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# Performance of Trawls Used in Resource Assessment

FRED WATHNE

## INTRODUCTION

A major activity at the NMFS Northwest and Alaska Fisheries Center (NW&AFC) is determination of the status of fish stocks. The importance of this work is expected to increase markedly in waters off the United States with the advent of extended fisheries jurisdiction, since only with reliable data on the stocks is it possible to determine sustainable catch levels and to achieve successful management of the resources. At present, knowledge of the abundance of fish stocks is obtained primarily by analyzing commercial catch data and from research vessel surveys. For the latter, trawls are used to obtain samples of the bottom fauna which constitute the basis for estimating the quantity and species composition over an area much larger than that covered by the net. Extrapolation of the sample data is based on an assumption of certain dimensions and operating characteristics of the trawl gear and on an assumption as to the percentage of animals encountered by the gear that are actually captured. Because these two factors are critical to the calculations of stock sizes and consequently could carry important economic implications, it is necessary that every effort be made to ensure their accuracy.

To assist in obtaining a better understanding of how the sampling trawls perform under the wide range of operating conditions encountered, the NW & AFC began, in 1974, a project to develop suitable instrumentation for evaluating trawl performance during survey operations. The objectives of this operation are to determine the variability of trawl performance and assess the desirability of instrumentation as part of the sampling systems. It is not within its scope to attempt engineering studies of the gear or to establish reasons for variations in performance.

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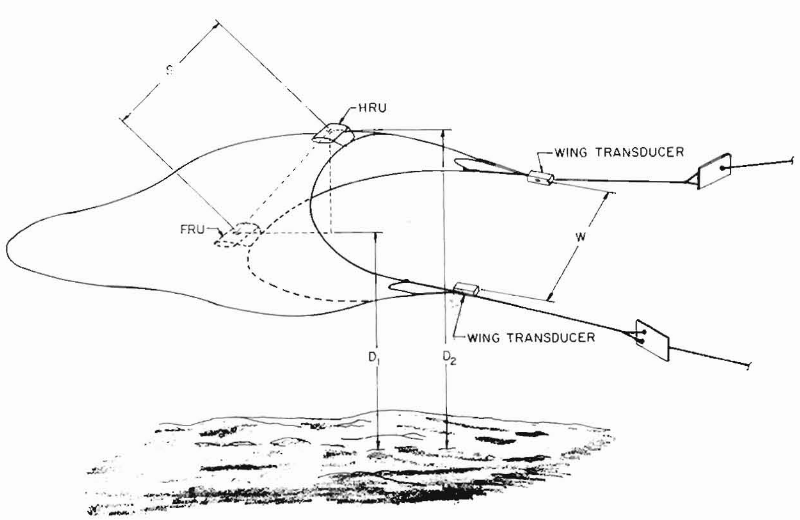
## DESCRIPTION OF INSTRUMENTATION

For a number of years there has been interest in designing electroacoustic systems to measure the performance of trawls. Recent advances in electroacoustic and electronic technology make the design and construction of relatively simple, compact, and reliable instruments possible. Several experimental systems are available (French, 1968; Allison, 1971; Calon, 1971; Drever, 1971; Horn, 1971; Kodera, 1971; Lusz, 1971; Okonski and Martini, 1971; Savrasov, 1971; Smith and Stubbs, 1971; Steinberg, 1971) as are commercial instruments that measure a few parameters (e.g., depth to headrope or headrope-to-bottom distance). Complex and sophisticated units are also available (Carrothers, 1968) for conducting detailed engineering studies of trawl performance. However, because of their limitations with respect to measurement capability, data storage, and portability, as well as transmission problems and/or technical complexity, none of these systems were considered satisfactory for our purposes. Consequently, a contract was let to the Applied Physics Laboratory of the University of Washington, Seattle, for the design and construction of a suitable prototype system.

Consultations were held with the design engineers to outline the parameters needing measurement and the operational conditions expected. Compromises were reached to stay within available funds. The general goal was a system that would measure and record the desired parameters and would withstand the severe operating conditions encountered in trawling operations. It also needed to be relatively simple to operate and maintain. The resulting system (Acker and Brune, 1974) is shown schematically in Figure 1. It measures and records the headrope-to-bottom distance ($D_2$), the footrope-to-bottom distance ($D_1$), the wingspread, and the headrope-to-footrope distance (S). All information is stored in digital form on a small cassette recorder in the

Figure 1.- -Schematic drawing showing relative locations of instrumentation system components.



headrope unit. A major concession to the cost limitation was forgoing a real-time surface readout.

The system consists of a headrope unit (HRU), a footrope unit (FRU), two wing transducers which are wired to the HRU, a cassette playback unit, and a battery charger. It measures and records the following parameters: 1) HRU to bottom, in feet (5-99); 2) HRU to FRU, in feet (0-99); 3) FRU to bottom, in tenths of a foot (0.9-15.0); and 4) wingspread, in feet (5-99).

### Headrope Unit

The HRU contains a 120-kHz transmitter and receiver, a system timer and control, a signal processor, a transmit-receive steering network, and digital data storage. The timer determines the basic sampling period for the system. A switch on the timer can set a sampling interval of 3.3, 6.6, 13.2, or 26.4 seconds. Due to the ample battery life and data storage capacity, we utilize the shortest period almost exclusively. The sample period ($T$) is further divided into three subperiods: $T_1$, $T_2$, and $T_3$. During $T_1$, the HRU operates as an echosounder and records the distance to the nearest two objects, the first of which is usually the bottom. During $T_2$, a transponding system to the FRU is used. The FRU answers the HRU with two pulses; the first provides data on the FRU-HRU distance and the second on the distance of the FRU to the bottom. During $T_3$, the HRU measures the time required for an acoustic pulse to travel from one wing transducer to the other. HRU power is provided by a 4.5-ampere-hour, 12-volt gel cell battery that can operate about 60 hours at the fastest repetition rate before recharging is required.

