Research of multilayer structure in the Sirius 3M trawl with 4, 8, and 16 net sections

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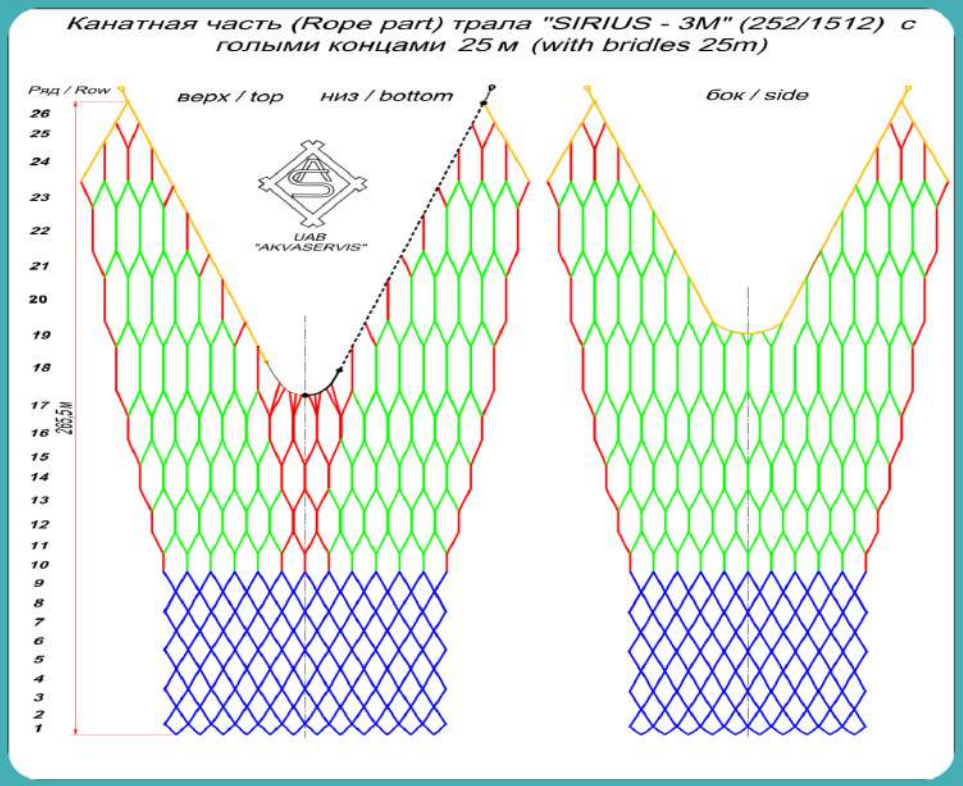
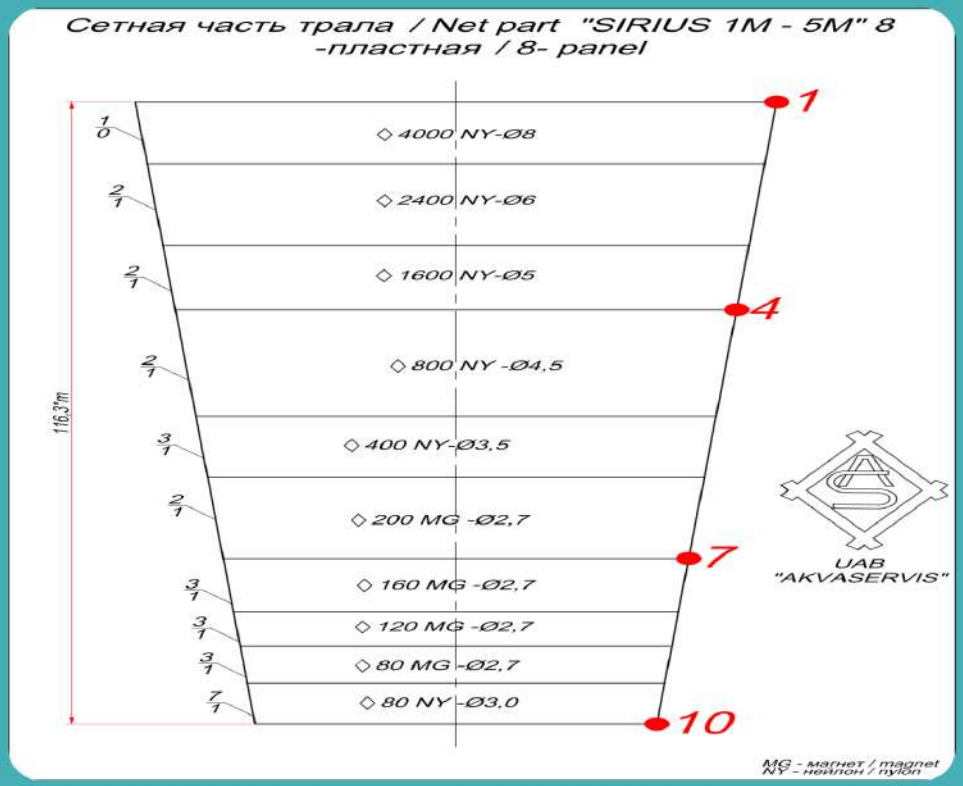
MODEL PARAMETERS OF THE TRAWL





