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COASTAL CURRENTS ALONG THE ATLANTIC COAST OF THE UNITED STATES

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PREFACE

At the beginning of practically every hour that has passed during the last 30 years, measurements of the direction and velocity of the current have been made at one or more of the lightship stations along our Atlantic coast. The Lighthouse Service for many years cooperated with the Coast and Geodetic Survey in securing the current observations, and the Coast Guard, which now operates the lightships, is helping to add to our knowledge of the complex movements of coastal waters.

The purpose of this volume is to make available in convenient form for the use of the mariner, the scientist and the general public the data derived from analyses of the current observations.

In addition to the data derived from the relatively long series of lightship observations, results from numerous short series secured in the vicinity of Georges Bank are incorporated in the current charts for that area, which are included in this volume.

The section on the general characteristics of tidal currents, which in this volume precedes the discussion of the observational material, was taken from Tides and Currents in New York Harbor, United States Coast and Geodetic Survey Special Publication No. 111, Revised (1935) Edition.

In connection with this publication attention is invited to Coast and Geodetic Survey Special Publication No. 121, Coastal Currents Along the Pacific Coast of the United States, which discusses current observations taken at lightships along that coast; and to the following publications which give observational current data for waterways along our Atlantic coast:

Tides and Currents in New York Harbor (1935); Tides and Currents in Delaware Bay and River (1926); Tides and Currents in Boston Harbor (1928); Tides and Currents in Portsmouth Harbor (1929); Tides and Currents in Chesapeake Bay (1930); Tides and Currents in Long Island and Block Island Sounds (1932); Tides and Currents in Hudson River (1934); Currents in Narragansett Bay, Buzzards Bay, Nantucket and Vineyard Sounds (1938); Currents in St. Johns River, Savannah River, and Intervening Waterways (1938).

Attention is invited also to the annual Current Tables, Atlantic Coast, North America. These tables contain data from which daily predictions of the current may be readily obtained for numerous locations.

CONTENTS

TABLES

COASTAL CURRENTS ALONG THE ATLANTIC COAST OF THE UNITED STATES

TIDAL CURRENTS, GENERAL CHARACTERISTICS

DEFINITIONS

Tidal currents are the horizontal movements of the water that accompany the rising and falling of the tide. The horizontal movement of the tidal current and the vertical movement of the tide are intimately related parts of the same phenomenon brought about by the tide-producing forces of sun and moon. Tidal currents, like the tides, are therefore periodic.

It is the periodicity of the tidal current that chiefly distinguishes it from other kinds of currents in the sea, which are known by the general name of nontidal currents. These latter currents are brought about by causes that are independent of the tides, such as winds, fresh-water run-off, and differences in density and temperature. Currents of this class do not exhibit the periodicity of tidal currents.

Tidal and nontidal currents occur together in the open sea and in inshore tidal waters, the actual current experienced at any point being the resultant of the two classes of currents. In some places tidal currents predominate and in others nontidal currents predominate. Tidal currents generally attain considerable velocity in narrow entrances to bays, in constricted parts of rivers, and in passages from one body of water to another. Along the coast and farther offshore tidal currents are generally of moderate velocity; and in the open sea, calculation based on the theory of wave motion, gives a tidal current of less than one-tenth of a knot.

REVERSING TIDAL CURRENTS

In the entrance to a bay or in a river and, in general, where a restricted width occurs, the tidal current is of the reversing or rectilinear type; that is, the flood current runs in one direction for a period of about 6 hours and the ebb current for a like period in the opposite direction. The flood current is the one that sets inland or upstream and the ebb current the one that sets seaward or downstream. The change from flood to ebb gives rise to a period of slack water during which the velocity of the current is zero. An example of this type of current is shown in figure 1, which represents the velocity and direction of the current as observed on August 8–9, 1922, in The Narrows, the entrance to New York Harbor.

The curve of figure 1 was drawn by plotting the velocity of the current as observed at the beginning of each hour and drawing a smooth curve that conformed as nearly as possible with the plotted velocities. The northerly setting or flood velocities were plotted above the line of zero velocity and the southerly setting or ebb velocities were plotted below this line. The velocities are given in knots, which is the unit generally used in measuring tidal currents and represents a velocity of 1 nautical mile per hour. Since a nautical mile has a length of 6,080 feet, knots may be converted into statute miles per hour by multiplying by 1.15, or into feet per second by multiplying by 1.69.

The curve of the reversing current resembles the tide curve. The maximum velocity of the flood current, called the strength of flood, corresponds to the high water of the tide curve, while the maximum velocity of the ebb, called the strength of ebb, corresponds to the low water. The current day, like the tidal day, has a length averaging 24 hours and 50 minutes.

The current curve shown in figure 1 represents the current near the surface in the axis of the channel of The Narrows. From observation and also from theory it is known that the tidal current extends from the surface to the bottom. In general it may be said that the velocity

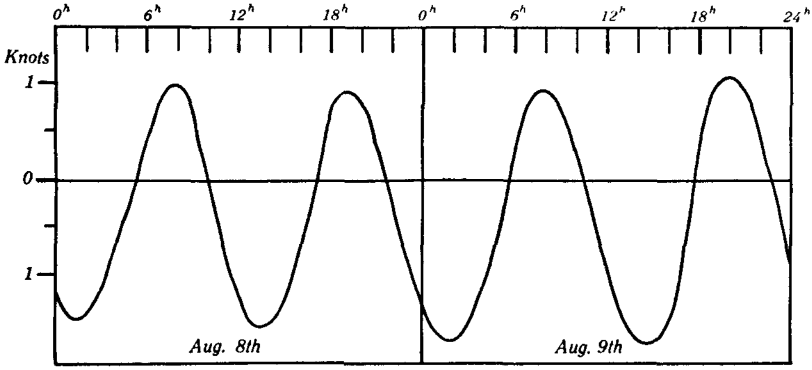

FIGURE 1.—Current curve, The Narrows, New York Harbor, August 8-9, 1922.

of the tidal current decreases from the surface to the bottom, the velocity near the bottom being about two thirds that at the surface. But the effects of wind and fresh-water flow may bring about considerable variation in the vertical velocity distribution.

The current in a channel is also characterized by a variation in the horizontal distribution of velocity. In a rectangular channel of uniform cross-section, the velocity is greatest in the center of the channel, and decreases uniformly to both sides. Combining both the vertical and horizontal variations, it may be said that the average velocity of the current in a section of a regular channel is about three-quarters that of the central surface velocity.

Where the current is undisturbed by wind or fresh-water flow, the flood and ebb velocities, and the durations of flood and ebb are approximately equal. In this case, too, the characteristics of the current from the surface to the bottom are much the same. That is, the strengths of the flood and ebb currents, and also the slacks, occur at about the same time from top to bottom. If, however, nontidal currents are present, the characteristics of the tidal flow are modified considerably. The effect of nontidal currents on tidal currents may be derived from general considerations.

In figure 2 a purely tidal current is represented by the curve referred to the line *AB* as the line of zero velocity. The strengths of the flood and ebb are equal, as are also the durations of flood and ebb. In this case slack water occurs regularly 3 hours and 6 minutes (one-quarter of the current cycle of 12 hours and 25 minutes) after the times of flood and ebb strengths. If now a nontidal current is introduced which sets in the ebb direction with a velocity represented by the line *CD*, the strength of ebb will obviously be increased by an amount equal to *CD* and the flood strength will be decreased by the same amount. The current conditions may now be represented by drawing, as the new line of zero velocities, the line *EF* parallel to *AB*, and distant from it the length of *CD*.

Figure 2 now shows that the nontidal current not only increases the ebb strength while decreasing the flood strength, but also changes the times of slack water. Slack before flood now comes later, while slack before ebb comes earlier. Hence the duration of ebb is increased while the duration of flood is decreased.

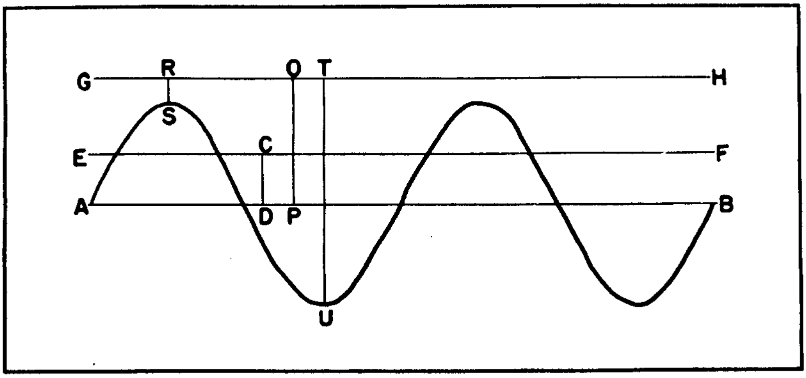

FIGURE 2.—Effect of nontidal current on reversing tidal current.

If the velocity of the nontidal current exceeds that of the tidal current at time of strength, the tidal current in the opposite direction will be completely masked and the resultant current will set at all times in the direction of the nontidal current. Thus, if in figure 2 the line *OP* represents the velocity of the nontidal current, the new axis for measuring the velocity of the combined current at any time will be the line *GH* and the current will be flowing at all times in the ebb direction. There will be no slack waters; but at periods 6 hours 12 minutes apart there will occur minimum and maximum velocities represented, respectively, by lines *RS* and *TU*.

Insofar as the effect of the nontidal current on the direction of the tidal current is concerned, it is only necessary to remark that the resultant current will set in a direction which at any time is the resultant of the tidal and nontidal currents at that time. This resultant direction and also the resultant velocity may be determined either graphically by the parallelogram of velocities or by the usual trigonometric computations.

VARIATIONS IN STRENGTH OF CURRENT

Tidal currents exhibit periodic changes in the strength of the current that corresponds closely with the periodic changes in range exhibited by tides. Stronger currents than usual come with the spring tides of full and new moon and the weaker currents with the neap tides of the moon's first and third quarters. Likewise, perigean tides are accompanied by strong currents and apogean tides by relatively weaker currents; and when the moon has considerable declination, the currents, like the tides, are characterized by diurnal inequality.

As related to the moon's changing phases, the variation in the strength of the current from day to day is approximately proportional to the corresponding change in the range of the tide. The moon's changing distance likewise brings about a change in the velocity of the strength of the current which is approximately proportional to the corresponding change in the range of the tide; but in regard to the moon's changing declination, tide and current do not respond alike, the diurnal variation in the tide at any place being generally greater than the diurnal variation in the current.

The relations subsisting between the changes in the velocity of the current at any given place and the range of the tide at that place may be derived from general considerations of a theoretical nature. Variations in the current that involve semidiurnal constituents will approximate corresponding changes in the range of the tide; but for variations involving diurnal constituents the variation in the current is about half that in the tide.

TYPES OF REVERSING CURRENTS

Since tides and tidal currents are merely different aspects of the tidal movement of the waters, the former being the vertical movement and the latter the horizontal movement, it is to be expected that tidal currents would show different types, corresponding to the different types of tide. Observations prove this to be the case. Reversing currents may be readily classed under the three types of semidaily, daily, and mixed. The semidaily type is one in which two flood strengths and two ebb strengths occur in a tidal day, with but little inequality between morning and afternoon currents. Figure 1, illustrating the current in The Narrows, New York Harbor, may be taken as representative of this type.

The daily type of tidal current is characterized by one flood and one ebb in a day. The upper diagram of figure 3, which represents the current as observed in the entrance to Mobile Bay, Ala., on May 2–3, 1918, exemplifies this type of current. The mixed type of tidal current exhibits two floods and two ebbs in a day with considerable inequality between the forenoon and afternoon cycles. The lower diagram of figure 3, which represents the current observed in Rich Passage, Puget Sound, Wash., on March 29–30, 1917, illustrates this type of current.

In general, it may be said that with reversing currents a given type of current accompanies a like type of tide; that is, semidaily currents occur with semidaily tides, mixed currents with mixed tides, and daily currents with daily tides. But as noted in considering the variations in strength of current, the variations in the current that involve semidaily constituents will approximate corresponding changes in the range of the tide, while in those involving daily constituents the variation in the current is about half that in the tide. Hence the diurnal inequality in the current at any place is generally less than in the tide at that place.

RELATION OF TIME OF CURRENT TO TIME OF TIDE

In simple wave motion the times of slack and strength of current bear a constant and simple relation to the times of high and low waters. In a progressive wave the time of slack water comes, theoretically, exactly midway between high and low water and the time of strength at high and low water; in a stationary wave slack comes at the times of high and low water, while the strength of current comes midway between high and low water.

The progressive-wave movement and the stationary-wave movement are the two principal types of tidal movements. A progressive

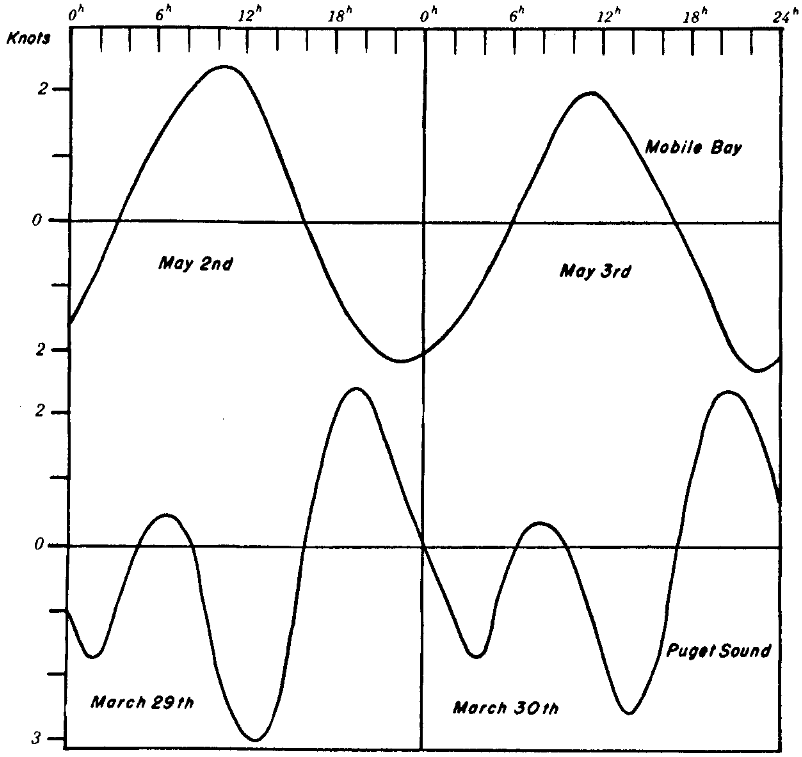

FIGURE 3.—Curves of daily and mixed types of reversing currents.

wave is one whose crest advances, so that in any body of water that sustains this type of tidal movement the times of high and low water progress from one end to the other. A stationary wave is one that oscillates about an axis, high water occurring over the whole area on one side of this axis at the same instant that low water occurs over the whole area on the other side of the axis.

The tidal movements of coastal waters are rarely of simple wave form; nevertheless, it is very convenient in the study of currents to refer the times of current to the times of tide. And where the diurnal inequality in the tide is small, as is the case on the Atlantic coast, the relation between the time of current and the time of tide is very nearly constant. This is brought out in figure 4, which represents the tide and current curves in The Narrows, New York Harbor, for August 8–9, 1922, the current curve being the dashed-line curve, representing the velocities of the current in the center of the channel, and the tide curve being the full-line curve, representing the rise and fall of the tide at Fort Hamilton, on the eastern shore of The Narrows.

The diagrams of figure 4 were drawn by plotting the heights of the tide and the velocities of the current to the same time scale and to such velocity and height scales as will make the maximum ordinates of the two curves approximately equal. The time axis or axis of X represents the line of zero velocity for the currents and of mean sea level for the tide, the velocity of the current being plotted in accordance with the scale of knots on the right, while the height of the tide reckoned from mean sea level was plotted in accordance with the scale in feet on the left.

From figure 4 it is seen that the corresponding features of the

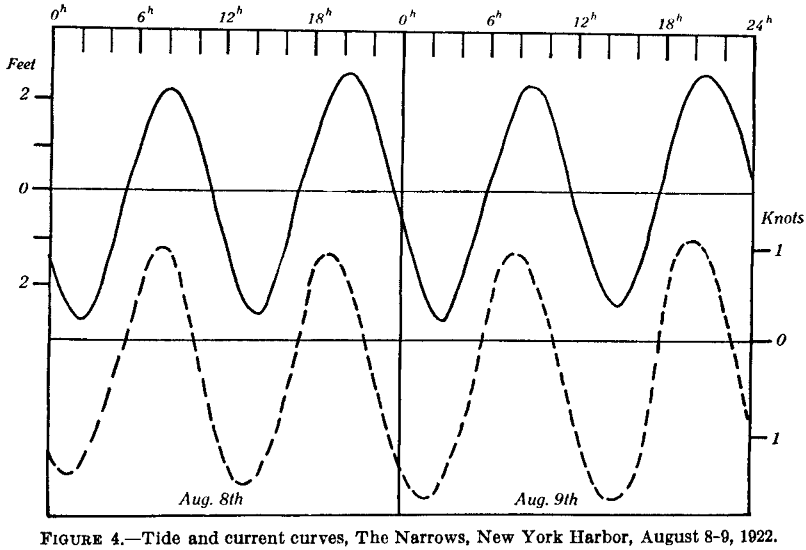

FIGURE 4.—Tide and current curves, The Narrows, New York Harbor, August 8–9, 1922.

tide and current at this station bear a nearly constant time relation to each other. This approximate constancy in time relations between current and tide is characteristic of tidal waters in which the diurnal inequality is small, and permits the times of slack and of strength of the current to be referred to the times of high and low water. Thus, from figure 4 we find that the strengths of the current come about an hour before the times of high and low water, while the slacks come about 1¾ hours after high water and 3 hours after low water. In this connection, however, it is to be noted that the time relations between corresponding phases of tide and current at any place frequently vary in consequence of disturbing effects of wind, weather, and fresh-water run-off.

Quite apart from the disturbing effects of nontidal agencies, the time relations between current and tide are subject to variations in regions where the tide exhibits considerable diurnal inequality; as for example, on the Pacific coast of the United States. This variation is due to the fact, previously mentioned, that the diurnal inequality in the current at any given place is, in general, only about half as great as that in the tide. This brings about differences in the corresponding features of tide and current as between morning and afternoon. However, in such cases it is frequently possible to refer the current at a given place to the tide at some other place with comparable diurnal inequality.

DISTANCE TRAVELED DURING A TIDAL CYCLE

The vertical distance traveled by a floating object during the tidal cycle at any place can be easily determined from the tide curve at that place, for the tide curve represents the successive heights of the surface of the water during the tidal cycle. Hence the vertical distance on the tide curve between a high water and low water gives the vertical distance through which a floating object moved during that tidal cycle.

The close resemblance between the curve of the reversing current and the tide curve might lead one to conclude that from the current curve the horizontal distance traveled by a floating object can be as readily derived as the vertical distance is from the tide curve. The current curve, however, gives the successive speeds of the horizontal movement, and not the successive positions of a floating object. Hence the current curve does not give directly the horizontal distance traveled by a floating object.

