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AN EXPERIMENT IN ELECTRICAL FISHING WITH AN ELECTRIC FIELD USED AS AN ADJUNCT TO AN OTTER-TRAWL NET

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SUMMARY

Electrical fishing is not a new fishing method; however, problems with application in a rine environment have limited its successful use to date. As part of cooperative research h the Smith Research and Development Company (SRD), the U. S. Bureau of Commercial sheries test-fished electical fishing equipment (developed by SRD) which was designed to rcome these problems.

The tests were conducted on New England commercial fishing grounds and used an elec- c field as an adjunct to an otter trawl (net) of commercial design. To determine the fishing ectiveness of the electric field, a comparative method of towing was employed. This con- ted of a series of as nearly identical tows as possible with the electric field used on alter- e tows.

The test results indicate that for over- fishing, the net with the electric field hed over 2.3 times as effective as the net ne. The fishing effectiveness of the net h the electric field was 1.5 times that of net alone for taking cod and haddock. r flatfish, the net with the electric field s twice as effective as the net without the d. The catch rate for taking whiting with of the electric field was 4.4 times the h rate of the net alone.

Plans for future work include specific ing to determine the answers to some e questions unresolved by these tests.

Fig. 1 - The Bureau of Commercial Fisheries' vessel Delaware operated by the Exploratory Fishing and Gear Research Base, Gloucester, Mass.

INTRODUCTION

Efforts to catch fish by means of an tric current, used independently or bined with accessory gear, have been ly common since the 1930's. Such efforts and the hopes of the various investigators of trofishing methods have been based upon two types of reaction of fish to d.c. electric cur- ts. These reactions have been termed electrotaxis: the guiding and stimulation of swim- g activity by means of electricity, and electronarcosis: the stunning of the fish for elec- al shock.

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If the proper form of electrical current is passed through a body of water containing f a remarkable change in the normal behavior pattern can be observed: the fish turn in the d rection of the positive electrode (the anode) and swim toward it. They will continue in this manner until they arrive within a certain proximity of the anode where, dependent upon th species of fish, the size of the individual, and the intensity of the electrical current, they b come immobilized, turn on their backs or sides, and remain in this stunned state until the electric power is turned off. After a recovery period, the fish can be induced to reverse t direction and swim to the opposite electrode by changing the polarity of the electrodes.

Upon observing this reaction, one is inclined to visualize an installation of generators o batteries with wires and electrodes placed in appropriate bodies of water, continuously ga ering in quantities of fish which can be removed by a simple mechanical means such as a net, seine, conveyor, or other device.

This has, indeed, been demonstrated to be an effective means of catching fish in fres water. Many state conservation agencies collect game fish species for biological studies ing simple battery-powered back-pack shockers or portable generators. (Use by private citizens for collection of fresh-water species is generally prohibited by law.) Successful plication in fresh water, however, has not been easily duplicated in sea water. Perhaps t most important factor which has limited the successful use of an electric field in marine ters is the electrical conductivity of the sea water; as the salinity increases, so does the i concentration and the resulting electrical conductivity of the water.

Earlier investigators of marine electrical fishing have determined that the conductivi of sea water is approximately 500 times greater than the average body of fresh water (Me Warden 1957). Because of this, the use of simple a.c. or continuous d.c. electric power is impractical for marine electrofishing. According to such investigations, it would be nece sary to produce up to approximately 10,000 kilowatts (10 million watts) of electric power attain an electrical fishing range (spherical radius from an electrode) of 10 meters (32.8 feet).

The search for a solution to astronomical power requirements has led, through exten research by physicists, biologists, and engineers in various countries over the past 20 ye to the general use of one or another form of condenser discharge pulses, or bursts of elec trical power applied at intervals. A major advantage of this type of discharge is that a ba of condensers can be charged over a relatively long period of time, for example, 20 milli onds, and discharged in a short period, one millisecond or less. Such an arrangement eff a great conservation of electrical power (Kreutzer 1963) and, to the encouragement of research efforts, has been determined to be extremely effective in guiding and stunning mos species of fresh- and salt-water fish. The experiment reported here was conducted with particularly effective modification of such high-power condenser-discharge pulses.

The major problems in the marine application of an electric field to groundfish fishi are (1) to supply the electric current required to produce the desired effect upon the fis to transform the current into the most efficient and effective form and type to catch fish to transport this current from the ship to the net (where it will be used) without exorbita loss, (4) to overcome or eliminate the effect of electrolysis upon the electrodes, and (5) provide rugged and practical equipment components necessary to withstand use aboard s and severe treatment during fishing operations.

