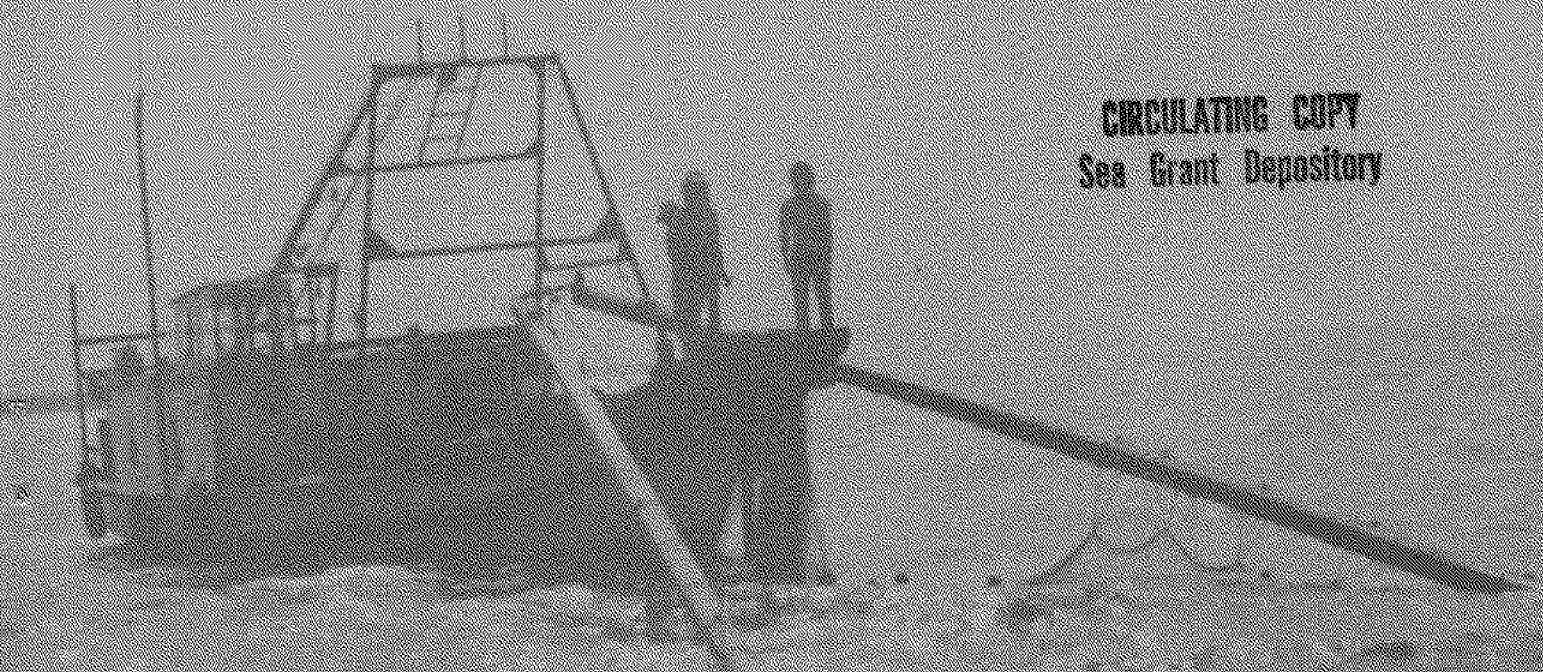
"CHOPSTICKS": INVESTIGATIONS OF THE PUSHER-HEAD TRAWL



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INTRODUCTION

In 1975, the United States experienced a large influx of Vietnamese refugees into the country as a result of the Vietnam conflict. By 1980, an estimated 1200 Vietnamese refugees had settled along the Mississippi Gulf Coast. That figure has since risen, with an estimated 80 percent of those refugees entering the commercial fishing industry in some capacity. Since the majority of those refugees fished commercially in Vietnam, they brought with them much experience and a fishing method new to the United States. This fishing method, the pusher-head trawl, has been locally referred to as "chopsticks".

Since the arrival of the Vietnamese refugees, conflicts between Vietnamese and domestic Americans have been widespread as documented by such authors as Bloom (1979), Kelly (1977), Orbach and Beckwith (1980), and Starr (1981 and 1982). This has been especially true in coastal areas, and Mississippi is no exception. One of the major problems facing the Gulf of Mexico shrimp industry has been over-capitalization; the addition of the Vietnamese people into the industry caused great resentment among domestic fishermen. Recently, much controversy has existed concerning the use of the "chopsticks" rig to catch shrimp. That controversy resulted in 1984 legislation banning "chopsticks" in state waters of Louisiana. Similar pressure in Mississippi resulted in ordinances limiting net mouth circumference.

As varying groups or individuals began to formalize cases either for or against the legalization of "chopsticks" as a fishing method in state waters, one fact became clear. No hard data existed on the technical aspects of the operation of "chopsticks". From a regulatory and legislative standpoint, data was vital to the development of regulations concerning the activity. The lack of data concerning the "chopsticks" technique was recognized by the staff of the Mississippi Sea Grant Advisory Service (MSGAS), who initiated an effort to address the topic.

As of August 1985, state regulations required that vessels operating with "chopsticks" have a foot rope length of sixty (60) feet or less, a head rope length of fifty (50) feet or less, and a maximum wing height (height of net along "chopsticks" pole) of twelve (12) feet. Complaints by users of the "chopsticks" technique stated that the twelve (12) foot tie-off point cause steering problems, sometimes resulting in broken poles. It also increased the effort required to eject foreign materials from the net mouth.

DESCRIPTION OF THE "CHOPSTICKS" TECHNIQUE

"Chopsticks" fishing, also known as pusher-head trawling, is accomplished by pushing a trawl net in front of a vessel. The net is framed by large poles (usually light or telephone poles) which are used to spread the net. This varies from standard otter trawl techniques in that an otter trawl is pulled behind the vessel with cables and is spread by otter trawl doors.

The cod-end of the net on a "chopsticks" rig usually runs under the front of the boat and is emptied by pulling the cod-end

onboard with a lazy line attached in front of the net bag. The cod-end is pulled onto the forward working deck every fifteen (15) to twenty (20) minutes. This differs from standard otter trawling in that the otter trawl is pulled for one to eight hours and must be winched completely onboard the vessel in order to empty the cod-end. Some benefits realized by using the "chopsticks" technique are:

1. Catch rate may be higher due to the lack of wheel wash in front of the net.

2. The net stay in the water all the time, while only the cod-end or bag is brought aboard to be emptied.

3. The bag can be emptied more often (usually every fifteen (15) to twenty (20) minutes) because the net continues to fish while the bag is onboard. Shrimp and fish are in better condition since they don't remain in the net as long.

4. Fuel efficiency may be enhanced since the technique does not use trawl doors which create significant drag.

5. Hangs are easy to handle by backing away and going around them. Frequently, a cable or chain is stretched between the skid ends of the poles, preventing net damage.

The major restriction encountered in using the "chopsticks" method of fishing is that the gear cannot be used in water depth in excess of sixteen (16) feet. This severely restricts the area which can be fished in Mississippi waters and, thus, limits the gear effectiveness unless shrimp are inshore.

Pole length and maximum spread varies from vessel to vessel. Average pole length in Mississippi is approximately sixty-two (62) feet (Table 1). Spread of the net is dictated by vessel power and net dimensions. These variables are important to the efficiency of the fishing technique.

METHODS AND MATERIALS

Two "chopsticks" vessels were used in the efforts conducted by the MSGAS. The use of the vessels, captain and crew, and fuel costs were donated by the owners of the two vessels. Vessel 1 measured, fifty-five (55) feet LOA, was powered by a GM 871 diesel engine, and turned a thirty (30) inch diameter forty (40) inch pitch wheel through a 4:1 reduction gear. Average trawling speed was 1100 RPM, or about 2.5 knots. Vessel draft, when unladen, was about 4.5 feet.

Vessel 2, measured forty-two (42) feet LOA, was powered by a GM 471 diesel engine, and turned a twenty-eight (28) inch diameter twenty-eight (28) pitch wheel through a 3:1 reduction gear. Average trawling speed was 1500 RPM, or about 2.0 knots. Vessel draft, when unladen, was about 4.5 feet. The relatively small diameter wheel on both vessels facilitated operation in shallow water.

Prior to initiation of any experimental activities, a special permit was obtained from the Mississippi Bureau of Marine Resources. The purpose of the project was to operate these two "chopsticks" vessels under normal conditions while varying the net wing tie-off from twelve (12) feet up to twenty-four (24) feet in four foot increments. Pertinent data included foot rope

length, head rope length, and height at each wing tie-off point (Figure 1). Interviews with the vessel captains provided subjective information about vessel maneuverability at each wing tie-off point.

By measuring pole length and the angle between the two poles, maximum spread of the poles was calculated. These data also facilitated calculations of the angle of the pole from the boat to the bottom, and revealed the size of the net mouth opening at the four wing tie-off points.

Three ten-minute net pushes at the tie-off points of twelve (12), sixteen (16), twenty (20) and twenty-four (24) were conducted. Species composition and abundance were recorded for each of the twelve (12) samples. These data were used to determine the difference, if any, in the amount and species caught with the four different net mouth openings.