If the velocity of the current during a tidal cycle were constant, the horizontal distance traveled by the water particles or by any object floating in the water would be given by multiplying the velocity by the period of duration. The velocity of the current, however, is not constant but changes continually throughout a tidal cycle. The distance traveled by the water particles is, therefore, the average velocity during the flood or ebb period in question, multiplied by the duration.

The average velocity of the current during any given interval may be determined in several different ways. By measuring the velocity on the current curve at frequent intervals, say every 10 or 15 minutes, the average velocity during the interval is easily derived. Or the area of the surface bounded by the current curve and the zero line of velocities may be determined by means of a planimeter and the average velocity derived by dividing this area by the length of the zero line included within the current curve.

The simplest method, however, consists in making use of the fact that the current curve approximates the cosine curve. And on the cosine curve it is known that the ratio of the mean ordinate to the maximum ordinate is $2 \div \pi$, or 0.637. Since the strength of the tidal current corresponds to the maximum ordinate, it follows that during any given flood or ebb period the average velocity will be the strength of the current multiplied by 0.637.

In the semidaily or mixed types of current the duration of a flood or ebb period approximates 6.2 hours. Hence, in the case of such a current which has a velocity at strength of one knot, a floating object will, during a flood or ebb period, be carried a distance of $0.637 \times 6.2 = 3.95$ nautical miles, or 24,000 feet. In a daily current of the same strength the distance will be twice as great.

It may be noted that the formula made use of in the preceding calculation can give only approximate results. For not only is the average current derived through the cosine relationship approximate, but what may be even more serious is the fact that in the formula it is assumed that the floating object during the various stages of its journey will experience the changes in velocity which occur at the point where it started. Where more exact results are desired, corrections to the above approximate results can be applied.

If the durations of flood and ebb are equal, and also the strengths of the flood and ebb currents, a floating object would be carried a given distance downstream and a like distance upstream. The presence of fresh water in tidal waterways, however, makes both the strength and duration of the ebb greater than the flood, and therefore floating objects tend to be carried out to sea.

DURATION OF SLACK

In the change of direction of flow from flood to ebb, and vice versa, the reversing tidal current goes through a period of slack water or zero velocity. Obviously, this period of slack is but momentary, and graphically it is represented by the instant when the current curve cuts the zero line of velocities. For a brief period each side of slack water, however, the current is very weak, and in ordinary usage "slack water" denotes not only the instant of zero velocity but also the period of weak current. The question is therefore frequently raised, How long does slack water last?

To give slack water in its ordinary usage a definite meaning, we may define it to be the period during which the velocity of the current is less than one-tenth of a knot. Velocities less than one-tenth of a knot may generally be disregarded for practical purposes, and such velocities are, moreover, difficult to measure either with float or with current meter. For any given current it is now a simple matter to determine the duration of slack water, the current curve furnishing a ready means for this determination.

In general, regarding the current curve as approximately a sine or cosine curve, the duration of slack water is a function of the strength of current—the stronger the current the less the duration of slack—and from the equation of the sine curve we may easily compute the duration of slack water for currents of various strengths. For the normal flood or ebb cycle of $6^h\ 12.6^m$ we may write the equation of the current curve $y=A \sin 0.4831t$, in which A is the velocity of the current in knots at time of strength, 0.4831 the angular velocity in degrees per minute, and t is the time in minutes from the instant of zero velocity. Setting $y=0.1$ and solving for t (this value of t giving half the duration of slack) we get for the duration of slack the following values: For a current with a strength of 1 knot, slack water is 24 minutes; for currents of 2 knots strength, 12 minutes; 3 knots, 8 minutes; 4 knots, 6 minutes; 5 knots, 5 minutes; 6 knots, 4 minutes; 8 knots, 3 minutes; 10 knots, $2\frac{1}{3}$ minutes. For the daily type of current with a given strength, the duration of slack is obviously twice that of a semidaily current with like strength.

VELOCITY OF CURRENT AND PROGRESSION OF TIDE

In the tidal movement of the water it is necessary to distinguish clearly between the velocity of the current and the progression or rate of advance of the tide. In the former case reference is made to the actual speed of a moving particle, while in the latter case the reference is to the rate of advance of the tide phase or the velocity of propagation of wave motion, which generally is many times greater than the velocity of the current.

It is to be noted that there is no necessary relationship between the velocity of the tidal current at any place and the rate of advance of the tide at that place. In other words, if the rate of advance of the tide is known we cannot from that alone infer the velocity of the current, nor vice versa. The rate of advance of the tide in any given body of water depends on the type of tidal movement. In a progressive wave the tide moves approximately in accordance with the formula $r=\sqrt{gh}$, in which r is the rate of advance of the tide, g the acceleration of gravity, and h the depth of the waterway. In stationary-wave movement, since high or low water occurs at very nearly the same time over a considerable area, the rate of advance is theoretically very great; but actually there is always some progression present, and this reduces the theoretical velocity considerably.

The velocity of the current, or the actual speed with which the particles of water are moving past any fixed point, depends on the volume of water that must pass the given point and the cross section of the channel at that point. The velocity of the current is thus independent of the rate of advance of the tide.

ROTARY TIDAL CURRENTS

Within the channel of a bay or river, the current is compelled to follow the direction of the channel, upstream on the flood and downstream on the ebb. Out in the open sea, however, this restriction no longer exists, the current having complete freedom so far as direction is concerned. Offshore, therefore, tidal currents are generally not of the reversing type. Instead of flowing in the same general direction during the entire period of the flood and in the opposite direction during the ebb, the tidal currents offshore change direction continually. Such currents are therefore called rotary currents. An example of this type of current is shown in figure 5, which represents the velocity and direction of the current at the beginning of each hour of the forenoon of July 30, 1922, at Nantucket Shoals Lightship, stationed off the coast of Massachusetts.

The current is seen to have changed its direction at each hourly observation, the rotation being in the direction of movement of the hands of a clock, or from north to south by way of east, then to north again by way of west. In a period of a little more than 12 hours it is seen that the current has shifted in direction completely round the compass.

It will be noted that the tips of the arrows, representing the velocities and directions of the current at the beginning of each hour, define a somewhat irregular ellipse. If a number of observations are averaged, eliminating accidental errors and temporary meteorological disturbances, the regularity of the curve is considerably increased. The average period of the cycle is, from a considerable number of observations, found to be $12^h\ 25^m$. In other words, the current day for the rotary current, like the tidal day, is $24^h\ 50^m$ in length.

A characteristic feature of the rotary current is the absence of slack water. Although the current generally varies from hour to hour, this variation from greatest current to least current and back again to greatest current does not give rise to a period of slack water. When the velocity of the rotary tidal current is least, it is known as the minimum current, and when it is greatest it is known as the maximum current. The minimum and maximum velocities of the

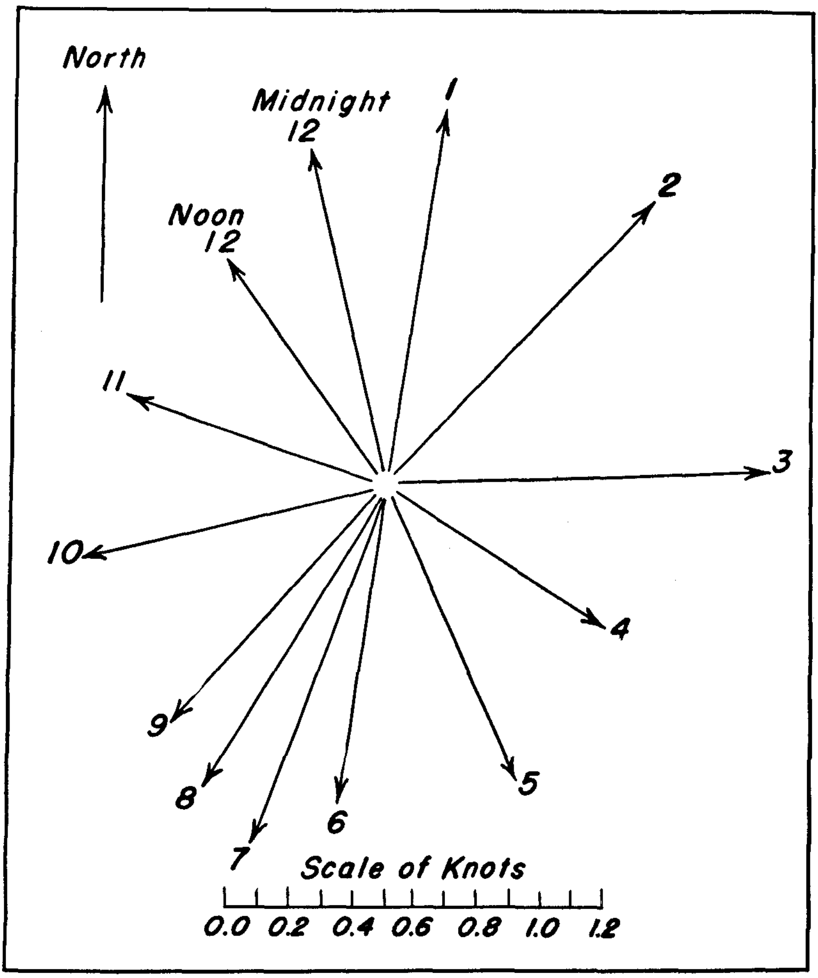

FIGURE 5.—Rotary current, Nantucket Shoals Lightship, forenoon of July 30, 1922.

rotary current are thus related to each other in the same way as slack and strength of the rectilinear current, a minimum velocity following a maximum velocity by an interval of about 3 hours and being followed in turn by another maximum after a further interval of 3 hours.

Since the current day corresponds to the tidal day, it is convenient, in determining the average hourly velocity and direction of the rotary current, to make use of the times of high and low water at some nearby place for purpose of reference. In figure 6 the average hourly velocity and direction of the tidal current at Nantucket Shoals Lightship is shown with reference to the times of high and low water at Boston, Mass., *H* standing for the time of high water, and *L* for the time of low water.

In figure 6 the velocity and direction of the current at the beginning of each hour is given by the length and direction of the line from

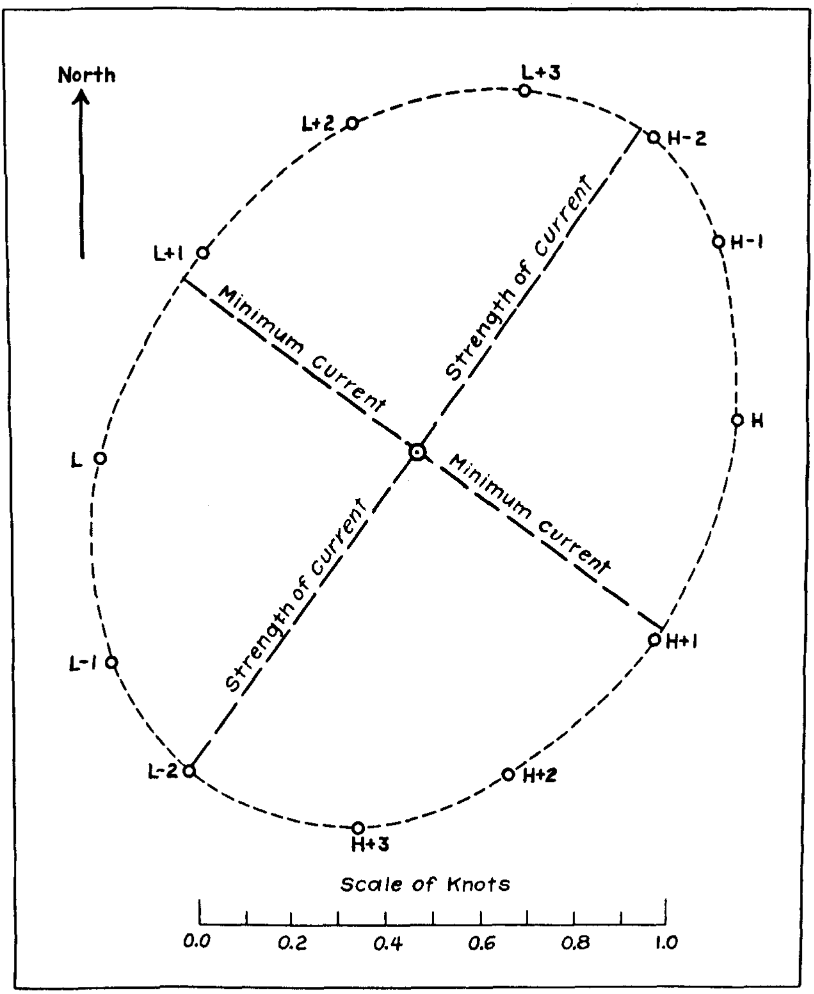

FIGURE 6.—Mean current curve, Nantucket Shoals Lightship.

the center of the ellipse to the hour in question. Thus at the time of high water at Boston the current at Nantucket Shoals Lightship has a velocity averaging 0.7 knot setting N. 85° E.

With regard to the current curve, or current ellipse as it may be called, which represents the rotary tidal current at any place, the basic features are the relation of the major and minor axes which determine the ellipticity of the curve, the direction of rotation, and the direction of the major axis. If the major and minor axes are nearly equal the ellipse will be nearly circular; if they differ greatly the ellipse will be flattened. In the northern hemisphere the direction of rotation of the rotary current is, as a rule, with the hands of a clock, while in the southern hemisphere it is counterclockwise. Local hydrographic features may bring about a reversal of this general rule.

Rotary tidal currents are subject to the periodic variations found in tides and reversing currents. These variations are related to the changes in the phase, parallax, and declination of the moon. At times of full and new moon the velocity of the rotary current is greater than the average, while at the times of the moon's first and third quarters the velocities are less than the average. Likewise when the moon is in perigee, stronger currents occur, while when the moon is in apogee the currents are weaker. In general it may be taken that the percentage of increase or decrease in the velocity of the current in response to changes in phase and parallax is the same as the like increase or decrease in the local range of the tide.

In response to changes in the declination of the moon the rotary current exhibits diurnal inequality like the tide and reversing current. This manifests itself as a difference between morning and afternoon current ellipses. When the moon is on the Equator the two current ellipses of a day are much alike, but when the moon is near its maximum semimonthly declination the two current ellipses exhibit differences, principally in velocity.

Like tides and reversing currents, rotary tidal currents may be grouped under the three types of semidaily, daily, and mixed. The semidaily type of rotary current is one which exhibits two full cycles within a tidal day, morning and afternoon currents differing but little. The daily type is one in which but one cycle occurs in a day; and the mixed type is one which exhibits two cycles within a day, but with considerable differences between morning and afternoon currents.

EFFECTS OF NONTIDAL CURRENTS ON ROTARY CURRENTS

In addition to the periodic variations to which rotary tidal currents are subject, they also exhibit fluctuations arising from the effects of nontidal currents. These effects can most conveniently be studied diagrammatically.

Figure 6 represents the purely rotary tidal current at Nantucket Shoals Lightship. Now suppose that on a given day a wind begins blowing from the northeast such that it produces a wind-driven current of half a knot in a southwesterly direction. For that day, obviously, the velocity and direction of the current at Nantucket Shoals Lightship will be different than represented in figure 6. At 2 hours before low water at Boston, for example, the tidal current sets southwesterly with a velocity of 0.85 knot on the average; but with a nontidal current of 0.5 knot due to the wind setting in the same direction, the velocity of the current now experienced will be $0.85+0.50=1.35$ knots, setting southwesterly. On the other hand, about 2 hours before high water, the current will be setting $0.85-0.50=0.35$ knot northeasterly.

The current conditions at this time may be completely represented by changing the origin of the hourly velocity and direction lines in figure 6 from the center to a point 0.5 knot northeasterly of its previous position. The lines drawn to the various hourly points on the ellipse from this new origin will now represent the velocity and direction of the tidal current as affected by the nontidal current.

The average velocity of the tidal current at the times of flood or ebb strength at Nantucket Shoals Lightship is 0.85 knot. If the nontidal current due to the wind in the case just considered is greater than 0.85 knot, the origin of the velocity lines would lie outside the ellipse. In that case the current would throughout the day be setting either southeasterly or southwesterly, completely masking the rotary character of the tidal current. By plotting the observed hourly velocities and directions of the current, however, the tidal current would appear in its rotary character. This is illustrated in figure 7 for the current at Frying Pan Shoals Lightship under different wind conditions. This lightship is stationed off the coast of North Carolina about 20 miles southeasterly from Cape Fear. The hourly velocity and direc-

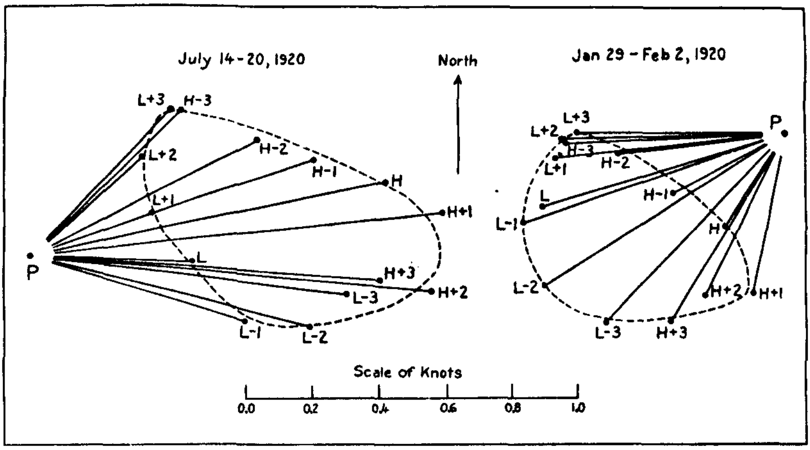

FIGURE 7.—Effect of nontidal current on rotary tidal current, Frying Pan Shoals Lightship.

tion of the current here is referred to the times of high and low water at Charleston, S. C.

Observations made at this lightship show the tidal current here to be rotary clockwise, the average velocity at strengths of flood and ebb being about a third of a knot and setting northwest and southeast, respectively. During the 5-day period January 29–February 2, 1920, the wind was blowing steadily from the northeast with a velocity of about 30 miles per hour, and the current was observed to be setting at all times southwesterly with a velocity varying from a little less than one-half a knot to a little more than three-quarters of a knot. Apparently the current here at this time was altogether nontidal. But if the hourly velocity and direction of the current during this period is plotted, the rotary character of the current is immediately apparent. The right-hand diagram of figure 7 represents the current conditions during this 5-day period, the velocity and direction of the current at the different hours being given by the length and direction of the lines drawn from the point *P*.

Now, although the current at all times during this period set southwesterly, the diagram reveals clearly the existence of a rotary current with a strength of about a third of a knot in a northwest and southeast direction. Furthermore, the diagram shows that the current actually observed consisted of a tidal current which was masked by a nontidal current of greater velocity. In fact the diagram permits the evaluation of this nontidal current. For this must clearly be given by the line joining the point *P* with the center of the current ellipse, and this is found to have a length of about half a knot and a direction of S. 60° W. This nontidal current was brought about by the northeasterly wind during the 5-day period in question.