The HRU electronic components are encased in a tubular housing designed for pressures to a depth of about 330 fathoms (615 m). External connections and an on-off-charge switch are mounted on one end-cap; the other end-cap is removable for access to the cassette recorder (Fig. 2). This unit and its faired housing (Fig. 3) weigh about 70 pounds in air but are neutral in seawater.

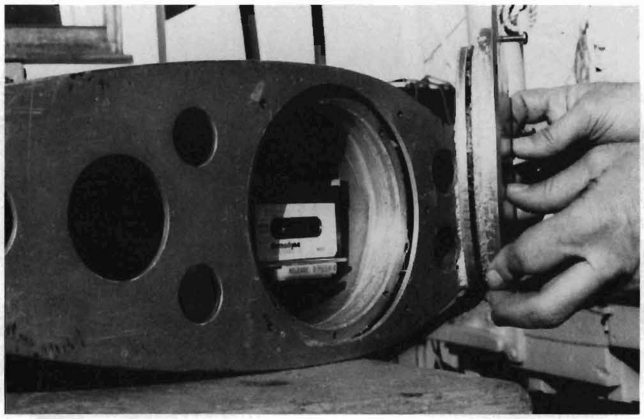


Figure 2.—Removing end-cap of HRU for access to the cassette tape.

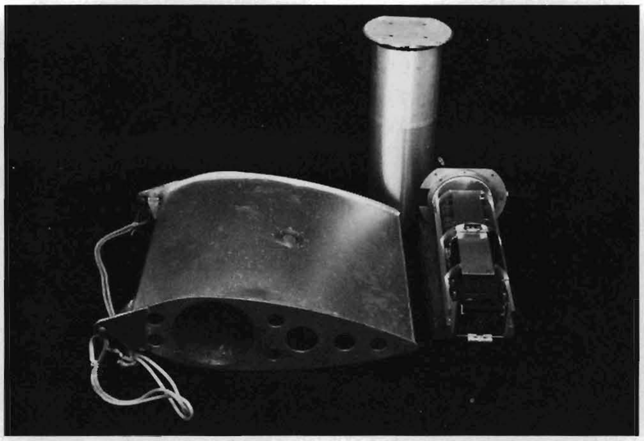


Figure 3.—The headrope unit components showing the electronic package, pressure vessel, and the faired housing.

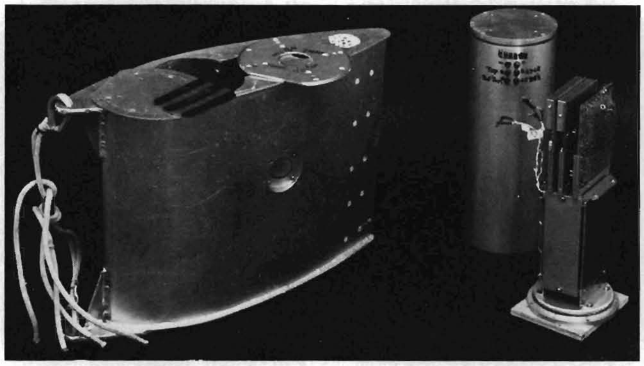


Figure 4.—The footrope unit components.

### Footrope Unit

The FRU (Fig. 4) consists of a 120-kHz transponder, a 400-kHz echosounder, a timer, and a signal processing control. The transmitter and receiver design is essentially the same as that in the HRU. The 400-kHz circuit is used to measure the bottom distance and the 120 kHz for telemetry to and from the HRU. The timer and signal processor gather data and send them to the HRU for storage. FRU power is also provided by a 4.5-ampere-hour, 12-volt gel cell battery, and the electronic components are encased in a tubular housing. External connections are made

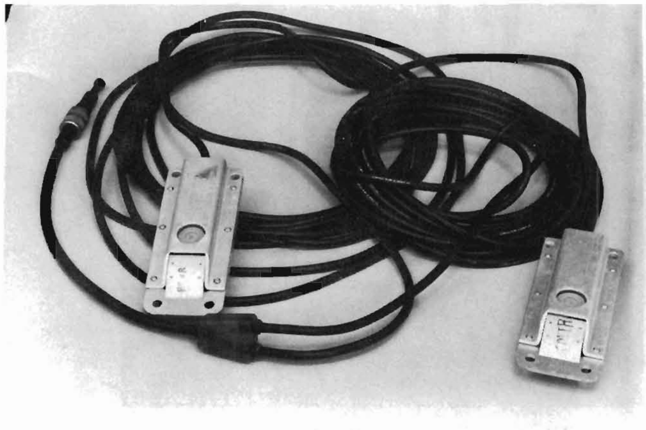


Figure 5.—Wing units used for measuring trawl spread.

