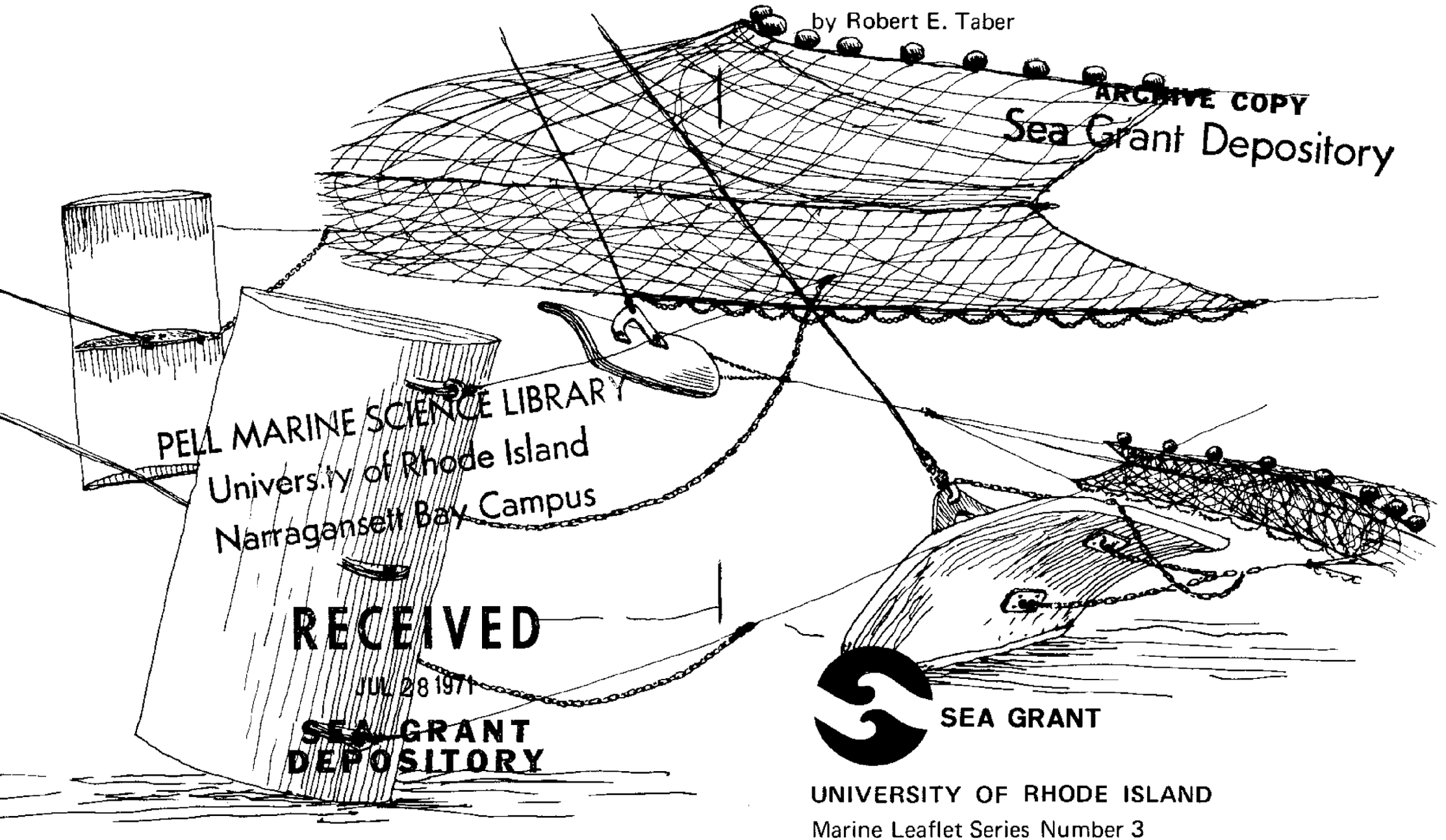
RIU-TL-71-002

THE DYNAMICS OF EUROPEAN WING TRAWLS

by Robert E. Taber



SEA GRANT

UNIVERSITY OF RHODE ISLAND
Marine Leaflet Series Number 3

THE DYNAMICS OF EUROPEAN WING TRAWLS

by Robert E. Taber, commercial fisheries specialist, University of Rhode Island Marine Advisory Service (MAS). Research on this project was carried out by the University's Marine Experiment Station, Jerusalem, Rhode Island. Cover drawing is from an original by John C. Sisson and other drawings are by Marc Stuart.

For further copies write to Marine Advisory Service, Narragansett Bay Campus, University of Rhode Island, Narragansett, Rhode Island 02882.

OTHER PUBLICATIONS

Other publications relating to fishing vessels and their gear are available from the MAS and the New England Marine Resources Information Program (NEMRIP) at the above address. They include:

Cutting Web Tapers – Geoffrey A. Motte
Selecting a Radar Set for a Fishing Vessel – Geoffrey A. Motte
Computing Horsepower Used in Trawling – Robert E. Taber
Fisheries Training Films (eight films in B/W 16mm sound) – University of Rhode Island Film Production Center
Factors Involved in the Storage and Transport of the American Lobster – Thomas L. Meade
Long-lining for Swordfish – Phillip Rhule
A Report of the 1970 Fishermen's Forum – Teree L. Hartt, ed.
Two-Boat Midwater Trawling for Herring – James McLeod
A Special Report on Fish Inspection Legislation – NEMRIP
New FCC Marine Radio Regulations – Robert W. Merriam

INTRODUCTION

The European wing trawls were introduced to the vessels of the southern New England fishing fleet in December, 1968, under the support of Public Law 88-309. The Point Judith Fishermen's Cooperative was the contracting agency, with David B. Thomson of the Department of Fisheries and Marine Technology at the University of Rhode Island contributing a major role in the project.