Personnel of the National Marine Fisheries and the Mississippi Sea Grant Advisory Service conducted dives using self-contained underwater breathing apparatus (SCUBA) to observe and document actual contact of the pole skids and the net of the "chopsticks" rig with the bottom. Film footage (16 mm) of the pole skids was taken, and observation of the condition of the bottom behind the "chopsticks" rig in operation were made.

RESULTS

Wing Height

The shrimp net aboard Vessel 2 was measured onboard prior to initiating the shrimping activities. The total circumference measured 127 feet, with a foot rope or lead line length of fifty-

three (53) feet. When the wings of the net were tied off up the poles at twelve (12) feet, a fifty (50) foot head rope or cork line length resulted.

By increasing the wing tie-off height to sixteen (16) feet, the head rope length increased to forty-two (42) feet. Another increase of four feet made the tie-off point twenty (20) feet and the head rope length thirty-four (34) feet. Finally, increasing the wing height to twenty-four (24) feet resulted in a head rope length of twenty-six (26) feet. As evidenced by the figures above, the head rope and wing length never exceed the seventy-four (74) feet required by present regulations, regardless of the height of the wing tie-off.

While fishing aboard Vessel 1, at a wing tie-off of twelve (12) feet, the net became entangled during a turn, and the resulting water pressure snapped two of the tie-off lines on the starboard pole. The fouled net was repaired by backing down and refastening the lines. Hangs could similarly be avoided and/or removed by backing the vessel off the obstruction. During one of the trawling intervals, a crab pot was entrained in the throat of the trawl. The obstruction was removed when a fisherman walked out on one of the poles to reach the net. When the vessel was backed down, the poles, and thus the net, rose to the surface, enabling obstructions to be reached.

Height of the Water Column Fished

Test measurements showed that in a water depth of seven (7) feet with a pole length of sixty-eight (68) feet, twenty-three (23) feet of the pole remained out of the water while forty-five

(45) feet were under the water's surface. Trigonometric calculations (Sin O x tie-off height = head rope height) measured the angle of pole entry at the surface to be nine degrees (Figure 2). The height of the pole rest point above the water was measured at two feet seven inches. Table 2 provides the head rope height above the bottom at the four experimental tie-off points (Figures 3 through 6).

The maximum depth at which "chopsticks" rigged vessels can operate is generally considered to be fourteen (14) to sixteen (16) feet. Performing calculations like those above at a water depth of fourteen (14) feet with a pole length of sixty-eight (68) feet, indicated that seventeen (17) feet two inches of the pole were out of the water while fifty (50) feet ten (10) inches were below the surface. This yielded an angle of entry of sixteen (16) degrees (Figure 2).

Net Configuration

As evidenced by the data presented above, increasing the net wing tie-off points, changed the configuration of the net. Figures 7 through 10 are drawn to a scale, eight (8) feet per inch, using a pole length of sixty-six (66) feet and a foot rope length of fifty-three (53) feet.

If the poles were spread to the maximum of fifty-three (53) feet and a wing tie-off of twelve (12) feet was used, the spread of the poles at twelve (12) feet up the poles was forty-five (45) feet (Figure 7). As stated earlier, using the net dimensions on Vessel 1, the head rope length with a wing height of twelve (12) feet was fifty (50) feet. A slight drop back was available.

When the wing tie-off points were moved to sixteen (16) feet, the spread across the poles at the tie-off points was forty-two (42) feet. Again, using the same net dimensions, the head rope length measured forty-two (42) feet. No drop back was available and the head rope was stretched to its maximum (Figure 8).

Figure 9 illustrates the configuration of the net at a wing tie-off height of twenty (20) feet. The pole spread at twenty (20) feet up the poles was thirty-nine (39) feet. Using the above net dimensions, a twenty (20) foot wing yielded a head rope length of thirty-four feet. Obviously, in this case, the head rope length restricted the maximum spread of the poles to the length of the head rope.

As in the case of the twenty (20) foot wing height, the twenty-four (24) foot wing height also restricted the maximum spread of the poles to twenty-six (26) feet, which is the head rope length of the net with a twenty-four (24) foot wing height (Figure 10).

Catch Composition and Abundance

In order to ascertain what effect increasing net wing height had on total catch, a comparison of total finfish catch was made from three ten minute net pushes at twelve (12), sixteen (16), twenty (20) and twenty-four (24) foot tie-off heights (Table 3 through 6):

A similarity index, $S = \frac{2C}{A + B}$

where A = # species in Sample 1, B = # species in Sample 2, and C = # species common to both samples), was calculated to illustrate the degree of similarity of species caught in three ten-minute net pushes at the four tie-off points used (Odom, 1971). The index measures on a scale of zero to one, where zero indicates no similarity and one indicates identical samples. The results of that test (Table 7) indicated no significant difference in the catch composition when pushing the net at wing tie-off points of twelve (12), sixteen (16), twenty (20) and twenty-four (24) feet. Table 8 and Figure 11, however, illustrate that, even though catch composition remains relatively the same, catch abundance appeared to decrease with increasing net wing heights. Table 9 and Figure 11 also illustrate that, though abundance of finfish decreased as wing height increased, shrimp catch remained virtually unchanged.

Diver Observations

Diver observations were made on the chopstick trawl to determine the effects of the chopstick pole skids on the bottom. Two dives were made on the trawl.

On the first dive, it was observed that the trawl fished lightly. The starboard sled barely skimmed the bottom, while the port sled fished from two (2) to three (3) inches off the bottom. The trawl was nearest the bottom when the water depth was 7.5 feet. The footrope of the trawl was attached to the chopsticks in such a manner that when bottom contact was made, the footrope was still ten (10) to twelve (12) inches off bottom.

On the second dive, the trawl was nearest the bottom at the beginning of the dive in a water depth of thirteen (13) feet. The trawl then passed over a hole in the sea floor and never touched bottom for the remainder of the dive, even though the rig was pushed into a water depth of eight (8) feet after the encounter with the hole.

Dives conducted alone the net path behind the "chopsticks" vessel revealed that no furrows were evidenced in the bottom from contact with the pole skids. Observations mentioned above explained this result. The only indications of gear contact with the bottom were fine striations caused by the body and cod-end of the net dragging over the sea floor.

DISCUSSION

Wing Height

The "chopsticks" rig was originally designed for the net to be tied off high enough on the poles so that the net mouth opening corresponded with the bow of the boat. In this regard, wing height was never a factor when rigging the fishing gear. The regulations in Mississippi required that nets on "chopsticks" rigs be tied off no higher than twelve (12) feet up the poles. Due to the configuration of the fishing gear, tying the net off at twelve (12), sixteen (16), and twenty (20) feet created pockets in the webbing because the mesh does not open or stretch properly. This pocketing effect caused handling problems, according to the captains of the "chopsticks" vessels, and was particularly problematic during turns.

As mentioned earlier, water pressure was so great at one point that net tie-off lines broke during a turn. Similar problems have resulted in poles breaking during turns. This can be costly due to the halt in fishing activity and replacement costs of the poles. Also, as evidenced in Table 2, when the net was tied at twelve (12), sixteen (16) and twenty (20) foot tie-off points, the mouth opening of the net varied from less than two feet off the bottom to about 5.5 feet off the bottom. Thus, the mouth of the net was rarely visible, making removal of obstructions in the net difficult.

According to the captains of the two vessels used in this study, a tie-off point of twenty-four (24) feet allows for noticeably better steering, and turns can be made with more ease. However, they stated that maneuverability was still hampered by the necessity of tying off the net below the water line. Also, at a twenty-four (24) foot tie-off point, the net mouth opening could be seen; however, it is sufficiently forward of the bow of the boat that the attending fisherman was forced to walk out on the poles to release any obstruction from the net.

Height of the Water Column Fished

Trawling techniques and trawls in particular have undergone intense study, and design modifications have been implemented to make trawls more effective and efficient at catching shrimp. One of those modifications was making the foot rope or lead line longer than the head rope or cork line. The effect of this is to cause the head rope to run forward of the footrope in normal fishing. Then, if shrimp jump up suddenly from the bottom,

rather than going over the top of the net, they are trapped by the overhanging head rope. This has become a standard design feature in trawls.

The "chopsticks" net, however, is just the opposite. Because of the configuration of the poles, and because the net is pushed rather than pulled, the foot rope runs considerably ahead of the head rope. As stated earlier, when approaching maximum fishing depth of "chopsticks", a tie-off point of twelve (12) feet allowed the net to open only slightly more than three feet--about the same as a standard flat net without extra floatation. Because of this situation, it was likely that shrimp loss occurred on legally rigged "chopsticks" vessels.

At a tie-off height of twenty-four (24) feet in fourteen (14) feet of water, the head rope height from the bottom was only 16.62 feet. During white shrimp season, it is customary to use high opening trawls such as bib net with additional floats added. This allows a standard otter trawling rig to fish higher in the water column (ten (10) to twelve (12) feet) so that white shrimp, which are found throughout the water column, can be harvested more effectively. Due to the regulations presently affecting "chopsticks" fishing, white shrimp cannot be effectively harvested.

Net Configuration

As reported in Table 1, the average "chopsticks" pole length from fourteen (14) rigs measured was sixty-two (62) feet. Calculations indicated in a theoretical maximum spread of 51.2 feet. Observations during actual fishing activities proved that

the theoretical maximum spread is never realized. Several factors affect net spread. Those factors are pole length, pole rest point, foot rope length, head rope length, and vessel horsepower. On the two experimental vessels, the actual foot rope lengths were forty-eight (48) and fifty-three (53) feet, respectively. Those foot rope lengths dictated the maximum net spread. However, even those spread widths were not attained.