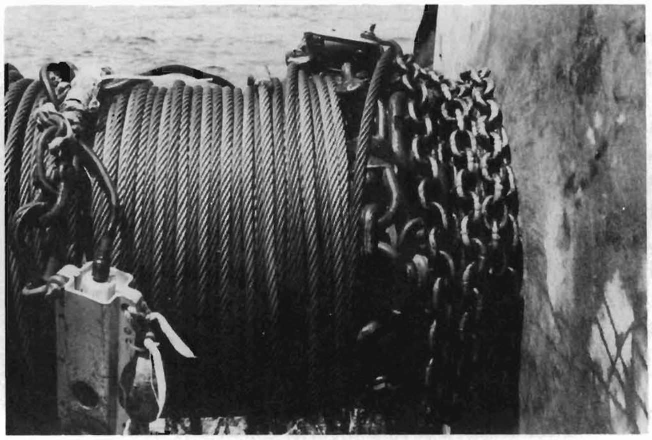


Figure 6.—Wing transducer wire crushed under dandyline while trawl is retreived on trawl drum.

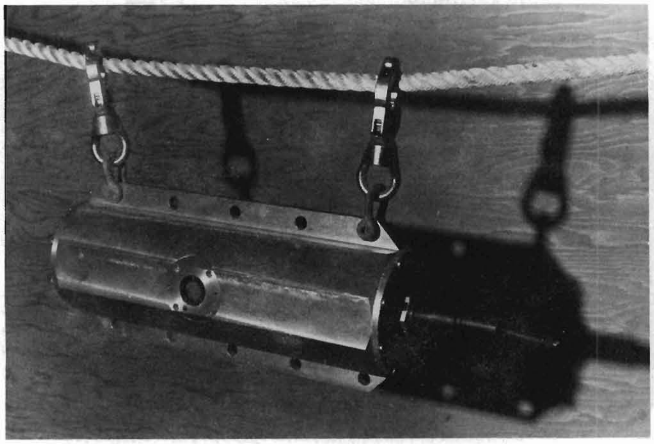


Figure 7.—Wing unit transponder.

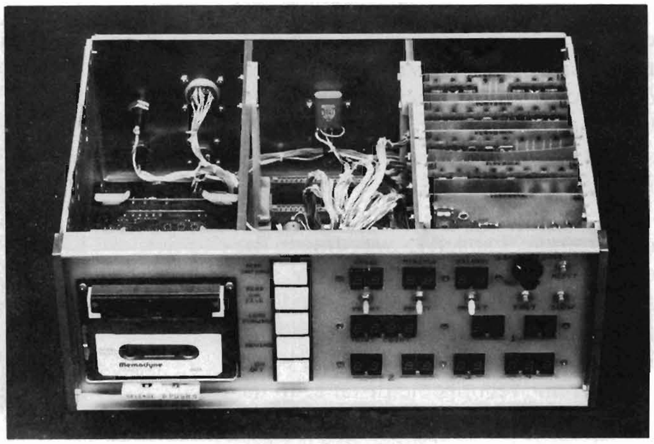


Figure 8.—Digital playback unit.

through the housing side wall with single-pin waterproof bulkhead connectors. An on-off-charge switch is located in one end-cap and both end-caps are removable. The housing is mounted inside a faired outer shell and the entire assembly is neutrally buoyant. Two transducers are housed in the fairing: a 120-kHz transducer with a beam width of 56° looks up and forward at an angle of 18°, and a 400-kHz transducer with a beam width of approximately 40° looks directly down. The assembly weighs about 35 pounds in the air but is neutrally buoyant in seawater.

### Wing Units

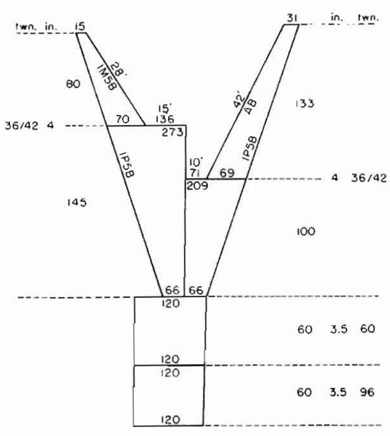
The wing units (Fig. 5) for measuring trawl spread initially consisted of two transducers each connected to the HRU by wire attached along the headrope. They had beam widths of about 60°. Problems with alignment between the two and wire damage due to handling during fishing (Fig. 6) resulted in system modifications, which have replaced one unit with a transponder and increased beam width of both to 150°. The first modification eliminated one headrope wire and the second reduced the alignment problem. The redesigned unit is shown in Figure 7.

### Playback Unit

The playback unit (Fig. 8) consists of a cassette tape playback, controls, a clock, digital displays for each of the measured parameters, and the point-count number. The data can be displayed incrementally by sets of data, or a fast read can be used to skip portions of the tape. The playback unit also includes an interface to a digital computer for data processing.

### Field Test Set

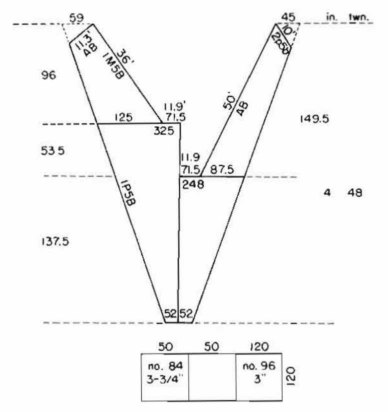
After a period of working with the system, we designed and constructed a portable field test set. Experience showed that use of such a system would reduce the number of "no-data" tows and the number of times the headrope unit needed to be opened to obtain the tape and verify system operation. Opening the HRU was usually done when we were exposed to the weather and, consequently, we not only risked getting seawater into the electronic components but increased the chance of O-ring damage. The test set determines if: 1) the headrope and wing transducers are working; 2) the coded pulse is arriving at the recorder; 3) the recorder motor is functional; 4) the wing and footrope systems are functioning; 5) the recorder head is engaged.