About 6 months later, throughout the 7-day period July 14–20, 1920, the current at Frying Pan Shoals Lightship was found to set easterly with velocities ranging from a little less than half a knot to more than a knot. On plotting the observations, as the left-hand diagram of figure 7 shows, the rotary character of the tidal current comes to light at once. During this 7-day period the wind was blowing steadily from the southwest with a velocity averaging approximately 30 miles per hour. This brought about a wind-driven current setting a little north of east with a velocity somewhat greater than half a knot, and this completely masked the tidal current.

HARMONIC CONSTANTS

The reversing tidal current, like the tide, may be regarded as the resultant of a number of simple harmonic movements, each of the form $y=A\cos(at+\alpha)$; hence, reversing tidal currents may be analyzed in a manner analogous to that used in tides and the harmonic current constants derived. These constants permit the characteristics of the currents to be determined in the same manner as the tidal harmonic constants, and they may also be used in the prediction of the times of slack and the times and velocities of the strength of current.

It can easily be shown that in inland tidal waters, like rivers and bays, the amplitudes of the various current constituents are related to each other, not as the amplitudes of the corresponding tidal constituents, but as these latter multiplied by their respective speeds; that is, in any given harbor, if we denote the various constituents of the current by primes and of the tide by double primes, we have

$$M'_2:\ S'_2:\ N'_2:\ K'_1:\ O'_1=m_2M''_2:\ s_2S''_2:\ n_2N''_2:\ k_1K''_1:\ o_1O''_1$$

where the small italic letters represent, respectively, the angular speed of the corresponding constituents. This shows at once that the diurnal inequality in the currents should be approximately half that in the tide.

Rotary currents may likewise be analyzed harmonically, but in this case it is necessary to resolve the hourly velocity and direction of the current into two components, one in the north-and-south direction and the other in the east-and-west direction. Each set of hourly tabulations is then treated independently and analyzed in the usual manner. When the two sets of harmonic constants have been derived the like-named constants of the north-and-south and east-and-west directions may be combined into a single resultant, which will be an ellipse.

MEAN VALUES

In the nonharmonic analysis of current observations it is customary to refer the times of slack and strength of current to the times of high and low water of the tide at some suitable place, generally nearby. In this method of analysis the time of current determined is in effect reduced to approximate mean value, since the changes in the tidal current from day to day may be taken to approximate the corresponding changes in the tide; but the velocity of the current as determined from a short series of observations must be reduced to a mean value.

In the ordinary tidal movement of the progressive or stationary wave types the change in the strength of the current from day to day may be taken approximately the same as the variation in the range of the tide. Hence, the velocity of the current from a short series of observations may be corrected to a mean value by multiplying by a factor which is the ratio of the mean range of the tide to the range for the period of the observations.

It is to be noted that in this method of reducing to a mean value, any nontidal currents must first be eliminated, and the factor applied to the tidal current alone. This may be done by taking the strengths of the tidal current as the half sum of the flood and ebb strengths for the period in question.

In some places the current, while exhibiting the characteristic features of the tidal current, is in reality a hydraulic current due to differences in head at the ends of a strait connecting two independent tidal bodies of water. East River and Harlem River in New York Harbor and Seymour Narrows in British Columbia are examples of such straits, and the currents sweeping through these waterways are not tidal currents in the true sense, but hydraulic currents. The velocities of such currents vary as the square root of the head, and hence in reducing the velocities of such currents to a mean value the factor to be used is the square root of the factor used for ordinary tidal currents.

COASTAL CURRENTS ALONG THE ATLANTIC COAST OF THE UNITED STATES

INTRODUCTION

The area covered by this discussion stretches along the Atlantic coast of the United States from Maine to Florida. It lies for the most part inside the 30-fathom depth curve and extends into a number of the larger sounds and bays that indent the coast. Although a detailed knowledge of the currents in this area is of great importance to navigators, the large expense generally involved in securing adequate current observations in unprotected waterways long prevented the acquisition of that knowledge.

During the last three decades, however, there has been in effect a cooperative arrangement between the Coast and Geodetic Survey and the Lighthouse Service whereby long series of current observations have been secured at lightship stations. Current measurements along our Atlantic coast have been made at approximately 50 such stations. Continuous series of hourly observations covering a year or more have been obtained at about half of these and a number of months at each of the others.

Much information derived from the observations has been published in various forms in the annual current tables and other publications of the Coast and Geodetic Survey. During the past few years many new reductions have been made of the accumulated records. The results of these reductions correlated with those previously obtained are given in considerable detail in the pages that follow. An attempt is made to present the material in such forms that with the aid of the explanatory text it will be intelligible to all users, and of value to the mariner and the fisherman as well as to the oceanographer and the tidal expert.

METHOD OF OBSERVING

In general, the process of observing currents consists of measuring at fixed intervals of time, such as hourly or half-hourly, the velocity of the current; noting the direction the current is flowing at each measurement of velocity; and recording the direction, the velocity, and the time at which each measurement is made. Various means of taking such observations have been employed. The current pole method of observing was used exclusively on all the lightships at which current measurements were made.

The current pole is a wooden pole so weighted with lead that it will submerge for most of its length and assume a vertical position when placed in the water. The pole is attached to a line and allowed to drift with the current while an observation is being made. The line, known as a *current line*, is marked in principal and secondary divisions, each secondary division being one-tenth of a principal division. The length of each principal division bears the same ratio to a nautical mile that the time the pole is allowed to drift bears to an hour. By this means the velocity in knots (nautical miles per hour) and tenths is read directly from the current line. The direction toward which the pole drifts is observed by means of a pelorus which is used in conjunction with the ship's compass. The pelorus used is a metal disk about 8 inches in diameter and graduated clockwise for every 5 or 10 degrees. The current pole used on the lightships was 15 feet long and was so weighted as to float with 1 foot of its length extending above the water surface. The current measured was therefore the average current for the first 14 feet of depth. In most cases the current observations were taken hourly throughout the 24 hours of each day. The velocity and direction of the wind at the time of each current observation were noted and recorded. The velocity of the wind was usually estimated but in some cases was measured by anemometer. The wind direction was determined by the ship's compass.

METHODS OF REDUCING THE OBSERVATIONS

PRELIMINARY STATEMENTS

As the current movement to be studied was a combination of a number of constituent movements, it was necessary to identify and insofar as possible to isolate and evaluate the more important of these constituent currents. For this purpose a number of reduction processes were used by means of which three main classes of results representing three important elements of the current movement have been derived. These three groups of results are presented in this volume under the headings: tidal currents, nontidal currents, and wind currents.

Because of their periodicity, the tidal currents can be readily separated from the observed movement, their characteristics determined, and their more important harmonic constituents calculated with considerable precision, provided a long series of observations has been secured.

The nonperiodic constituents of the current cannot readily be separated from each other. The values given under the heading "nontidal currents" are the residual currents for the periods and stations indicated. They include wind effects in combination with other nontidal effects such as oceanic circulation and drainage.

The wind currents given are the average currents that accompanied the indicated wind directions and velocities at the stations named during the periods stated. They are therefore not in all cases purely the result of winds but may include other nontidal effects.

The methods of reducing the reversing and rotary types of tidal currents as well as nontidal currents and wind currents are discussed in detail in U. S. Coast and Geodetic Survey Special Publication No. 215, "Manual of Current Observations." They will be described here briefly, much of the detail that is not essential to an understanding of the results being omitted.

NONHARMONIC REDUCTION OF REVERSING TIDAL CURRENTS

Under this heading is briefly described the process which with some modifications in individual cases was used for reducing tidal currents having relatively large velocities—usually half a knot or more—and little or no tendency to rotate. The reduction of weak reversing currents will be taken up in connection with rotary currents in the next section. The observed directions were reduced to magnetic directions by applying to each pelorus reading the proper corrections for the ship's head and the deviation of the ship's compass.

The observed velocities were plotted on cross-section paper, the times of observations being taken as abscissae and the velocities plotted as ordinates, the flood velocities above and the ebb velocities below the horizontal line representing zero velocity. Smooth curves were drawn following the general trend of the plotted velocities and from these curves the times of slack waters and the times and velocities of the strengths of flood and ebb were taken. These times and velocities, together with the magnetic direction of each strength of flood and ebb were tabulated, usually in monthly groups, on forms prepared for the purpose. The times of slack water and of strength of current were then compared with the times of high and low water at a tidal reference station and average time differences computed for each of the four phases of current—namely, slack before flood, strength of flood, slack before ebb, and strength of ebb. Average magnetic directions of flood and ebb were obtained for each series of observations and the average velocities of flood strength and ebb strength were computed.

Finally the average time differences for the four phases were referred to Greenwich transits of the moon by means of known time relations between the Greenwich transits and the high and low waters at the reference station, and the magnetic directions of the flood and ebb strengths were changed to true directions by applying the magnetic variation.

NONHARMONIC REDUCTION OF ROTARY TIDAL CURRENTS

Rotary currents and weak reversing currents were, in general, treated identically. As a preliminary step, the observed hourly velocities were resolved into their north and east component velocities. The component velocities were then tabulated in hourly groups arranged according to the times of the high- and low-water phases at a tidal reference station. The north and east components for each group were summed and averaged separately, usually by months. These averages included both tidal and nontidal currents. In order to separate the two, the north and east components of the nontidal current were obtained by averaging separately all the north components and all the east components of the observed hourly velocities. This process eliminated the cyclic or tidal current, leaving only the north and east components of the average nontidal current. These north and east components of the nontidal current were then subtracted algebraically from the corresponding components of the observed current for each hourly group. The resulting north and east components for each hour represented the tidal current for that hour. From these components the velocities and directions of the tidal current for each hour of the tidal cycle were obtained. These hourly velocities and directions were plotted on cross-section paper, separate graphs with the same time scale being made for velocity and direction.

From the known time relationships between the Greenwich transit of the moon and the high and low waters at the tidal reference station, a second time scale reckoned from the Greenwich transit of the moon was prepared for each set of graphs. Using the last-mentioned scale, the hourly velocities and directions for each hour after the Greenwich transit were read from the graphs. Also, the times of the maximum and minimum phases of the rotary current or of the strengths and slacks of the reversing current referred to the Greenwich transit were similarly obtained directly from the graphs.

HARMONIC REDUCTION

A detailed explanation of harmonic analysis as applied to the reduction of tides and tidal currents is given in United States Coast and Geodetic Survey Special Publication No. 98, "Manual of Harmonic Analysis and Prediction of Tides."

Harmonic analyses have been made of the hourly current velocities observed at many of the lightship stations. For the series for which nonharmonic reductions were made on a reversing basis the velocities were analyzed along the axis of flow, the flood velocity being taken as positive and the ebb velocity as negative. For the weak or rotary currents the north and east component velocities were analyzed separately, a double set of harmonic constants being derived.

NONTIDAL CURRENT REDUCTION

The nontidal current for most stations was computed for monthly groups of observations in connection with, or from the results of, the tidal current reductions briefly described above. For those reversing-current series that were plotted and tabulated without being resolved into north and east components, the nontidal current was determined from the average observed velocities and directions of flood and ebb strengths. One-half the vector sum of the two strengths, determined either mathematically or graphically, represented the nontidal current for the period covered by the observations. The method of determining the nontidal current from the north and east components of the observed currents has been described in connection with the reduction of rotary tidal currents.

WIND CURRENT REDUCTION

As currents due to winds occur in combination with tidal currents as well as with other nontidal currents, long series of observations are necessary in order that tidal effects may be averaged out in the reductions. Wind effects are relatively important at offshore stations where the tidal current is weak or rotary. At such stations the observed velocities had been resolved into north and east component velocities as a preliminary step to the tidal current reduction. This resolution is also necessary for the wind reduction, and stations at which a year or more of hourly north and east component velocities were available were selected for the wind reductions.

With some variations in details the wind reductions were made as follows: The hourly component velocities, north and east, of the current were grouped according to the direction and velocity of the wind. Sixteen wind directions beginning with north, north-northeast, northeast, and continuing around the compass were employed. For each wind direction a number of wind velocity groups were tabulated, the first group including the current velocity components corresponding to observed winds of 5 to 15 statute miles per hour; the second group, to winds of 16 to 24 miles per hour; the third group, to winds of 25 to 35 miles per hour, and so on. Observations taken when the wind was less than 5 miles per hour were generally not used. An average wind velocity of 10 miles per hour was assumed for the first group, 20 miles per hour for the second group, 30 miles for the third group, and so on. The north and east component velocities were averaged separately for each velocity group for each of the sixteen directions. The current velocity and direction corresponding to the average north and east component velocities for each wind velocity group were obtained for each of the sixteen wind directions.

The directions of wind and current used in the reductions were generally magnetic directions, but the results were modified to apply to true directions of both wind and current.

The averages of current velocity and direction for each station, modified to a true-direction basis, were arranged in tabular form and further averages obtained of all the tabular current velocities and directions for each of the 16 wind directions, and of the current velocity for each wind velocity for all 16 wind directions. The several wind velocities for which the corresponding currents had been determined were also averaged for each wind direction. From the final averages of current and wind velocities thus obtained the velocity ratio of current to wind for all wind velocities was derived for each of the 16 wind directions, and the same ratio—current to wind—was obtained for all 16 wind directions for each wind velocity. From the final averages of direction the deviation of current direction from wind direction was obtained for each of the 16 wind directions.

Further treatment of results for the purpose of obtaining general relations of current to wind for the entire coast will be mentioned later in this text.

PRESENTATION OF THE RESULTS

LOCATIONS OF STATIONS

The locations of the lightship stations at which currents were observed are indicated by red circles accompanied by the names of the stations on figures 8 to 12. Approximate values for the depth of water at each current station and its distance from land are given in table 1, page 26.

EXPLANATION OF THE TABULAR DATA

The tabular material comprises a number of different kinds of current information which is given in various forms for the different stations. The characteristics of the current movement, the lengths of the observational series, and the methods of reducing the observations were factors which determined the nature and form of the data presented for a given station. However, uniformity of presentation was aimed at and accomplished wherever feasible. Table 2 contains the results derived from series of current observations at a number of lightships by the process described under the heading "Nonharmonic reduction of reversing tidal currents." The name of the lightship station and its latitude and longitude to the nearest tenth of a minute are given in the first column of the table. In the second and third columns the month and year in which the series of observations began and ended and the length of the series in days are given. Next are given the time of slack before flood, the time, direction and velocity of flood strength, and the duration of flood. These are followed by similar values for the ebb, and in the last column is the mean current hour.

All times are expressed in solar hours and hundredths. The times of slack water, the times of flood and ebb strengths, and the mean current hours are referred to the Greenwich transit of the moon. The true directions of the current at the times of flood and ebb-strengths are reckoned from the true north (0°), through east (90°), south (180°), and west (270°). The velocities are given in knots (nautical miles per hour) and hundredths. The mean current hour is the mean interval of time between the Greenwich transit of the moon and the time of the strength of the flood current as modified by the times of slack water and strength of ebb. It is computed by taking an average of the Greenwich intervals of the following modified phases: Flood strength, slack before flood increased by 3.10 hours, slack before ebb decreased by 3.10 hours, and ebb strength increased or decreased by 6.21 hours. Before taking the average, the four phases must be made comparable by such addition or rejection of the tidal period of 12.42 hours as may be necessary. The values given in table 2 are direct averages of observed currents. They include the average nontidal current for the period of the observations.

In table 3 are given results for stations where the current, although essentially of the reversing type, was too weak to admit of a satisfactory tabulation and reduction of the individual slacks and strengths. The observations were therefore treated as explained for rotary tidal currents. The results given represent the tidal current only, the nontidal current having been eliminated by the reduction process. Otherwise the values are on the same basis as those given in table 2.

The results given in table 4 are for stations at which the current is more or less rotary in character. The results are similar to those given in tables 2 and 3 except that the times, directions, and velocities of the minimums before flood and ebb take the places of the times of the slack waters given in those tables. It will be noted that Pollock Rip Slue and Brunswick lightships appear in both table 2 and table 4, one set of results having been obtained by plotting and tabulating the observations on a reversing current basis and the other set by resolving the velocities and carrying them through the process usually employed for rotary currents. As in table 3, the results apply to the tidal portion of the observed current, the nontidal current having been eliminated.

The hourly velocities and true directions of the tidal current at all the lightship current stations are given in table 5. This table includes data for some stations that do not appear in the tables showing the phases of current because the nature of the movement is such that no well-defined times of strength or minimum current can be selected. At some of these stations, of which Winter Quarter Shoal Lightship is a good example, the current ellipse is practically a circle, the velocity being very nearly the same throughout the cycle and the direction shifting continuously in a clockwise direction.

In tables 2 to 5, inclusive, the times of current given are reckoned from the Greenwich transit of the moon. They may be referred to times of high or low water at any one of the tide stations listed in table 6 through the use of the time relations, of high and low waters to the

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Greenwich transit, given in the table. Daily predictions of high and low waters for the tide stations listed are included in the annual Coast and Geodetic Survey tide tables.

The harmonic constants derived from series of current observations at a number of the lightship stations are given in tables 7, 8, and 9. These constants consist of the amplitudes and the phase lags or epochs of the more important periodic constituents of the current. Such constants form the basis for daily predictions of the current. From them also may be determined the general characteristics of the current movement and various nonharmonic quantities which are usually obtained directly from observations.

In table 7 the north and east components of the movement are represented separately, south and west being negatives of these. The epochs have reference to the maximum velocities of the constituents in a north or east direction. From the north and east component movements, the rotational features of the constituents may be developed. For details of such development, reference is made to United States Coast and Geodetic Survey Special Publication No. 215, "Manual of Current Observations." In tables 8 and 9 the constants represent a reversing condition, the movement in the flood direction being positive and that in the ebb direction, negative. The phase lags or epochs in this case refer to the maximum flood of each constituent.

Comparing the current harmonic constants for the lightship stations with tidal harmonic constants derived from tide observations at various points along the coast, it is found that the diurnal solar constituent S_1 for the current is, relative to the other harmonic constitutents, many times larger than for the tide. This relatively large magnitude of the S_1 current constituent was apparently unnoticed until a few years ago when harmonic analyses of long series of offshore current observations were begun. An investigation led to the conclusion that offshore the S_1 current was due to a periodic land and sea breeze rather than to the tidal forces.

Although it appears generally too weak to be of much practical importance, the S_1 current movement has been developed in detail for a number of current stations largely because of the interest attached to investigating a newly found or unusual phenomenon. The results of the development appear in table 10 in the form of a velocity and a direction for each hour of the solar day for each station. These values were derived from the S_1 constituents of the north and east component velocities as given in table 7. They were obtained by a graphic process and an occasional value may differ slightly from the corresponding value as derived mathematically.

In table 10 the hours of the solar day are given in 75th meridian time; the directions are in true degrees reckoned clockwise from north, and the velocities in knots are given to three decimals. An examination of the tabular values reveals that as with other currents, the characteristics of the S_1 current differ from place to place. At most stations it is largely rotary in character, but at a few, notably at Nantucket Shoals Lightship, it is mainly reversing. The rotation is clockwise at all the stations except Diamond Shoal Lightship, where it is counterclockwise. The velocity at strength varies from about 0.02 knot at Boston Lightship to about 0.10 knot at St. Johns Lightship. In general, the S_1 current sets toward the land at about 15 hours or 3 p. m. and seaward, about 3 a. m. At a few locations, however, notably Nantucket Shoals and Diamond Shoal Lightships, it differs markedly from the above timing.