With the exception of item (1) above, the solution to each major problem depends up successful resolution of a number of other directly or collaterally associated problems. of these are highly technical in nature and require specialized knowledge and training in which are frequently distinct and dissociated. Mainly for this reason, progress to date h been limited. However, successful electric harpoons and hooks, which shock large fish o mammals into submission, have been developed and used (Houston 1949) and, in the menh fishery, the "attracting effect" (electrotaxis) of an electric field is currently being used conjunction with pumps as a means for transferring net-caught fish from the sea to ship holds. Also, electrical currents have recently been successfully tested and experimenta ed in fishing for shrimp in the Gulf of Mexico (Wathne 1963); plans for commercial applica- n are now being expedited. These, and perhaps other illustrations, can be cited as exam- es of present use of this fishing method in the sea; but extended work is still required be- re commercial-scale employment of the electrical fishing method in the groundfish fishery n be achieved.

The purpose of this paper is to report on one segment of continuing research which has d successful results. Efforts were made to guide bottom-dwelling fish toward the opening an otter-trawl being towed across the sea bottom in the usual manner and to shock them ficiently upon their arrival at the net so that they would be immobilized and swept easily o the body of the trawl. The equipment was thus designed to prevent escapement of the fish thin the path of the trawl and to eliminate the possibility of any of the fish swimming back of the mouth of the net once they had been engulfed by it. The electrical equipment[1] used developed by the Smith Research and Development Company of Lewes, Del.

EXPERIMENT

Fishing trials were conducted over portions of commercial fishing banks which are fish- seasonally by New England trawlers for groundfish. The depths fished ranged from 47 to fathoms, most of the tows being made in depths between 50 and 56 fathoms. The transport urrent was over a 300-fathom length of conductor-towing warp which was payed out as ded from a trawl winch. (The entire 300 fathoms remained in the electrical circuit at all es regardless of what portion of the warp was run off the winch into the water).

The tests were conducted from July 11 to August 24, 1962, by staff members of the Bu- u's Exploratory Fishing and Gear Research Base, Gloucester, Mass., using the exploratory ing vessel Delaware (fig. 1). Representatives of the Smith Research and Development npany installed their equipment and operated it during most of the cruise.

FISHING AREAS: The areas in which the tests were conducted (fig. 2) were chosen be- se of (1) their good trawlable bottom (a necessity for avoiding possible damage to, or loss of, the electrical components on the net), and (2) their close proximity to each other (in the event it became necessary, in order to maintain suitable catches of fish, to shift fishing areas during the tests). The primary fishing area chosen lies offshore from Cape Cod in the general area between Nauset Harbor and Chatham, Mass., in approximately 49 to 58 fathoms of water (long. 69°42.5' W., lat. 41°43.5' N.; to long. 69°48.5' W., lat. 41°47.7' N.). The secondary fishing area chosen lies on the western side of Georges Bank in a region known as the "Bight of Clarks" (long. 68°33.2' W., lat. 41°27.5' N.; to long. 68°30' W., lat. 41°32.5' N.). The fishing tests were made in two parts: during the first part, all fishing was in the Cape Cod area; during the second part, fishing was conducted in both the Cape Cod and Bight of Clarks areas.

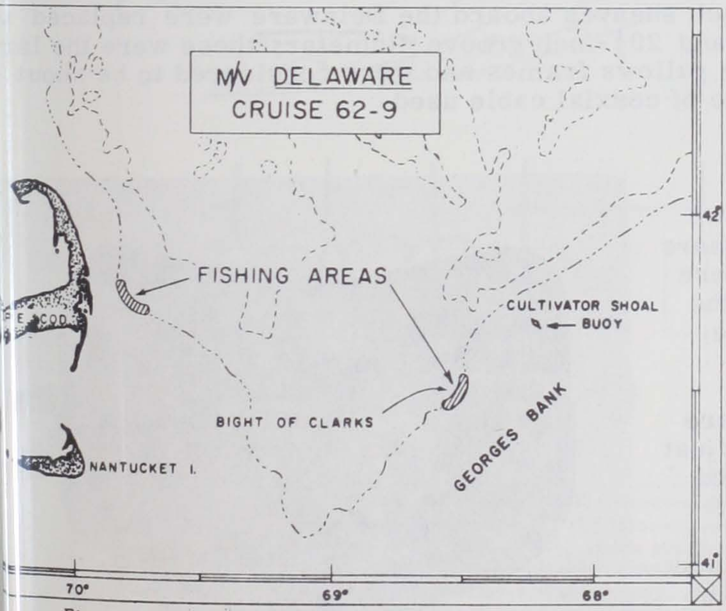

Fig. 2 - Areas fished during electrical-fishing experiments.

FISHING GEAR: A No. 41 large- h otter trawl was used during the experiments. This net had a 79-foot headrope and a 100-foot ope. It was rigged with three 15-foot sections of 16-inch diameter wooden rollers on the ope, 5-fathom wire legs, and 30 floats on the headrope; the floats were cast aluminum

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ails of the electrical equipment are included in a separate appendix attached to the reprint of this article.

with 7.5 pounds of static lift for each. The internal stretched mesh size of the netting measured 4.5 inches. The net was constructed of multifilament polypropylene twine. Accessory ropes were either polypropylene or nylon. Trawl warps were $1\frac{1}{16}$-inch diameter conductor-cable (fig. 3).

