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AN ATTITUDE ON "FISHERY HYDROGRAPHY"

BY

J. N. CARRUTHERS

Hydrographic Department of the Admiralty
(Oceanographical Branch) Cricklewood, London

[An essay on the theme that the fortunes of North Sea fish broods may be determined by some factor (or by some complex of factors) resident within those broad features of water circulation which are ruled by widespread wind conditions inferable from the study of atmospheric pressure gradients, followed thereafter by an ADDENDUM (due to Günter Dietrich) dealing with month-by-month wind conditions over the northern North Sea during the half century now ending, and by an ADDENDUM NOTE briefly indicating what progress has been made along the lines concerned and what is in prospect.]

INTRODUCTION

This essay was written on learning that particular attention would be paid to Fishery Hydrography at the 1950 reunion of the International Council for the Exploration of the Sea. It happened that the writer and his colleagues had just finished preparing a series of papers dealing with the close inter-relationship of wind and water movement. For that work, several special tabulations of wind conditions had been commissioned, these tabulations being of a type quite novel in some respects. Since the first of these to come to hand dealt with the northern North Sea area, it was decided to apply it in an attempt to carry further (in respect of haddock) what had been started in 1938 when a first attempt was made to find correlations between brood-strength fluctuations of that fish and wind conditions.

The paper then written was entitled: Fluctuations in the herrings of the East Anglian autumn fishery, the yield of the Ostend spent herring

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1 This paper is published with the approval of the Lords Commissioners of the Admiralty, but the responsibility for any statements of facts or opinions expressed rests solely with the author.

The essay was placed before the Northern North Sea Committee of the International Council for the Exploration of the Sea during its 38th annual reunion held in Copenhagen in October 1950. On that occasion, its content was summarized in lecture form by the author, and it was debated in concert with other themes within the general field of “Fishery Hydrography,” which topic will be much to the fore at the 1951 reunion of the Council.

fishery, and the haddock of the North Sea—in the light of relevant wind conditions. Considering that the results then obtained in respect of haddock were of promise, the following steps were decided upon when the topic was reopened in 1950:—

1. To write the following essay so that the basic belief could be adequately set down on paper. This belief is that wind rules water to a degree which compels the thought that fish fortunes can hardly fail to be dependent in large measure upon wind conditions.

2. To put into the hands of other workers in the field of fishery research certain new presentations of wind conditions over a goodly term of years, thus enabling them to seek causative linkages in their own special spheres of interest should they so wish. Of these new wind presentations, that which is the subject of the Addendum (p. 113) is the first.

3. To put the general thesis of this essay to the test by applying it in a study of fish fluctuations (see Addendum Note, p. 116).

Because the northern North Sea was initially concerned, the writer naturally decided to turn first to the haddock. Considering that a new approach by persons fresh to the subject might well prove profitable, he briefed his colleagues in the Admiralty and gave them a free rein with the wind data and all the published haddock data on brood strength variations which he could find. By so doing it came about that adequate mathematics was applied. If results proved promising enough, the idea was to make application to the Director of the Scottish Home Department's marine laboratory at Aberdeen to have the matter taken over by B. B. Parrish, who would be able to bring to it the requisite full knowledge from the haddock side. When the present essay was placed before the Northern North Sea Committee (thanks to the good offices of C. E. Lucas), placed with it was a report by Parrish setting out what had come from the collaborative effort of all concerned in the matter of associating haddock fortunes and wind conditions.

"Hydrography" and "Hydrographer." We shall here invest these two words with the connotation accepted in International Council circles, although the word "Hydrographer" in Britain and the U. S. A. customarily attaches to one person only and has a long-standing meaning accordingly. Much discussion around these terms can be found in early issues of the International Hydrographic Review published from Monaco.

By "Fishery Hydrography" we mean those studies of water conditions which are devoted mostly, though not exclusively, to the aim of
explaining why the spawning products of different years produce such different accessions to the stocks of adult fish some years later. Sight is not lost of the necessity to establish by proper investigations whether or not the stocks of adult fish in the sea were better in one year than another.

In the following essay we shall use the expressions “Water Events” and “Fish Events” with obvious meaning to avoid some needless repetitions.