Values for the nontidal current, derived as explained on page 19, are given in table 11. As the nontidal current at many of the stations varies with the seasons, the velocities and directions are tabulated on a monthly basis to bring out this variation. In addition, an average for all months is given in the last column of the table. As in previous tables, the velocities are in knots and the directions are true.

At most of the lightship stations off the Southern States the seasonal change in the nontidal current is very well defined. The month of July particularly stands out at a number of stations as having a maximum northward or eastward flow. For Stone Horse Shoal Lightship, Overfalls Lightship, and a few other stations similarly situated near the entrances to inland waterways, the nontidal current as computed sets generally toward the nearby land. At such locations the residual current represented by the values given is in strictness hardly nontidal in character, as it obviously results from the flood and ebb of the tidal current setting in directions that are not opposite, due to local hydrographic conditions.

The average currents accompanying winds of different velocities blowing from 16 points of the compass are given for a number of lightship stations in table 12. The results were derived from a year or more of observations at each station by the reduction process outlined on pages 19 and 20. In table 12, wind velocities are expressed in statute miles per hour, current velocities in knots, and directions of wind and current are true. The ratio of current to wind was obtained by dividing the current velocity in knots by the wind velocity in statute miles per hour. In interpreting the values presented it should be borne in mind that they represent merely the average observed current for the given wind and station based on the number of observations indicated. It is not to be assumed that each time the given wind blows at the given station the indicated wind current results. For it seems certain from studies of observational data as well as from a general consideration of the problem that a wind current often depends upon factors other than the local wind at the time and place of the current.

An examination of the values of table 12 reveals that both the direction and the velocity of the average current accompanying a given wind vary considerably with the locality, and the reasons for some of the variations are made clear by reference to figures 18 to 22, which show the locations of the stations. For example, the tendency of the current to follow the direction of the shore line is evidenced at most stations by large deflections of the current direction from the wind direction. These deflections are to the right or left depending generally upon the angle the wind direction makes with the shore line. They are particularly noticeable where the wind is blowing toward the shore or has a considerable shoreward component. The physical conditions existing in the vicinities of the entrances to inland waterways also are clearly reflected in the directions taken by wind currents in those localities. The general tendency of the wind current to set to the right of the wind direction is evident at most of the stations. This tendency results from the deflective force of the earth's rotation, which in the northern hemisphere tends to deflect all moving bodies to the right.

The location of the station with respect to the coast line also affects the average current velocity due to a given wind velocity. As an example, the results for Diamond Shoal and Cape Lookout Shoals lightships, situated off prominent projections of the coast line, show greater average velocities for a given wind velocity than do any of the other stations.

From the statements just made, as well as from a study of the values of table 12, it is evident that the average current accompanying a given wind varies with the locality. Average values for the entire area covered by the lightship stations, or any considerable part of it, are, therefore, of limited value as an index to the wind current at a specific location. Results from stations very near or at least similarly situated serve better as a guide to conditions at such a location. For this reason it is not desired to emphasize values obtained by averaging results for all stations. However, for the purpose of comparing results for one station with those for another, as well as for obtaining averages for all stations for what they may be worth, velocity and direction averages of table 12 for the various stations have been tabulated and averaged in several groupings. The tabulations are shown in tables 13, 14, and 15. The values in these tables are on the same basis as those of table 12. It will be seen from the tables that the average ratio of current velocity in knots to wind velocity in statute miles per hour for all wind velocities and all wind directions at all stations is 0.014. The average deviation of the current direction to the right of the wind direction is 14 degrees. The average current velocity produced by a wind of 10 statute miles per hour is about 0.2 knot, for a wind of 20 miles per hour, 0.3 knot; 30 miles per hour, 0.4 knot; 40 miles per hour, 0.5 knot; and 50 miles per hour, 0.6 knot.

As stated previously in this text, the values given in tables 12 to 15 are averages of observed currents grouped according to the direction and velocity of the wind. The tidal currents presumably are eliminated, but residual nontidal effects, whether or not they are wind-produced, are included in these results. A separation of wind current and residual current was not attempted as it is believed that the practical value of the results would not be increased by such a separation. Moreover, the extent to which the residual current itself is a wind current is generally uncertain.

EXPLANATION OF THE GRAPHIC DATA

The graphic data contained in figures 8 to 22 seems to require little explanation other than that given on the figures themselves, and in the text explaining the tabular material from which the arrows representing the currents were plotted. The tidal current data represented on figures 8 to 12, were taken from table 5; the nontidal current data on figures 13 to 17, from table 11; and the wind current data on figures 18 to 22, from table 12.

THE GULF STREAM AT DIAMOND SHOAL LIGHTSHIP

Diamond Shoal Lightship station is situated about 15 miles off Cape Hatteras Light. The approximate inner limit of the Gulf Stream as shown on Coast and Geodetic Survey chart No. 1001 is about 10 miles off Cape Hatteras Light and the station, therefore, lies within the Gulf

Stream as located on the above-mentioned chart. Actually, the position of the Gulf Stream shifts and it has been reported that its inner limit is at times farther from shore and at other times nearer to shore than is the lightship. The lightship is, therefore, sometimes within the stream and sometimes outside its limits. The results of table 12, which are based upon a long series of observations and may be assumed to reflect conditions near the inner edge of the stream, show that at Diamond Shoal Lightship the average direction of the nontidal current for each month of the year falls within the northeast quadrant. They also show a definite seasonal variation with large northeastward velocities during the summer months, reaching a pronounced maximum in July, and considerably smaller velocities setting more to the eastward during the autumn, winter, and spring months.

The long series of current observations at Diamond Shoal Lightship appeared to offer an opportunity to investigate a supposed fluctuation of the Gulf Stream, depending upon the declination of the moon. Inasmuch as the fluctuation had been described as an expansion of the stream at high declination and a contraction at low declination, the location of the station near the edge of the stream seemed well suited for such an investigation. Reductions designed to develop the declinational effect were made of values from 9 years of observations. The results show that any monthly or semimonthly variation in the velocity of the Gulf Stream at Diamond Shoal Lightship due to changing declination of the moon is less than 0.1 knot. In addition, two other reductions of the same series of observations were made, one referring the current to the phases of the moon and the other, to its distance. As in the case of the declinational reduction, the results of both were negative.

It, therefore, appears certain that at Diamond Shoal Lightship there is no appreciable variation in the velocity of the Gulf Stream due to the changing declination, phases, or distance of the moon.

CURRENT CHARTS, GEORGES BANK AND VICINITY

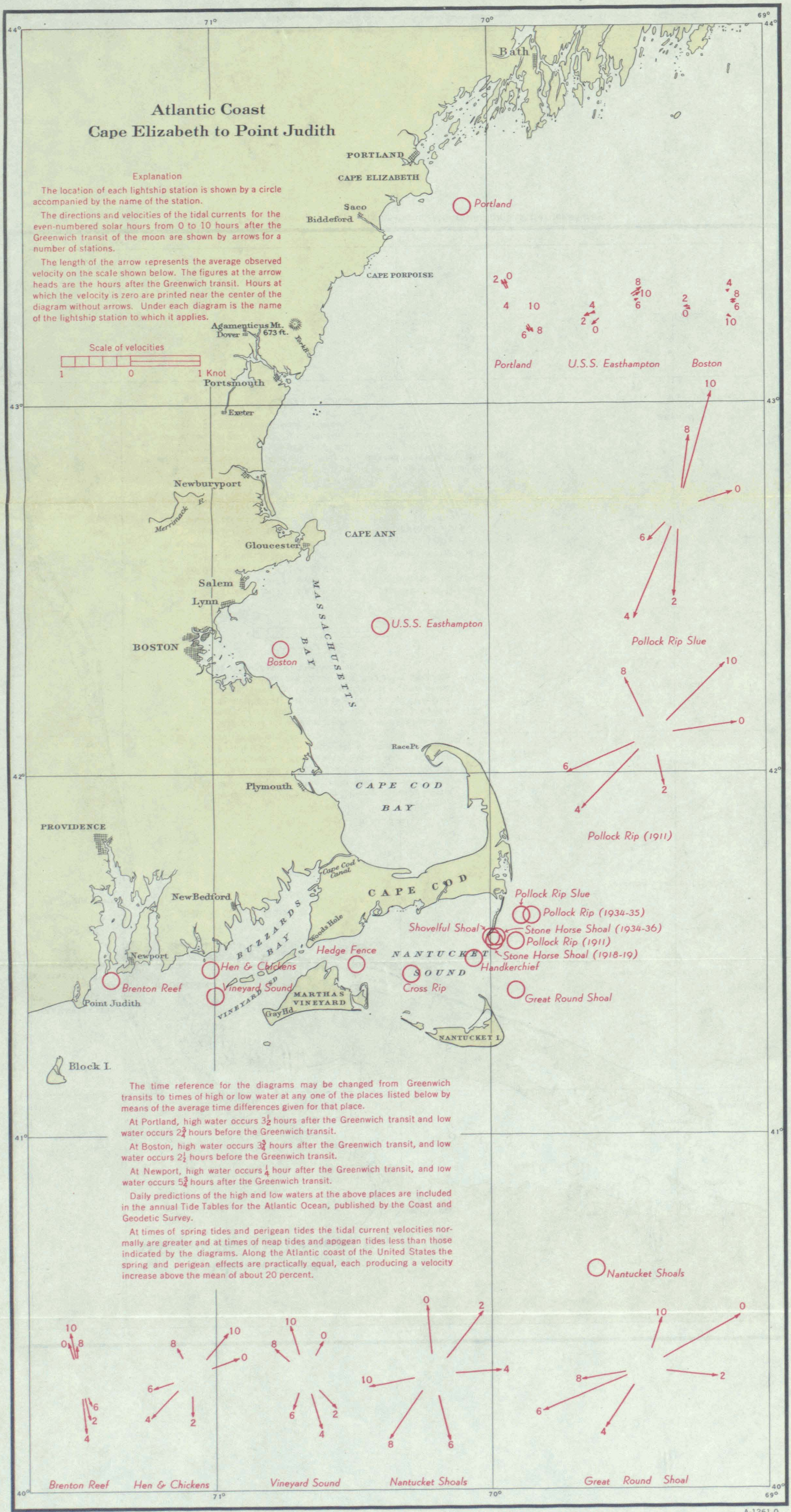
In the area eastward of Cape Cod and Nantucket Island, Mass., comprising Georges Bank and the eastern approaches to Nantucket Sound, series of current observations have been secured at a considerable number of locations. As the currents in this region have large velocities and vary in rotational characteristics from place to place, current charts showing the details of the observed movement at the various stations and in the area as a whole were considered desirable. The charts, figures 23 to 35, depict the rotary current movement over Georges Bank in its relation to the rotary and reversing movements in Nantucket Sound and its eastern approaches.

The observed directions and average velocities of the tidal current at selected locations for each hour, from 0 to 12 hours after the Greenwich transit of the moon, are represented. The observations used in preparing the charts were secured at various times by Coast and Geodetic Survey parties and by the crews of lightships. They were all taken within 14 feet of the surface. The locations at which the observations were taken are marked by small circles. The observed directions of flow for the designated hour of the tidal cycle are represented by arrows drawn through the circles. The mean velocities for the designated hour are shown to the nearest tenth of a knot by numerals near the circles. At times of spring tides and perigean tides, the velocities normally are greater and at times of neap tides and apogean tides, less than those given on the charts. The spring and perigean effects are practically equal in this locality, each producing a velocity increase above the mean of about 20 percent. When spring and perigean effects combine, the velocities of the tidal current are greatest. When neap and apogean effects combine, the velocities of the tidal current are least. Winds and other meteorological conditions at times modify both the direction and the velocity of the current.

TABLE 1.—***Atlantic Coast Lightship Current Stations, Depth of Water, and Distance from Land***

Lightship station	Depth of water	Distance from land	Lightship station	Depth of water	Distance from land
	Feet	*Nautical miles*		*Feet*	*Nautical miles*
Portland	150	5	Scotland	63	3
U. S. S. *Easthampton*	90	16	Barnegat	78	7
Boston	108	5	U. S. S. *Falcon*	180	47
Pollock Rip Slue	46	3	Northeast End	84	13
Pollock Rip (1934-35)	60	5	Five Fathom Bank	91	16
Stone Horse Shoal (1934-36)	84	1	Overfalls	66	3
Shovelful Shoal	78	1	Fenwick Island Shoal	90	13
Stone Horse Shoal (1918-19)	27	1	Winter-Quarter Shoal	78	16
Pollock Rip (1911)	34	4	U. S. S. *Brant*	180	44
Great Round Shoal	72	5	Cape Charles	39	7
Nantucket Shoals	180	41	Chesapeake	63	12
Handkerchief	49	4	Tail of the Horseshoe	36	3
Cross Rip	42	6	Diamond Shoal (1909-18)	180	13
Hedge Fence	54	3	Diamond Shoal (1919-28)	174	13
Vineyard Sound	102	3	Cape Lookout Shoals (1912)	78	17
Hen and Chickens	60	2	Cape Lookout Shoals (1918-19)	90	19
Brenton Reef	84	1	Frying Pan Shoals	60	18
Ram Island Reef	60	1	U. S. S. *Long Island*	90	22
Bartlett Reef	66	2	Charleston (1912-16)	39	7
Cornfield Point	162	3	Charleston (1921)	42	8
U. S. S. *Finch*	180	39	Martins Industry	52	11
Fire Island	96	9	Savannah	48	10
U. S. S. *Cardinal*	120	21	Brunswick	50	13
Ambrose Channel (1912-22)	78	6	St. Johns	57	5
Ambrose Channel (1936-38)	78	7			

For reference to above table, see p. 20.

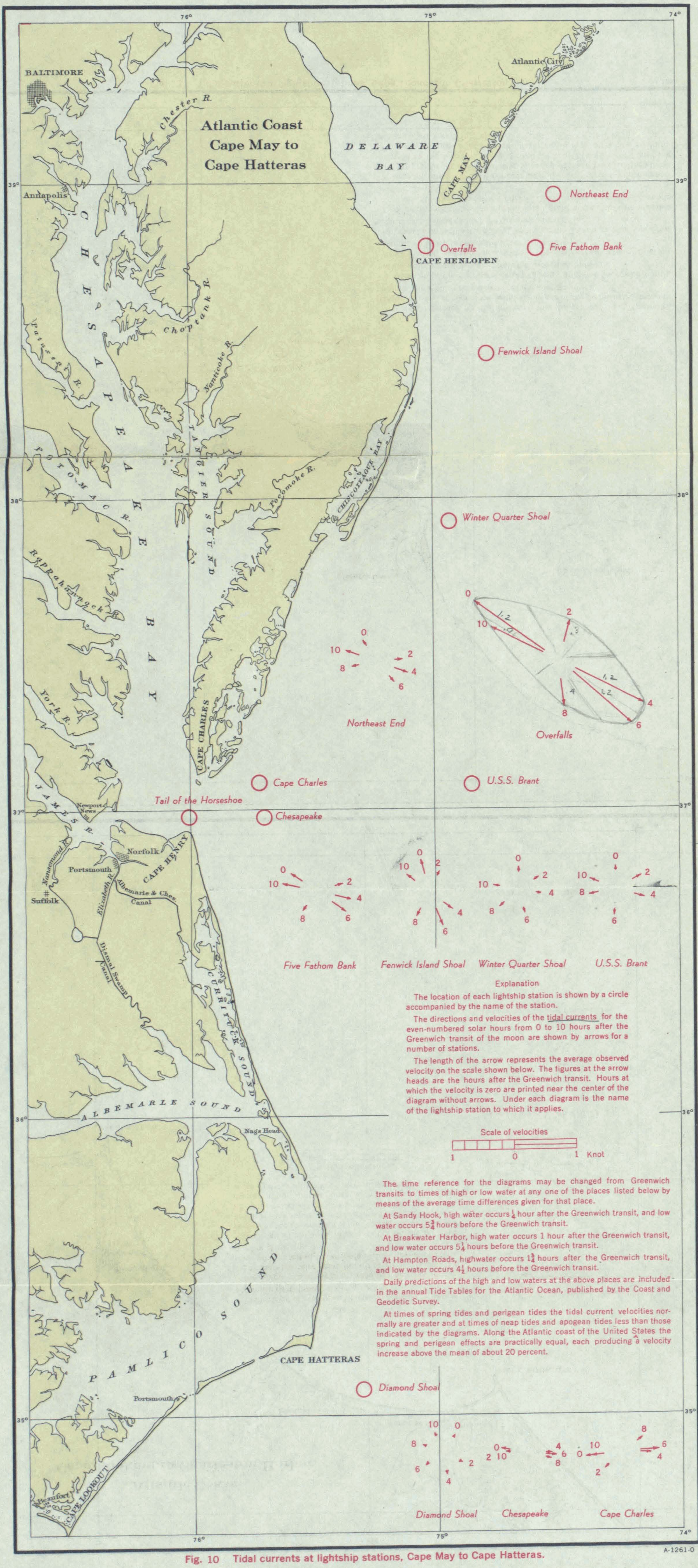


A-1261-0

Fig. 8 Tidal currents at lightship stations, Cape Elizabeth to Point Judith

Fig. 9 Tidal currents at lightship stations, Montauk Point to Barnegat Bay.

A-1261-0



Explanation

The location of each lightship station is shown by a circle accompanied by the name of the station.

The directions and velocities of the tidal currents for the even-numbered solar hours from 0 to 10 hours after the Greenwich transit of the moon are shown by arrows for a number of stations.

The length of the arrow represents the average observed velocity on the scale shown below. The figures at the arrow heads are the hours after the Greenwich transit. Hours at which the velocity is zero are printed near the center of the diagram without arrows. Under each diagram is the name of the lightship station to which it applies.

The time reference for the diagrams may be changed from Greenwich transits to times of high or low water at any one of the places listed below by means of the average time differences given for that place.

At Sandy Hook, high water occurs $\frac{1}{4}$ hour after the Greenwich transit, and low water occurs $5\frac{3}{4}$ hours before the Greenwich transit.

At Breakwater Harbor, high water occurs 1 hour after the Greenwich transit, and low water occurs $5\frac{1}{4}$ hours before the Greenwich transit.