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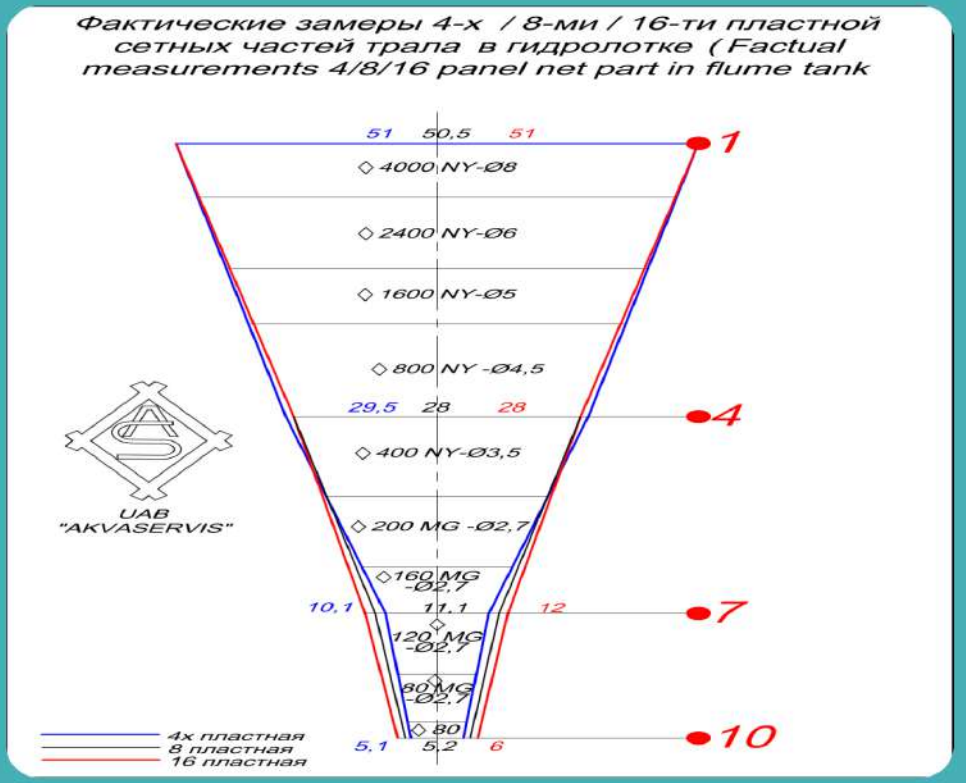
MEASUREMENTS OF NETTING DURING TESTS

Trawl name	SIRIUS 3M 302 / 1512 with bridles 25м		
Net part	Sirius 1M-5M 4 panel	Sirius 1M-5M 8 panel	Sirius 1M-5M 16 panel
Scale	1:40	1:40	1:40
Speed, kt	5	5	5
Sweepline, m	50	50	50
Bridle, m	25	25	25
Setback, m	5+2	5+2	5+2
Sinking weight, kg	2000+500	2000+500	2000+500
Trawl position	midwater	midwater	midwater
Cable tension, T	15,6	16	15,4
Horizontal opening, m	137	138	135
Vertical opening, m	55	53,8	54,5
Door spreading, m	205	208	205

Net part opening at points						
	height, m	width, m	height, m	width, m	height, m	width, m
Point 1	25,8	51	23,7	50,5	23	51
Point 4	13,2	29,5	15,3	28	16	28
Point 7	8,2	10	9	11,1	9	12
Point 10	5,4	5,1	5,5	5,2	5	6



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MEASUREMENTS OF NETTING DURING TESTS

From the table, it can be seen that the cross-sectional areas in the conical part of the codend, from 4 to 16 panels, increase (shifting the critical zone) due to improved mesh opening, while the trawl resistance remains unchanged due to better filtration. For most target fish species, the mesh size is 40–60 mm.

The smaller the mesh size in the panel, the greater the number of meshes in height. When increasing the cutting ratio from 2/1 in a 4-panel codend to 4/1 in an 8-panel codend and 8/1 in a 16-panel codend, a greater effect is achieved in opening the netting in the critical zone. Therefore, in the critical zone, it is adVisable to manufacture the netting section with 8 or 16 panels.
A 16-panel configuration creates favorable conditions for increasing both vertical and horizontal opening by reducing the influence of contracting forces in these areas. This increases the effective fishing zone and reduces hydrodynamic pressure within the netting structure of the fishing gear.
As a result, fish enter the codend more quickly, and the critical zone shifts toward the codend, where small-mesh netting is installed.

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MEASUREMENTS OF NETTING DURING TESTS

Based on the results and analysis of the trials, it is evident that the best performance in the large-mesh section (4000 mm) was achieved by the 4-panel netting, while in the small-mesh section (400 mm–80 mm), the best results were demonstrated by the 16-panel netting.
At the 2400 mm–800 mm range, the performance of the 8-panel and 16-panel netting is similar; therefore, it is more efficient to use the 8-panel netting in this section.

Net part opening at points						
	4 panels net part		8 panels net part		16 panels net part	
	height, m	width, m	height, m	width, m	height, m	width, m
Point 1	25,8	51	23,7	50,5	23	51
Point 4	13,2	29,5	15,3	28	16	28
Point 7	8,2	10	9	11,1	9	12
Point 10	5,4	5,1	5,5	5,2	5	6

After the trials, it was decided to manufacture a netting section based on the best-performing configurations of the 4-, 8-, and 16-panel sections and compare it with the netting section of the Orion trawl, which is the most commonly used in commercial fishing.