400-MESH EASTERN

Netting—nylon, preshrunk and dyed green.
Headrope—71 ft of 3/8 in, 6 × 19 galvanized wire rope wrapped with 3/8 in polypropylene rope.
Footrope—94 ft, 1/2 in, 6 × 19 galvanized wire rope srapped with 9/16 in polypropylene rope.
Breastlines—6 ft, 1/4 in proof coil galvanized chain.
Footrope wieght—1/4 in, proof coil galvanized chain, 112.5 ft long (9 links per 7½ in hanging).
Flotation—15 pieces, 8 in diameter floats (5.5 lb buoyancy each).
Codend liner—1¼ in mesh, no. 18 nylon; 340 meshes around, 240 meshes deep, secured 15 meshes up from bottom of intermediate (leave about 2 ft of liner extending from end of bat).
Otterboards—5 × 7 ft V-doors, 820-850 lb each.
Dandylines—double, 20 fathoms, 1/2 in, 6 × 19 galvanized wire rope.

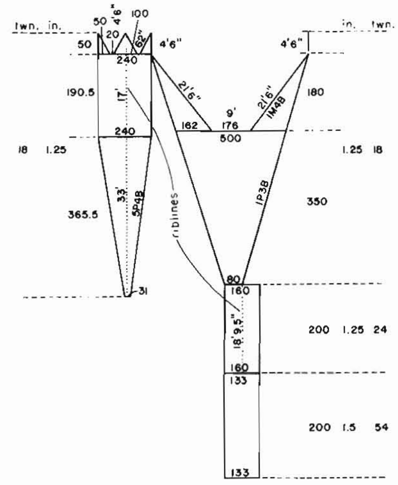
Figure 9.—Diagram of 400-mesh Eastern trawl used for resource assessment surveys at the NW & AFC.



83/112 EASTERN

Netting—nylon, preshrunk and dyed green.
Headrope—83 ft, 1/2 in 6 × 19 galvanized wire rope, wrapped with 5/16 in polypropylene rope.
Footrope—111.8 ft, 5/8 in diameter, 6 × 19 galvanized wire rope wrapped with 5/16 in polypropylene rope.
Footrope weight—5/16 in proof coil galvanized chain, 112 ft long.
Breastlines—1/2 in diameter galvanized 6 × 19 wire rope, wrapped with 1/4 in polypropylene rope.
Riblines—3/4 in diameter braided nylon extending length of first intermediate.
Flotation—40-8 in aluminum floats (5.5 lb buoyancy each).
Chafing gear—46 ML × 55 M around, 9½ in mesh, 3/8 in diameter polypropylene rope, hogringed.
Codend liner—1¼ in mesh, no. 18; 340 meshes around, 240 meshes deep.
Dandy lines—single 10 fathoms, 3/4 in, 6 × 19 and 25 fathoms double (3/8 in top 3/4 in bottom).

Figure 10.—Diagram of 83/112 Eastern trawl.



61′ SHRIMP SAMPLING TRAWL

Netting—nylon, preshrunk.
Headrope—61 ft of 3/8 in 6 × 19 galvanized wire rope, tight wrapped with 5/16 in polypropylene rope.
Footrope—61 ft of 1/2 in, 6 × 19 galvanized wire rope, tight wrapped with 1/2 in polypropylene rope.
Breastlines—20 ft of 1/2 in braided nylon (Stablebraid).
Sidepanel riblines—73 ft 3½ in of 5/8 in braided nylon (Stablebraid).
Flotation—29 pieces, 8 in diameter (5.5 lb buoyancy each).
Footrope chain—60 ft of 3/8 in suspended with six 12-in chain droppers (3/8 in diameter).
Tickler chain—55 ft of 3/8 in secured at wing tips.
Otterboards—5 × 7 ft V-doors, 815 lb.
Dandylines (sweeplines)—3 pieces, 10 fathoms each, top and middle of 3/8 in diameter, 6 × 19 galvanized wire rope, bottom of 1/2 in diameter; top with 24 in extension and middle with 18 in extension—both of 3/8 in proof coil chain.

Figure 11.—Diagram of 61-foot shrimp sampling trawl.

## RESULTS

At the NW & AFC, three basic trawls are now used for resource assessment. The 400-mesh Eastern (Fig. 9) has been used for this purpose for about 20 years and is still used in the surveys which utilize vessels of less than about 500 horsepower. More recently, with larger survey vessels, an 83/112 Eastern (Fig. 10) has been adopted. The 4-inch mesh in both of these trawls is smaller than the 5- to 5½-inch used in the commercial fisheries of the area, but it is considered desirable to continue with the smaller size to ensure a degree of comparability of new data with those obtained in earlier years. The 61-foot shrimp sampling trawl shown in Figure 11 has been used during the last 4 years by both the National Marine Fisheries Service and the Alaska Department of Fish and Game for Alaska shrimp surveys.

## 400-Mesh Eastern Trawl Measurements

Data were obtained on this gear during 38 tows by the NOAA fishery research vessel *John N. Cobb* while engaged in Pacific hake, *Merluccius productus,* assessment cruises off California in the spring and fall of 1975. As shown in Table 1, the tows were made in depths from 30 to 145 fathoms using scope ratios (wire length:water depth) from 3.3:1 in the shallow end of the range to 2.5:1 on the deep tows. Choice of scope ratio was varied somewhat among cruises, especially during shallow tows.