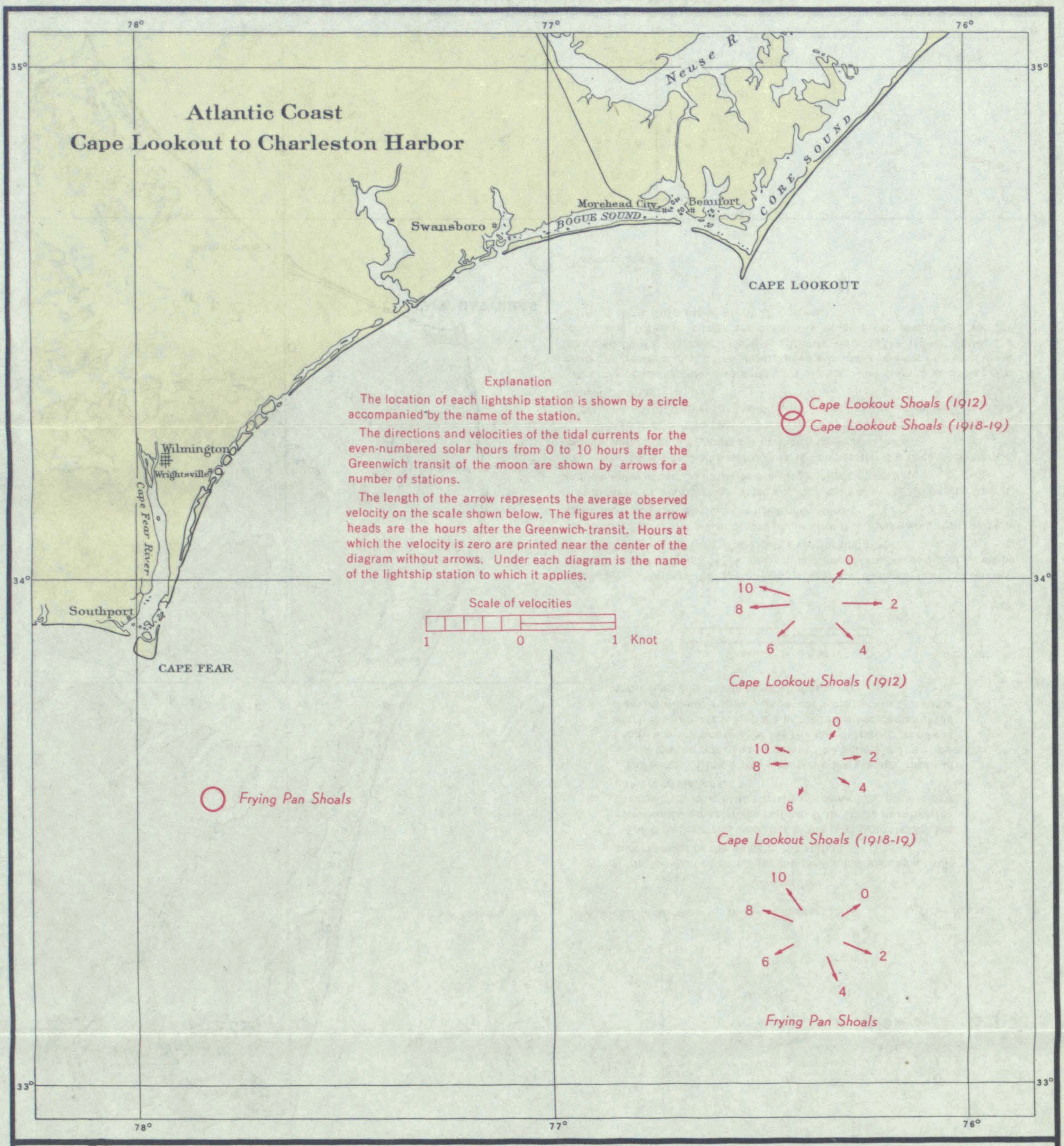
At Hampton Roads, highwater occurs $1\frac{3}{4}$ hours after the Greenwich transit, and low water occurs $4\frac{1}{2}$ hours before the Greenwich transit.

Daily predictions of the high and low waters at the above places are included in the annual Tide Tables for the Atlantic Ocean, published by the Coast and Geodetic Survey.

At times of spring tides and perigean tides the tidal current velocities normally are greater and at times of neap tides and apogean tides less than those indicated by the diagrams. Along the Atlantic coast of the United States the spring and perigean effects are practically equal, each producing a velocity increase above the mean of about 20 percent.

Fig. 10 Tidal currents at lightship stations, Cape May to Cape Hatteras.

A-1261-0



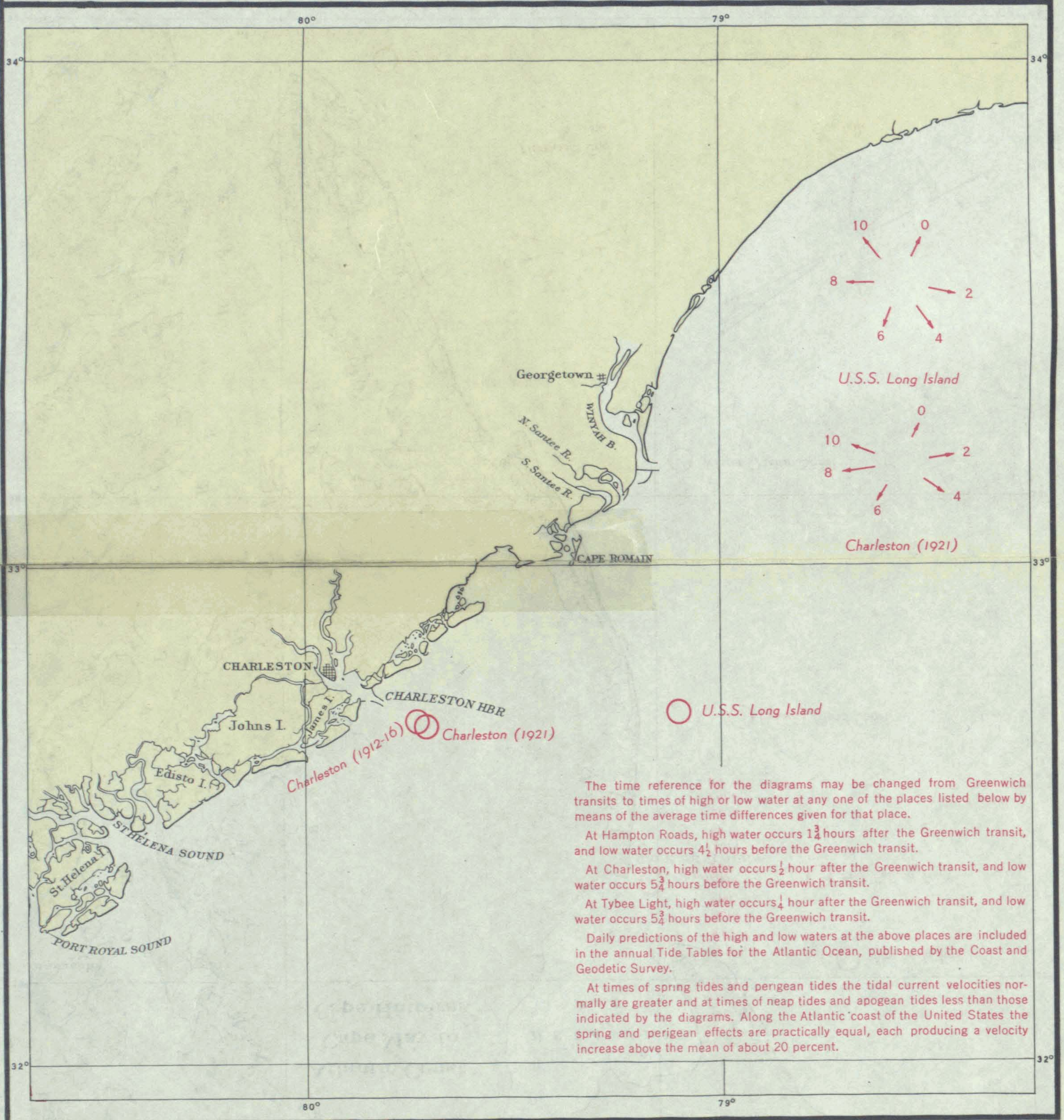


Fig. 11 Tidal currents at lightship stations, Cape Lookout to Charleston Harbor.

A-1261-0

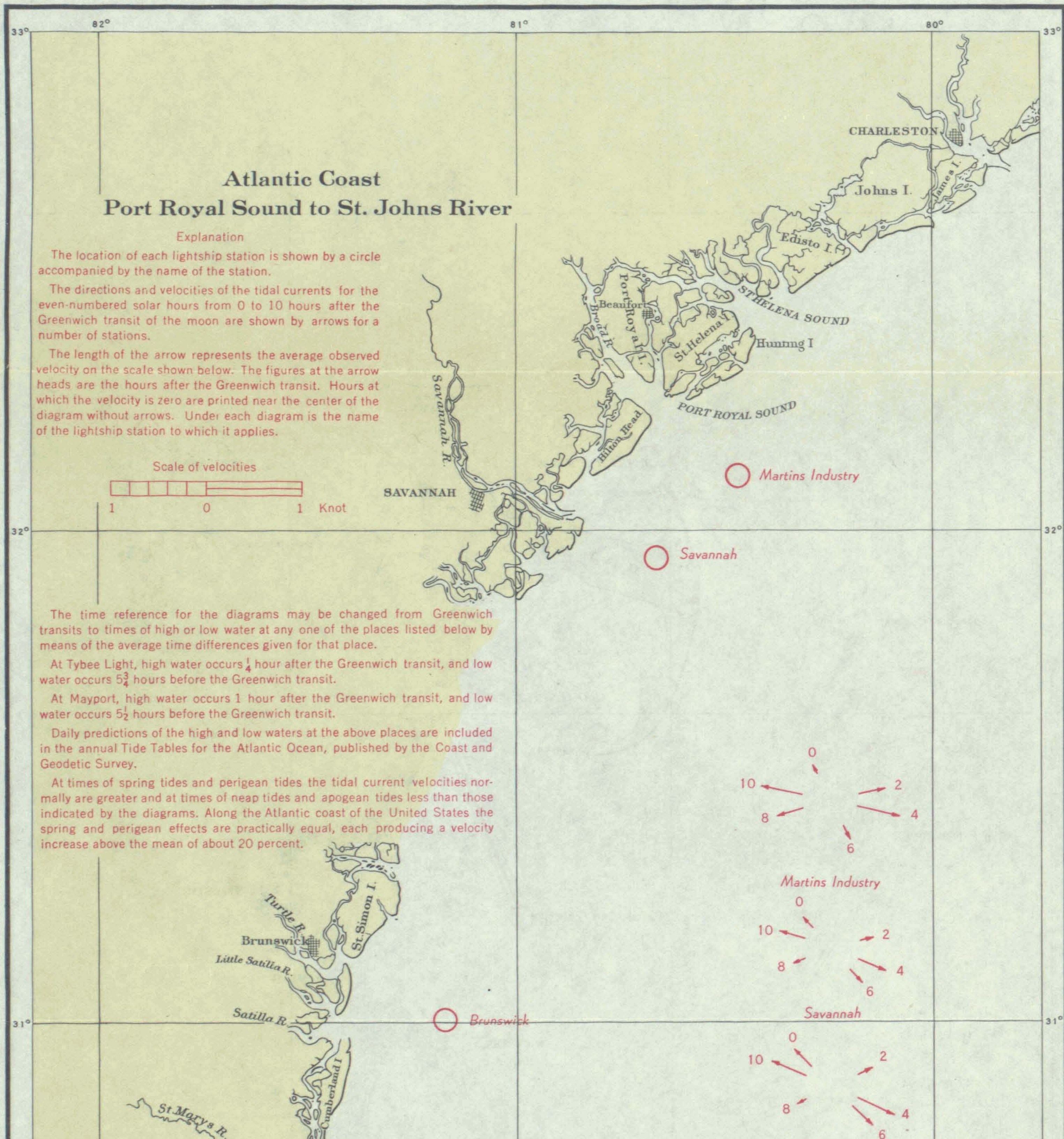


Fig. 12 Tidal currents at lightship stations, Port Royal Sound to St. Johns River.

A-1261-0

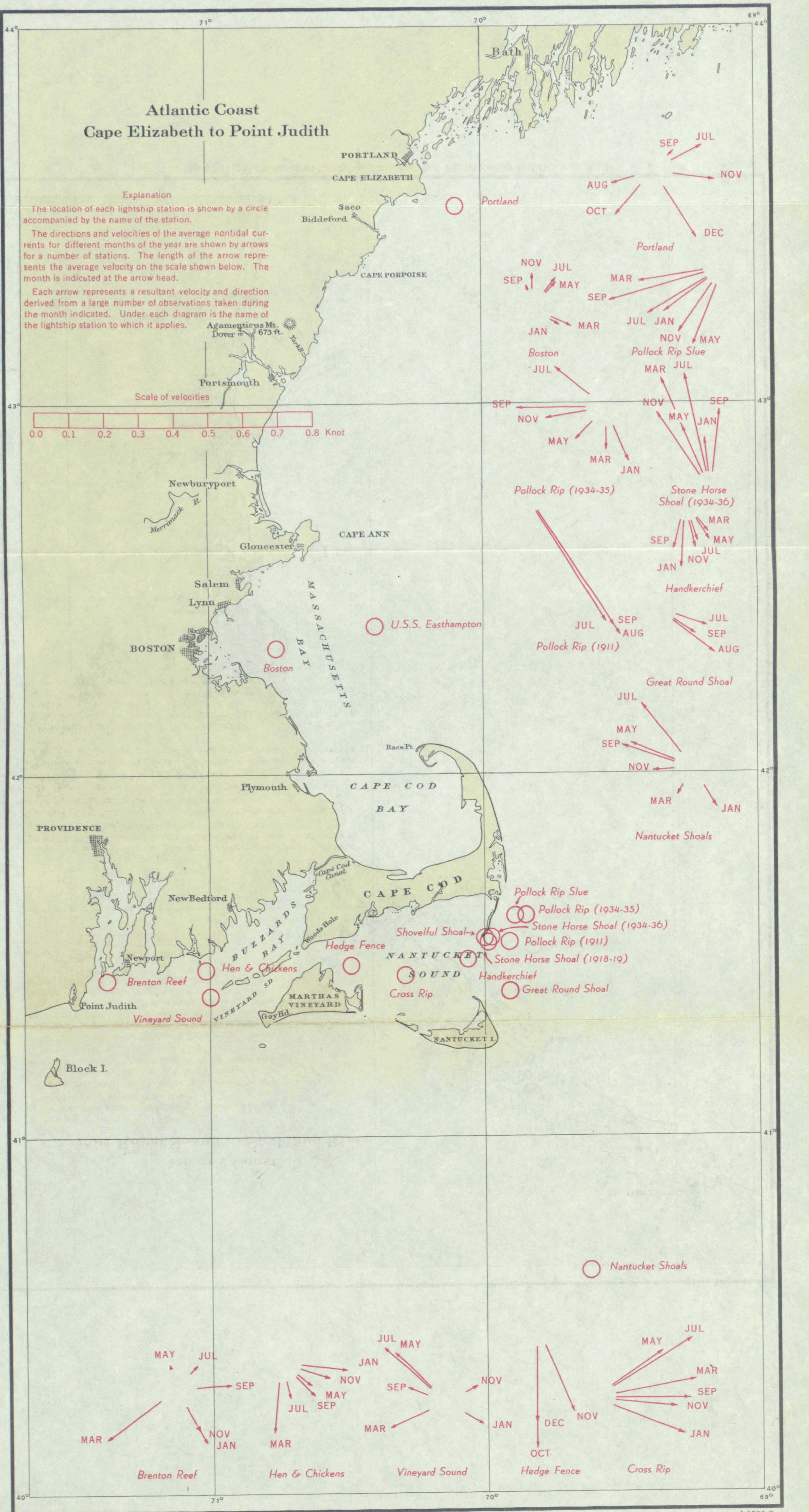


Fig. 13 Nontidal currents at lightship stations, Cape Elizabeth to Point Judith.

A-1261-0

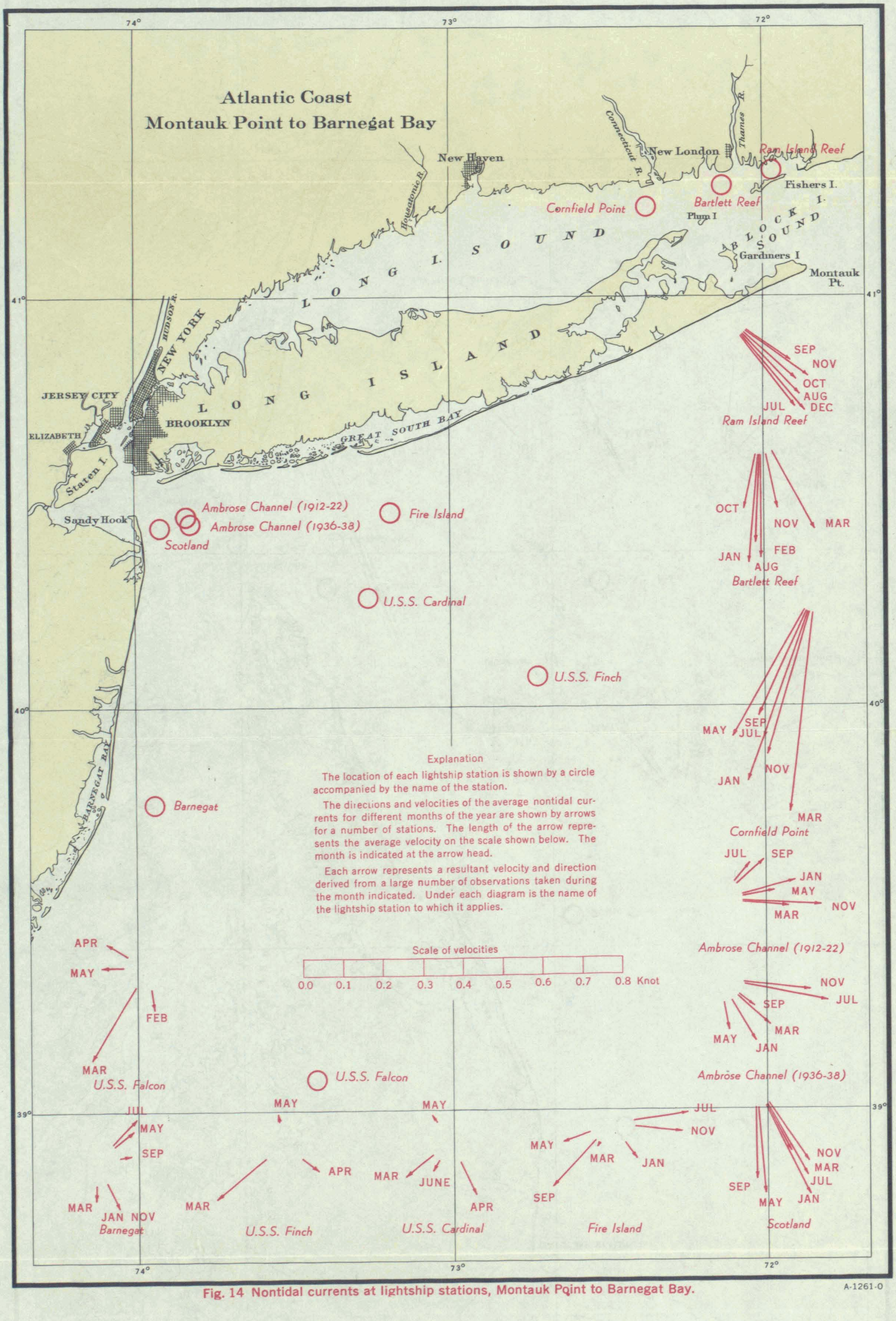


Fig. 14 Nontidal currents at lightship stations, Montauk Point to Barnegat Bay.