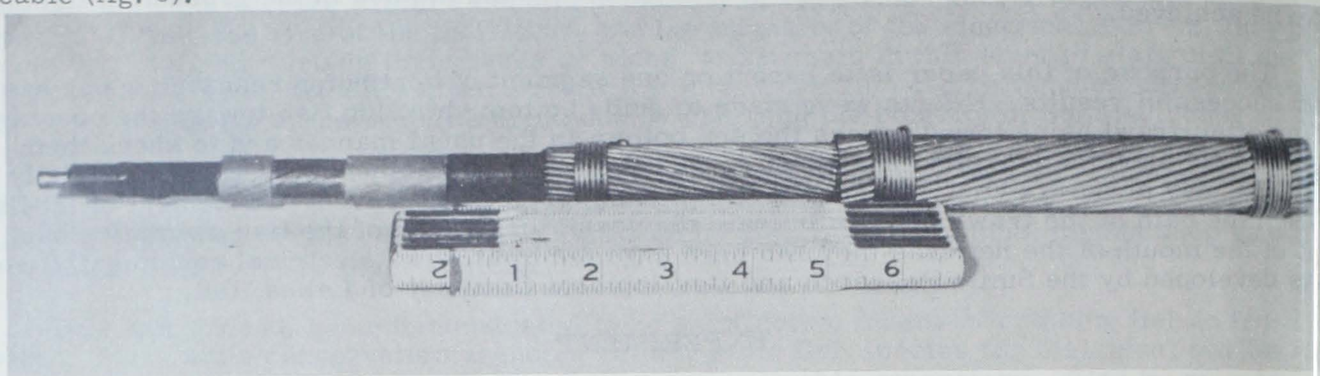

Fig. 3 - Construction details of special electrical-conductor trawl cable.

The conductor cable is made of two distinct parts: (a) strength members, and (b) electrical conductors. Two outer layers of single-strand steel wires provide tensile strength in this cable; to reduce kinking, one layer is left-lay while the other is right-lay. Two No. 4 (American Wire Gage) unplated copper conductors were arranged coaxially and, with their insulating material, formed the core of the cable. Disconnect plugs made the electrical connections at the winch drums; conduit-housed wires conducted the current from its source to these plugs.

Special accessory gear were (1) patented cable grips to attach the linkage for the trawl-door hook-up towing chain to the towing warp without making a break in the electrical conductors, and (2) sheaves of especially large diameter required by the large size electrical conductor trawl warp. The cable grips were the type that wrap around the cable upon which the are mounted (the towing warp) and contract when pulled upon to increase their grip as the tension is increased. The normal 16-inch sheaves aboard the Delaware were replaced with sheaves of 25-inch outside diameter and $20\frac{1}{2}$-inch groove diameter; these were the large size that could be accommodated by the gallows frames and were considered to be about the smallest practical diameter for the size of coaxial cable used.

PROCEDURE

The fishing tests were conducted in two parts; during both parts the net transformers or cable-output transformers (fig. 4) were shackled to the footrope of the net and the cathodes were laced to the netting in the after part of the bottom belly.

The first part of the fishing tests were made with the anodes laced to the netting just behind the footrope and positioned around the transformers (fig. 5).

The second part of the tests was made with the anodes positioned just behind the headrope of the net. While the anodes were positioned at the headrope, that portion of the electrical field which is formed about the anodes was spread between the electrodes at the headrope and the transform-

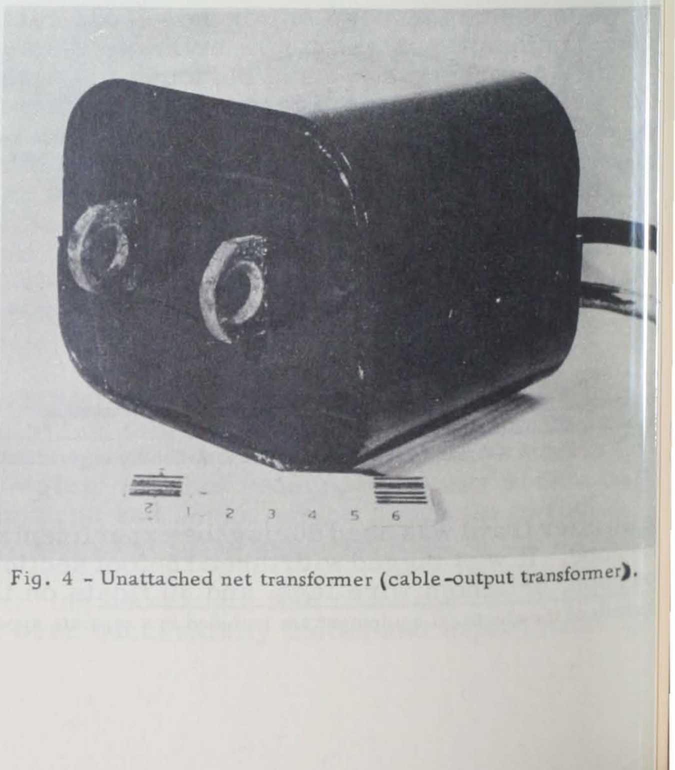

Fig. 4 - Unattached net transformer (cable-output transformer).