The purpose of the project was to increase the catch of Atlantic herring *(Clupea harengus)*, which occasionally are found in abundance along the Rhode Island coast during the late fall and winter. Moderate success was gained by two of the vessels trying the trawls; they landed 1 million pounds of the herring during the period December 9, 1968 - January 17, 1969.

Little was known about the dynamics of the two-bridle or the three-bridle trawl used other than both lifted higher and did not tend the bottom as hard as conventional trawls. Thus, this report addresses itself to the following questions: (1) What are the physical capabilities of the trawls? (2) What operational parameters influence their operation? (3) To what extent do the rigging and towing parameters govern their physical capabilities?

The trials, or evaluations, were carried out as part of the Sea Grant Program by personnel at the University of Rhode Island's Marine Experiment Station using the fishing vessel *La Nina* stationed there. Principal personnel making the evaluations were Robert E. Taber and John C. Sisson, skipper. The Department of Fisheries and Marine Technology and the Marine Advisory Service of the University also cooperated.

PROCEDURE

To evaluate the trawls pairs of tows were made through a known distance for each given set of parameters. Each tow (listed in the data) consisted of a pair of tows in opposite directions in order to minimize the effect of tide and wind. The parameters consisted of such things as the doors or otter boards used, their angle of attack, the length of ground cables and bridles, engine RPM, and the number of floats used. The size of the vertical mouth opening, warp tension, and velocity of the trawl, or horsepower, were the responses noted and calculated. For calculating the velocity and horsepower of the trawl tows, the times and distances were each summed for every pair of oppositely directed tows. Hence, the velocities, as presented in the data, are equivalent to slack water ground speeds.

The evaluation area, commonly known as the "torpedo range," lies approximately eight miles east of Point Judith, Rhode Island. The area is shown in Figure 1. The distances between the buoys were obtained from the U.S. Navy, Underwater Ordinance Station, Newport, Rhode Island.

Horsepower was calculated, using the following formula from *Computing Horsepower Used in Trawling* by Robert E. Taber. (See other publications available, page 2.)

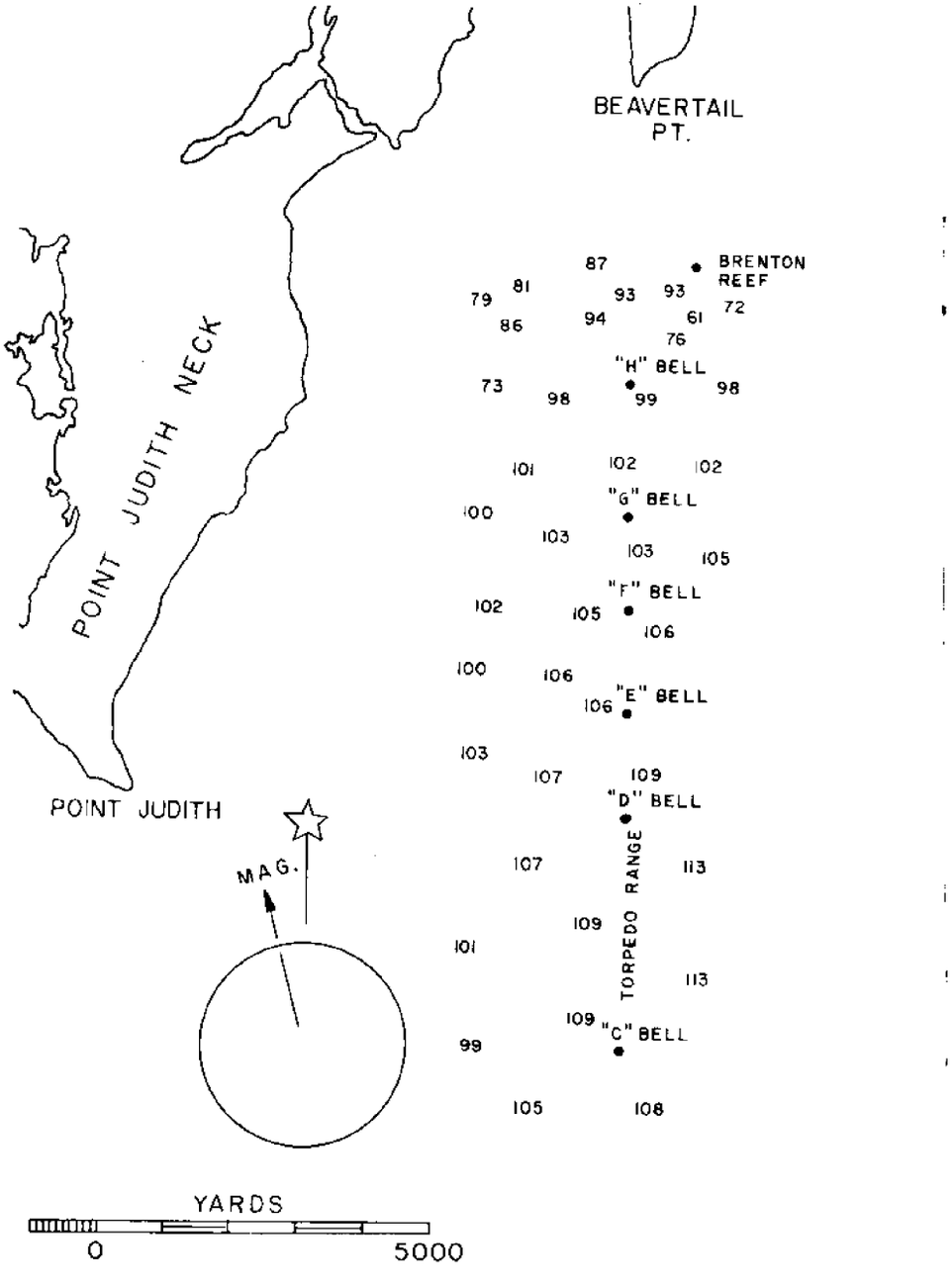


FIGURE 1

$$hp = \frac{2TV}{33{,}000} \sqrt{1 - \left(\frac{D}{L}\right)^2}$$

where T = average warp tension (lbs.), V = velocity of vessel (ft./min.), D = depth from towing point to trawl (ft.), and L = length of tow warp used (ft.).

