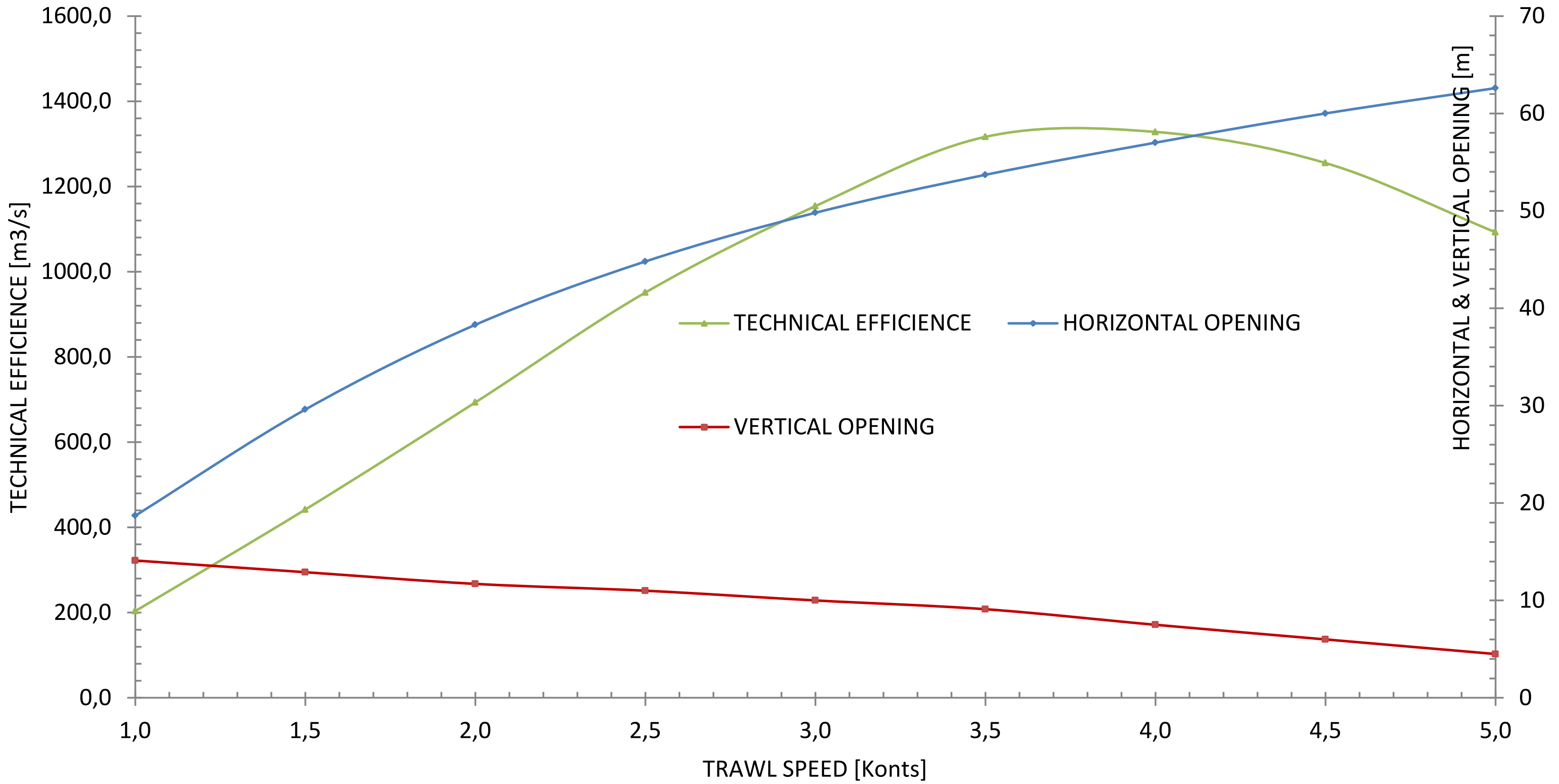
OPTIMAL TRAWLING SPEED

The following graph presents the relationship between ¨technical efficiency¨ (volume of filtered water m³/s), speed and trawl performance.



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CONCLUSION

Using TrawVision software, we were able to analyze, evaluate and digitize the Twin Trawl components of the Northern Osprey III ship. We verify the perfect combination of the forces that interact in the trawl system allows highly efficient performance and hydrodynamic balance. These carefully calibrated forces ensure that each component of the system works in harmony, optimizing the resistance and speed of water flow. This synergy not only improves the vessel's energy efficiency, but also enhances its fishing capacity. As a result, a profitable and specific operation for shrimp capture is achieved, thus maximizing the productivity and sustainability of the fishing activity using the interaction of the Vónin Company and analysis by software from the AcruxSoft Company.

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