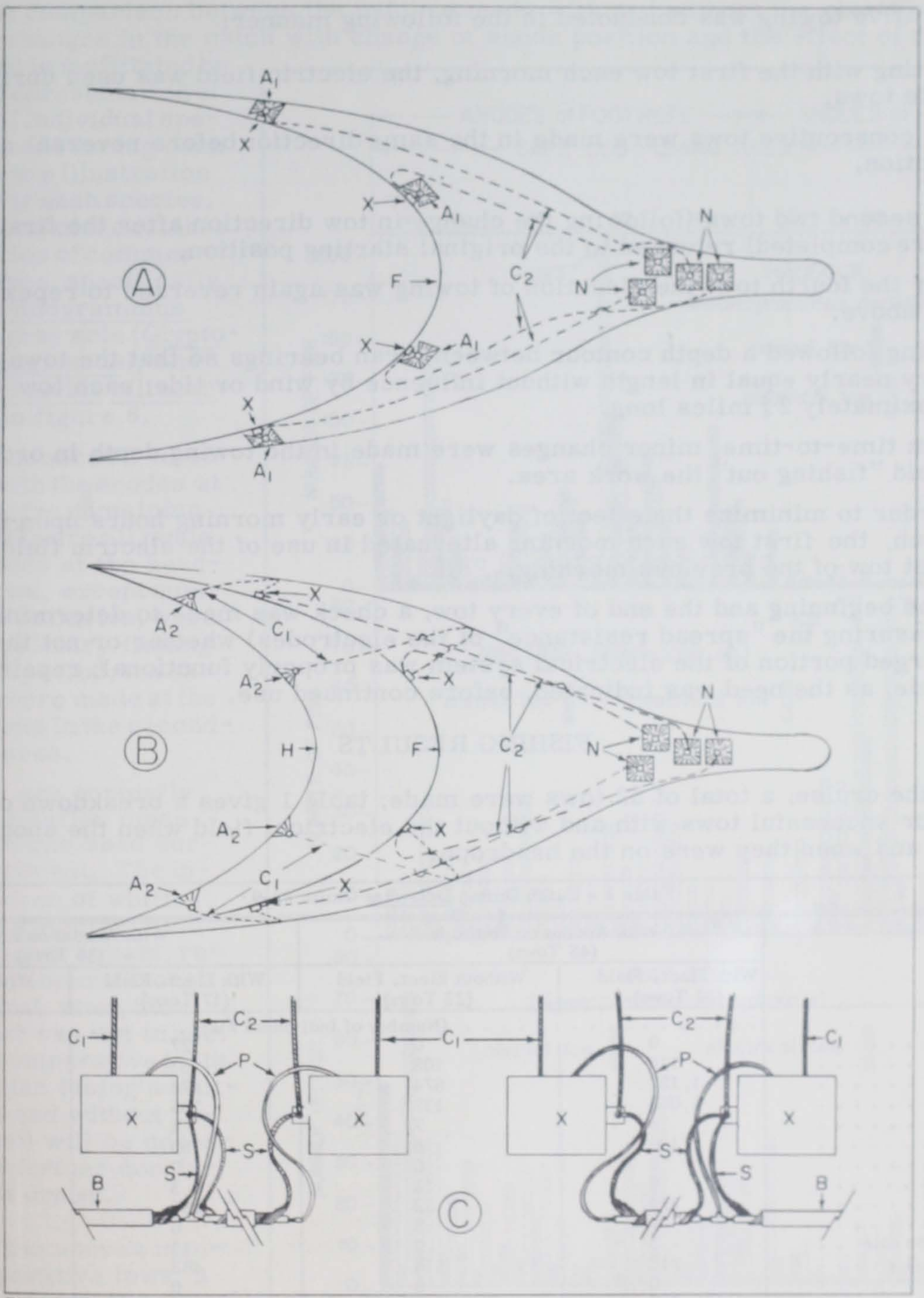

Fig. 5 - Electrical arrangement on net. (A) Transformers and anodes at net footrope. (B) Anodes at net headrope, transformers at footrope. (C) Hook-up arrangement of net transformers. Key: F=footrope; H=headrope; X=transformers; A_1=anode positioned near footrope; A_2=anode positioned near headrope; N=cathode; P=high-voltage conductor to transformer primary; S=shield (common return from transformer primary and secondary); C_1=conductor from transformer secondary to anode; C_2=conductor from transformer secondary to cathode; B=conductor for high-voltage current from shipboard power source.

the footrope, the aluminum housings of which also acted as anodes. Whatever the ef-
fe node separation may have had upon the shape of the electric field, the undetermined ef-
fe this modification should not be overlooked when examining the catch results for the in-
e of anode position upon the catch.