In the shrimping industry, as in any industry which harvests bottom dwelling organisms, the spread of the net across the bottom is the most important dimension of the gear. Thus, in an effort to regulate the shrimping industry, head rope length (or net spread) was the factor on which regulations were promulgated. In Mississippi, present regulations allow a fifty (50) foot shrimp net which ordinarily has a head rope length of fifty (50) feet and a foot rope length of 670 feet to allow for drop back. Due to inefficiencies built into otter trawl rigs, a net spread of eighty (80) percent of net size is considered good. "Chopsticks" rigs in actual practice do not equal and, surely, do not exceed that spread.

Aboard Vessel 2, while fishing in approximately ten (10) feet of water with a twelve (12) foot wing tie-off, a head rope length of fifty (50) feet was available. If the poles were spread to their maximum of fifty-three (53) feet, the head rope would have been stretched tightly across the poles. Observations revealed that this was not the case, as a considerable amount of drop back in the head rope was observed.

Upon increasing the wing tie-off to sixteen (16) feet, a head rope length of forty-two (42) feet was available. If maximum spread of fifty-three (53) was attained, that forty-two (42) foot head rope would have been stretched tightly across the poles (Figure 8). Again, this was not the case, as drop back in the head rope was observed.

When fishing the net at a twenty (20) foot wing tie-off, a head rope length of thirty-four (34) feet resulted. As seen in Figure 9, that head rope length restricted the net opening to a maximum of forty-seven (47) feet. If that maximum spread were attained, then the head rope would be stretched tightly across the poles; however, observed drop back in the head rope revealed that the maximum spread was not attained.

Finally, at a wing tie-off of twenty-four (24) feet, the available head rope was twenty-six (26) feet. As Figure 10 illustrates, that head rope length restricted the maximum net spread to thirty-five (35) feet. Again, this spread was not attained, as drop back in the head rope was observed.

As illustrated in the above examples, as the wing tie-off points were increased, the spread of the net became restricted by the head rope rather than the foot rope. In actual practice, however, it is more likely that engine horsepower is the limiting factor in total net spread, since in no case was the net stretched tightly between the poles. This means that the spread of the poles on Vessel 2 probably never attained thirty-five (35) feet. Further investigation will reveal actual maximum net spread in operation. It is evident that a "chopsticks" boat with

sixty-six (66) foot poles and a net circumference of 127 feet is spreading its net equal to, or less than, a standard otter trawling rig with a fifty (50) foot net.

Catch Composition and Abundance

The results of the three ten-minute net pushes at twelve (12), sixteen (16), twenty (20) and twenty-four (24) foot wing tie-off points indicated that fish catch should not be a factor in determining wing attachment points. It is understood that additional replication of these tests would yield more statistically valid results; however, the authors believe that the results of these data are representative of the effect of varying wing tie-off points on fish and shrimp abundance.

The similarity index calculated for each sample revealed no significant difference between the species composition of each sample recorded. A significant difference was noted in the total abundance of finfish in those samples. Figure 11 illustrates that, as wing tie-off points increased, finfish abundance decreased while shrimp catch remained relatively stable. Though the reasons for this are not conclusive, it is believed that at twelve (12), sixteen (16), twenty (20) foot tie-off points, the pocketing effect discussed earlier confused and entangled fish making escape from the net unlikely. As the net was stretched more tightly by increasing the wing tie-off points, the meshes are opened up, correcting the pocketing effect and allowing a certain percentage of finfish to escape through the meshes. Further investigation is warranted due to the increased attention in recent years placed on finfish by-catch in the shrimp fishery.

In that respect, it should be noted again that the short push time of the "chopsticks" rig yielded a smaller catch per haul, and most, if not all of the finfish by-catch is returned to the water alive. This seldom occurs when using traditional trawling methods.

Diver Observations

The chopstick poles were rigged with floats tied just above the skids so that when the vessel was stopped, the chopstick poles floated to the surface. The floats keep the chopstick poles from digging too hard in the sea bed which would cause the sled on the end of the poles to wear out quickly on a sand or hard bottom and would cause the rig to bog or lead up with mud on a soft bottom.

This particular trawl was apparently too buoyant, causing it to fish too lightly. Some of the floats should be removed to allow better bottom contact. A survey conducted by the Mississippi Sea Grant Advisory Service revealed that the experimental vessel, rigged with sixteen (16) black floats on each pole, was typical of the "chopsticks" fleet.

The trawl could be further improved by using a separate line from the trawl to keep poles from over-spreading. This would allow the trawl to keep poles from over-spreading. This allows the trawl footrope to hang free from the chopstick pole allowing better bottom contact, with the addition of chain in a conventional trawling manner. Also, short leglines (three (3) to five (5) feet) would give the footrope more freedom to adjust to irregular bottom conditions. This would also mean that fewer

modifications would have to be made to conventional trawls for attachment to the chopstick poles.

CONCLUSIONS

1. Low wing tie-off points (below the water line) decreased maneuverability and increased the effort to clear obstruction from the net. Maneuverability was increased with increased wing tie-off points.

2. As wing tie-off points increased finfish abundance decreased while shrimp catch remained stable. No significant difference was noted in catch composition at any of the wing tie-off points; consequently, tie-off height of the net should not be regulated due to finfish catch.

3. The short time duration between emptying the cod-end of the net allowed finfish by-catch to be returned to the water with near 100 percent survival.

4. Contact of the net and poles with the sea floor was minimal due to gear design and configuration and caused no adverse effects.

5. The restriction of "chopsticks" rigged vessels to water depths of approximately sixteen (16) or less also restricts the areas in which the gear can be used. Thus, competition with other gear types is also limited.

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Table 1. Pole length, rest points length, restpoint width, and calculated maximum pole spread of fourteen (14) "chopsticks" vessels in Harrison County, Mississippi.

Vessel	Pole length (feet)	Length from Apex to Restpoint (inches)	Rest Point Width (inches)	Calculated Spread (feet)
1	71.00	114	84	52.32
2	66.33	132	100	50.25
3	62.17	86	71	51.32
4	44.33	90	78	38.42
5	61.17	108	80	45.31
6	67.67	114	90	53.42
7	65.33	112	102	59.50
8	56.00	108	101	52.37
9	61.00	88	83	57.53
10	47.75	N/A (New Poles)	70	---
11	70.00	133	100	52.63
12	65.00	88	67	49.49
13	65.17	112	93	54.11
14	68.33	115	86	51.10
MEAN	62.02	107.69	86.07	51.20

Table 2. Height of the head rope or cork line above the bottom when fishing in seven (7) and fourteen (14) feet of water at wing tie-off points of twelve (12), sixteen (16), twenty (20) and twenty-four (24) feet.

Wing Tie-Off Height	Head Rope Height Above Bottom (7 feet)	Head Rope Height Above Bottom (14 feet)
12'	1.88'	3.31'
16'	2.50'	4.41'
20'	3.13'	5.51'
24'	3.75	6.62'

Table 3. Species composition and abundance in three ten-minute tows at a tie-off height of twelve (12) feet.

Genus/Species	Common Name	1	2	3
Micropogonias undulatus	- Atlantic croaker	36	92	5
Bagre marinus	- Gafftopsail catfish	15	11	5
Dorosoma petenense	- Threadfin shad	15	7	5
Citharichthys spilopterus	- Bay whiff	15	11	0
Peprilus alepidotus	- Harvest fish	6	7	5
Chlorosombrus chrysurus	- Atlantic bumper	6	0	8
Cynoscion arenarius	- Sand seatrout	2	5	5
Symphurus plaginsa	- Blackcheek tonguefish	4	0	1
Leiostomus xanthurus	- Spot	0	2	2
Vomer setapinnis	- Moonfish	3	0	1
Trichiurus lepturus	- Ribbon fish	2	1	0
Bairdiella chrysoura	- Silver perch	1	2	0
Arius felis	- Hardhead catfish	1	0	1
Peprilus burti	- Butterfish	0	2	0
Trinectes maculatus	- Hogchoker	1	0	0
Scomberomorous maculatus	- Spanish mackerel	0	0	1

Table 4. Species composition and abundance in three ten-minute tows at a tie-off height of sixteen (16) feet.

Genus/Species	Common Name	1	2	3
Micropogonias undulatus	- Atlantic croaker	12	150	45
Chloroscombrus chrysurus	- Atlantic bumper	12	2	20
Peprilus alepidotus	- Harvestfish	8	2	9
Bagre marinus	- Gafftopsail catfish	4	0	8
Cynoscion arenarius	- Sand seatrout	2	2	4
Citharichthys spilopterus	- Bay whiff	0	3	1
Carcharhinus sp.	- Shark	3	0	0
Vomer setapinnis	- Moonfish	1	0	1
Bairdiella chrysoura	- Silver perch	1	1	0
Symphurus plaginsa	- Blackcheek tonguefish	0	1	1
Dorosoma petenense	- Threadfin shad	0	0	2
Arius felis	- Hardhead catfish	0	1	0
Dasyatis americanus	- Stingray	1	0	0
Polydactylus octonemus	- Atlantic Threadfin	0	0	1
Trinectes maculatus	- Hogchoker	0	0	1

Table 5. Species composition and abundance in three ten-minute tows at a tie-off height of twenty (20) feet.