A-1261-0

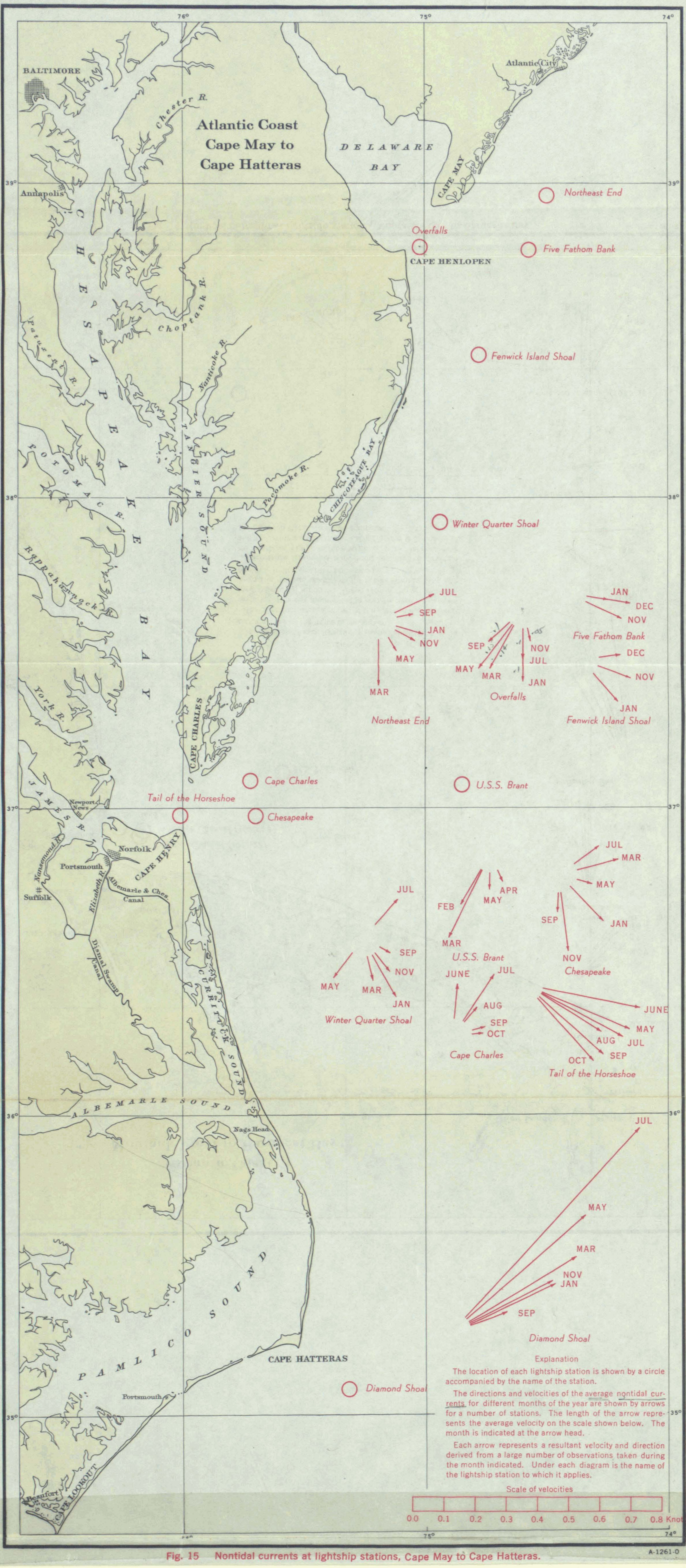


Fig. 15 Nontidal currents at lightship stations, Cape May to Cape Hatteras.

A-1261-0

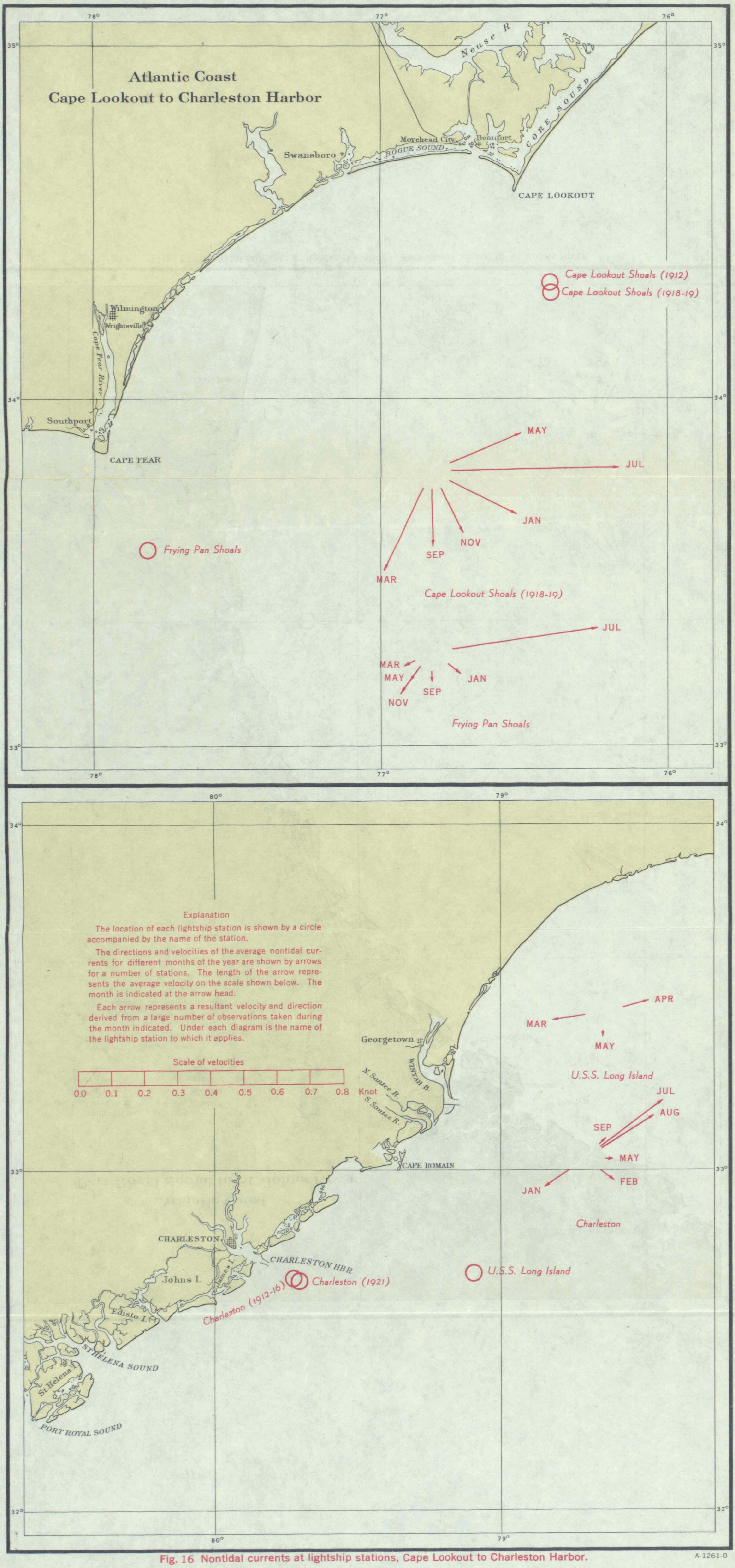


Fig. 16 Nontidal currents at lightship stations, Cape Lookout to Charleston Harbor.

A-1261-0

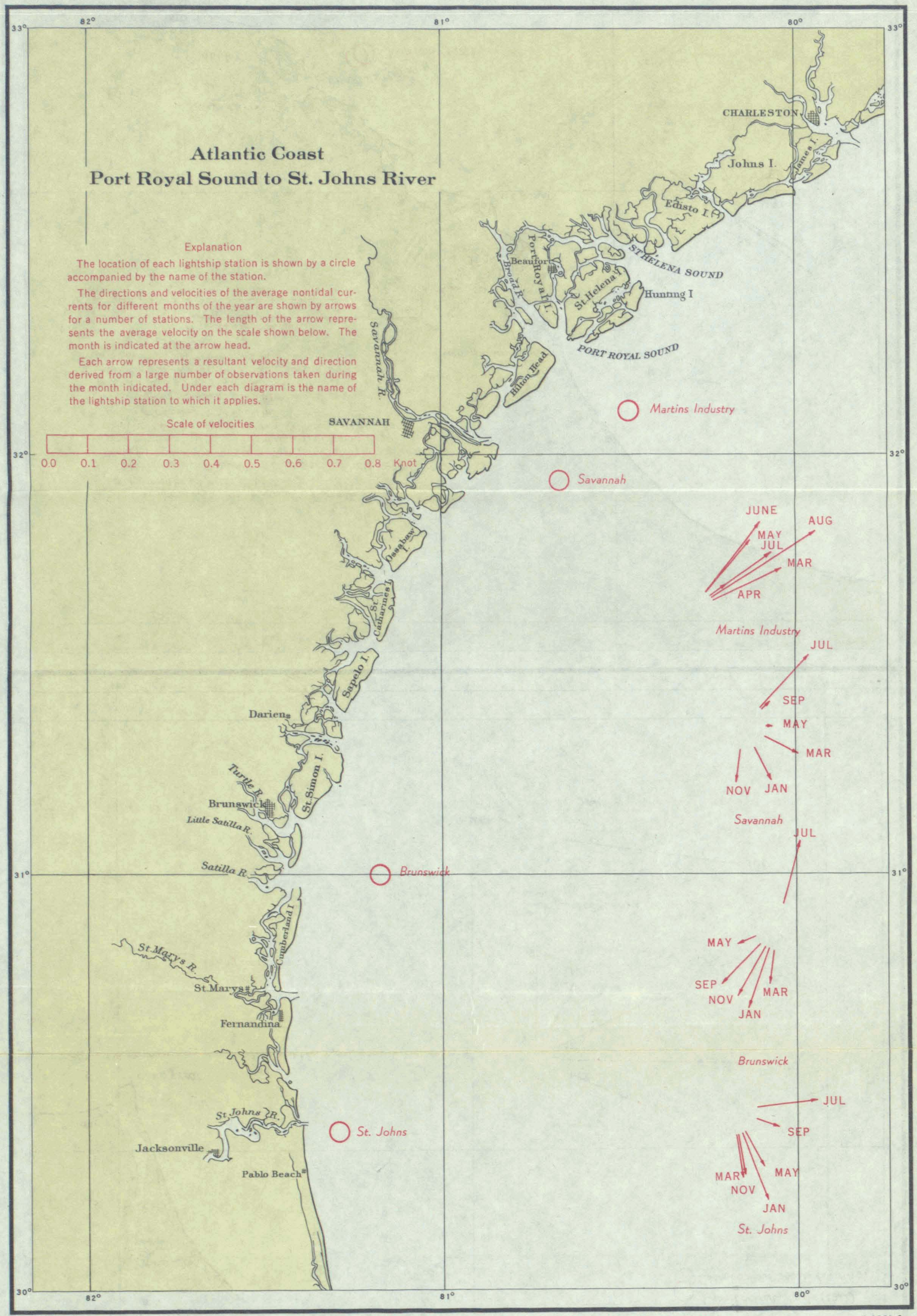


Fig. 17 Nontidal currents at lightship stations, Port Royal Sound to St. Johns River.

A-1261-0

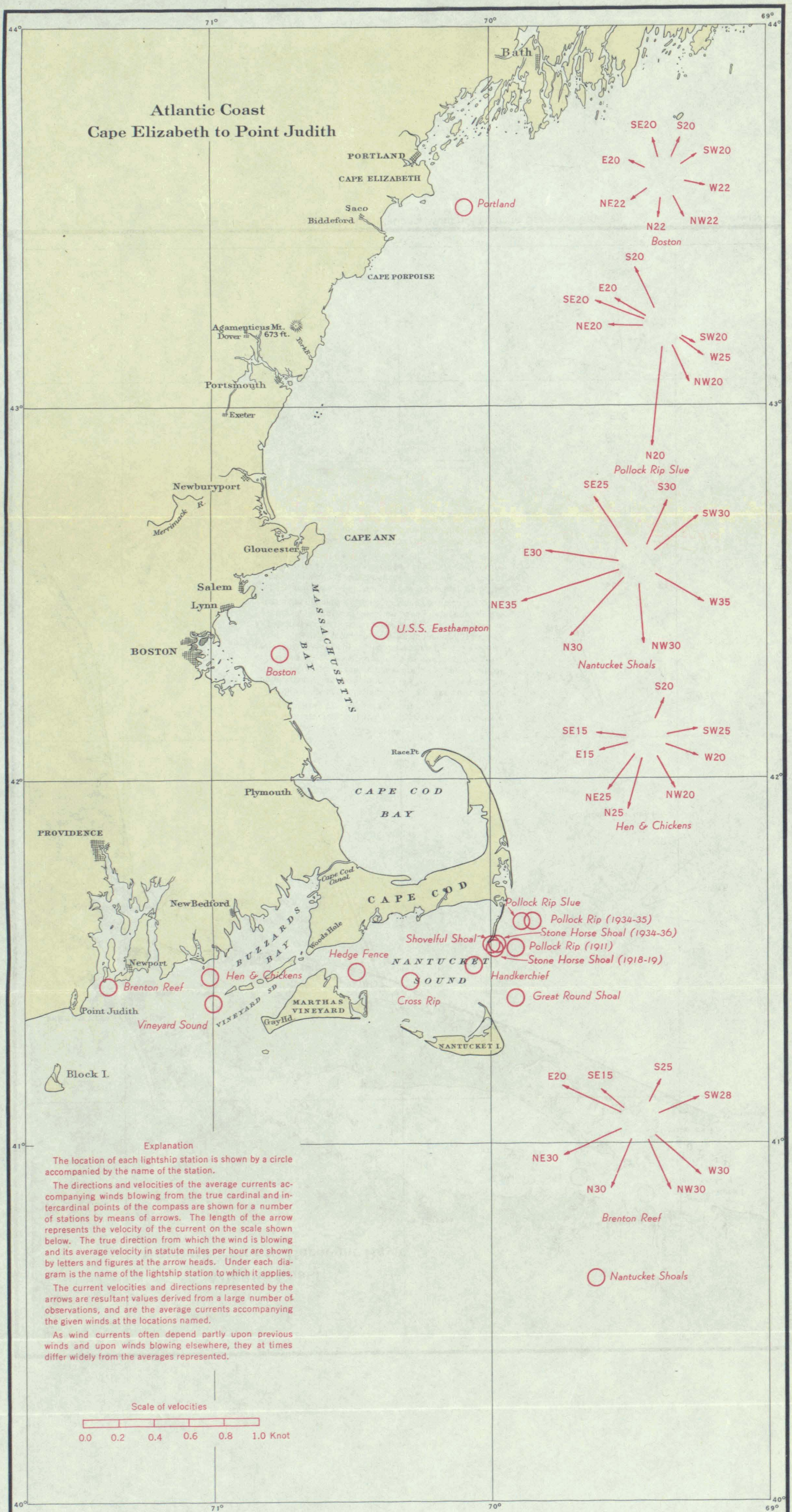


Fig. 18 Wind currents at lightship stations, Cape Elizabeth to Point Judith.

A-1261-0

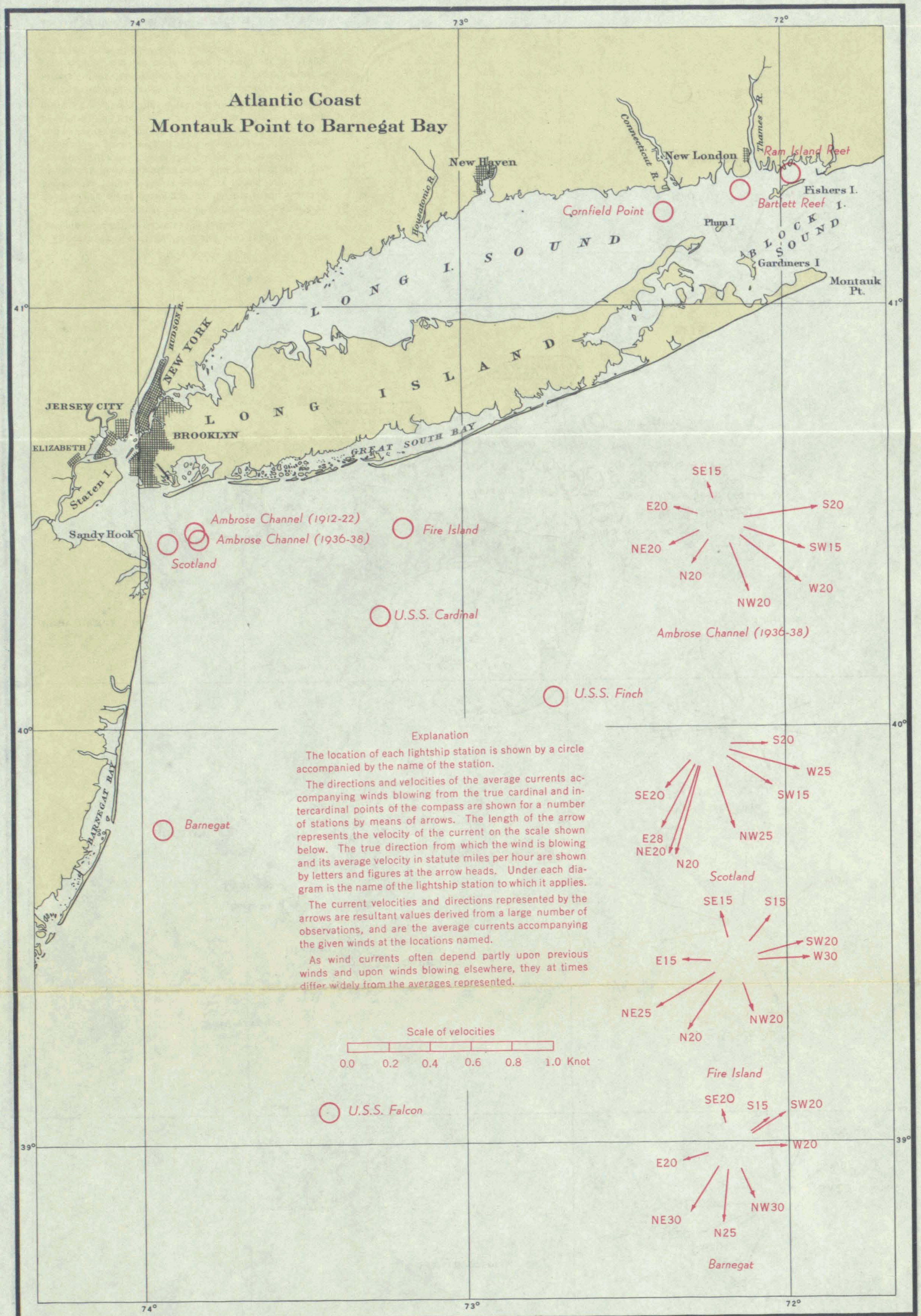


Fig. 19 Wind currents at lightship stations. Montauk Point to Barnegat Bay.