APPARATUS

Vessel: The 55-foot steel trawler/seiner *La Nina* powered by a 6-71 GM with 4½ to 1 reduction and swinging a 50 x 32 inch propeller.
Net Sounder: Furuno Model FNR-200 acoustically linked head-rope transducer.
Warp Tension Indicator: Martin-Decker Model UA1 Tensometer.
Otter Boards or Doors: a) Tomkiewickz* – 6'6" x 3'6", 670 lb. each; b) Marco Vee – 6'2" x 3', 470 lb. each; c) Suberkrub 3m^2 mid-water.
Trawls: a) Two-bridle wing trawl (Bridport-Gundry); b) Three-bridle wing trawl (Iver Christensen).

RIGGING DETAILS: (Two-bridle Wing Trawl, 93-118)

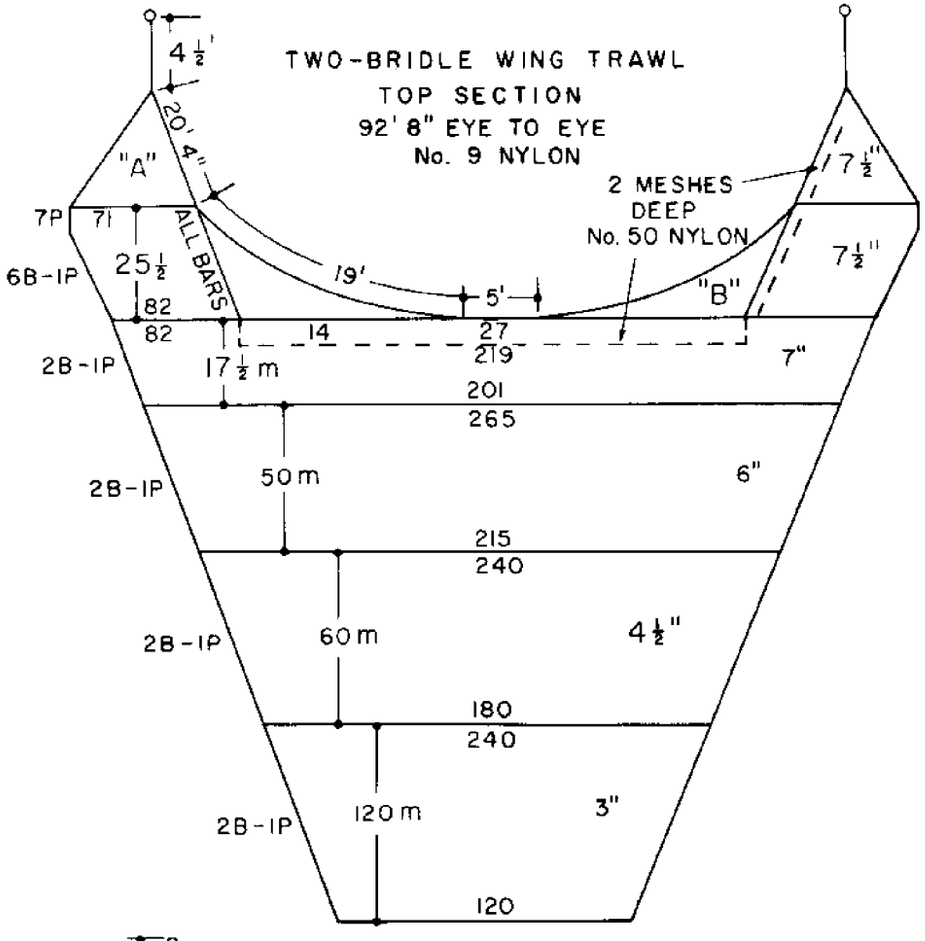
Foot Rope: One-inch manila seized to the hanging line with 48 pounds of lead rings. Total number of rings is 192, four to the pound. The rings are threaded around the foot rope in 63 places and seized to both the foot rope and the hanging line at the same points. (Detail of half of the bottom sweep is shown on page 10.) The rings and sweep are seized at 31 equally spaced points along each half of the sweep according to the numbers noted directly below the sweep line. The sweep is hung without any slack after shrinkage.
Hanging Lines: Half-inch stainless steel-synthetic combination rope.
Floats: From 22 to 26 eight-inch floats.
Gores: Four meshes are taken into the gore from each section along the sides, unless otherwise noted.
Wing Ends: The ten meshes on the top (section A, page 6) and the three meshes on the bottom (section C, page 7) are hung on a loop spliced into or seized onto the hanging lines.
Take Ups: On the bottom section where the lower wing and the belly are sewn together, at every fourth wing mesh two belly meshes are picked up.
Hanging Note: Caution must be observed in hanging the net to the specified dimensions so the twine is hung tighter than the hanging line along the wings.

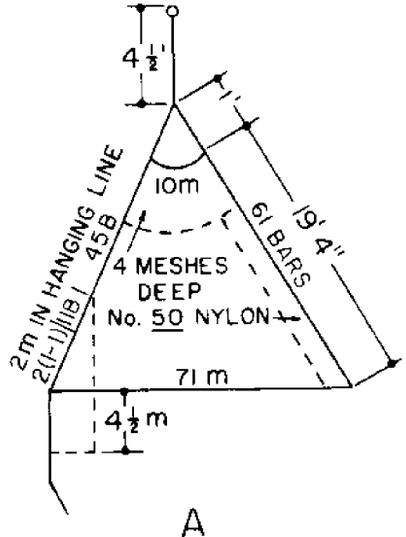
RIGGING DETAILS: (Three-bridle Christensen Wing Trawl, 103-130)

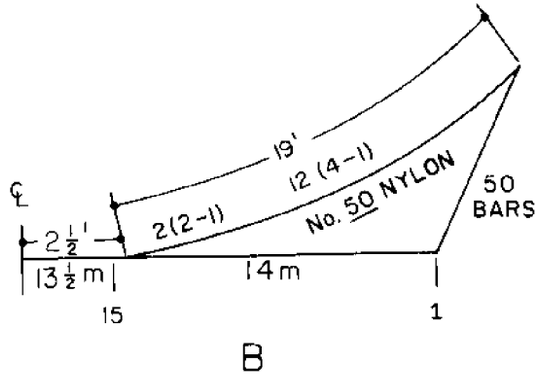
Foot Rope: A 5/8-inch poly line is seized to the hanging line with 29 inches of line seized at 24-inch intervals (See page 10). Fifteen shots of 3/8-inch chain, 36 inches long, are spaced equally along the foot rope.