Genus/Species	Common Name	1	2	3
Barge marinus	- Gafftopsail catfish	9	18	10
Microponias undulatus	- Atlantic croaker	26	0	5
Peprilus alepidotus	- Harvestfish	6	4	7
Dorosoma petenense	- Threadfin shad	4	2	9
Citharichthys spilopterus	- Bay whiff	2	12	0
Chloroscombrus chrysurus	- Atlantic bumper	5	0	3
Vomer setapinnis	- Moonfish	1	0	7
Cynoscion arenarius	- Sand seatrout	3	1	0
Arius felis	- Hardhead catfish	3	0	0
Menticirrhus americanus	- Stingray	0	3	0
Bairdiella chrysoura	- Silver perch	0	1	0
Peprilus burti	- Butterfish	1	0	0
Lagodon rhomboides	- Pinfish	0	0	1
Oligoplites saurus	- Leatherjacket	0	0	1

Table 6. Species composition and abundance in three ten-minute tows at a tie-off height of twenty-four (24) feet.

Genus/Species	Common Name	1	2	3
Citharichthys spilopterus	- Bay whiff	2	23	15
Micropogonias undulatus	- Atlantic croaker	5	5	15
Chloroscombrus chrysurus	- Atlantic bumper	15	0	7
Bagre marinus	- Gafftopsail catfish	9	3	8
Peprilus alepidotus	- Harvestfish	5	3	5
Dorosoma petenense	- Threadfin shad	9	0	0
Vomer setapinnis	- Moonfish	2	0	7
Leiostomus xanthurus	- Spot	1	3	5
Menticirrhus americanus	- Southern kingfish	4	2	2
Harengula pensacolae	- Scaled sardine	6	0	0
Synodus foetens	- Lizard fish	0	0	2
Peprilus burti	- Butterfish	1	0	0
Arius felis	- Hardhead catfish	1	0	0
Prionotus rubio	- Blackfin searobin	1	0	0
Scomberomorus maculatus	- Spanish mackerel	1	0	0
Lagodon rhomboides	- Pinfish	0	0	2
Dasyatis americanus	- Stingray	0	1	0

Table 7. Indices of similarity of species composition from three ten-minute pushes between tie-off heights of twelve (12), sixteen (16), twenty (20) and twenty-four (24) feet.

12 ' x 16'	12' x 20'	12' x 24'	16' x 20'	16' x 24'	20' x 24'
.77	.74	.67	.69	.56	.71

Table 8. Total number of finfish/push and mean catch/push in three ten-minute pushes at tie-off heights of twelve (12), sixteen (16), twenty (20) and twenty-four (24) feet.

Tie-off Height	Total Finfish	X Finfish Catch/tow
12'	343	114.33
16'	299	99.67
20'	144	48.00
24'	154	51.33

Table 9. Shrimp catch in three ten- minute pushes at tie-off heights of twelve (12), sixteen (16), twenty (20) and twenty-four (24) feet.

Tie-off Height	Total Shrimp	X Shrimp Catch/tow
12'	33	11.00
16'	38	12.67
20'	30	10
24'	28	9.33

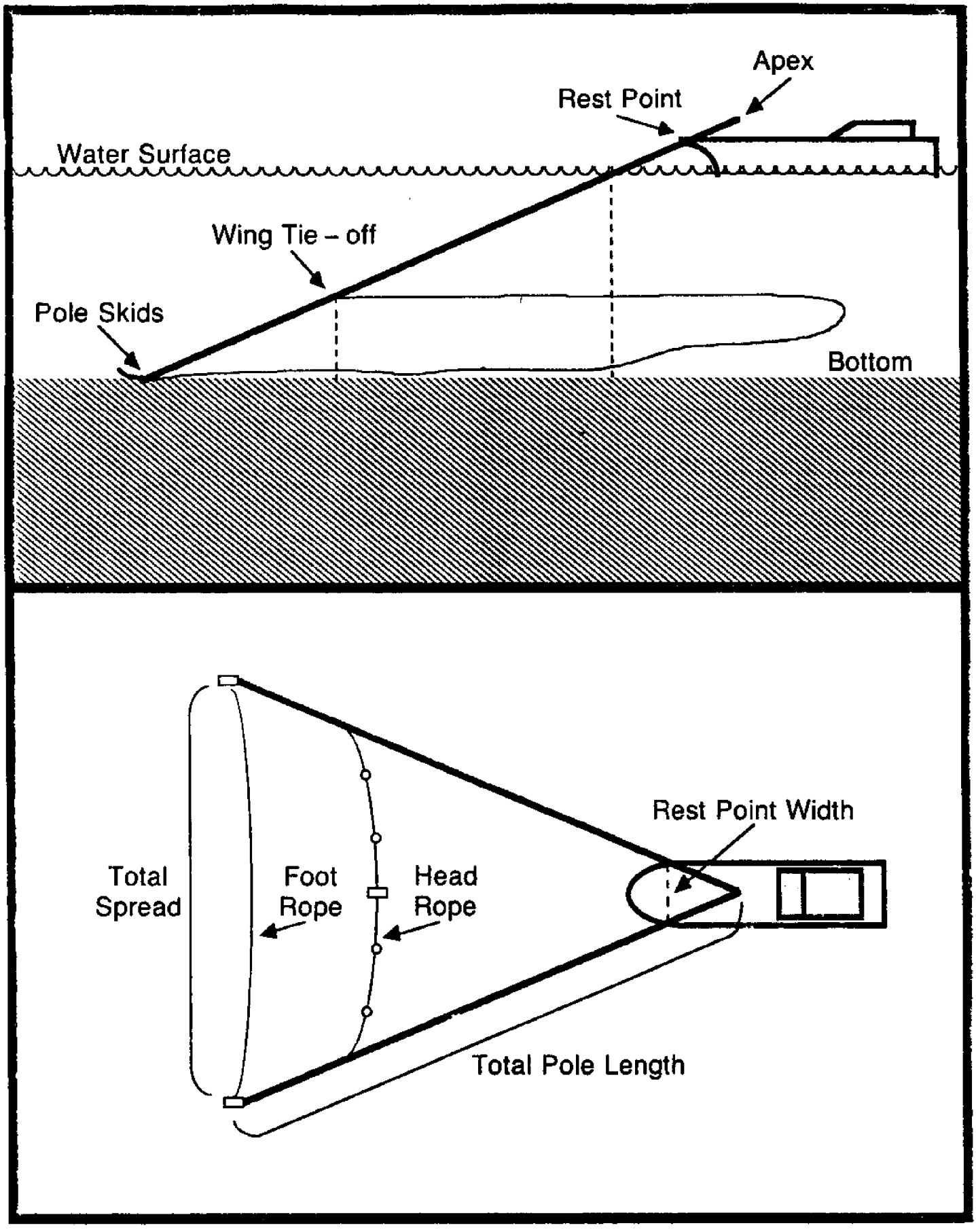

Figure 1. Pole apex, rest point, rest point width, wing tie – off, skids, pole length, total spread, foot rope and head rope on a "chopsticks" rig.