Comparative towing was conducted in the following manner:

1. Starting with the first tow each morning, the electric field was used during alternate tows.
2. Two consecutive tows were made in the same direction before reversal of tow direction.
3. The second two tows (following the change in tow direction after the first two tows were completed) returned to the original starting position.
4. After the fourth tow, the direction of towing was again reversed to repeat (2) and (3) above.
5. Towing followed a depth contour between loran bearings so that the tows were very nearly equal in length without influence by wind or tide; each tow was approximately $2\frac{3}{4}$ miles long.
6. From time-to-time, minor changes were made in the towing depth in order to avoid "fishing out" the work area.
7. In order to minimize the effect of daylight or early morning hours upon the total catch, the first tow each morning alternated in use of the electric field with th first tow of the previous morning.
8. At the beginning and the end of every tow, a check was made to determine (throug measuring the "spread resistance" of the electrodes) whether or not the submerged portion of the electrical system was properly functional; repairs were made, as the need was indicated, before continued use.

FISHING RESULTS

During the cruise, a total of 82 tows were made; table 1 gives a breakdown of the cat by species for successful tows with and without the electrical field when the anodes were the footrope and when they were on the headrope.

Table 1 - Catch During Delaware Cruise 62-9

Species	With Anodes on Footrope (45 Tows)		With Anodes on Headrope (36 Tows)	
	With Elect. Field (22 Tows)	Without Elect. Field (23 Tows)	With Elect. Field (17 Tows)	Without Elect. (19 Tows)
	(Number of Individual Fish)			
Butterfish	0	0	127	86
Cod	116	108	33	28
Haddock	1,127	874	476	244
Red hake	1,063	137	235	54
White hake	4	7	4	2
Herring	180	6	80	14
Ocean perch	2	0	0	3
Pollock	9	12	3	1
Whiting	394	52	456	148
Wolffish	1	5	0	1
Blackback or lemon sole	3	2	13	7
Dab	918	515	453	410
Four-spot	0	0	0	1
Grey sole	565	208	408	86
Yellowtail	17	5	9	12
Lumpfish	0	0	1	1
Monkfish	119	32	117	52
Ocean pout	67	27	7	2
Sea Raven	44	69	38	42
Rockling, four-bearded	0	0	1	0
Sculpin	23	13	36	11
Shad	6	2	1	1
Dogfish	190	195	9	18
Skate	55	65	195	110
Crab	0	0	1	1
Lobster	3	0	1	0
Scallop	0	0	88	55
Shrimp	0	0	0	6
Squid	747	360	540	678

A visual comparison between the catches made with and without the electric field, as well
possible changes in the catch with change of anode position and the effect of fishing areas
n the catch is facilitated by
graphic representation of
catches of individual spe-
s of fish made during each
v. A separate illustration
required for each species.
ck diagrams of the catches
hree species of commer-
l importance, specifically
dock (*Melanogrammus*
efinus), gray sole (*Glypto-*
halus cynoglossus), and
ting (*Merluccius bilinear-*
appear in figure 6.

Tows numbered 1 to 45
e made with the anodes at
footrope; the remaining
s (46 to 82) were all made
n the anodes at the head-
e. All tows, except num-
s 69 to 77 inclusive, were
de in the primary fishing
a off of Cape Cod; the ex-
ted tows were made at the
t of Clarks in the second-
fishing area.

Whiting are normally
ed with smaller mesh
s than the one used dur-
the experiment. The in-
ased number of whiting
n with the electric field
6) may have, in part, re-
ted escapement through
large mesh when the
tric field was not in use.
itional comparative tests
his species (using a whit-
net with and without the
tric field) will be neces-
before further conclu-
s can be drawn.