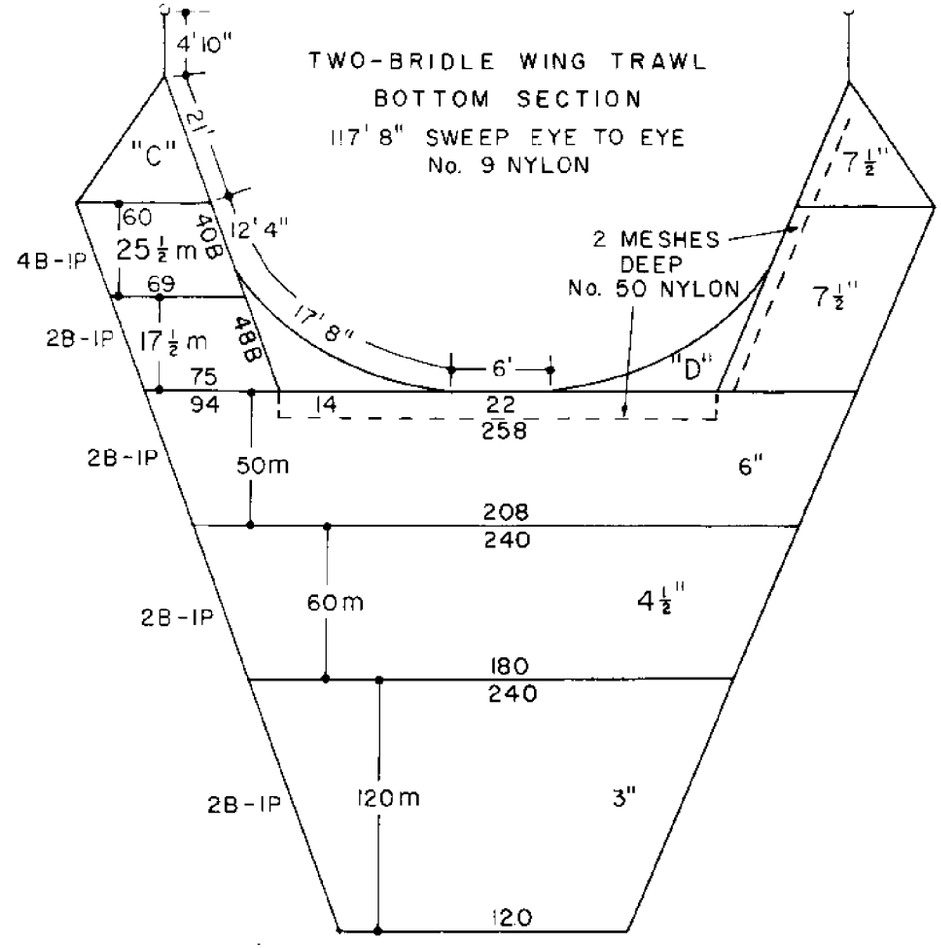
(RIGGING DETAILS continued page 12)

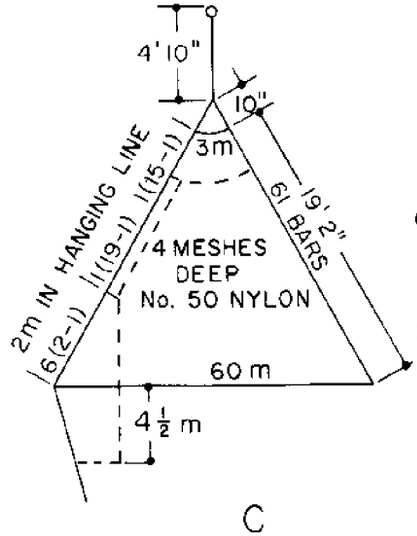
*Tomkiewickz and Westebeke doors are equivalent (rectangular, steel-framed wood).

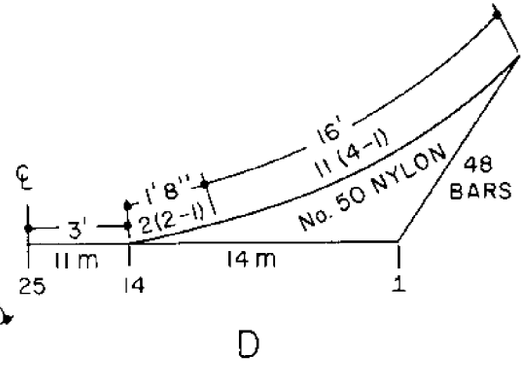

TWO-BRIDLE WING TRAWL
TOP SECTION
92' 8" EYE TO EYE
No. 9 NYLON
4½'
20' 4"
"A"
7P
71
ALL BARS
19'
5'
"B"
7½"
2 MESHES
DEEP
No. 50 NYLON
6B-1P
25½
82
82
14
27
219
7"
2B-1P
17½ m
201
265
50 m
6"
2B-1P
215
240
60 m
4½"
2B-1P
180
240
120 m
3"
2B-1P
120