The data from these two cruises indicate a number of performance features of interest. These include a large number of tows that were abnormal in some way with minor within-tow variability and greater between-tow variability. Of the 38 tows for which data were recorded, 11 (29 percent) were abnormal in that the trawl was off bottom for a substantial part of the time. On three of these, the trawl took from 7 to 11 minutes to reach bottom (standard tow length is 30 minutes) but functioned normally thereafter. On three others, the gear fished normally during the first part of the tow but left bottom after 10, 14, and 18 minutes, respectively, and remained off bottom during the rest of the tow (Fig. 12). On tows 56 and 69, the gear was off bottom 1-2 feet or more intermittently throughout the tow. The remaining three abnormal tows involved late arrival on bottom (15 minutes), intermittent bottom contact, and fluctuating wing-spread measurements ranging from 10 to 50 feet. The widely varying wing-spread indicates the gear was not

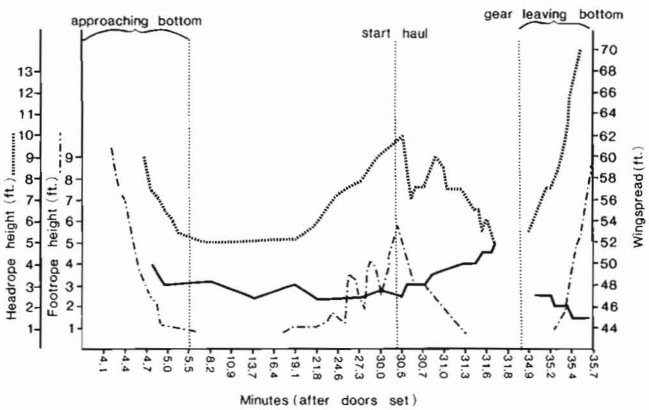



Figure 12.—Graph of data showing gear leaving bottom about 12 minutes before hauling started.

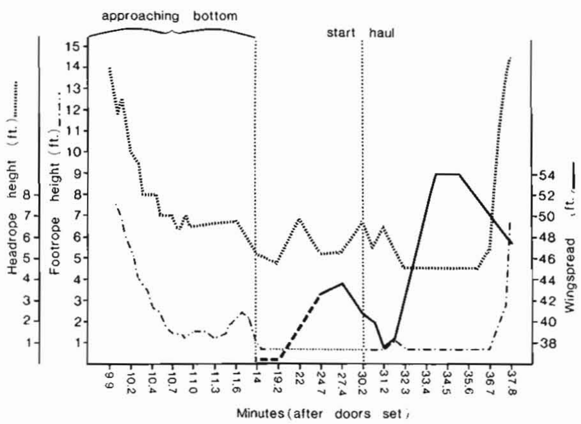



Figure 13.—Graph of data from tow 62—C75-2.

spreading properly. Figure 13 illustrates the performance of the net on tow 62, which was typical of these three tows. The delay in reaching bottom, narrow and widely fluctuating wingspread measurements, and the loss of both wing and FRU data suggest severe distortion of the trawl probably due to water currents acting on the vessel and gear.

On tows where problems with performance were not detected, within-tow variability was very low. The vertical opening fluctuated less than $\pm 0.25$ foot and the horizontal spread less than $\pm 1.5$ feet. Figure 14 is a plot of these data for a typical normal tow. However, between-tow variation of horizontal spread was somewhat greater, with a range from about 36 to about 48 feet. A plot of wingspread against depth of tow (Fig. 15) suggests that, within these depths, spread increases with depth; the greatest rate of change is at the shallow end of the range. The vertical opening on the tows deeper than 40 fathoms was 5 feet or less in all tests. On the 10-fathom tows, it ranged from less than 5 feet to 7 feet.

## Eastern Trawl (83-112 Foot) Measurements

With the trend toward larger research vessels in recent years, it was necessary to select a sampling system to better match their greater power. The trawl shown in Figure 10 was chosen as a compromise which would do this and retain the principal sampling characteristics of the 400-mesh Eastern trawl. The gear was studied in the fall of 1975, on a resource assessment cruise with the NOAA fishery research vessel *Miller Freeman*—a 2,000 horsepower stern trawler. The otterboards were 7 × 10 feet, V-design, and weighed 3,000 pounds each. The trawling warp was 1 inch in diameter. Unfortunately, the wingspread measurement circuit was not functioning on this cruise and, therefore, only HRU and FRU data were obtained. Consequently, observations of performance were limited to