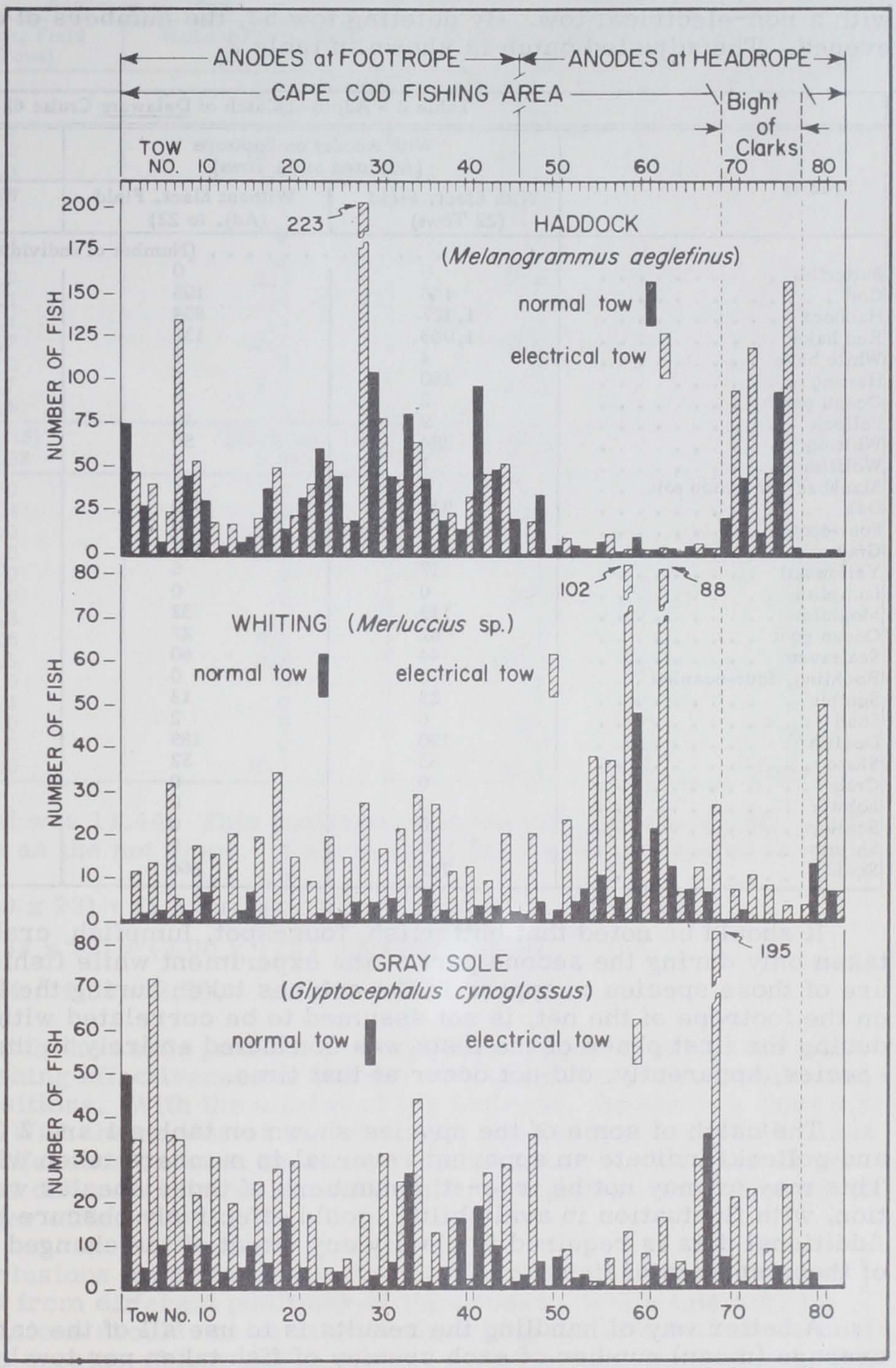

Fig. 6 - Catches of haddock, whiting, and gray sole for each tow during *Delaware* Cruise 62-9.

Due to the uneven num-
of comparative tows, a
al comparison of catch
lts is difficult. To fa-
ate a direct comparison,
stments to the data can
ade so that (1) the num-
of comparative tows (with and without the electric field) is equal, and (2) the catches re-
ng from the deleted tows are also subtracted from the total catch. Three tows are suit-
for this adjustment: tow number 45 was the last tow completed on a day during which an
number of tows was made; towing was begun and ended this day with non-electric tows.
eleting the last tow, the numbers of electrical and non-electrical tows is evened. Tow
ber 49 was an electrical tow which was not completed due to electrical difficulties. The

comparative non-electrical tow (No. 48) is correspondingly deleted. Tow number 52 (like t number 45) was an extra non-electrical tow completed at the end of a day which had beg with a non-electrical tow. By deleting tow 52, the numbers of comparative tows is aga evened. The adjusted catch is shown in table 2.

Table 2 - Adjusted Catch of Delaware Cruise 62-9

Species	With Anodes on Footrope (Adjusted to 44 Tows)		With Anodes on Headrope (Adjusted to 34 Tows)	
	With Elect. Field (22 Tows)	Without Elect. Field (Adj. to 22)	With Elect. Field (17 Tows)	Without Elect. Fie (Adj. to 17)
	(Number of Individual Fish)			
Butterfish	0	0	127	86
Cod	116	105	33	23
Haddock	1,127	854	476	206
Red hake	1,063	132	235	49
White hake	4	7	4	2
Herring	180	6	80	14
Ocean perch	2	0	0	2
Pollock	9	12	3	1
Whiting	394	50	456	140
Wolffish	1	4	0	1
Blackback or lemon sole	3	2	13	7
Dab	918	500	453	361
Four-spot	0	0	0	1
Gray sole	565	207	408	78
Yellowtail	17	5	9	10
Lumpfish	0	0	1	1
Monkfish	119	32	117	49
Ocean pout	67	27	7	2
Sea raven	44	60	38	35
Rockling, four-bearded	0	0	1	0
Sculpin	23	13	36	10
Shad	6	2	1	1
Dogfish	190	189	9	18
Skate	55	52	195	108
Crab	0	0	1	1
Lobster	3	0	1	0
Scallop	0	0	88	55
Shrimp	0	0	0	6
Squid	747	360	540	450

It should be noted that butterfish, four-spot, lumpfish, crab, shrimp, and scallop were taken only during the second part of the experiment while fishing at the Bight of Clarks. F ure of those species to appear in the catches taken during the first part, when the anodes w on the footrope of the net, is not assumed to be correlated with the electrode position; fishi during the first phase of the tests was conducted entirely in the Cape Cod area where thos species, apparently, did not occur at that time.