4½'
1'
10m
19' 4"
61 BARS
2m IN HANGING LINE
2(1-1)|1B
45B
4 MESHES
DEEP
No. 50 NYLON
71 m
4½ m
A

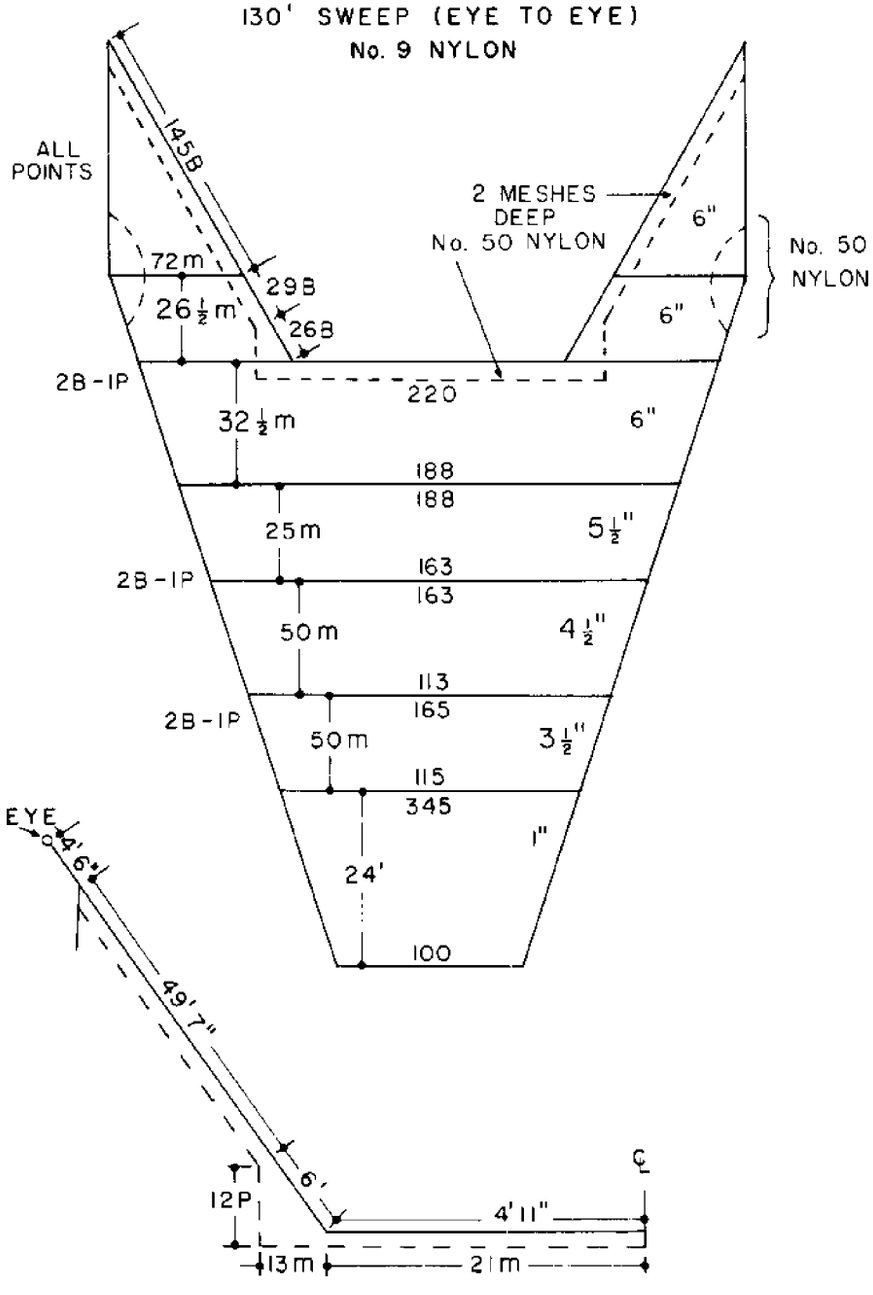

℄
2½'
19'
2(2-1)
12 (4-1)
No. 50 NYLON
50
BARS
13½ m
14 m
15
1
B


TWO-BRIDLE WING TRAWL
BOTTOM SECTION
117' 8" SWEEP EYE TO EYE
No. 9 NYLON
4' 10"
21'
"C"
7½"
60
40B
12' 4"
2 MESHES
DEEP
No. 50 NYLON
4B-1P
25½ m
69
48B
17' 8"
6'
"D"
7½"
2B-1P
17½ m
75
94
14
22
258
2B-1P
50m
6"
208
240
2B-1P
60m
4½"
180
240
2B-1P
120m
3"
120