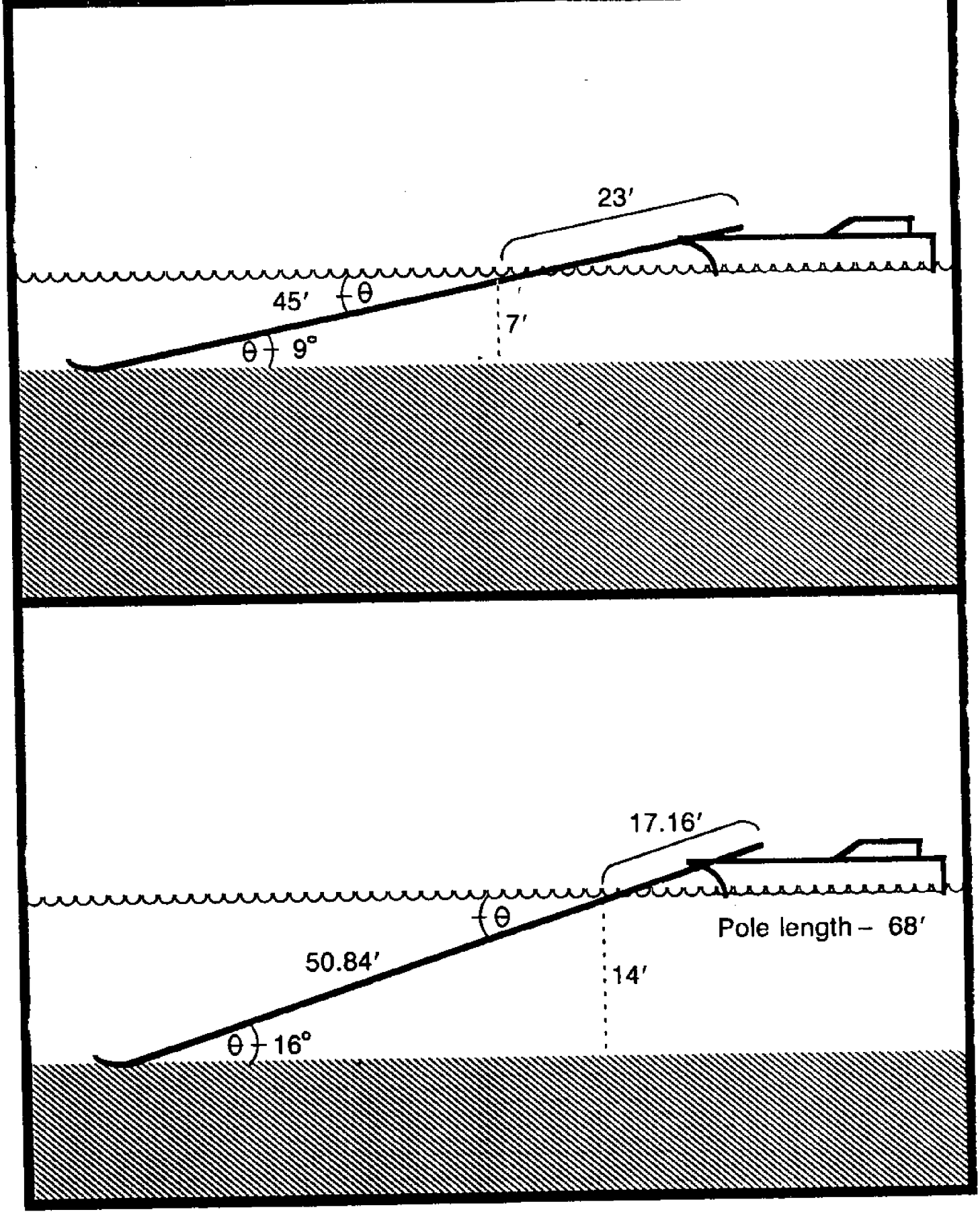

Figure 2. Configuration of 68 foot "chopsticks" poles while fishing in seven and 14 feet of water.

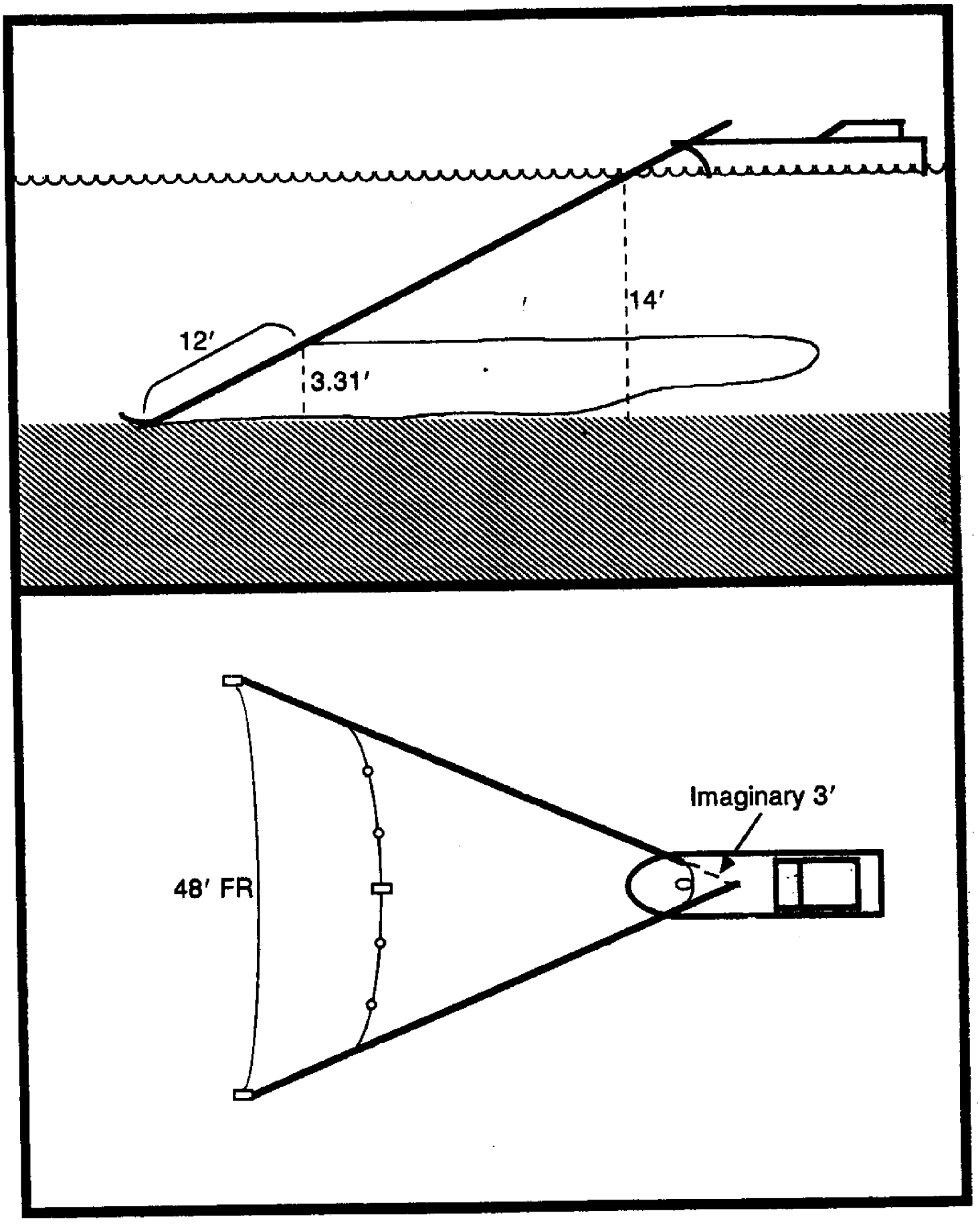

Figure 3. Configuration of "chopsticks" net while fishing in 14 feet of water with a wing tie – off point of 12 feet.

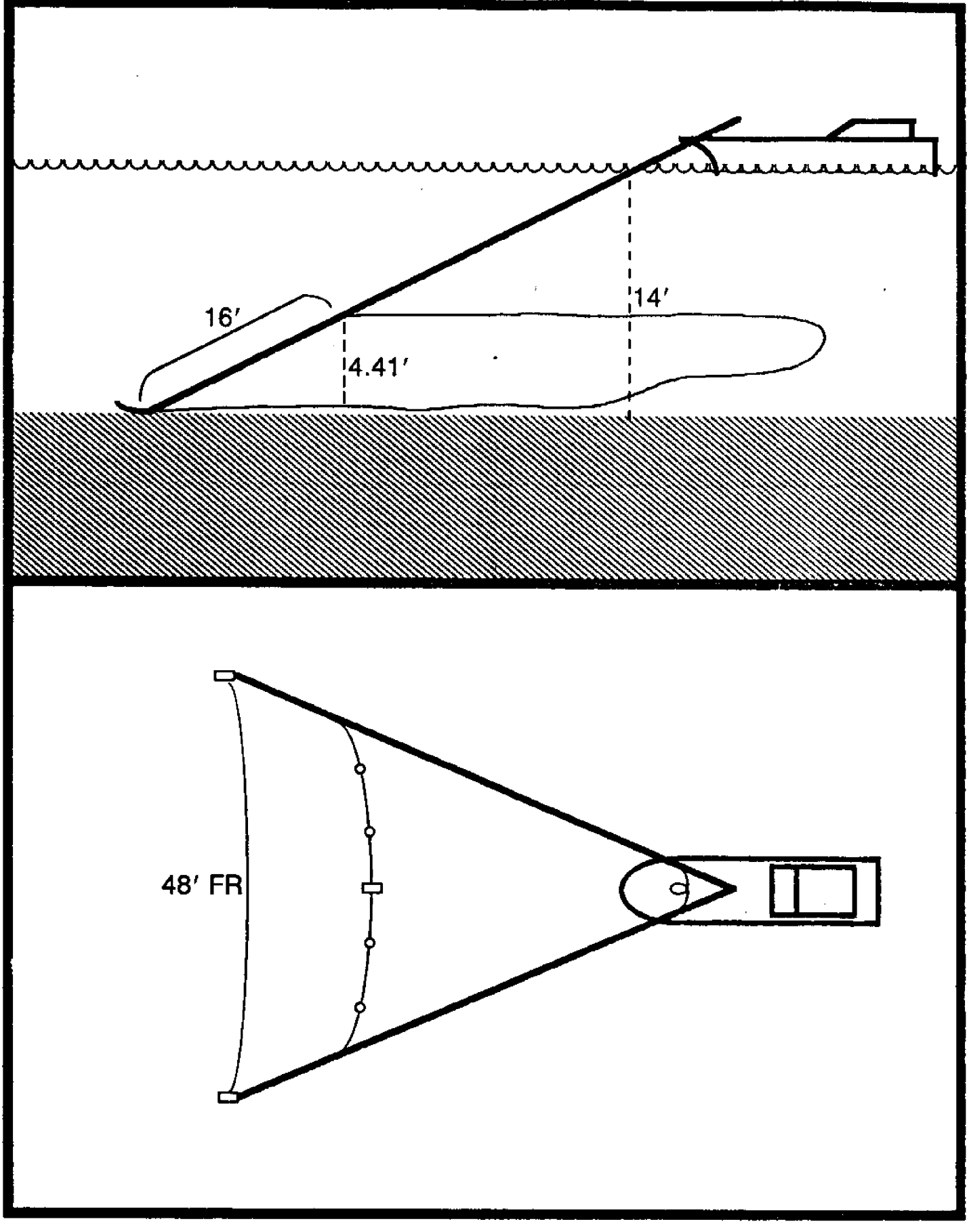

Figure 4. Configuration of "chopsticks" net while fishing in 14 feet of water with a wing tie – off point of 16 feet.