The catch of some of the species shown on tables 1 and 2 (notably white hake, ocean pe and pollock) indicate an apparent reversal in numbers taken with the change of anode posit This may or may not be true--the numbers of those species were small and sampling vari tion, with fluctuation in availability, could effectively obscure the expression of a valid tr Additional data is required to clarify any effect of the changed anode position upon the cat of these species of fish.

A better way of handling the results is to use all of the catch data and to determine th average (mean) number of each species of fish taken per tow by each method. By separat the catches made while the anodes were in different positions, it is possible to discern the effect, if any, of anode position upon the catch. Table 3 shows the mean number of fish ta per tow during the comparison tows; the two positions of the anodes and the resulting cat rates are also indicated.

To evaluate the fishing effectiveness of the electric field, as compared to the net with the field, a comparison is made between the catches which were taken by each method. Fr the data given in table 3, a weighted averaged of 4.80 fish (for each of the 15 commercial s cies listed) was taken per tow without using the electric field. The comparable average f ble 3 - Mean Number of Individual Fish of Each Species Taken Per Tow During Electrical and Nonelectrical Comparative Fishing

pecies	Anodes on Footrope		Anodes on Headrope	
	With Elect. Field (22 Tows)	Without Elect. Field (23 Tows)	With Elect. Field (17 Tows)	Without Elect. Field (19 Tows)
	(Number of Individual Fish)			
terfish	0	0	7.5	4.5
	5.3	4.7	1.9	1.5
dock	51.2	38.0	28.0	12.8
hake	48.3	6.0	13.8	2.8
ite hake	.2	.3	.2	.1
ring	8.2	.3	4.7	.7
an perch	.1	0	0	.2
ock	.4	.5	.2	.1
ting	17.9	2.3	26.8	7.8
fish	.1	.2	0	.1
kback or lemon sole	.1	.1	.8	.4
	41.7	22.4	26.6	21.6
-spot	0	0	0	.1
sole	25.7	9.0	24.0	4.5
owtail	.8	.2	.5	.6
(of the means) for mmercial species above	(200/15) 13.33	(83.8/15) 5.59	(135/15) 9.00	(57.8/15) 3.85
pfish	0	0	.1	.1
kfish	5.4	1.4	6.9	2.7
an pout	3.0	1.2	.4	.1
raven	2.0	3.0	2.2	2.2
kling, four-bearded	0	0	.1	0
lpin	1.0	.6	2.1	.6
	.3	.1	.1	.1
fish	8.6	8.5	.5	.9
te	2.5	2.8	11.5	5.8
b	0	0	.1	.1
ster	.1	0	.1	0
llop	0	0	5.2	2.9
mp	0	0	0	.3
d	34.0	15.7	31.8	35.7

taken *with* the electric field was 11.44. This indicated that the net *with* the electric field hed 2.38 times as effectively as the net alone. Calculations for the values shown were:

a. (5.59 x 23) + (3.85 x 19) / 23 + 19 = 4.80;

b. (13.33 x 22) + (9.00 x 17) / 22 + 17 = 11.44;

c. 11.44 / 4.80 = 2.38.

To determine the effect which the anode position may have had upon the catches, a com- ison is made between the fishing effectiveness of the net with the electric field while the cles were at the different positions. With the anodes at the footrope, the catches were 2.39 es the nonelectric catches. With the anodes at the headrope, the catches were 2.34 times nonelectric catches. The difference between those two values is 0.05 or less than 2 per- t of either value. This small difference is not considered to be significant as other varia- s could have introduced larger differences.

Based upon the above, conclusions might be drawn that, for overall catches of fish, no ificant differences resulted from different positions of the anodes. While this may be e for overall catches, conclusions should not be drawn concerning the effect of anode posi- upon the catch of individual species of fish where species behavior and level of suscepti- y to pulse frequency, pulse shape, or to the strength of the field may determine a real dif- nce in catch levels with the change of anode position. Adequately programmed research e future would include (1) experimentation with electrode position for a determination of mum position for species effect, (2) levels of species susceptibility, and (3) optimum pulse pe and frequency for influencing commercially desirable size fish.

Otter-trawling is the fishing method most used in New England waters for taking ground- . For this reason, the data on cod (*Gadus callarias*) and haddock (*Melanogrammus aegle- s*) are considered separately. When the data for those two species are grouped, about 1.5

times as many fish of those species were taken when the electric field was in use as were caught by the net without the field.