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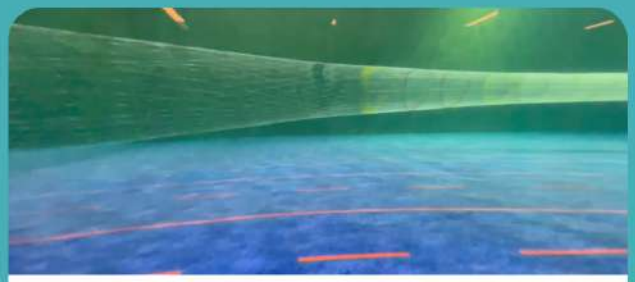
COMPARISON OF NETTING SECTIONS

4 panels net part



Cheaper to manufacture compared to 8- and 16-panel codends; however, wave-like motion is observed in the netting. During turns, the netting collapses, resulting in no effective fish capture.

8 panels net part

Compared to the 4-panel netting section, it is slightly more complex to manufacture, but wave-like motion is eliminated, structural rigidity is improved, and the netting does not collapse during turns, which leads to a significant increase in catch.

16 panels net part

More expensive than the others, but it provides maximum perimeters in the critical zone, increasing the fishing area and facilitating the entry of fish into the codend.

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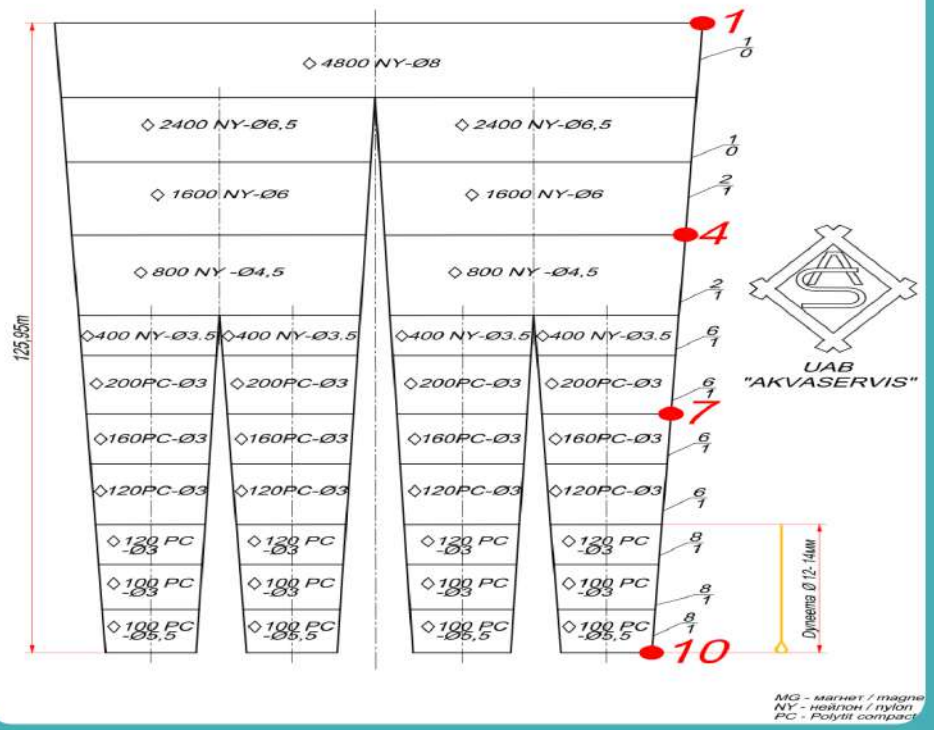
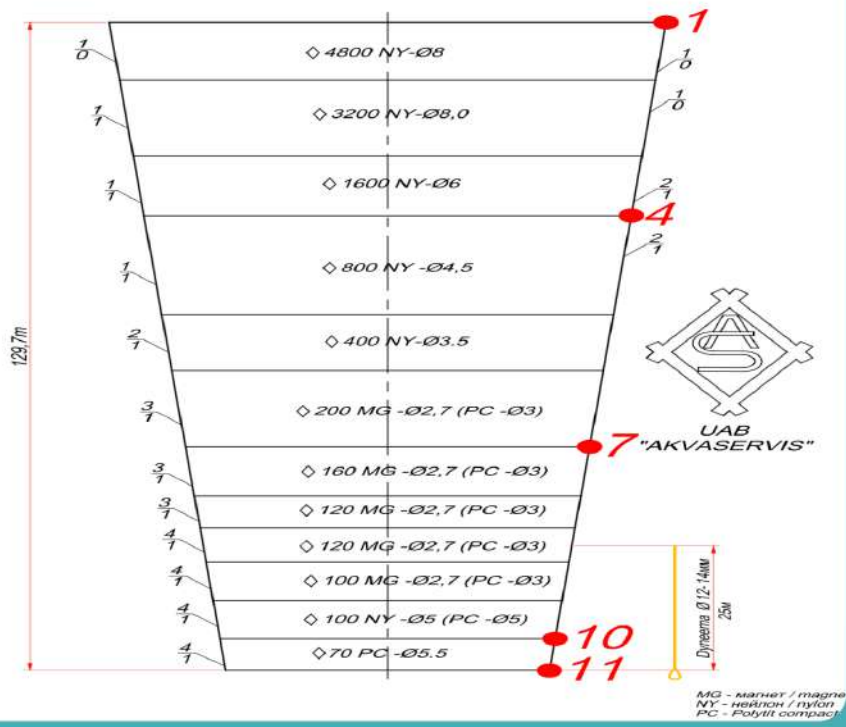
SIRIUS 3M TRAWL PARAMETER MEASUREMENTS WITH DIFFERENT NETTING PARTS