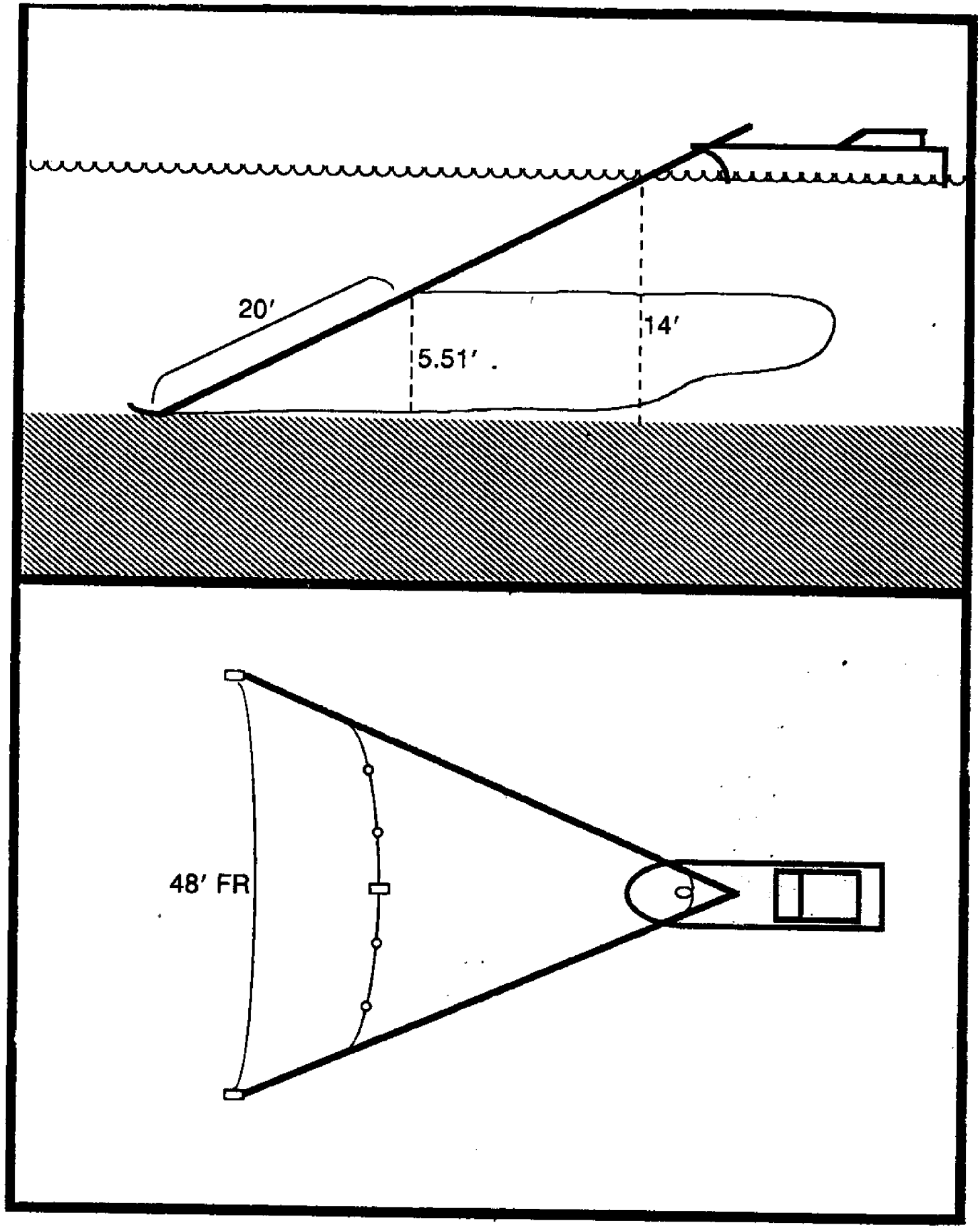

Figure 5. Configuration of "chopsticks" net while fishing in 14 feet of water with a wing tie – off point of 20 feet.

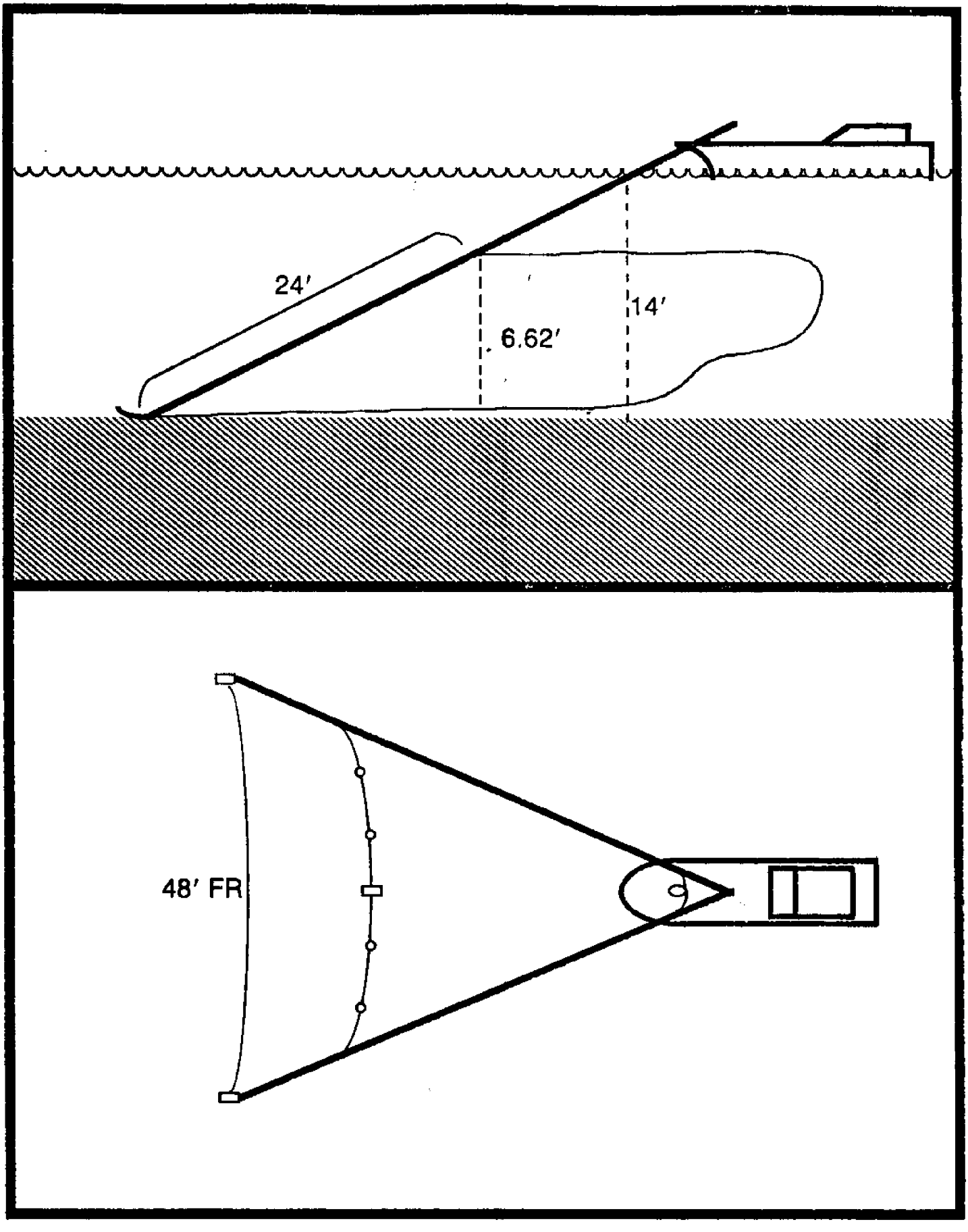

Figure 6. Configuration of "chopsticks" net while fishing in 14 feet of water with a wing tie – off point of 24 feet.