4' 10"
10"
3m
19' 2"
61 BARS
2m IN HANGING LINE
6(2-1) |1(19-1) |1(15-1)
4 MESHES
DEEP
No. 50 NYLON
60 m
4½ m
C

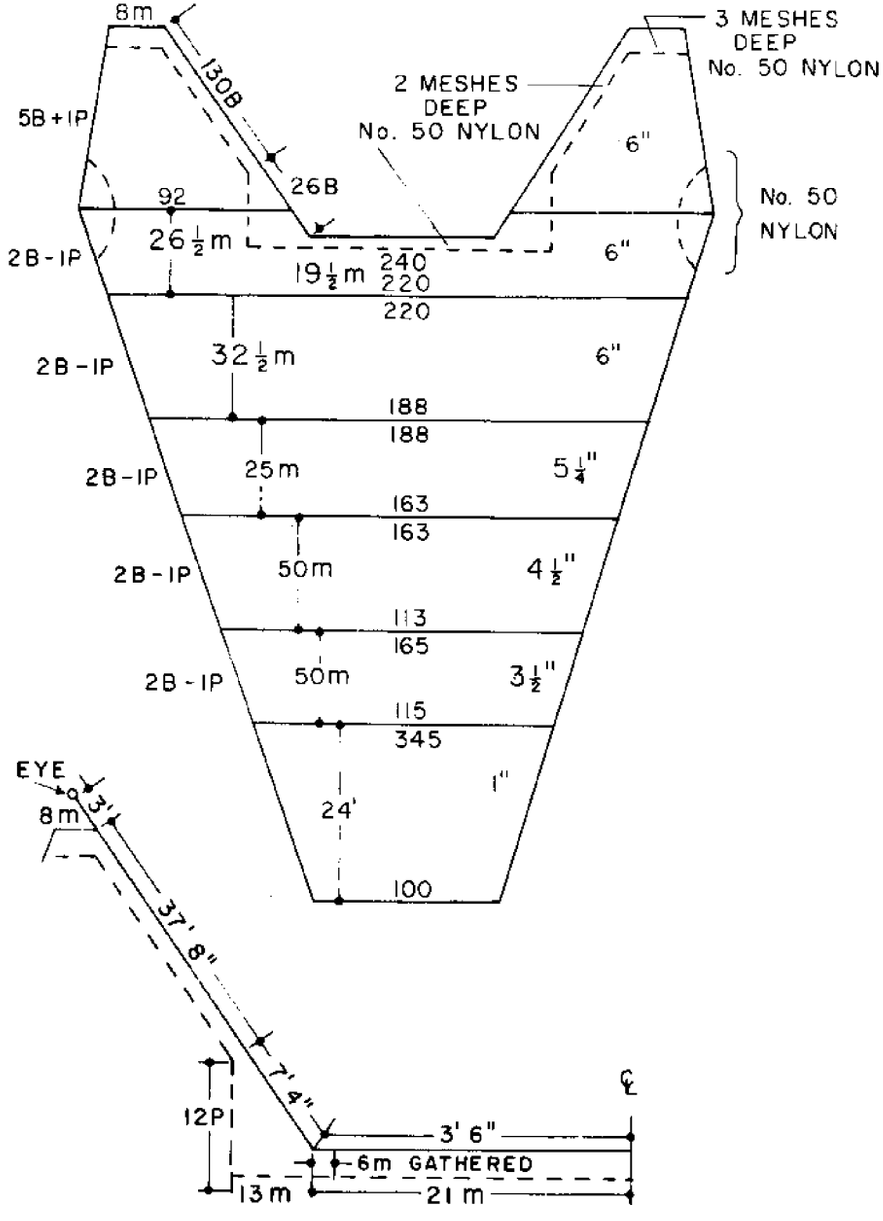

℄
1' 8"
16'
11 (4-1)
2(2-1)
No. 50 NYLON
48
BARS
3'
11 m
14 m
25
14
1
D

THREE - BRIDLE CHRISTENSEN TRAWL
BOTTOM SECTION
130' SWEEP (EYE TO EYE)
No. 9 NYLON

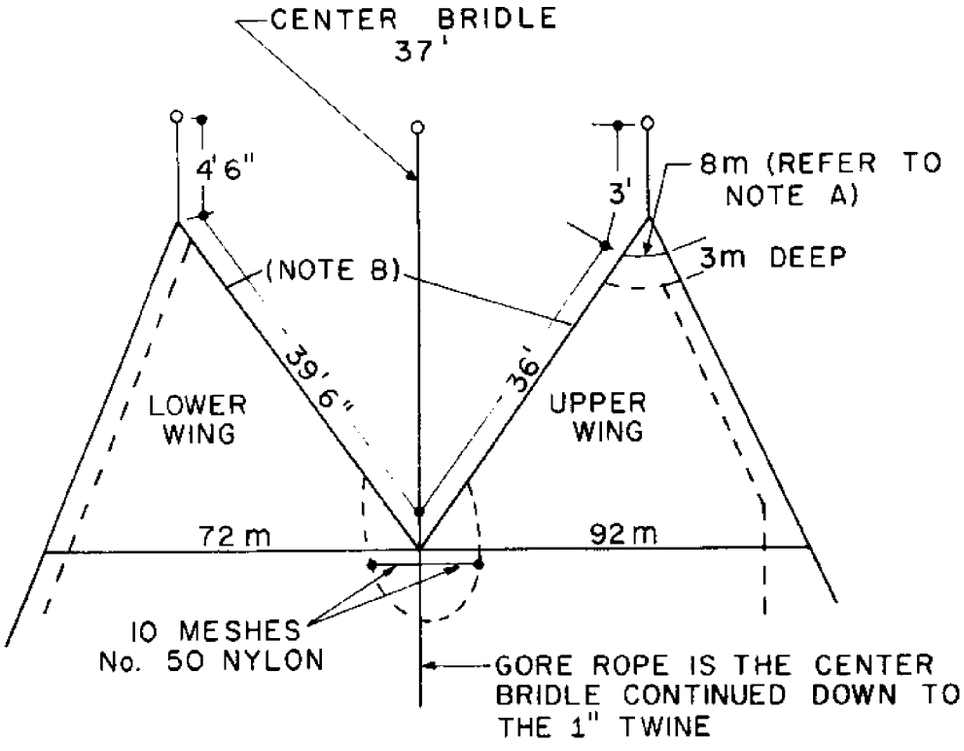


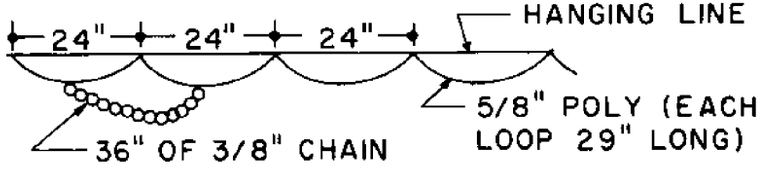
FOOTROPE DETAIL

THREE - BRIDLE CHRISTENSEN TRAWL
TOP SECTION
103' SWEEP (EYE TO EYE)
No. 9 NYLON

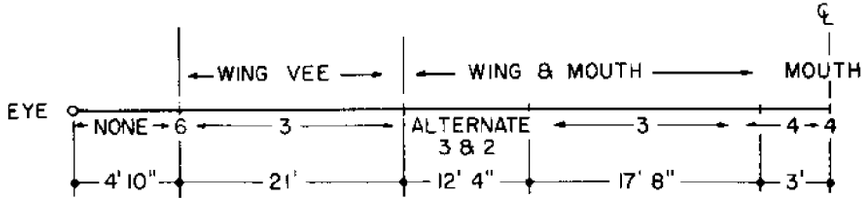


HEADLINE DETAIL



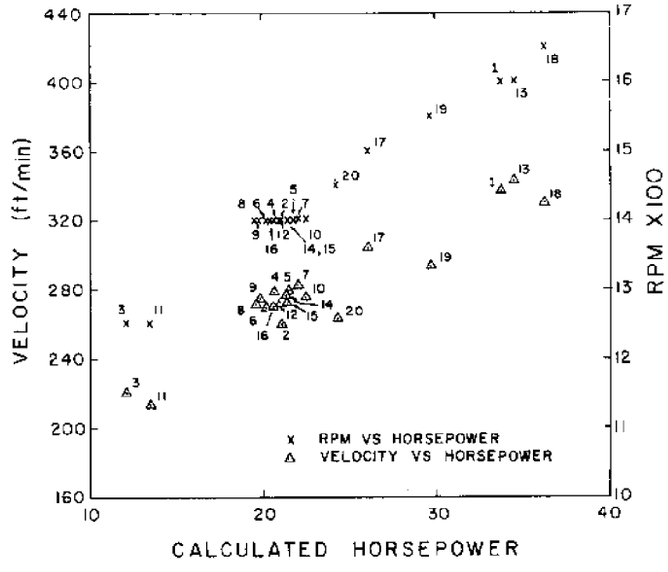


BOTTOM SWEEP DETAIL (Three-bridle)

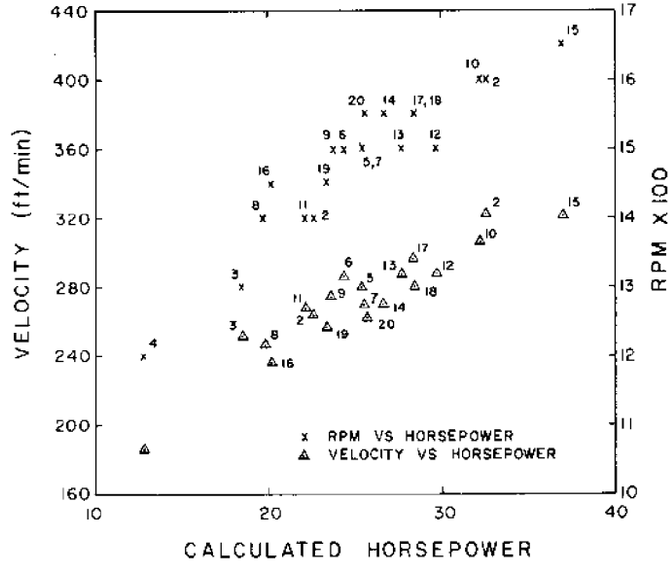


BOTTOM SWEEP WEIGHT DISTRIBUTION (Two-bridle)

TWO-BRIDLE WING TRAWL



THREE-BRIDLE CHRISTENSEN TRAWL



Hanging Lines: All hanging lines, bridles and gore ropes are ½-inch stainless steel-wire combination rope.
Floats: From 22 to 26 eight-inch floats.
Gores: Three meshes are taken in from each section and seized to the gore rope.
Miscellaneous: On the upper wing, the eight meshes at the end of the wing (note A, page 10) are hung on a loop of 3/8-inch nylon which is spliced into the top bridle. The hanging line (note B, page 10) for the wing ends is one continuous line which is spliced into the top and bottom bridles and is seized to the center bridle where the gore rope begins.

TWO-BRIDLE WING TRAWL: DATA SHEET AND COMMENTS

Tow	Total Distance (ft.)	Total Time (min.)	Velocity (ft./min.)	Average Total Warp Tension (lbs.)	RPM	Calculated Power (hp)	Opening (ft.)
1	9875	29.2	337	3440	1600	33.8	13½
2	9540	36.7	260	2780	1400	21.1	18