Сетная часть трала / Net part "ORION" 4-8-16 пластная / 4-8-16 panel



Сетная часть трала / Net part "ORION" , "ORION L", "ORION M" , "ORION S" 8 - пластная / 8-panel



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MEASUREMENTS AND COMPARISON OF NETTING DURING TESTS

Net part	Orion 8 panels net part		Orion 4-8-16 panels net part	
Scale	1:40		1:40	
Speed, kt	5		5	
Trawl position	midwater		midwater	
Vertical opening, m	131		133,5	
Horizontal opening, m	44		43,2	
Net part opening at points				
	height, m	width, m	height, m	width, m
Point 1	17,8	47,36	19,07	47,76
Point 4	13,92	20,24	13,6	22,4
Point 7	9,8	12,2	9,6	16,6
Point 10	5,08	5,32	8	8

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COMPARISON OF NETTING SECTIONS

The 8–16 panel netting section creates favorable conditions for increasing both horizontal and vertical opening of the trawl by reducing the influence of contracting forces within the netting. This increases the effective fishing zone and reduces hydrodynamic pressure inside the netting structure of the fishing gear. As a result, fish enter the codend more quickly, reducing trawling time and improving product quality.

In fishing gear, regardless of its design, there is a "critical zone" where fish reorient and begin moving out of the trawl. Installing an 8–16 panel netting section ahead of an 8-panel codend significantly reduces the attack angle of the netting and shifts the "critical zone" closer to the codend, where fish can no longer escape.

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CONCLUSION

In the new 4–8–16 netting section design, the netting area in the critical zone is 160.4 m², which is 40.8 m² greater than that of the proven 8-panel Orion model.

Due to the increased area, this netting configuration provides better trawl filling and more efficient catch performance. Therefore, we recommend implementing the 4–8–16 configuration.

Net part opening at points				
	height, m	width, m	height, m	width, m
Point 1	17,8	47,36	19,07	47,76
Point 4	13,92	20,24	13,6	22,4
Point 7	9,8	12,2	9,6	16,6
Point 10	5,08	5,32	8	8

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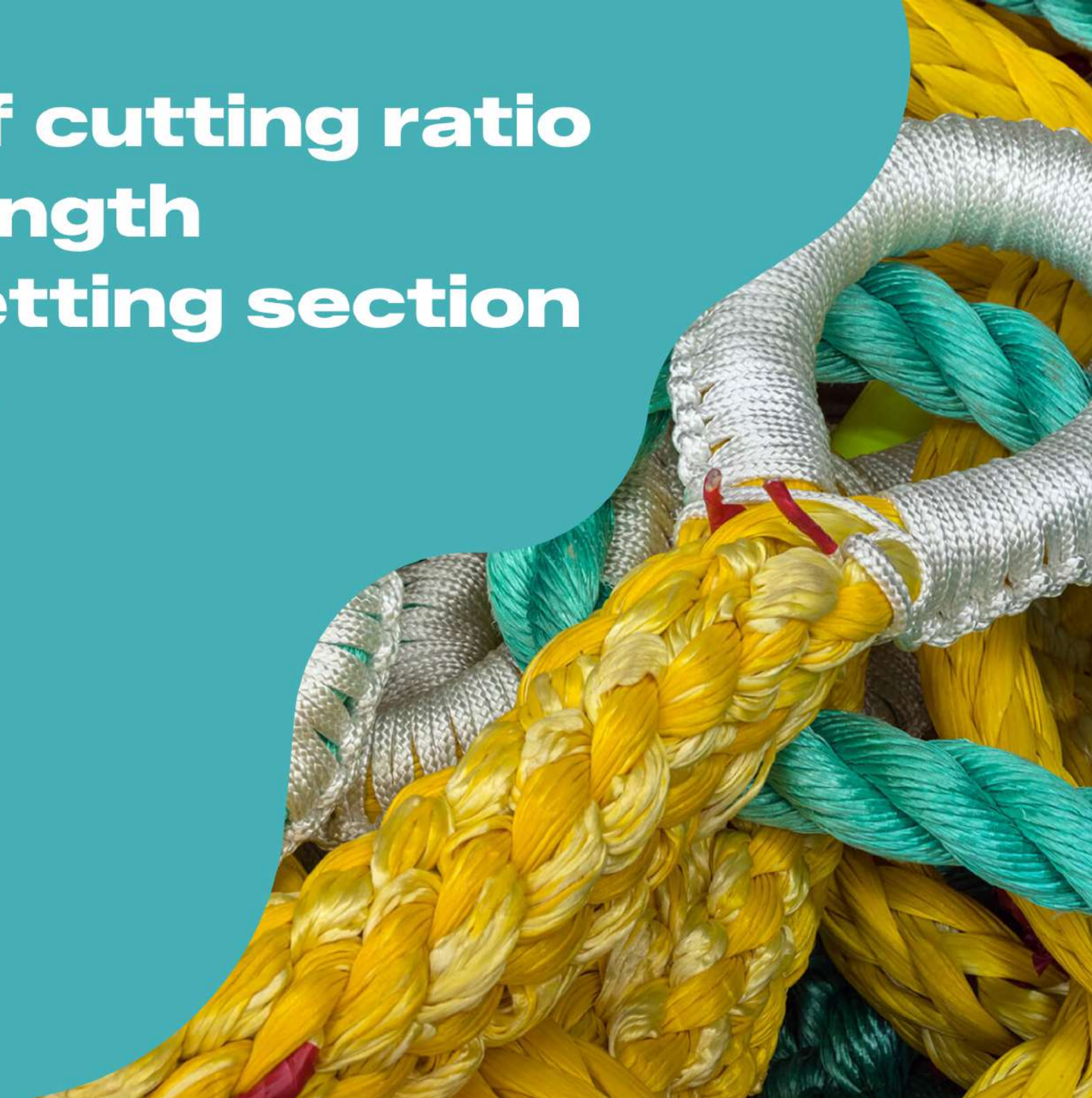
Effect of cutting ratio on the length of the netting section in trawls