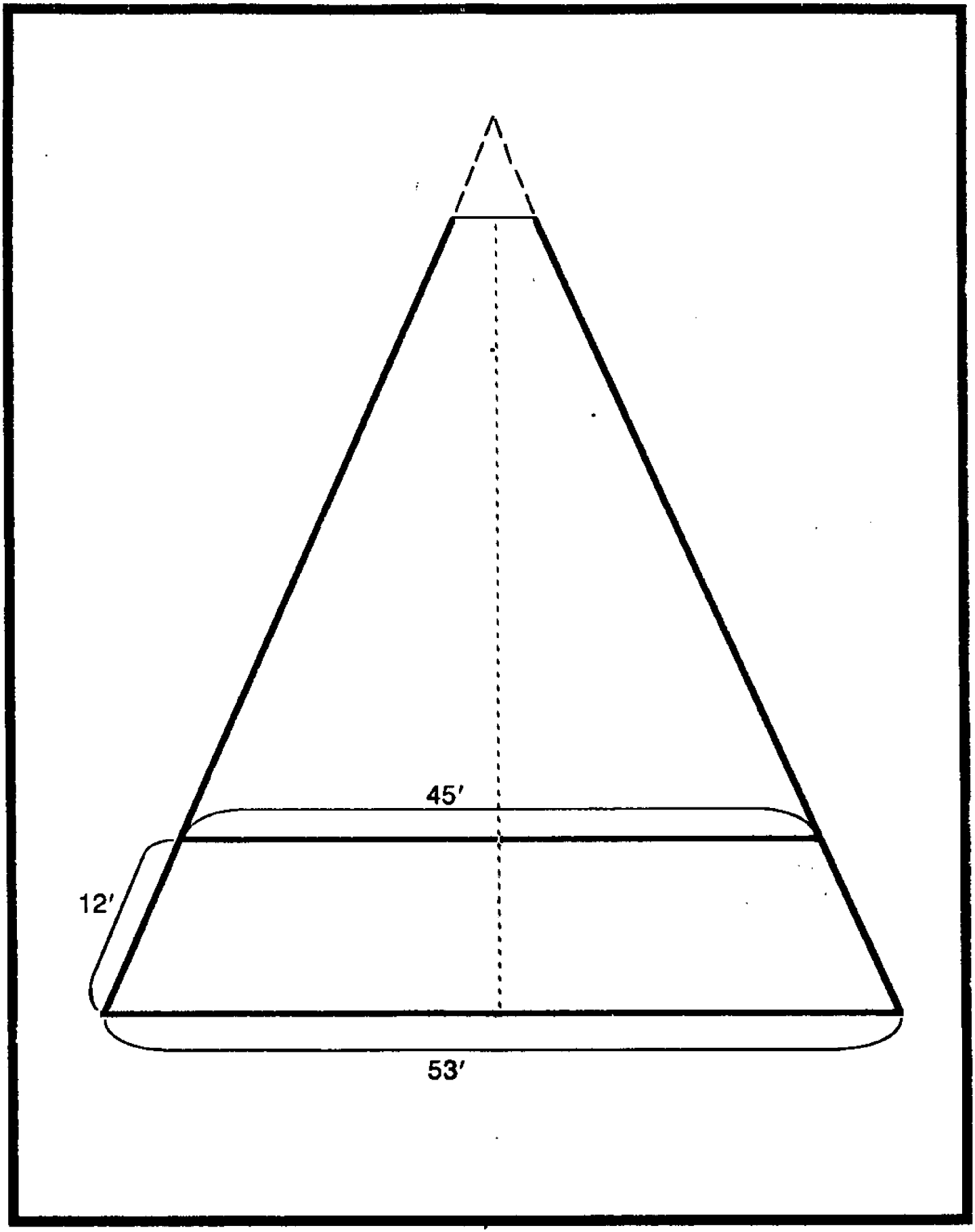

Figure 7. Maximum spread and net configuration on a "chopsticks" net with a 53 foot "foot rope", 50 foot "head rope" and 12 foot wing tie – off point.

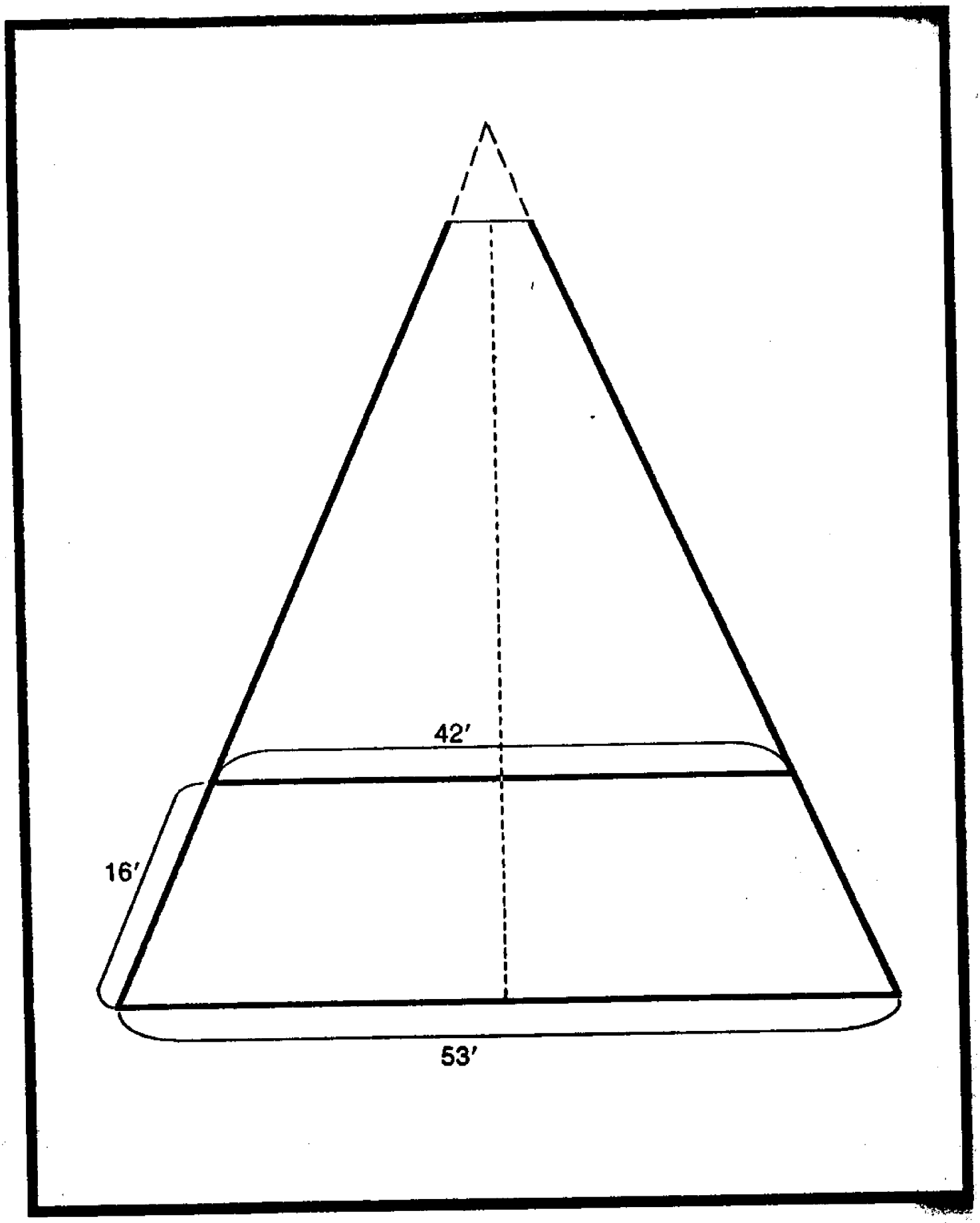

Figure 8. Maximum spread and net configuration on a "chopsticks" net with a 53 foot "foot rope", 50 foot "head rope" and 16 foot wing tie – off point.