**Table 1.—Trawl parameters observed during cruises of the *John N. Cobb* during spring and fall of 1976.**

| Season and tow no. | Depth (fathoms) | Scope ratio | Time to bottom (minutes) | Spread (feet) | Height (feet) | Bottom contact | Problem tow |
|---|---|---|---|---|---|---|---|
| Spring | | | | | | | |
| 58 | 30 | 3.3 | 2.2 | — | 4.5 | good | — |
| 67 | 36 | 3.3 | 3.1 | 44 | 4.5 | good | — |
| 65 | 40 | 3.0 | 5.5 | 44 | 4.5 | good | — |
| 48 | 50 | 3.0 | 15.0 | — | — | — | x |
| 49 | 50 | 3.0 | 2.4 | 43 | 4.6 | good | — |
| 53 | 50 | 3.0 | 3.9 | 44 | 4.8 | good | — |
| 59 | 54 | 3.0 | 3.2 | 46 | 4.5 | good | — |
| 40 | 54 | 3.0 | 2.0 | 46 | 5.2 | poor | x |
| 51 | 70 | 3.0 | 1.9 | 47 | 4.5 | good | — |
| 64 | 70 | 3.0 | 11.0 | 44 | 5.0 | good | x |
| 39 | 77 | 3.3 | 4.8 | 46 | 5.0 | good | — |
| 60 | 88 | 3.0 | 4.3 | — | 5.0 | poor | x |
| 46 | 106 | 2.8 | 3.4 | 49 | 5.0 | good | — |
| 56 | 106 | 3.3 | 4.3 | 51 | 5.0 | erratic | x |
| 62 | 132 | 2.7 | 14.6 | — | 5.8 | — | x |
| 52 | 145 | 2.5 | 7.6 | 47 | 5.0 | — | x |
| Fall | | | | | | | |
| 76 | 43 | 3.5 | 3.0 | — | 5.5 | good | — |
| 80 | 45 | 3.6 | — | — | 5.5 | good | — |
| 84 | 45 | 3.6 | 2.0 | — | 5.5 | good | — |
| 68 | 51 | 2.9 | 3.0 | — | 5.5 | — | — |
| 90 | 54 | 3.2 | 3.0 | — | 5.5 | — | — |
| 71 | 58 | 2.8 | 4.3 | 44 | 5.5 | — | — |
| 77 | 62 | 3.1 | 4.7 | — | 5.5 | good | — |
| 83 | 63 | 3.0 | 4.7 | — | 5.5 | good | — |
| 75 | 70 | 3.0 | 5.2 | — | 6.9 | poor | x |
| 85 | 75 | 3.0 | 3.8 | — | 5.5 | good | — |
| 69 | 75 | 3.0 | 4.5 | 45 | 5.5 | poor | x |
| 78 | 75 | 3.0 | 4.9 | — | 6.0 | good | — |
| 79 | 75 | 3.0 | 4.5 | — | 6.0 | good | — |
| 81 | 77 | 3.0 | 4.1 | — | 5.5 | — | — |
| 72 | 83 | 3.0 | 5.1 | 47 | 6 | poor | x |
| 74 | 92 | 3.0 | 4.4 | — | 5.5 | — | — |
| 70 | 94 | 3.2 | 3.7 | — | 5.5 | — | — |
| 73 | 106 | 3.0 | 5.6 | — | 5.5 | — | — |
| 82 | 108 | 2.9 | 5.4 | — | 5.5 | good | — |
| 91 | 110 | 2.7 | 3.4 | — | 5.5 | — | — |
| 86 | 110 | 3.0 | 4.6 | — | 5.5 | — | — |
| 87 | 111 | 2.7 | 7.1 | — | 5.5 | — | x |

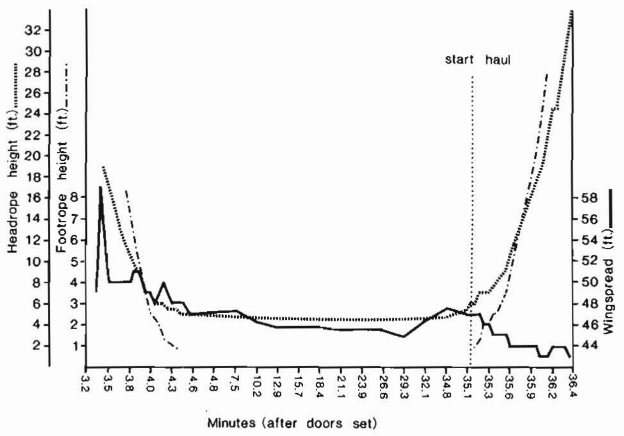



Figure 14.—Graph of data from tow 39—C75-2.

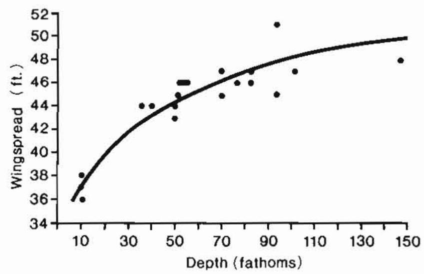



Figure 15.—Wingspread-towing depth relationships for the 400-mesh Eastern trawl. Curve fitted by inspection.

measurements of time to reach bottom, vertical opening, and footrope bottom contact. This gear settled to the bottom much faster than the 400-mesh Eastern. The average time was only 2.2 minutes and ranged from about 0.5 to 6.0 minutes, except for tow 85 in 194 fathoms, when it took 13 minutes. This was the deepest tow of those observed with the instruments during the cruise.

The gear was off bottom while towing on only six of the 77 tows for which data were recorded and only for a maximum of 1.2 feet. Again an exception was tow 85, when the trawl was off bottom from 1.5 to 5.0 feet for 75 percent of the time after it had reached bottom. On this 30-minute tow, the gear was on bottom only about 4 minutes, or 13 percent of the towing time.

The effect of floats on the headrope height was found to be significant. With 40 floats (288 pounds buoyancy), the average height measured on 28 tows was 7.6 feet (range from 6.3 to 9 feet). In nine tows with 30 floats (216 pounds buoyancy) the average height was less than 5.5 feet (range from less than 5 to 6 feet). Data from the FRU showed that the greater headrope height was the result of a change in trawl shape rather than of lifting of the gear off the bottom.