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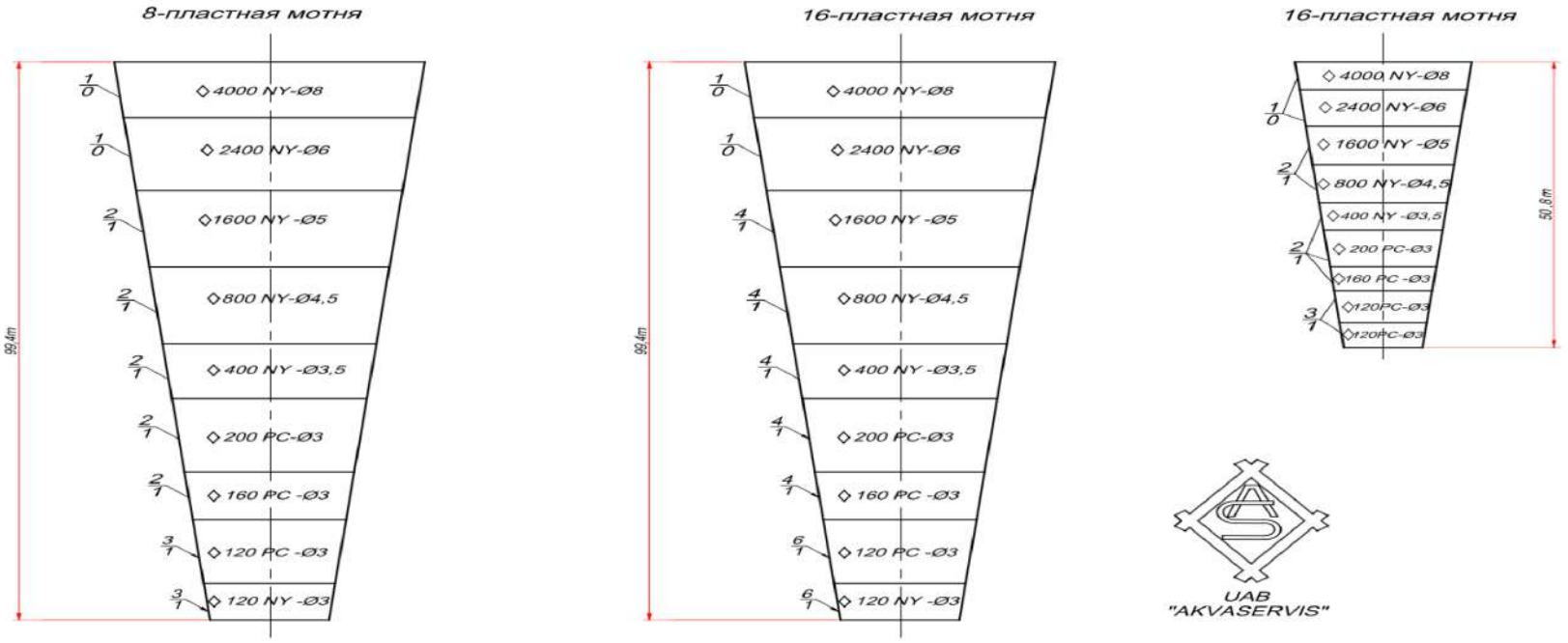
EFFECT OF CUTTING RATIO ON THE LENGTH OF THE NETTING SECTION IN TRAWLS



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COMPARISON OF NETTING SECTIONS

When operating trawls on continental shelves, in ice conditions, and when targeting fast-swimming fish species, it is advisable to manufacture shorter netting sections while maintaining the perimeters of the cross-sections in the netting structure (especially in the critical zone). Video observations have shown that as the net cone narrows, fish exhibit increased swimming activity, typically expressed by turning in the direction of towing, partial entry into the codend, and escape from the trawl, which significantly affects catch efficiency.

Reducing the height of netting panels while maintaining the cutting ratio—by increasing the number of panels in the netting structure of a multi-panel trawl (while preserving the total number of meshes in the upper and lower sections)—creates favorable conditions for faster entry of fish into the codend. Fish do not have time to turn during towing, trawling time is reduced, and product quality is improved.

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EFFECT OF CUTTING RATIO ON THE LENGTH OF THE NETTING SECTION IN TRAWLS

$L = V \cdot T$

where:

L — length of the netting section, m

V — trawling speed, kt (1 kt = 0.514 m/s)

T — time, s

For the 8-panel netting section:

99.4 m = 5 kt × T

T = 99.4 / (5 × 0.514) = 38.7 s

For the 16-panel netting section:

50.8 m = 5 kt × T

T = 50.8 / (5 × 0.514) = 19.8 s

The calculations show that the shorter netting section (L = 50.8 m) passes the target catch approximately twice as fast.
This has a significant impact on:

- Catch efficiency — fish do not have time to turn and escape from the trawl.
- Material usage — the amount of material required is reduced by approximately two times.
- Product quality — improved due to reduced trawling time.