3	9875	44.7	221	1800	1250	12.1	18
4	9875	35.5	278	2560	1400	20.7	19
5	9875	33.2	297	2500	1400	21.6	18
6	9875	36.5	270	2560	1400	20.2	15
7	9875	35.9	283	2680	1400	22.1	16½
8	9875	36.4	271	2490	1400	19.7	12
9	9875	36.1	274	2480	1400	19.8	13
10	9875	35.8	276	2800	1400	22.5	16½
11	9875	46.1	214	2160	1250	13.5	17
12	9540	35.2	271	2800	1400	22.1	16½
13	9875	28.8	343	3460	1600	34.6	15
14	9875	35.7	277	2640	1400	21.3	16½
15	9875	36.2	273	2680	1400	21.3	14
16	9875	36.5	270	2620	1400	20.6	15
17	9875	32.5	304	2940	1500	26.1	14
18	9875	30.0	330	3780	1650	36.3	19
19	9840	32.6	293	3480	1550	29.7	19
20	9875	37.4	264	3160	1450	24.3	20

Tow*	Comments
1,2,3	Tomkiewickz doors, 20 FL,† 10 FG, 26 cans, tops even
4,5	Tomkiewickz doors, 20 FL, 10 FG, 26 cans, tops slacked 8 inches
6	Tomkiewickz doors, 20 FL, 10 FG, 26 cans, brackets tucked, tops even
7	Tomkiewickz doors, 20 FL, 10 FG, 26 cans, brackets tucked, tops even, top backstrap lengthened 3 inches
8	Tomkiewickz doors, 10 FL, 10 FG, 26 cans, brackets normal
9	Tomkiewickz doors, 10 FL, 10 FG, 26 cans, backstraps off end of doors
10	Tomkiewickz doors, 20 FL, off end of doors, 26 cans
11,12,13	Marco V doors, second hole from forward most, 20 FL, 10 FG, 26 cans
14	Marco V doors, 20 FL, 10 FG, 26 cans, first hole (minimum cut)
15	Marco V doors, 20 FL, 10 FG, 26 cans, fourth hole (maximum cut)
16	Marco V doors, 20 FL, 10 FG, 26 cans, bottom hole (heels door outboard)
17	Marco V doors, 20 FL, 10 FG, 26 cans, second hole, same as tow 11
18,19,20	$3M^2$ Suberkrub doors, 20 FL, 26 cans minimum cut, 50-pound lead weights on end of lower wings