However, this method of consolidating the data tends to obscure a difference between catches made with the anodes in different positions. While the anodes were at the footrope, the mean electric catch rate was about 1⅓ times (1.32) the nonelectric catch rate; but when the anodes were at the headrope, the electric catch rate was slightly more than double (2.09) the nonelectric catch rate. The difference between 2.09 and 1.32 is 0.77; this is 36.8 percent of the former and 58.3 percent of the latter value. There is a significant difference here which will be considered during future work.

For analysis of the effect that might be expected in the flatfish fishery, the data for lem sole and blackback (*Pseudopleuronectes americanus*), dab (*Hippoglossoides platessoides*), gr sole (*Glyptocephalus cynoglossus*), and yellowtail (*Limanda ferruginea*) were grouped. By grouping in this manner, it *can be* seen that the catch rate *with* the electric field was more than twice (2.04 times) as effective for those species as the catch rate made by the net *without* the field. In comparing the difference in fishing effectiveness with changes in anode pos tion, the electric catch rate was 2.1 times the nonelectric catch rate when the anodes were the footrope and 2.39 times the nonelectric catch rate when the anodes were at the headrope. The difference between the two values (2.15 and 2.39) is 0.24 or about 11 percent of the former and 10 percent of the latter. The approximate 10-percent difference might have been due to the directional force of the field. With the anodes on the headrope the directional effect might have brought the fish off of the bottom before they became stunned and drifted back in the net. This is another point needing further investigation and clarification.

A seasonal fishery exists in New England based upon whiting (*Merluccius* sp.). While th electric catch rate was 4.43 times that of the nonelectric comparative rate, a significant difference in catch rate is apparent between electrical catches with the anodes in different positions. While the anodes were at the footrope, a catch rate of 7.78 fish per tow resulted; a co parative rate of approximately 3.44 resulted from fishing with the anodes at the headrope. T difference between the two values is 4.34 which is 55.76 percent and 126.16 percent of the catch rates, respectively, for the footrope and headrope positions of the anodes while fishing

DISCUSSION

Many questions concerning the type of tests conducted, the conduct of the tests, and their results may be clarified by the following:

1. Experimental electrical fishing was conducted to determine the fishing effectiveness of the method, i. e., of an electric field (as applied) used as an adjunct to an otter-trawl net (a) in a true marine environment, (b) at commercial trawling depths, and (c) in areas suitab for commercial fishing.

2. The specific electrical equipment used was not subject to testing as a "commercial prototype" because it was experimental in nature and was neither a prototype nor intended be either suitable or recommended for commercial application. However, positive test results may presumably lead to future development of similar equipment for use by the indus

3. Commercial quantities of fish and competitive tows with commercial trawlers were neither required nor desirable at this stage of experimentation. It was only required that catch results were sufficiently large to allow for evaluation of the effectiveness of the meth

The effectiveness of the electric field in catching fish such as herring (*Clupea harengu* which otherwise escape the large mesh net, suggest an applicability to midwater trawling, o the-bottom trawling, and other similar types of fishing.

We believe that successful future application of electrical fishing in marine waters will limited only by the amount of investigational effort expended and the development of equipm appropriate to practical use within specific segments of the fishing industry.

APPENDIX

Details of the electrical equipment are available as an appendix attached to the reprint of this article. Write for Separate No. 734. It contains details on the power source, pulse forming and firing circuits, electrical control panel, auxiliary power source, transmission line, net transformers, modifications during experiments, electrodes, and splices.

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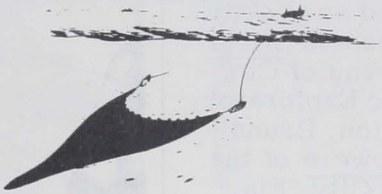

"PUSH" FROM BEHIND MOVES FISH FORWARD IN A SCHOOL

Fish in a school may move forward because of stimuli from behind them--not because they are leading or following a fish in front. This new theory about the movements of fish has been set forth by Dr. Evelyn Shaw, Department of Animal Behavior, American Museum of Natural History, New York City.

After working with hundreds of young atherina fish, similar to the silversides, Shaw concludes that each fish in a school moves forward in response to a neighboring fish moving past its eye vision.

As one fish from behind moves, this movement stimulates the fish ahead which moves and triggers the next fish, and so on. In this way the whole school moves forward. As for the last fish, she said, it seems to straggle and lag behind.

Fish can see a wide area on both sides of the body. The vision is almost semicircular, sweeping from mouth to tail. Thus a movement from behind is easily noticed.

Shaw conducted her experiments on different fish of the schooling or social type, such as the common household pet, the tetras, and the zebra fish. She placed tanks of those fish inside a rotating drum which had stripes, usually yellow and black, painted on the inner walls. As the drum was turned, the stripes would move and the fish would be stimulated to move, tending to lead rather than follow the patterns. (Science News Letter, November 14, 1964.)