Those who read this essay will be able to accuse the writer of assailing his own cloth; they may not infer, however, that he necessarily regards the house of the nonhydrographers as completely in order. Snobbery is rife in science, as in so many other walks of life, and the writer has no great confidence that the simple line of work he urges below will make any solid appeal. If there were real likelihood of it doing so, there would have been some reaction earlier to a paper in which he said so much along similar lines.3

It does seem to be the case that interest is always aroused by, and support ever forthcoming for, grandiose plans of work which require impressive paraphernalia with provision of much gear, many workers, and lots of money.

Cinderella has little chance in the beauty chorus of modern research, but the writer is entirely sincere in what he advocates, because he feels convinced that only the wide view holds any real promise in Fishery Hydrography. With such a vast and unruly thing as the sea to deal with, who shall say of fisheries research that the day of “bits of string and bits of wire” has completely passed, and that the ball now lies only at the feet of the smart scientist with his plethora of gadgets?

GENERAL DISCUSSION

Fishery research literature abounds with discussions of what may have determinative influence upon the upgrowth of spawning products, and numerous papers could be cited with ease which deal with different aspects of the brood survival problem. It would seem that there is a risk of forgetting that relevant studies of very real merit were made quite a long time ago. That this is so emphasizes all the more the need to pause a while to take stock and assess what progress has been made to date.

An address given by A. T. Masterman before the British Association as long ago as September 18964 would be no bad starting point for a


4 Natural Science, Vol. 10, (64) June 1897.
man who might attempt to lay out the task facing a Fishery Hydrographer who aimed to associate water conditions and fish fortunes with a view to discovering anything of real elucidative value in the former. As far back as 1864, G. O. Sars, who recorded instances in which adverse currents had "beached" myriads of cod eggs to form a long glistening line at high tide, was speculating upon the possible effect of such destruction of spawning products. Strangely enough, there seems to be no record of observations that plaice eggs from the great spawnings in the southern North Sea have ever been beached. In 1893, C. G. Petersen was devoting much thought to the part played by physical conditions upon larval fish which supposedly need to reach waters near shore "at the right time" to find satisfactory survival conditions. Fulton, Hjort, Dannevig and others were no less alive to the importance of studying water conditions such as temperature, saltness, currents, etc. in connection with the dispersal of products of spawning, and they adduced ideas as to what was adverse and what optimal.

In the early paper by Masterman, just cited; there was already talk of the voracious gobbling of herring ova by haddocks. As will be known to all who may read this essay, that habit has been considered by some people to be a possible, if no more than a partial, explanation of the surprising "oppositeness" of good haddock years and good herring years. If the linkage is a feeding one, obviously it can operate only if the voracious young haddock occur where the herring ova are present. The existence of this situation can be quite well understood from lines of argument developed by the present writer in an earlier paper, and which are implicit in what follows.

The citations given above from writings of early days, antedating the establishment of the International Council, have a deliberate purpose. Surely, the work done in the ensuing 50 years of the Council's existence does justify the stand taken by those who would now call upon the hydrographers for a "stocktaking," so to speak. Nothing said in what follows implies that the writer holds hydrography to be a less important concern of the Council than is fisheries biology, but it is only fair to admit that we hydrographers who assemble periodically in Copenhagen should now declare where we have gotten and how we propose to direct our steps in the future.

We have a special job to do.

In marine laboratories not specifically charged with Fishery Hydrography and not State-financed to that end, all researches, no matter what their description or potential usefulness, are fully justified as strivings after knowledge of the sea. In those institutions which have fish problems as their major raison d'etre, however, there must surely
be some particular and less-dispersed attention to lines of work which, on \textit{a priori} grounds, would appear promising.

Here the writer fully realizes that he courts rebuke on the grounds that such doctrine is "unscientific," for who shall say that the most unlikely researches might not reveal the answers to the problems? The history of science is rich in showing that important discoveries have emerged from investigations in no wise deliberately steered. These things are fully realized, and nothing is further from the writer's wish than that meticulous researches on plankton, on phosphates, on silicates, and on a host of other factors, should in any way slow up or be discouraged. Admittedly, from them might well come the answer to important problems in Fishery Hydrography, but there are certain serious practical considerations to face.

With the passage of each year the mountain of data gets ever bigger, and the hydrographers insist on more and more details. Their requirements in the field of sampling become ever closer, their consumption of ships' time becomes ever more extensive, their call upon the help of analysts becomes ever more serious, the cost of their investigations becomes ever more expensive, and their lists of published data become ever more formidable. As the poet Burns so pertinently remarks: "Facts are chiels that winna ding and downa be disputit ... " and we must face them.