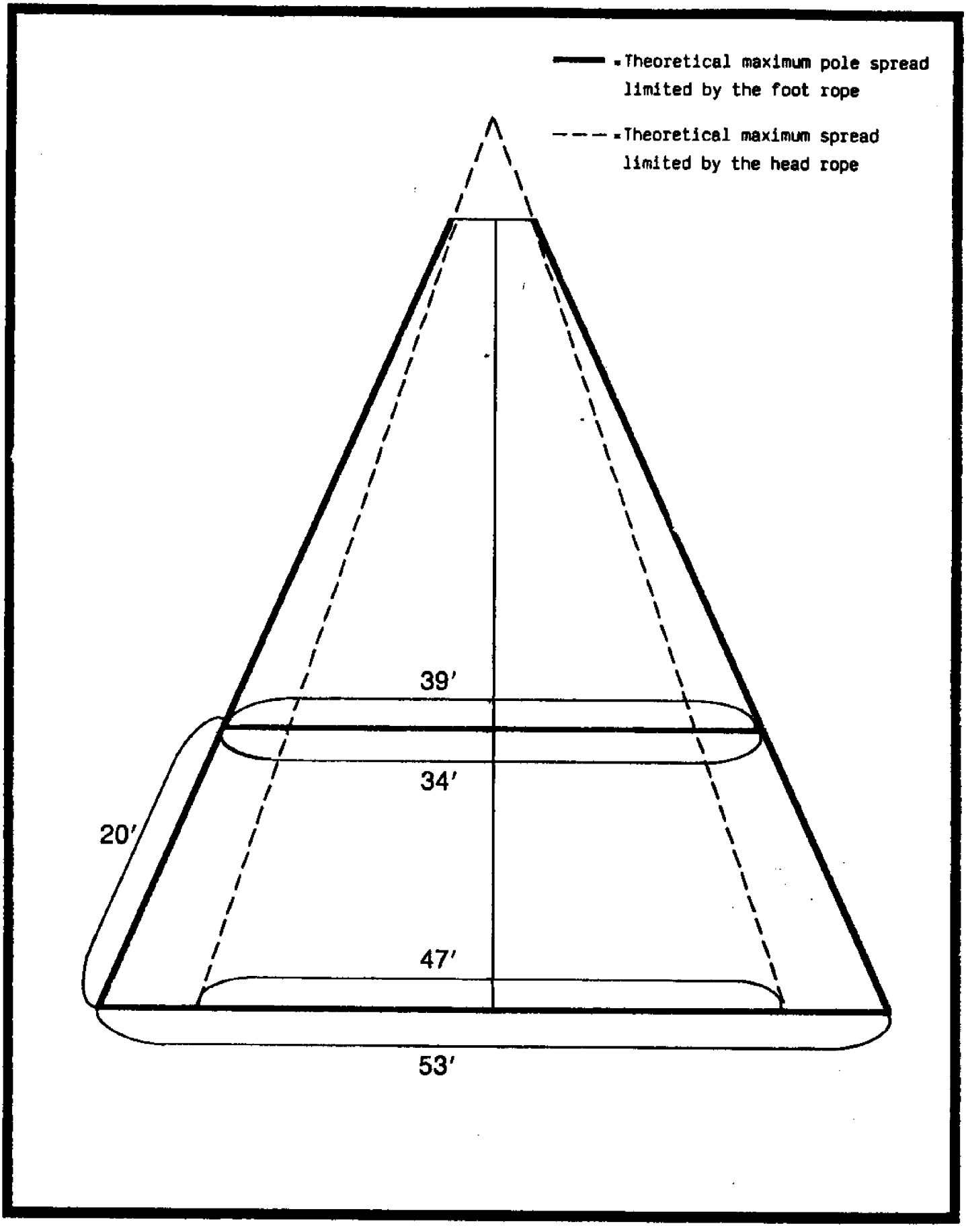

Figure 9. Maximum spread and net configuration on a "chopsticks" net with a 53 foot "foot rope", 50 foot "head rope" and 20 foot wing tie – off point.

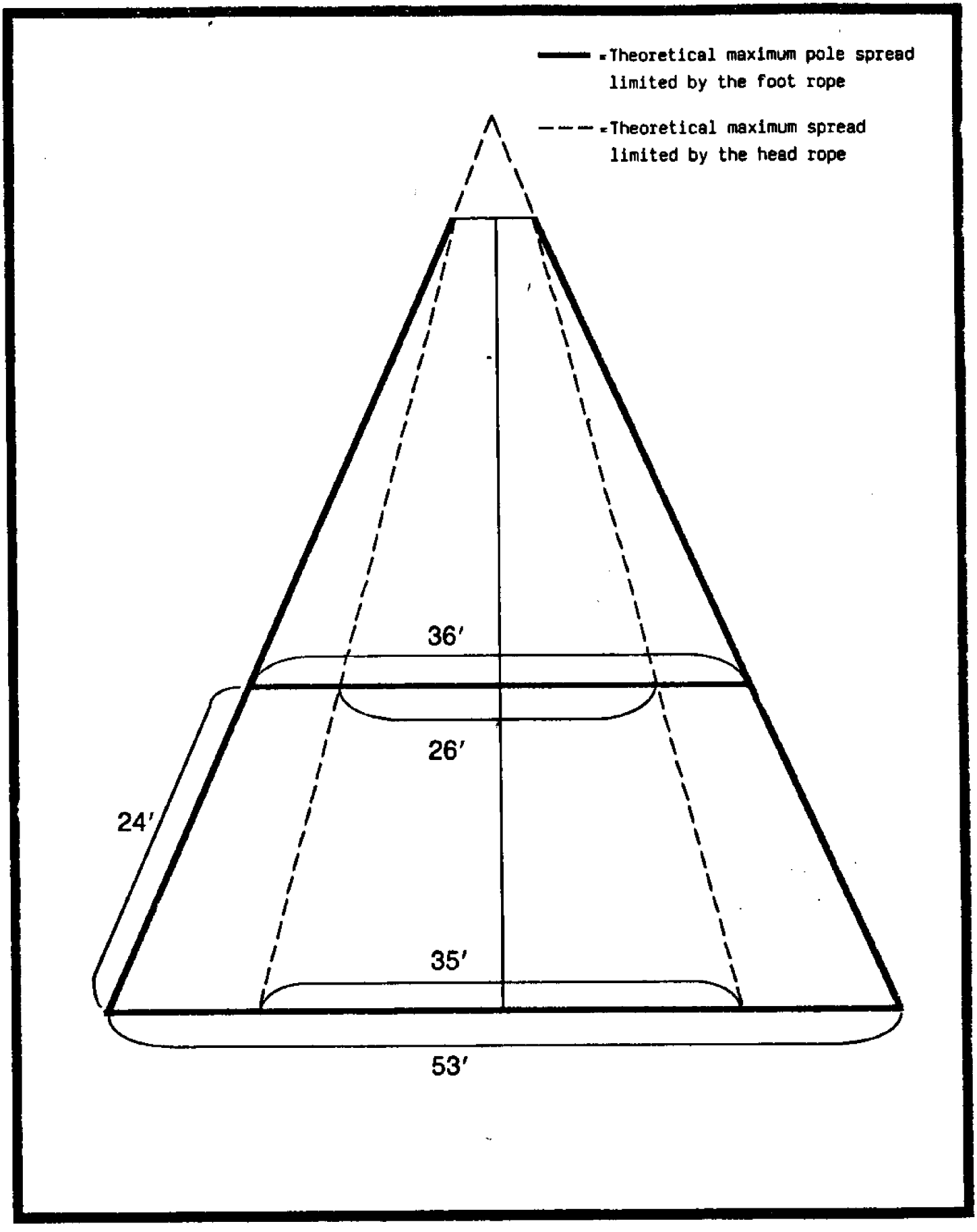

Figure 10. Maximum spread and net configuration on a "chopsticks" net with a 53 foot "foot rope", 50 foot "head rope" and 24 foot wing tie – off point.

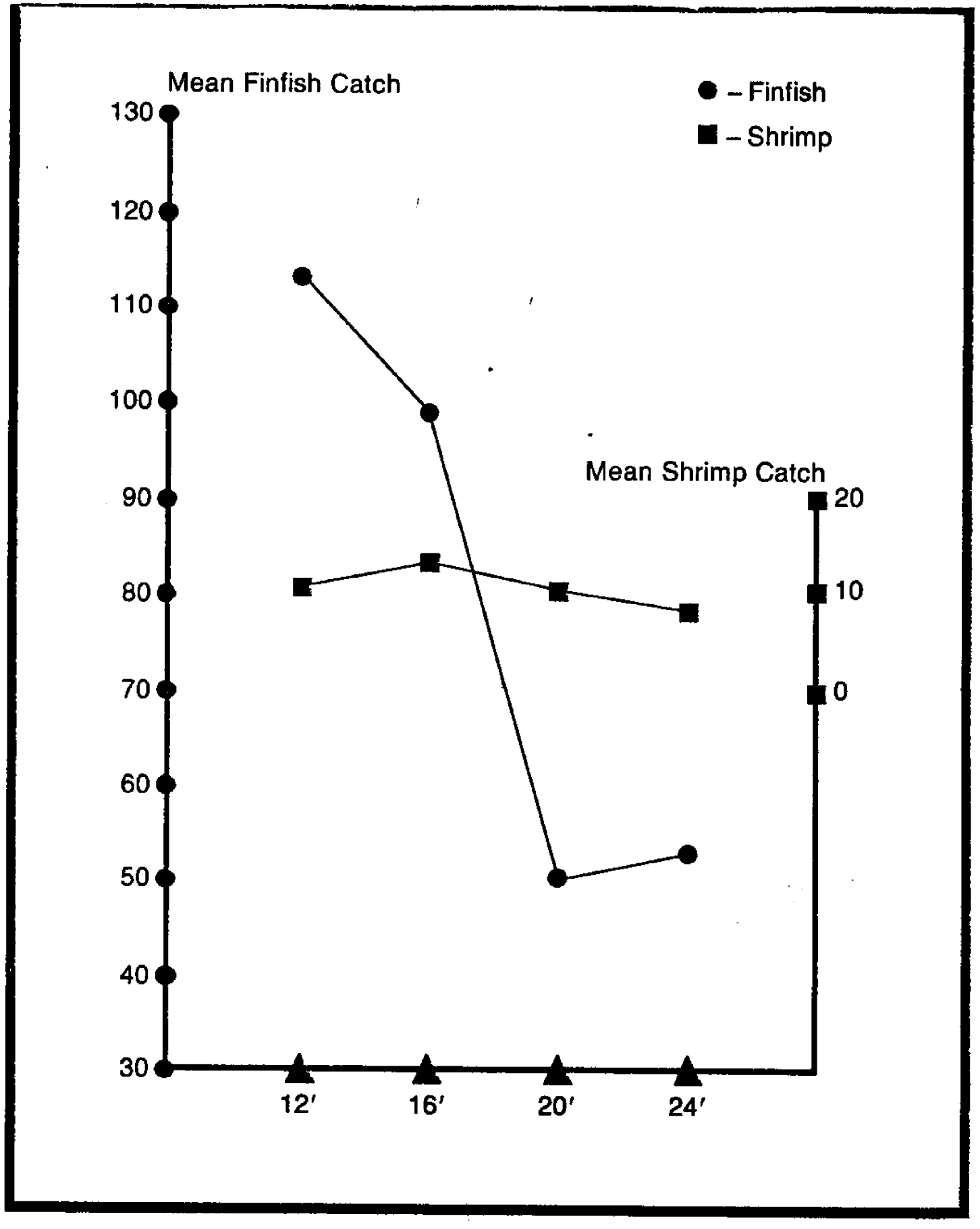

Figure11. Finfish and shrimp catch from three ten minute pushes at tie – off heights of 12, 16, 20, and 24 feet.