**Tows 1-17 on bottom; 18-20 mid-water.*
†FL = fathom legs; FG = fathom ground cables.

THREE-BRIDLE CHRISTENSEN TRAWL: DATA SHEET AND COMMENTS

Tow	Total Distance (ft.)	Total Time (min.)	Velocity (ft./min.)	Average Total Warp Tension (lbs.)	RPM	Calculated Power (hp)	Opening (ft.)
1	9875	30.6	322	3480	1600	32.6	15
2	9540	35.5	264	2760	1400	21.6	18½
3	9875	39.2	252	2530	1300	18.5	20½
4	9540	51.1	186	2360	1200	12.8	19½
5	9875	35.3	280	3120	1500	25.4	20
6	9875	34.4	287	2920	1500	24.4	11
7	9875	36.6	270	3240	1500	25.5	13
8	9875	40.0	247	2760	1400	19.8	16½
9	9540	34.7	275	2960	1500	23.8	15
10	9875	32.2	307	3600	1600	32.2	14
11	9875	36.8	268	2840	1400	22.2	13½
12	9875	34.2	288	3550	1500	29.8	13½
13	9875	34.2	288	3300	1500	27.7	14
14	9875	36.6	270	3400	1550	26.7	21
15	9540	29.6	322	3840	1650	37.0	21
16	4938	20.8	237	2960	1450	20.2	21
17	4938	16.6	297	3280	1550	28.4	17
18	9875	35.2	280	3480	1550	28.4	16
19	9540	37.1	257	3120	1450	23.4	17
20	9875	37.6	262	3360	1550	25.6	14

Tow*	Comments
1,2	Marco V doors, second hole from forward most, 20 FL,† 10 FG, 30 cans, tops even, center of sweep approx. 3-4 feet off bottom
3,4,5	Marco V doors, second hole, 20 FL, 10 FG, 30 cans, tops even, added approx. 20 pounds to sweep, center of sweep approx. 3 feet off bottom
6	Marco V doors, second hole, 20 FL, 10 FG, 24 cans, tops even, removed the 20 pounds added to sweep
7	Marco V doors, increased cut to maximum (fourth hole), otherwise same as tow 6
8,9,10	Marco V doors, same rigging as tow 6
11,12,13	Tomkiewickz doors, 20 FL, 10 FG, 24 cans
14,15,16	$3M^2$ Suberkrub doors, minimum cut, 26 cans, 20 FL, 50-pound lead weights on end of lower wings
17,18,19	$3M^2$ Suberkrub doors, maximum cut, otherwise same as tow 14
20	$3M^2$ Suberkrub doors, 50-pound weights removed, otherwise same as tow 14

RESULTS

The two trawls investigated in this report are presented together due to their similar characteristics and capabilities. The material presented here is not meant to be interpreted precisely but is meant to give the reader insight into the trawls' capabilities and the effects of various rigging and towing parameters on their operation. No special or sophisticated scientific equipment was used in gathering the data and, hence, complete accuracy is not inferred. However, the procedure for gathering the data was controlled so that the margin of error between any two data gatherings should be constant.

From the plots of the data some generalizations may be made. For example, both plots are very much alike for the mid-water tows. In fact, the velocity vs. horsepower plots for the two mid-water traces are nearly coincident. Approximately 20 percent more power is required for towing in mid-water than on the bottom in order to maintain the same velocity. The two-bridle trawl requires a greater increase in power for mid-water trawling than the three-bridle does. This may be explained by the fact that the two-bridle wing trawl experiences a greater increase in mouth opening in changing from bottom trawling to mid-water trawling than does the three-bridle trawl. Hence, the increase in drag or required horsepower is greater for the two-bridle. The reader should note from the net plans that both trawls are very light, with much larger physical dimensions, compared to the common bottom trawl of comparable horsepower requirements. Hence, when compared to the common bottom trawl a much larger percentage of the drag for the two trawls discussed here must be attributed to fluid drag rather than seabed friction.

For the two-bridle wing trawl fishing on the bottom, the greatest increase in head rope height or mouth opening resulted from slacking the top legs eight inches, and the greatest decrease resulted from shortening the legs from twenty to ten fathoms. Other more subtle changes may be noted from the data sheet. For example, tucking the brackets on the Tomkiewickz doors appears to be detrimental, but when using the Marco V doors, decreasing the cut, or angle of attack, increases the opening considerably.

The options for varying the rigging of the three-bridle trawl are somewhat different due to the third bridle. In slacking the bridles or legs to increase head rope height, the opposite procedure from that for a two-bridle trawl must be used, that is, the bottom leg must be lengthened to increase the opening. In fact, if the top leg is lengthened, the loss of as much as four to five feet in the opening may be experienced. In general, any slacking or lengthening of the legs should be limited to about eight to ten inches. Increasing the leg lengths by as much as 16 inches appears to be too much; this decreased the opening from that in the eight to ten-inch range.

In general, both of the trawls are quite similar in towing characteristics and a recommendation of one over the other is not intended. The three-bridle trawl had a slightly greater mouth opening on the average, but the two-bridle was easier to handle. In any respect, it should be recognized that both trawls were designed for relatively large openings with only a light or gentle tending of the seabed. As is true for any trawl, the key to maximum gear performance is in the balance of the rigging, i.e. the adjustment of legs, ground cables, doors and number of floats to match the particular vessel's towing capability.

** Tows 1-13 on bottom; 14-20 mid-water.*

† FL = fathom legs; FG = fathom ground cables.