It is in no sense a question of "selling the pass" if one hydrographer declares himself somewhat in sympathy with the disquietude of the International Council's Executive over the situation.

Just before World War II, a situation had come about wherein that body was beginning to take a stand which might be put more or less in the following words:—

We have every sympathy with what the hydrographers tell us it is necessary to do; we have no lack of appreciation of their stated needs for greater density of stations and detail of sampling, and we realize that such an increase of work will naturally require more and more pages in the Bulletin Hydrographique. Yet, the time has come to ask ourselves whether greater charges on time, on ships' effort, and on money and printing can be afforded.

To dwell upon such matters is to concern oneself with things which are not science, but it does no good to reject them as absurd. At this stage it is well for hydrographers to claim acquaintance with various ideas put forward in numerous papers over past years regarding those supposed linkages between water events and fish events wherein \textit{may} lie fish survival explanations.

We recall the importance with which the question of dispersal of eggs and early stages has been invested; must young stages be trans-
ported to certain areas within a critical time in order to experience good survival? We recall too, the idea that there must be adequate planktonic food at about the time when young fish pass the yolk-sac stage. We are not unaware of the importance supposedly attached to the habit of some fish to move off contranatantly to spawn. Known to us also is the alleged importance of barriers in the sea consisting of those masses of noxious plankton which are supposed to be responsible for obstructing the movements of, or deciding the distribution of, herring. We are also aware that adult fish, enfeebled by spawning, may be more or less passively transported by currents.

Questions of upwelling, of cascading, of shifts (horizontally and vertically) in the position of thermoclines, of nutrient-poor and nutrient-rich water, of the formation and movements of slicks and of convergences and divergences, of types of bottom, of strengths of current, of lethal salinities, of comfortable temperatures, and of many other things, are, it is hoped, sufficiently within our ken to warrant our topical attention. All of these will be borne in mind, and we shall think also of such things as Hodgson's views on the response of adult clupeoids to wind (opposite for herrings and pilchards).

Although no Fishery Hydrographer ought to be ignorant of those numerous divisions of the field of fisheries research in which many of his fellow investigators must work, our present point is that a few of his kind ought to ignore them pro tem, as problems needing specific attention, and ought to try first a broad simple approach on lines comprehending them all at once, more or less. That may sound like extravagant over-simplification, we freely admit, but it is hard to suppose that the pronounced modifications of water circulation which are produced by the winds' influence can be without marked effect on important fish events in the North Sea.

By no means have we set down all of the water events which could be taken into account in some measure by devoting attention to water movements indirectly via the consideration of wind conditions inferred from atmospheric pressure data. There is a whole string of water events which depends upon the outflow from the Skagerrak. Fluctuations in the strength, width, and volume of the north-going surface current up the coast of Norway do so depend, and, in turn, so does the distribution of water characteristics produced by them.

In recent years, ways have been worked out to forecast the water movements through the Danish waterways, and interconnections have been established between Baltic-to-North Sea currents and barometric pressure distributions.

We think that these and earlier remarks strongly support our advocacy of what is urged below.
A POSSIBLE SHORT CUT

Part 1. Observations on Currents. Whatever factor, or complex of factors, may be responsible for exerting determinative influence upon the products of spawning, i.e., whatever it may be which spells good or bad augury for fish broods, one can reasonably expect that it will be taken account of by (because comprehended within) an adequate consideration of water movements. Whatever chemical, physical, or planktonological conditions may be critical, such will necessarily be in a state of space flux dependent upon currents. That seems reasonable enough, and to make the requisite study of currents would amount to devoting attention to something much more widely embracing than any one line of detailed research concerning some one specific factor, in as much as so many things would be included. In what follows, it is fully realized that arguments will suffer some loss of force from the facts that the writer will inevitably be "pushing his own wares," will be advancing proposals likely to be attractive to the "Powers that Be," and in general will perhaps be displaying himself as "unscientific."

This is all freely accepted.