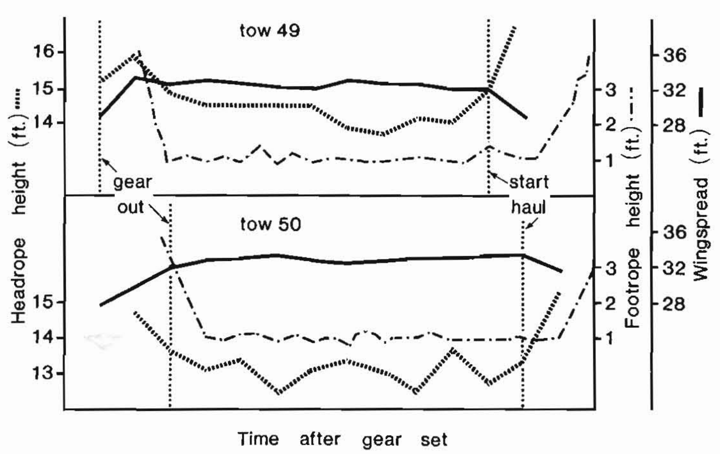
Another variation noted was a difference in vertical opening between two presumably identically rigged nets of the same design and from the same manufacturer. Net no. 1 was used on tows 7-9 with an average vertical opening of 7.8 feet. Net no. 2 was fished on tows 10-13 with an average opening of 6 feet. In another series, net no. 1 was measured 16 times between tows 20 and 40 and had an average opening of 7.2 feet. On the 13 observations of net no. 2 on tows between no. 41 and no. 60, the average was 5.5 feet. The reason for the substantial difference in this parameter between the two trawls is unknown.

## 61-Foot Shrimp Sampling Trawl Measurements

The shrimp sampling trawl (Fig. 11) was designed by NMFS personnel specifically for assessment of the shrimp stocks in the waters near Kodiak, Alaska. The major objective of the design was a trawl with a larger vertical sampling capability than the Gulf of Mexico shrimp trawl designs used in earlier surveys. The net is fished from 5 × 7 foot V-doors on 10-fathom triple dandylines (the wire assembly between the trawl and doors).

Data were obtained on 10 tows in May 1974, during a shrimp assessment cruise of the NOAA fishery research vessel *Oregon* in Alaska. Although measurements were incomplete due to equipment and operational problems, they provided some indication of the gear's performance. Time to bottom on the three tows where it was obtained averaged 3.7 minutes, which is within the normal range measured on the Eastern trawls for tows in similar depths (approximately 90 fathoms). On tows 49 and 50, complete data were obtained (Fig. 16). It appears that when operating normally in 90 fathoms, this gear fishes about 1 foot off bottom, spreads about 32-34 feet, and opens vertically 11.5-13.5 feet (headrope height minus footrope distance off bottom). Both distance off bottom and the horizontal spread were relatively stable but the

Figure 16.—Graph of data from tows 49 and 50, *Oregon* cruise 75-1.



vertical opening fluctuated considerably more than was found for the Eastern trawls. The percentage change of the footrope height off bottom was large (30 percent) but the absolute change was only 3.6 inches. On tow 58, the horizontal spread was a relatively steady 37-38 feet, suggesting that between-tow variability may be of some significance with this gear also. Data on the other two parameters were not obtained on this tow. The remaining tows produced limited data which were variable and usually outside the ranges described above. For example, on tow 51 the headrope height ranged from 16.5 to 18.5 feet, which is much greater than on tows 49 and 50 (as was the variability). FRU data were not obtained, so how much of this is attributable to the trawl being off bottom is not known. Other tows produced similar erratic data and frequent loss of signals, suggesting that distortion of the gear due to water currents was probably a factor.

In a separate experiment with this trawl, the effect of load-bearing riblines on net configuration was tested. The four riblines are installed with the webbing hung in 13 percent (ribline length is 13 percent less than the stretched mesh length of the webbing hung to it). Commercial shrimp trawls usually have no riblines or they are as long as or longer than the stretched mesh webbing to which they are attached. The first series of tows was made with the riblines and the second with them removed. As depicted in Figure 17, there was a marked decrease in vertical opening without the riblines, especially at the higher speeds. The effect on horizontal spread was minor. Likewise, towing speed and total warp tension were not noticeably affected by the presence or absence of the riblines.

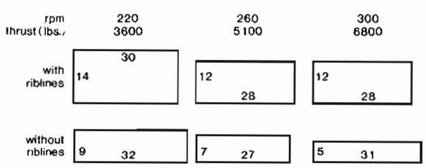


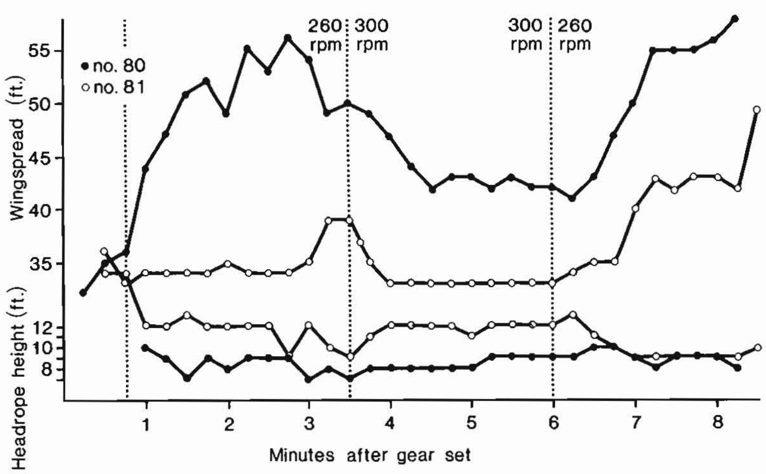

Figure 17.—Changes in dimensions of the 61-foot shrimp sampling trawl with and without riblines at three towing speeds.