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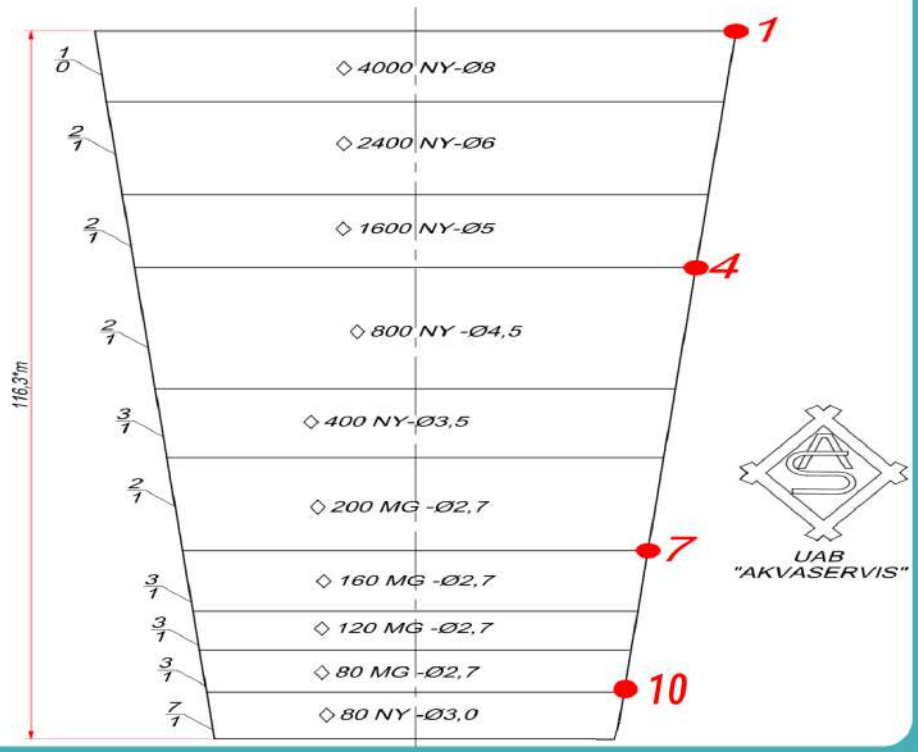
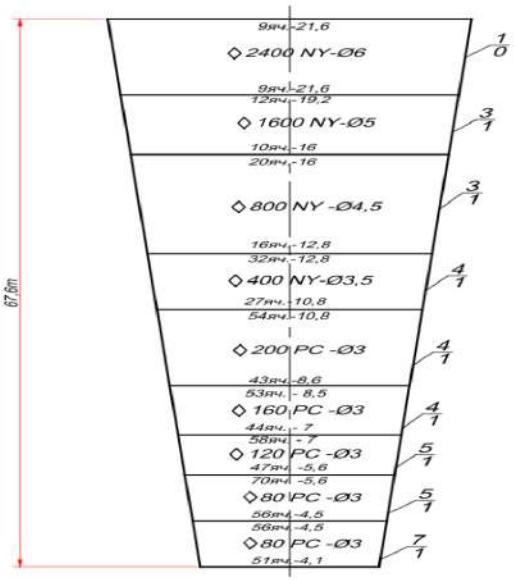
SIRIUS 3M TRAWL PARAMETER MEASUREMENTS WITH VARIOUS NETTING SECTIONS

Сетная часть трала / Net part "SIRIUS 1M - 5M" 8 -пластная / 8- panel



16 -пластная сетная часть с улучшенной фильтрацией воды



UAB "AKVASERVIS"

1. Расстояние между досками - 204м
2. Горизонтальное раскрытие - 137м
3. Вертикальное раскрытие - 51м
1. Сопротивление - 16т

PC - Polytit compact
MG - магнет / magnet
NY - нейлон / nylon

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SIRIUS 3M TRAWL PARAMETER MEASUREMENTS WITH VARIOUS NETTING SECTIONS

Net part opening at points				
	Sirius 1M - 5M, 8 panels		Sirius 3M, 16 panels	
	height, m	width, m	height, m	width, m
Point 1	23,7	50,5	21,14	42,75
Point 4	15,3	28	15	16
Point 7	9	11,1	13,18	14,4
Point 10	5,5	5,2	5,8	11,6
Photo				

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Load reduction in trawl netting through the use of compensators

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LOAD REDUCTION IN TRAWL NETTING THROUGH THE USE OF COMPENSATORS

The reduction of the net cone perimeter in trawls occurs due to changes in the spreading force of the trawl doors, which control horizontal opening, and the kite/float rigging, which controls vertical opening. As a result, the forces applied to the upper and lower panels differ significantly from those acting on the side panels.

In large-tonnage vessels, the spreading force is generated by trawl doors (2 units) with an area of 8–16 m^2, while the kite rig has a maximum area of $12 \times 0.6 = 7\ m^2$.

As the opening increases, the bridle sections (L2) move forward, creating excessive tension in the netting, which reduces the perimeter of the cone.
The installation of compensators in the netting at the junction between the netting section and the codend allows for a reduction of stress in the critical zone, improves opening, and increases water filtration.