To seek "explanations" of fish fluctuations and attendant matters good for the North Sea, it is urged that as good a way as any would be found in a programme of continuous current observations at as many places as possible. Means exist whereby it could be learned, for all days of all months, year after year, how the water had moved past all lightships in the North Sea. There is nothing fanciful about this at all; there is no maybe about it in the least. It could certainly be done.

The aim would be to have a synoptic picture of the water movements that would be good for all time, and, if salinity or plankton (or something else) proved to be the factor that really mattered, then the distribution of that factor would automatically be taken account of without thinking of it specifically. Just before World War II there had been a considerable approach to what is now urged. At ten light vessels such a programme was in being. The necessary apparatus exists, and the cost to run such a programme, with the instrument possessed, would be about £90 a year per ship, according to present British experience. Papers published in the Council's Rapports et Procès-Verbaux just before the war (when the present writer was "Recorder on Currents" to the Southern North Sea Committee) show the way in which things were then moving in this connection.

Since those days means have been provided whereby gaps could be filled in for areas in which no lightships are moored. With the "rough and ready" current-measuring instrument as a means to the results
given in those \textit{R. et P.-V.} papers, one had in being a programme of continuous observations of water movements which let the results be known with great speed.

There was no awkward piling-up of data; all one really needed to know about the water movements over a whole year at a number of places could be set down in very little space in a printed report. If so wished, the results could be collected at sea almost immediately after observations had been taken. This was customarily done by having the records floated out to a visiting ship in a watertight tin veered away from the lightship at the end of a casting line.

Working along lines now urged, one could later set down, in very modest printed space, the information on water movements for many places (without breaks in continuity caused by wild weather) which would serve for application to studies of fish events. That there need be no waiting and no gaps in the data is amply attested by past experience. There is no serious expense; there is no consumption of research vessel time; there is next to no call upon the time of scientists; and there is no ponderous analysis to be done before the information on water movements is available for use in the fish connection.

The information accruing from a programme of continuous current observations such as is here advocated is not limited in usefulness to fishery research workers; it also has solid value to physicists studying storm surges, to engineers concerned with coast erosion, to climatologists, to sedimentary petrologists, and to persons concerned with navigational matters. These other interests could doubtless be drawn in to help with the modest expense.

\textit{Part 2. Currents via Wind.} Just before the war the writer of this essay had thought it a good idea to go even further to determine whether the practitioner of Fishery Hydrography could possibly get information of elucidatory value in the fish connection from a line of work even simpler, much more widely embracing, and cheaper to the point of nearly no cost at all. This he did by turning to the consideration of widespread wind conditions as inferred from a study of barometric pressure gradients. This step had not been taken until it had been sufficiently established that wind rules water to a very profound degree over the North Sea and adjacent regions. For instance, at the position of the Sandettie Lightship, a place important in several fish connections, it was found that a thick surface layer of water moves averagely 13.2 miles northeastward and 11.6 miles southwestward in the course of a day (a net flow of 1.6 miles per day towards the northeast). Records show that, under certain wind conditions, the respective flows have been 4.9 and 20.3, evidencing a net travel of 15.4 miles.
in the day towards the southwest. Still thinking of a thick surface layer of water (which could, within reason, be as thick as desired) and of water travel within a day, it may be added that the water at the position of the North Goodwin Lightship has been known to move 13.5 miles over-all per day towards the southwest on one occasion, and 10.5 miles towards the northeast on another. At a position within the Thames estuary (here the thought of manurial salts discharging into the sea comes to mind) the extremes can be as much as 10.2 and as little as 4 miles seawards.

As far back as 1874, William Ferrel derived the relation between the barometric gradient and the velocity of the wind, so we may read, but even before that, in 1868, people in Britain were already plotting barometric gradients over the North Sea and working out the strengths and directions of wind implied by such gradients. It was Thomas Stevenson in 1867 who first used the expression “Barometric Gradient,” and in those days it was remarked that a gradient of “0.02 inches of mercury per 15 miles, indicates the probability of as much wind as an ordinary yachtsman likes to meet with.” In those early days we find the interested persons calculating winds of different speeds and of various directions over the North Sea from the directions of gradients, and we read that they standardized the statements for separation distances of 100 miles.

It is interesting historically to set down these facts, since one of the author’s chief concerns here is to emphasize the length of time over which people have been busy on questions which have such present day interest, thereby giving weight accordingly to the plea that a stock-taking is now amply called for.