It is of interest to note that commercial shrimp trawlers in the northeastern Pacific Ocean obtain larger catches at towing speeds of only 1-2 knots than at the usual speeds of about 3 knots. Possibly one reason for reduced catches at higher speeds is the reduced vertical opening of the trawl.

### Other Observations

During early trials with the instruments in Saratoga Passage, Puget Sound, a series of tows with a modified Eastern trawl in 45 fathoms revealed an interesting phenomenon apparently related to the tidal currents in the area. The trawl used was similar to the Eastern trawl reported earlier and shown in Figure 9. The otterboards were the same. A major difference was that 40, rather than 20-fathom dandylines were used.

Figure 18.—Graph of data from tows in Puget Sound's Saratoga Passage showing erratic trawl configuration at slow speed in one towing direction.




The experimental procedure was to tow at an engine speed of 260 rpm for 3.5 minutes, increase to 300 rpm for 2.5 minutes, and reduce again to 260 rpm for 2 minutes. In seven paired tows (one north and one south), the measurements were relatively stable at both speeds in one direction although the spread was narrower and the height greater than would be expected at this depth. The behavior in the opposite direction, however, was extremely erratic. At the low speed, the spreads were very wide (to 55 feet) and variable. The vertical opening was higher than normal but comparatively stable at both speeds. A graph of the measurements from one pair of tows is shown in Figure 18.

Of interest also, was the HRU to FRU measurement during the erratic tows. At the low speed, this measurement decreased from the normal 18-19 feet down to 9 or 10 feet, increased back to normal when the speed was increased, and decreased again when speed was reduced. This also suggests severe distortion since the two units were apparently almost one above the other at the slow speeds. The apparent distortion is probably related to tidal currents—on some days it occurred when towing to the north but on others to the south.

A limited number of observations were made of an 82-foot shrimp trawl used for groundfish assessment surveys in the Gulf of Mexico. This gear is fished on 12 foot by 5 foot otterboards with only 9 foot dandylines (leglines). Two tows in 40 fathoms in the same location but in opposite directions showed the gear reaching bottom at 7 and 4 minutes. This is of some interest since the standard towing time in these surveys is only 10 minutes. The gear spread about 56-57 feet and opened vertically 7 to 8 feet. Figure 19 is a graph of the vertical and horizontal measurements taken on tow 31. Although the headrope measurements in particular were more erratic than with other gear

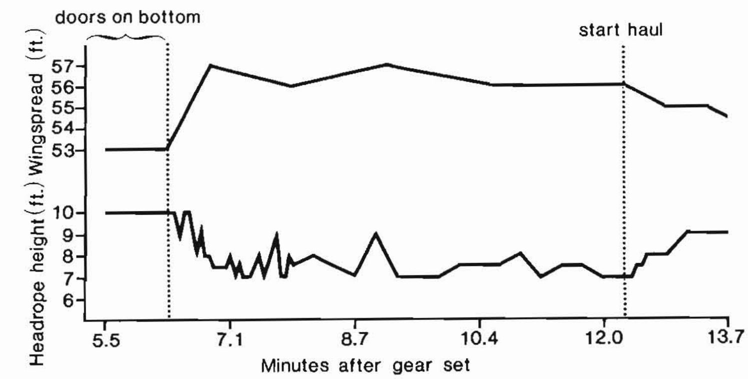



Figure 19.—Graph of data from tow with an 82-foot shrimp trawl.

measured, it appears the trawl reached bottom when the spread increased from 53 to 57 feet and vertical opening dropped from 10 to about 7 feet. This change in geometry is what is expected when the otterboards move from midwater to the bottom where a greater spreading force is developed and is especially true when very short dandylines are used.

On the two tows in 100 fathoms, the data obtained suggest the gear did not reach bottom at any time during either tow. Failure to get readings from the FRU precludes a positive determination of this, but the minimum of 10 feet on the HRU measurement and the 52-53 foot wing spread throughout the tow indicate the otterboards were not in contact with the bottom and therefore not spreading the trawl fully. The absence of any catch in either tow tends to confirm this.

## SUMMARY

Measurements to date indicate that the performance of assessment trawls used at the NW & AFC is more variable than had been assumed. In particular, the bottom contact in the forms of late arrival on bottom, lifting off bottom early, or sporadic contact throughout a tow was found to be of some significance at times—especially on deeper tows and in areas of strong currents. Variability of trawl spread and headrope height was found to be relatively small within the 30-minute tows but somewhat greater between tows. These variations are probably the result of water currents acting on the gear and vessel.

The instrumentation is currently being modified to eliminate the wire used for transmitting the wing spread data to the HRU; a trawl-to-vessel acoustic telemetry link is being incorporated to provide a real-time readout at the surface. The recording of data at the HRU will continue, however, at least until experience demonstrates that data loss due to transmission problems is at an acceptable level.

The equipment will continue to be used for acquiring data on resource assessment trawls during survey operations to better understand what variation in performance occurs under the various conditions the gear is used. A primary objective will be to determine the potential value of incorporating certain instrumentation as an integral part of the sampling systems.

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