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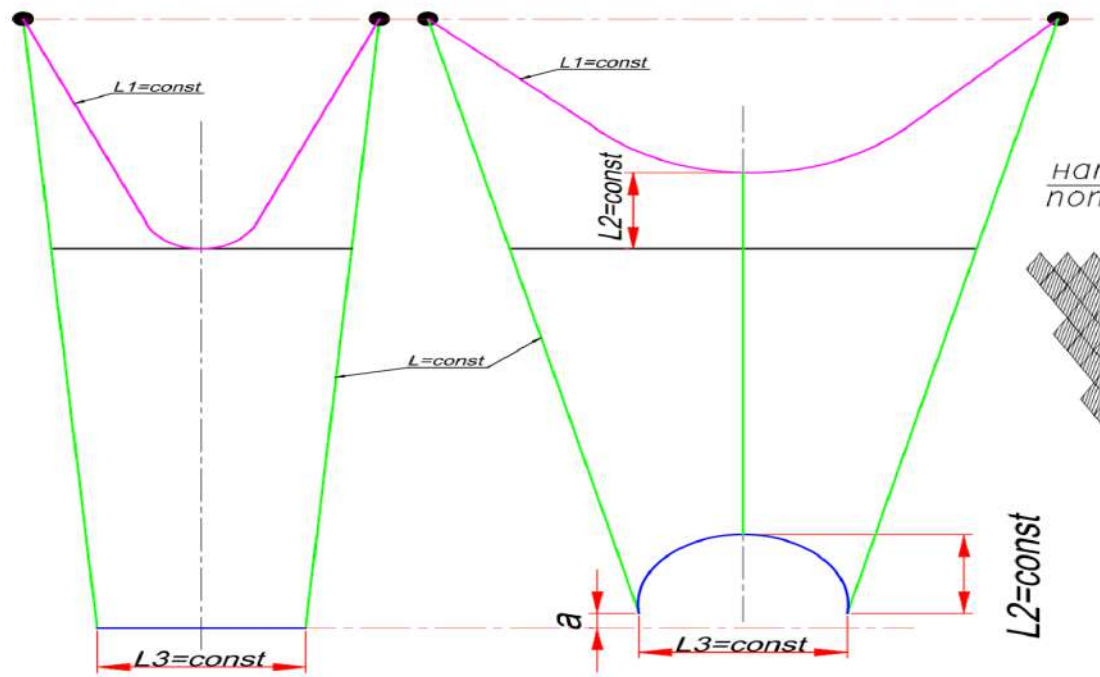
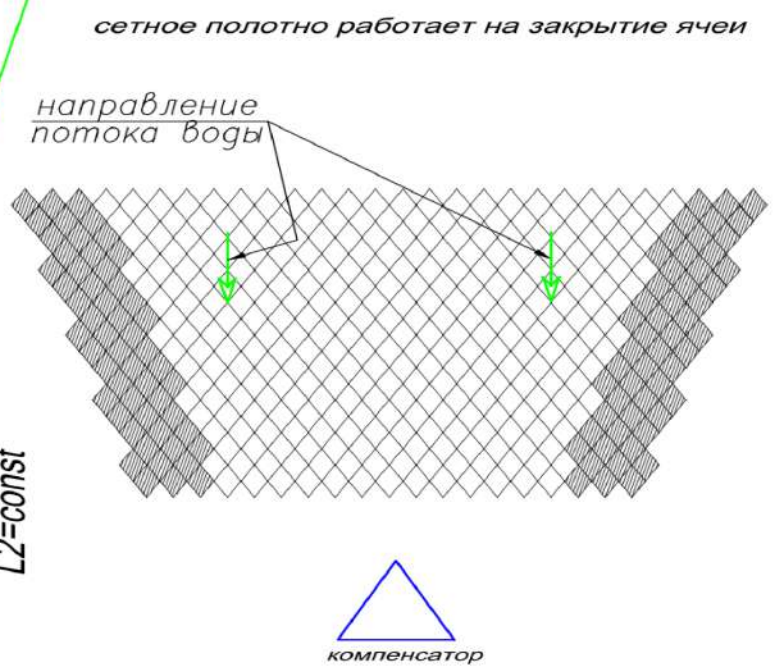
LOAD REDUCTION IN TRAWL NETTING THROUGH THE USE OF COMPENSATORS