A-1261-0

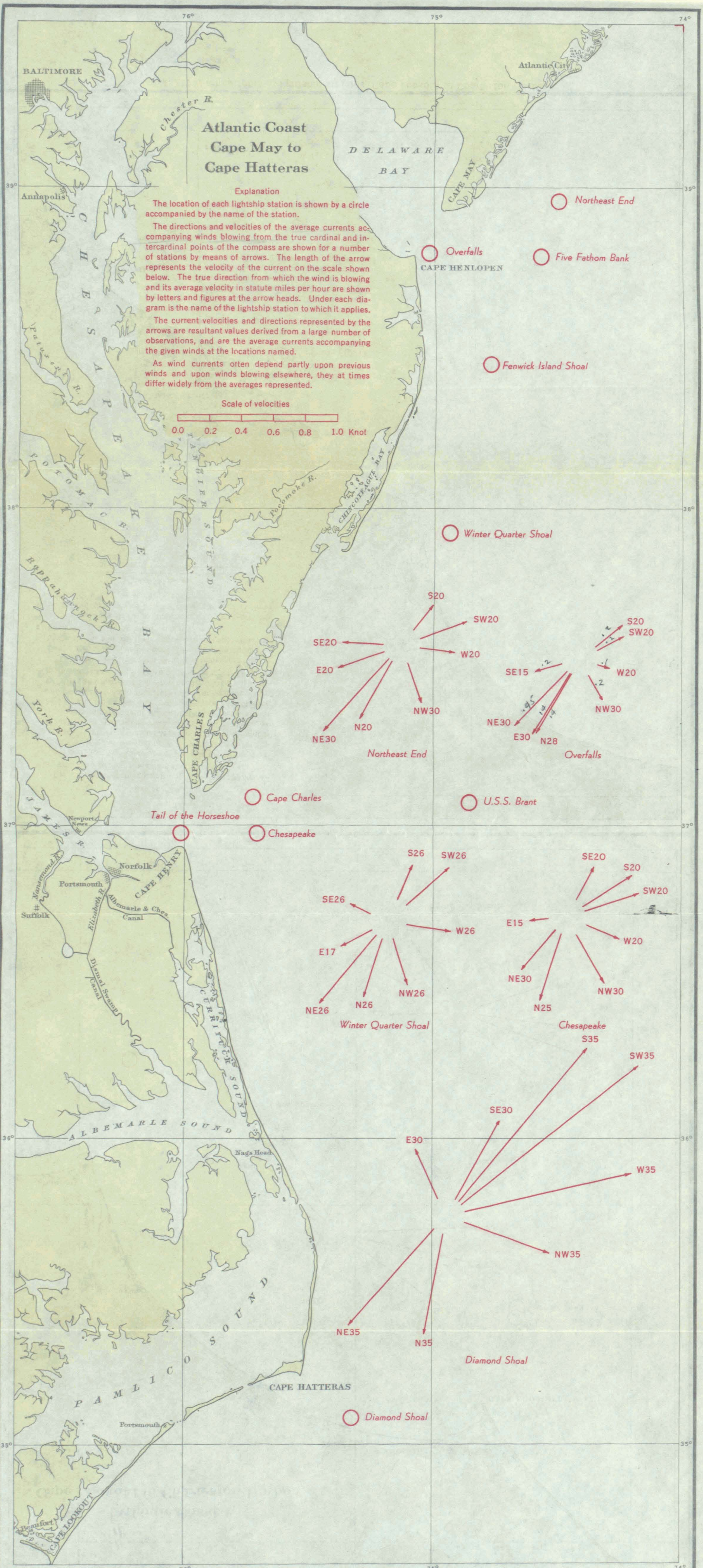


Fig. 20 Wind currents at lightship stations, Cape May to Cape Hatteras.

A-1261-0

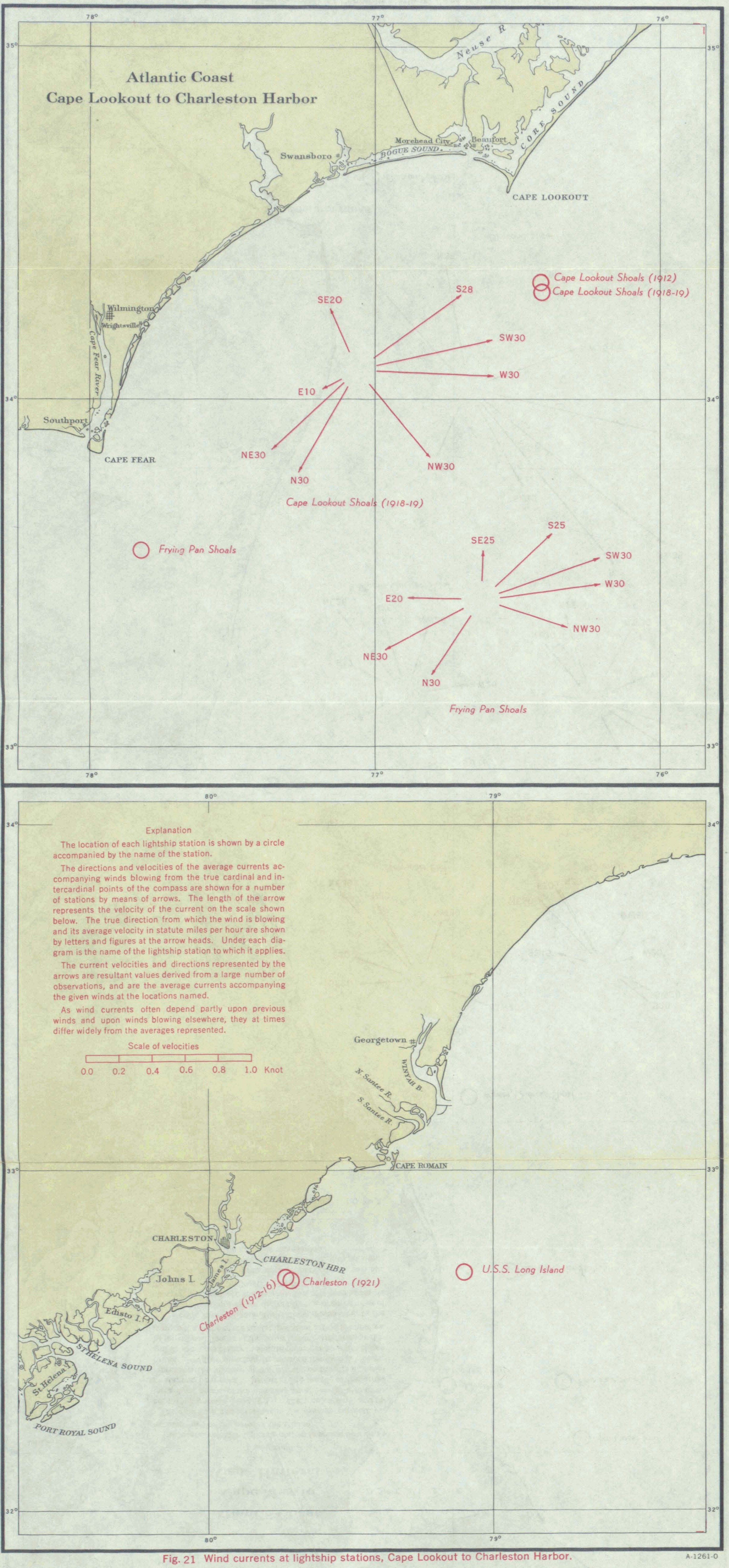


Fig. 21 Wind currents at lightship stations, Cape Lookout to Charleston Harbor.

A-1261-0

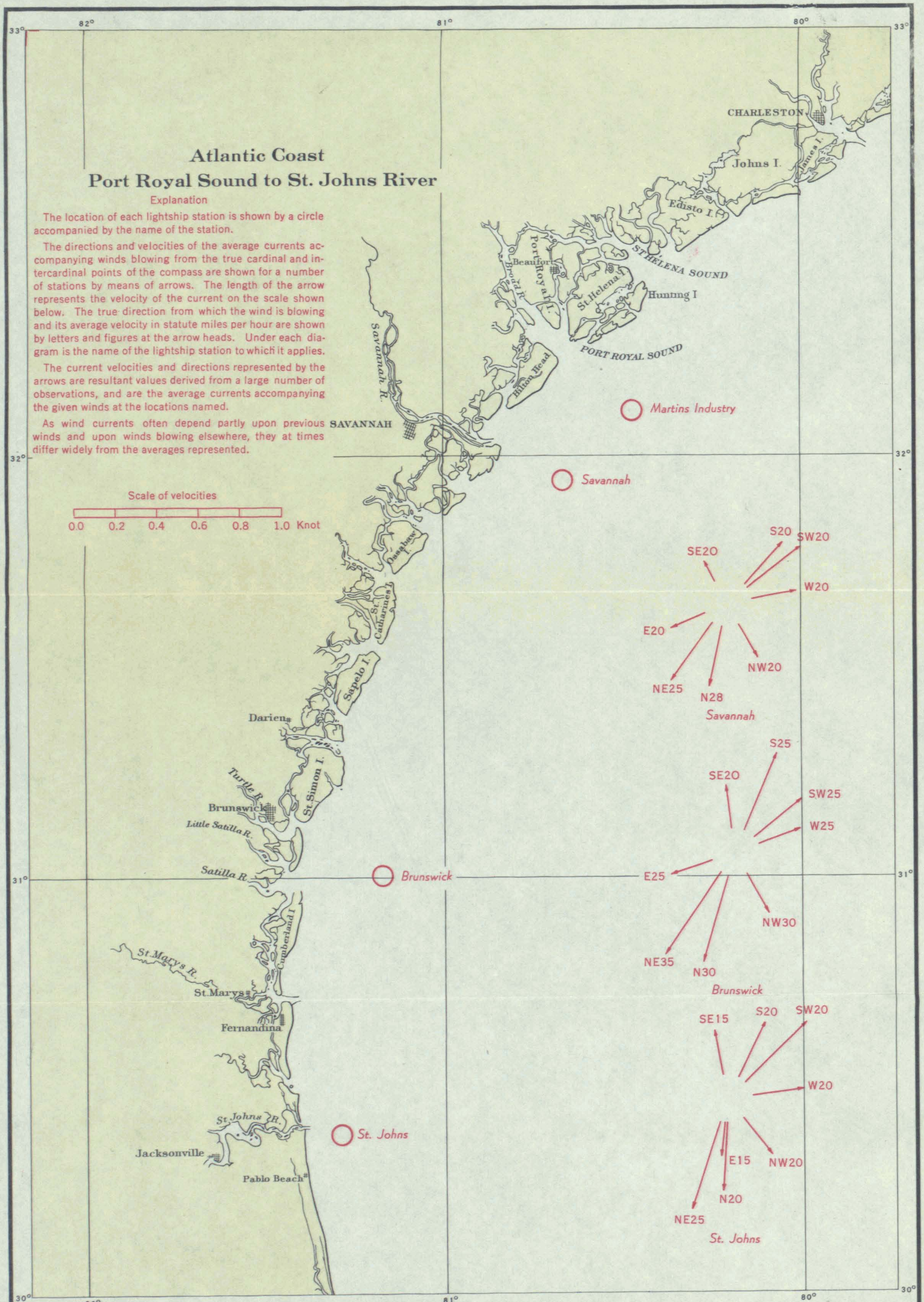
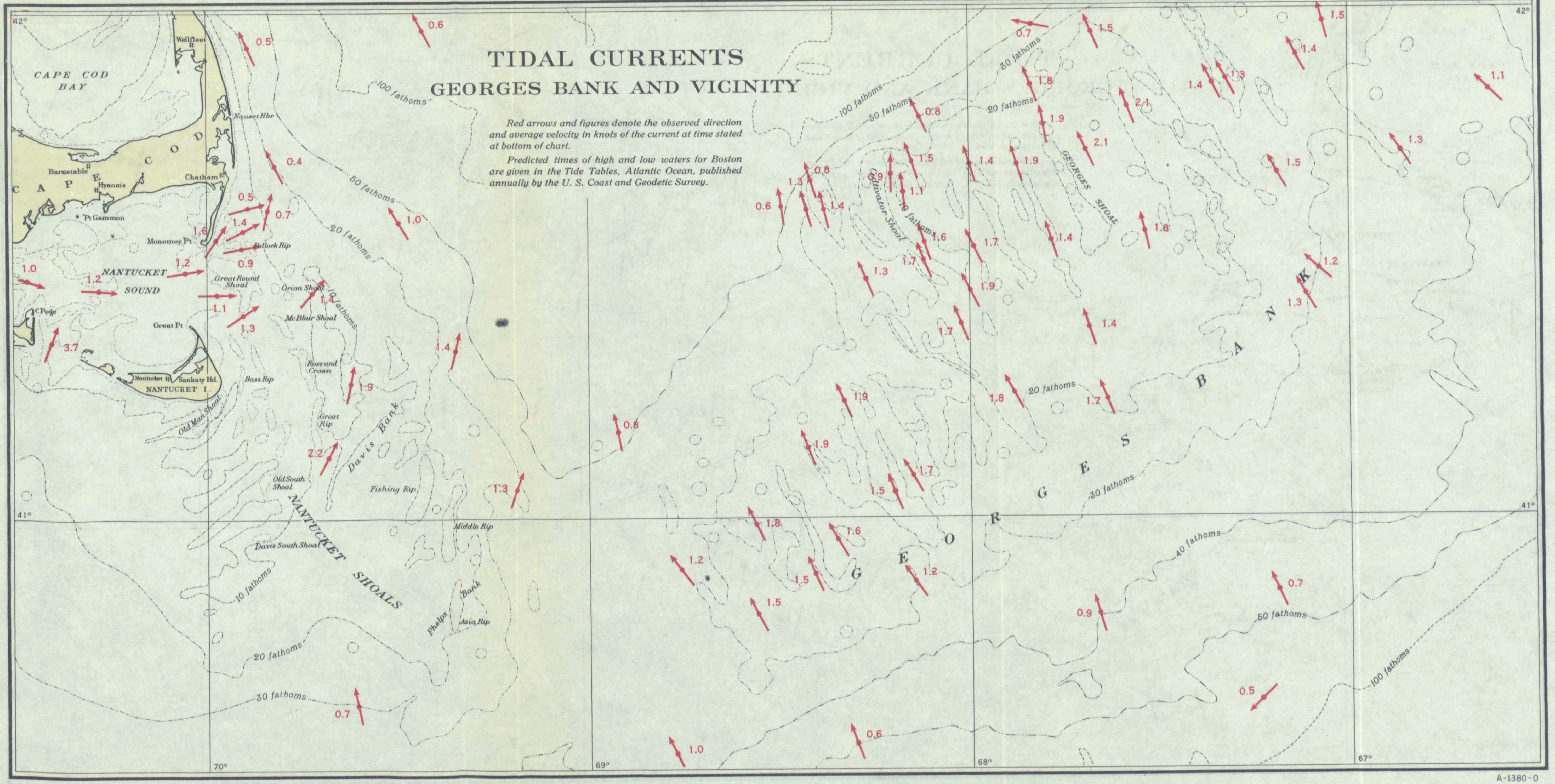


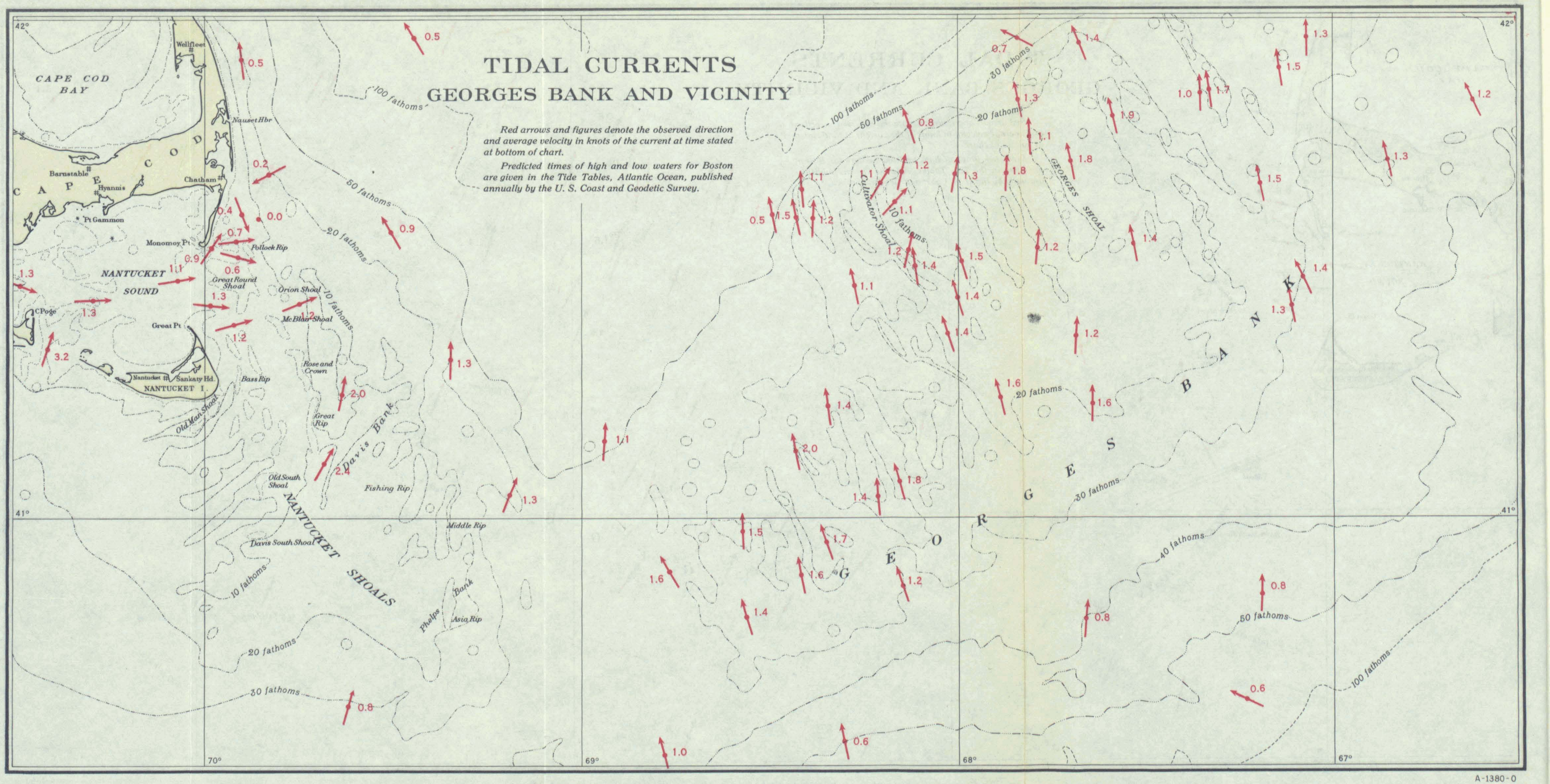
Fig. 22 Wind currents at lightship stations, Port Royal Sound to St. Johns River.