If it can be shown that fish events of interest to the Council (be they in connection with newly-spawned eggs and young larvae or with enfeebled shotten fish) and of concern to the practitioners of Fishery Hydrography are correlated with the broad water movement features of the North Sea inferable from barometric pressure gradients, some progress of value will undoubtedly have been made. In such a happy case we could handle barometric pressure data directly as though they were indicative of currents, and we should be in a position to go far with no expenditure of money to matter. The writer urges the doing of work along the lines here indicated on the grounds that it is reasonable and requires next to no expenditure of money.

More than that! We have to realize that we could never extend any programme of actual continuous current measuring to the deep and wide waters of the northern North Sea. There are means which could serve at great expense and trouble to give us data for which we should not have to wait, but they would not serve us adequately.
Figure 1. Yearly fluctuations in herring of the East Anglian autumn fishery and in the yield of the Belgian spent herring fishery compared graphically with yearly fluctuations in the atmospheric pressure gradient controlling the run of wind northwards up the Southern Bight during December and January. (Of the two scales on the left, the outer one gives the atmospheric pressure gradient and the inner one the percentage occurrence of herrings at three years old in the East Anglian catches. The inverted scale on the right refers to the yield of the Belgian spent herring fishery; values \( \times 100 \) give in kilograms Gilson's mean weight of a day's capture.)

There is good reason to think that major fish events in the North Sea may well be decided by water events within that sea; at any rate, when the present writer was studying Graham's data on cod-brood strengths, with the great advantage of help from Sir Gilbert Walker, there seemed to be obtainable no suggestion of correlation with meteorological events over the Atlantic.

Before moving to the finish of this essay, a remark concerning the herring of the southern North Sea should be made. There seems never to have been enough thought given to the possible effects of catastrophes. Years ago, the writer questioned the sense of straining after explanations of good and bad years via the consideration of what could possibly be only minor influences without first giving due weight to the thought that one bad gale might destroy large areas of ova in the Cap d'Antifer region by siltation. A number of bad gales spread over the spawning season might reasonably be expected to spell bad augury. Now it is one feature of the proposed line of study through atmospheric pressure gradients that such catastrophes would be taken account of.

The fact that Lumby in Lowestoft is paying close attention to meteorology in the field of Fishery Hydrography, and doing so in a
Figure 2. Showing (a) Raitt's curve of the relative numerical values of North Sea haddock broods in the first year of life, 1919-1936, (b) a curve portraying pressure gradient values from the SE quadrant during March, April and May, and (c) a curve relating to "East in the Wind" as computed from observations during February, March, April and May at three appropriate stations.
way good for a very extensive area (stretching far to the north), is to be heartily applauded. There seem to be grounds for hoping that fish events will receive some elucidation from the data he is so laboriously compiling. If they do not, the present writer feels but mildly optimistic of getting at any useful explanations otherhow.

An accompanying pair of figures (Figs. 1 and 2) show an attempt made just before the war by the present author along the lines we have dwelt upon. Those who are aware of the close attention given *inter alia* to the dispersal of spawning products in many sea areas of the world may be moved by these to give the writer's suggestions a trial.

Before leaving this topic, it might be added that the writer, before embarking on the barometric pressure gradient work, had suggested that oceanographers ought to possess a totalizing anemometer of robust and simple nature. With such, the interconnection of air and water movements could be investigated very far and very easily. It may still be a good idea, but the matter has been left in abeyance for the time being in favour of the present interest.

**Note on Wind Presentations.** Available were: a large table of wind vectors, one of wind components, and a large sheet of wind anomaly arrows. All the underlying computational work, and the text, were the work of Günter Dietrich working in Hamburg. Fig. 3 is a specimen portion of the half-century long sheet of wind anomaly arrows.

For much assistance in the provision of the requisite barometric data from the British side, acknowledgment is made to the British Meteorological Office. Through the good offices of J. M. Stagg, Branch M.O. 3a of that Office prepared a valuable table of mean values appropriately corrected and adjusted. Thanks are tendered to the head of that Branch and to J. Glasspoole who was involved in the work.

At the time of writing the above essay, the Dietrich wind data had been delivered for only the northern North Sea, although preparation of comparable material for the southern North Sea, for the central North Sea, for Shetland waters, for the English Channel, and for the Irish Sea was going on at the time.