Фиг. 5

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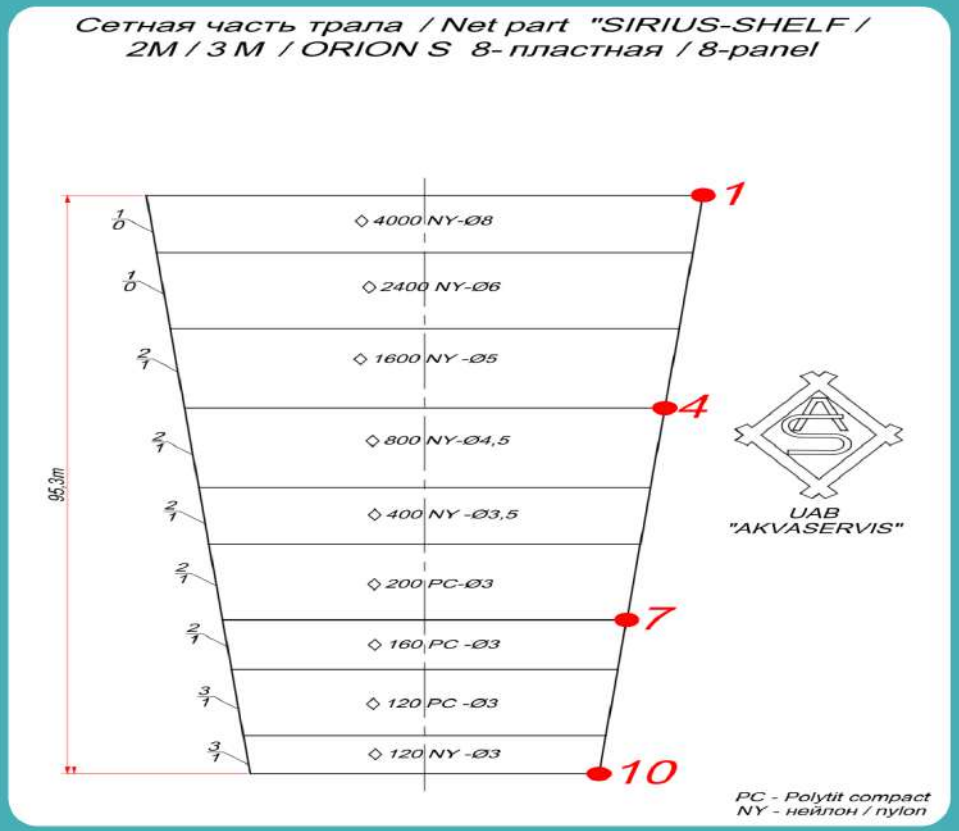
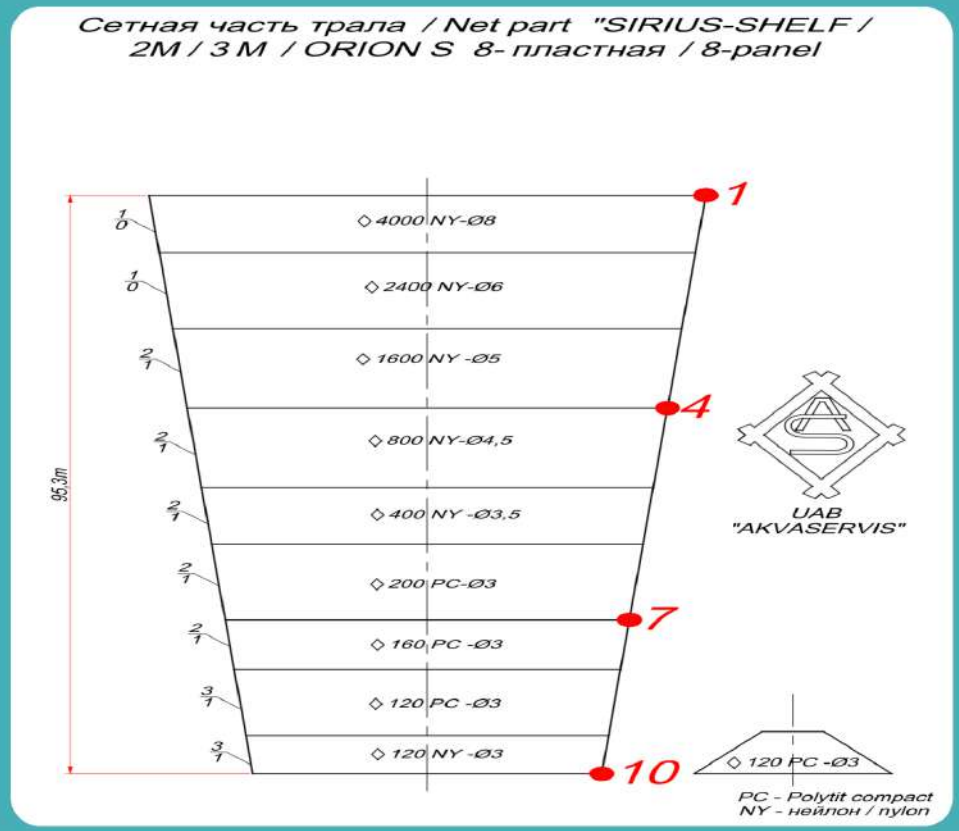
LOAD REDUCTION IN TRAWL NETTING THROUGH THE USE OF COMPENSATORS





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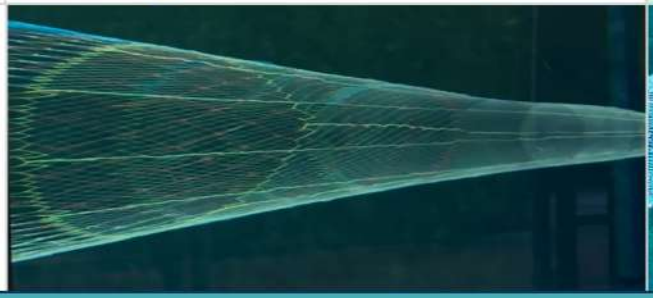
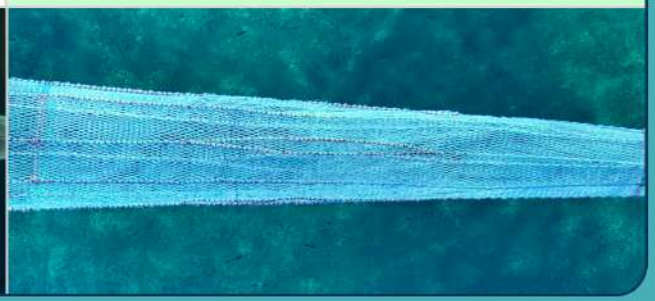
LOAD REDUCTION IN TRAWL NETTING THROUGH THE USE OF COMPENSATORS

Net part	Orion 3MK (266/15120)		Orion 3M 4K (310/1512)	
Scale	1:40		1:40	
Speed, kt	5		5	
Trawl position	midwater		midwater	
Net part opening at points				
	height, m	width, m	height, m	width, m
Point 1	20	42	20	37
Point 4	13	23	13	19
Point 7	11	11	8	15
Point 10	3	5	5	4
Photo				

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