Since then, the wind material for the central and the southern reaches of the North Sea has been received, and use (deemed very satisfactory) has been made of it in connection with the herring, the plaice, and the cod. Some relating remarks are made in the concluding **Addendum Note.**
Owing to the important part played by the wind in the water movements and in the oceanographic structure of the sea, wind conditions over the sea are of special interest. It is comparatively easy to obtain wind data above the sea surface either by direct observation or by derivation from pressure distribution. However, only a few systematic series of observations regarding the dependent processes in the sea are available.

Therefore, if it is desired to investigate those processes in certain sea areas, it will be possible to do so only by drawing conclusions for the known wind conditions. So far as the inter-relations between the wind and the processes under study in the sea are established, this offers many advantages over the direct method and is no makeshift.

It is believed that the wind presentations provide the data needed for the application of such a method of investigation of conditions in the northern North Sea. They show the monthly and annual mean wind values for the first half of this century, and they provide a present basis for discussion without considering, at this moment, further inter-relations of the seasonal and secular variations of the wind.

Earlier wind observations were based on personal estimations of the direction and force of the wind and are not free from subjective errors of estimation. Besides, long-period series of wind observations are available for land stations only. Owing to the great differences observed between the conditions of friction above solid ground and those occurring over the sea, land wind data cannot be taken as satisfactory for conditions obtaining over the sea. Further, air currents are locally influenced by the conditions of the ground. For these reasons, it is inadvisable to consider wind observations made at land stations as truly representative of conditions prevailing over greater sea areas.

The summarizing representation of wind conditions (shown in part in Fig. 3) above the northern North Sea (1900 to 1949) has been based on such atmospheric pressure gradients as could be calculated from the corners of a triangle by means of analytic geometry once the atmospheric pressure values were known. The monthly mean values of the air pressure of the Shetland Islands (Lerwick), North England (Tynemouth or Scarborough) and South Norway (Mandal or Oksøy) have been taken as a basis after they had been uniformly reduced to mean sea level and normal gravity at 45° latitude. The centre of this triangle is in the northern North Sea at Lat. 58° N, Long. 2° E. The
underlying air pressure values have been given in various meteorological publications. The monthly means of recent years were made available by J. N. Carruthers (Admiralty, London) and by Th. Hesselberg.

It is a well known fact also that air currents above the sea do not correspond to the pure geostrophic winds. Hesselberg and Sverdrup treated the influence of friction exercised by the solid soil, and Baur and Philipps extended the investigations to the open sea. From their results it follows that, on the average, at Lat. 58° N, the wind direction does not turn at an angle of 90° to the right of the direction of the pressure gradient as would happen with no friction existing, but at an angle of 76°; it follows too that the velocity of the surface wind amounts to only 69% of that of the geostrophic wind. An atmospheric pressure gradient of 1 mb/100 Km at Lat. 58° N, with a mean air density of 1.28 KG/m³, corresponds to a surface wind of 4.35 m/sec. In consideration of these influences of friction, the monthly mean values of the wind above the northern North Sea for the period 1900 to 1949 were derived from the calculated monthly mean values of the air pressure gradient. Data for half a century in tabular form, supplied to J. N. Carruthers but not reproduced here, show monthly mean values of the direction from which the wind blew as well as the appropriate speed in m/sec for each month; also given are the annual mean values and grand mean values of the speed for 1901–1930.

Fig. 3 (data in part only) shows the anomalies of each calendar month referred to the normal mean values of the wind (to 1930) in a way which accentuates far more clearly the peculiarity of each individual month than would be possible by a representation of the mean values of the wind. The arrows for the individual months and years represent the wind which would have to be algebraically added to the normal wind of the monthly mean values (1901 to 1930) to produce the actual conditions; from their length, the speed anomaly of the wind is to be seen immediately. By vectorially adding the individual wind anomalies to the normal wind, it would be possible to arrive at the monthly mean winds set out in the data supplied to J. N. Car-

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Carruthers: Attitude on "Fishery Hydrography"

**Figure 3. Northern North Sea—Anomalies of the Mean Monthly Winds, 1900–1949, from the Monthly 30-year Means, 1901–1930.**

It should be observed that the wind speed scale for the annual mean values is five times that used for the monthly means.

Analogous representations for the central and the southern North Sea have also been made available, and further ones for other areas are in preparation.
ADDENDUM NOTE

[Briefly indicating what progress has been made so far along the lines concerned and what is in prospect.]

In the case of the first important food fish to be dealt with, namely the haddock of the northern North Sea, it is expected that a full account of the results obtained will be given in a report to be published from the Aberdeen Marine Laboratory of the Scottish Home Department. Parrish, of that laboratory, who supplied the requisite haddock data and with whom the writer and his associates, A. L. Lawford and V. F. C. Veley, have collaborated closely, gave a brief account of the correlations arrived at when the matter was under discussion in Copenhagen at the time the foregoing essay was tabled and debated. Since then the work has been polished up a good deal, but here we shall refer only to its main outcome.

First it must be remarked that Parrish had not been able to explain haddock year-class strength fluctuations either on grounds of temperature or via biological reasoning. Using the wind data obtained from Dietrich, work in the oceanographical branch of the Hydrographic Department of the Admiralty led to the discovery (by Veley) of a wind function which successfully accounted for over 30 years of fluctuations in year-class strengths of haddock.

There were only two misfits, these being for the products from the spawning seasons of 1947 and 1946; of this pair, it seems that the former can be reasonably ascribed to highly unusual temperature (cold) conditions, and the latter to an insufficient area having been covered when the fish census was made via trawl hauls. In this connection it is worthy of remark that much brood from the 1946 haddock spawning is known to have been transported to the coastal waters of Norway, a rare event doubtless due to the high prevalence of west wind during the period under consideration.

What emerged from the work was the discovery that wind-caused dispersal of haddock spawning products in one direction was favourable to brood survival; with dispersal in the opposite direction the augury was good also but to a lesser degree; dispersal in cross directions was unfavourable in point of survival prospects. These discoveries can be quite well understood on ecological grounds, as will doubtless be shown by Parrish in his future paper.

The outcome in the case of the haddock has fully justified the hope of being able to predict stock recruitment from year to year reasonably satisfactorily in the future, to claim no more.

In the case of herring of the southern North Sea with their main spawning locus in the Cap d’Antifer region off the French Coast at the eastern end of the English Channel, attention was paid to the months
of December, January, and February. The work in this case was carried out by Veley, and, from his preliminary attempts to correlate the fish and wind factors, it appears that the height of spawning probably varies somewhat in time from year to year. In the outcome Veley discovered how to choose the month in which the south-wind factor would be expected to be most important in urging the greatest quantity of herring fry away from land into midchannel. To devote attention thereafter to west wind during the ensuing period, was, he argued, to consider whether the fry would or would not be carried through Dover Straits into the North Sea (a transport held to be beneficial).

The choice of the month within which north-moving wind had to be considered was the crux of the situation, since no approach to predicting power was possible unless the choice could be made. Veley found that the amount of west wind in December was the key to the situation; from that factor he was able to infer the peak month of spawning and thereby learn to which period the south wind factor had to be applied in a given year. In the final outcome, the agreement between wind factors and year-class strengths was established for upwards of 20 years without misfits. Thus good reason now exists for hoping that it may be possible in the future to predict herring year-class strengths satisfactorily from the wind argument by using the procedure formulated by Veley.

Applying identical procedure to the Belgian spent herring industry, a high degree of correlation has emerged between the fortunes of this fishery and wind conditions.

To turn to the plaice of the North Sea is to direct attention to the fish which has been the subject of most thinking in this matter of fry dispersal and survival. Some years before World War II, Bückmann, working from Heligoland, attempted to correlate wind and year-class strengths in the case of the plaice of the German Bight. Veley has since deduced a relationship between wind components in the North-South direction during November and December and the peak time of the plaice spawning.

Without going into detail here, it can be stated that if, on the above deduction, south and west wind be considered for the months dictated, then a completely acceptable correlation emerges. Unfortunately Veley has been limited so far to numerical expressions of plaice year-class quality over a mere ten years.

An investigation carried out by Lawford on the cod of the North Sea shows a connection between brood survival and resultant wind during the principal spawning months, and holds out the possibility of at least qualitative production.
Recently, Dietrich has been able to supply wind data for the English Channel and the Irish Sea. Using these and in part the theories outlined by Hickling in his Buckland lectures, Veley has explained brood fluctuations in the hake hatched to the south of Ireland over a period of ten years.