A-1261-0



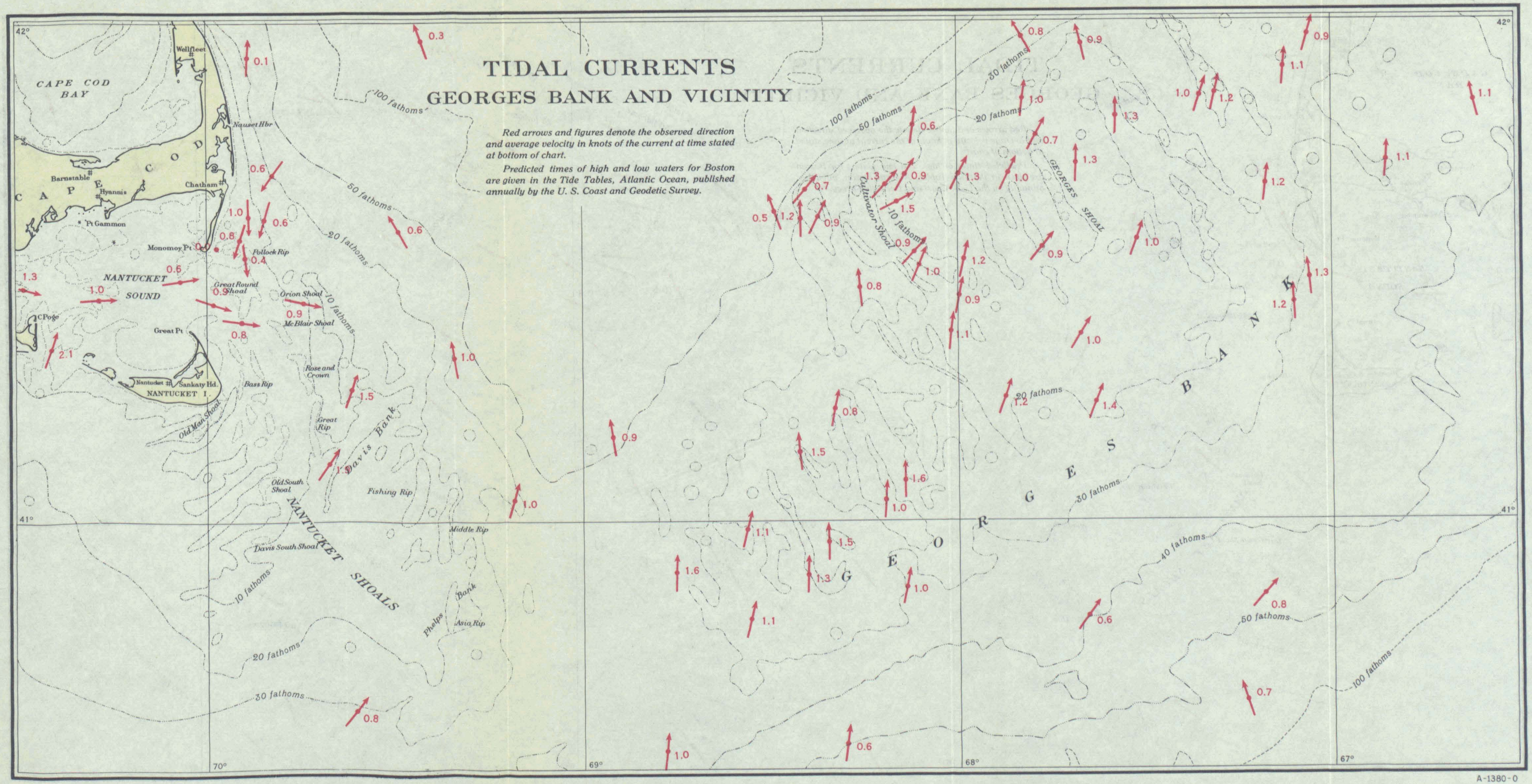
A-1380-0

Fig. 23 Currents at time of Greenwich transit (2 hours 30 minutes after low water at Boston).



A-1380-0

Fig. 24 Currents 1 hour after Greenwich transit (2 hours 45 minutes before high water at Boston).



A-1380-0

Fig. 25 Currents 2 hours after Greenwich transit (1 hour 45 minutes before high water at Boston).

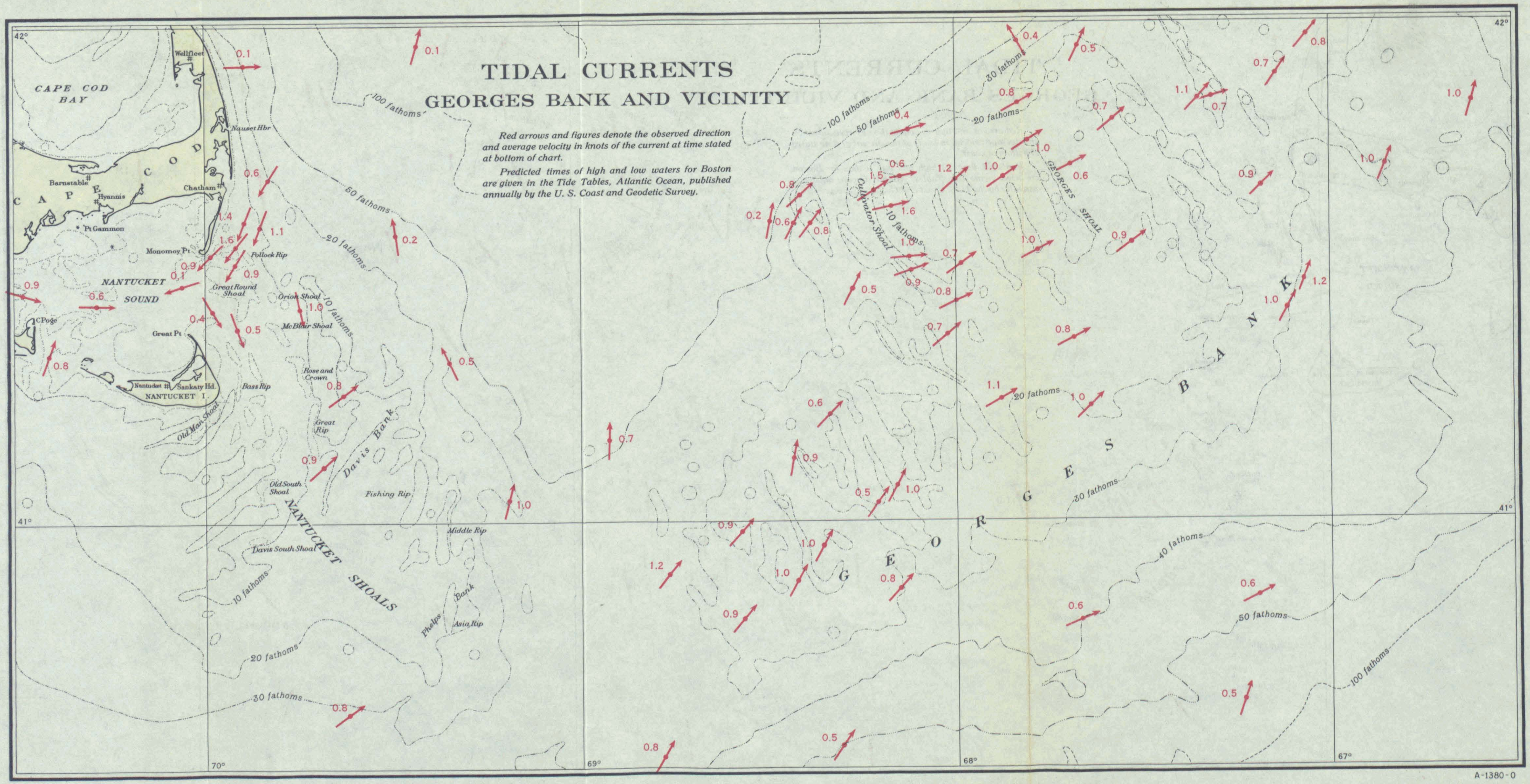
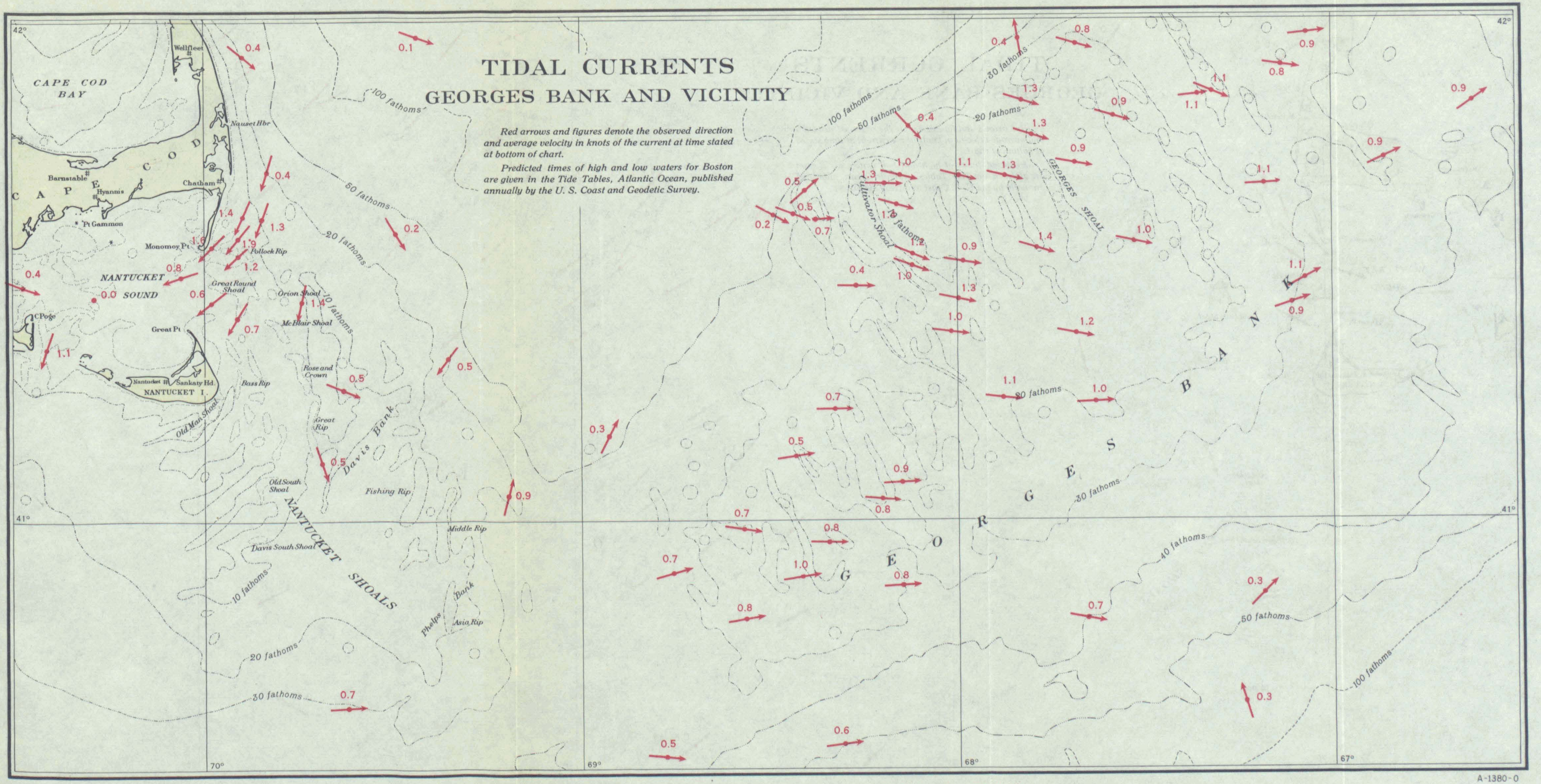


Fig. 26 Currents 3 hours after Greenwich transit (45 minutes before high water at Boston).



A-1380-0

Fig. 27 Currents 4 hours after Greenwich transit (15 minutes after high water at Boston).

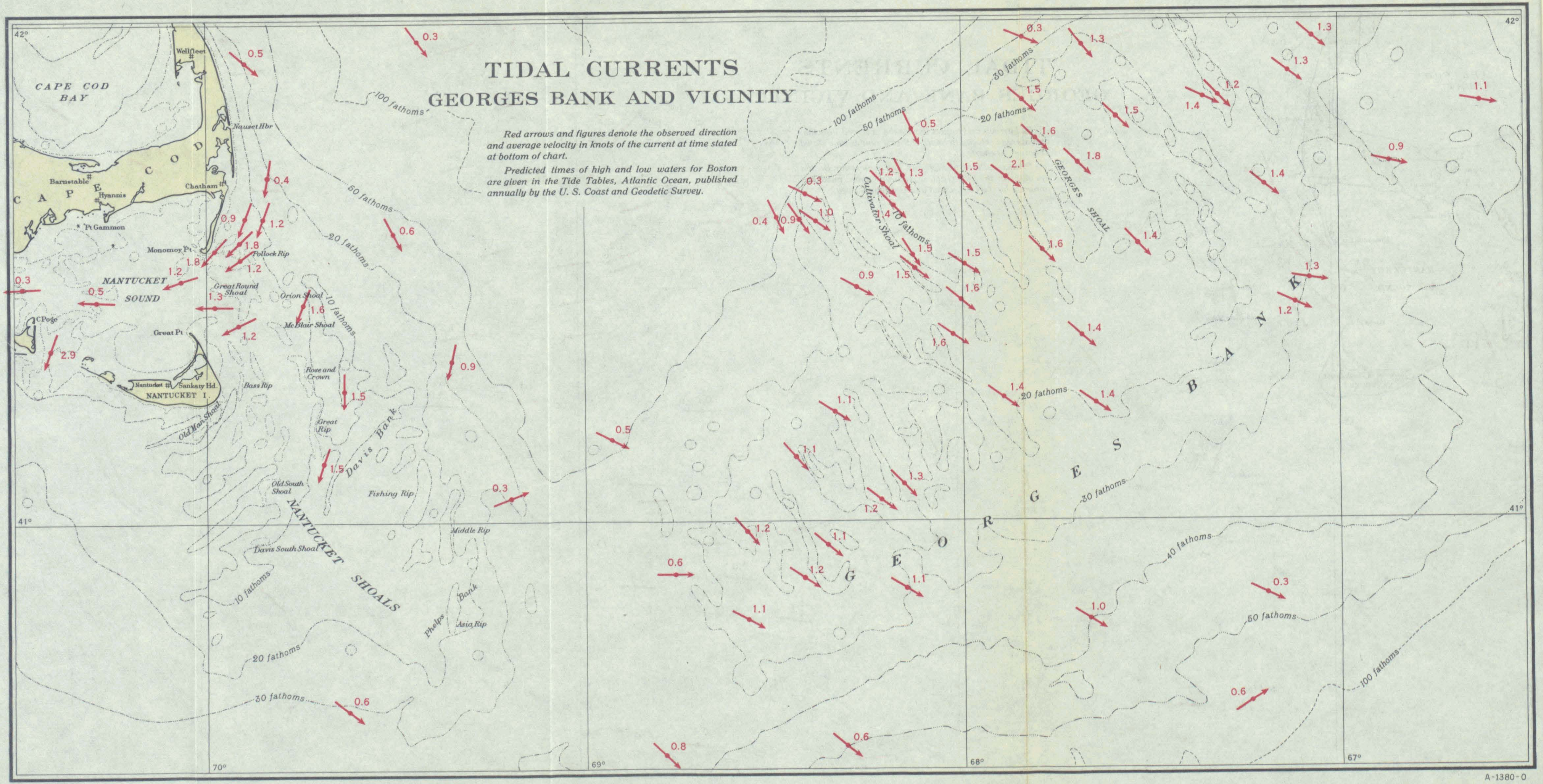


Fig. 28 Currents 5 hours after Greenwich transit (1 hour 15 minutes after high water at Boston).

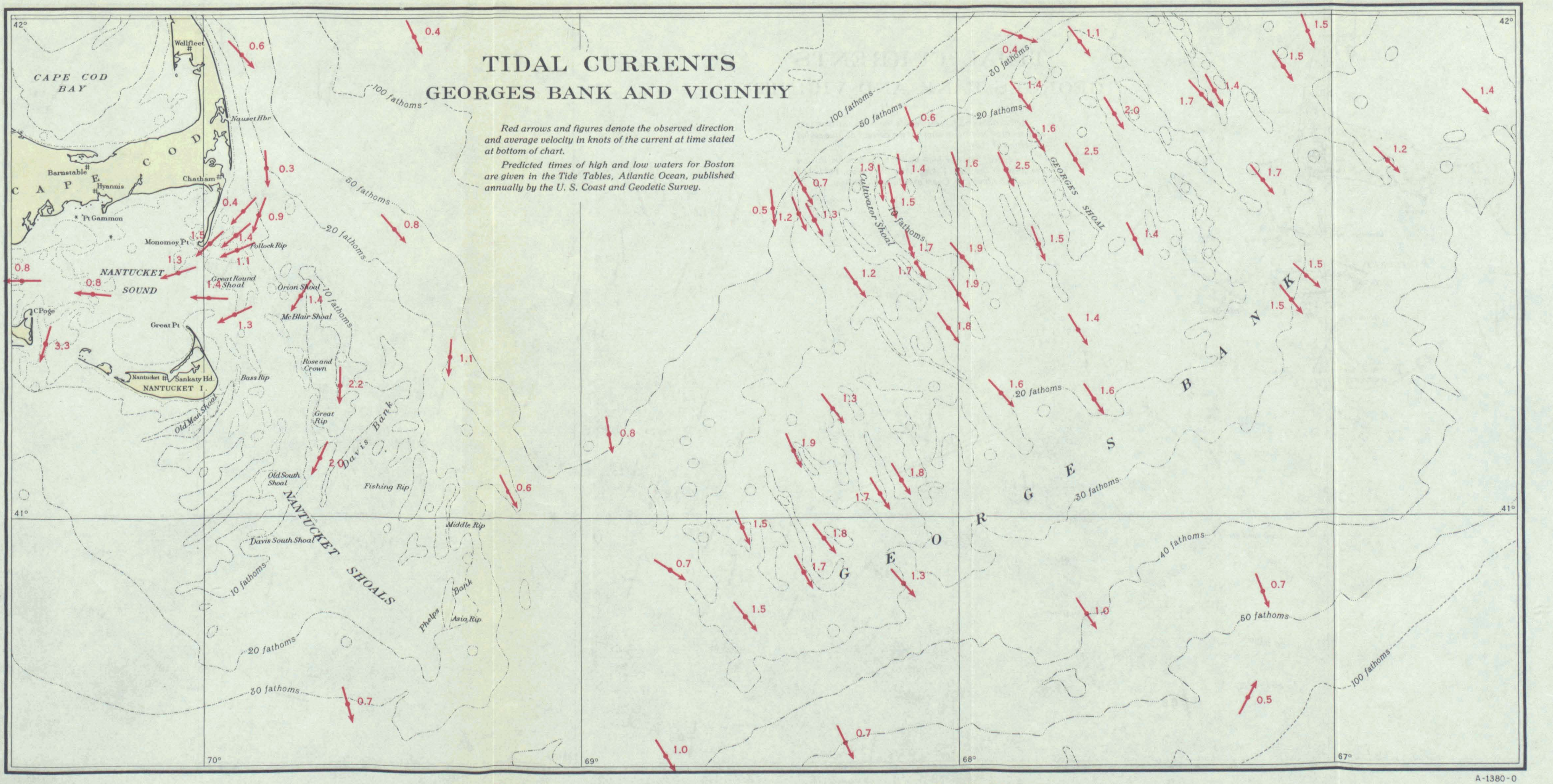
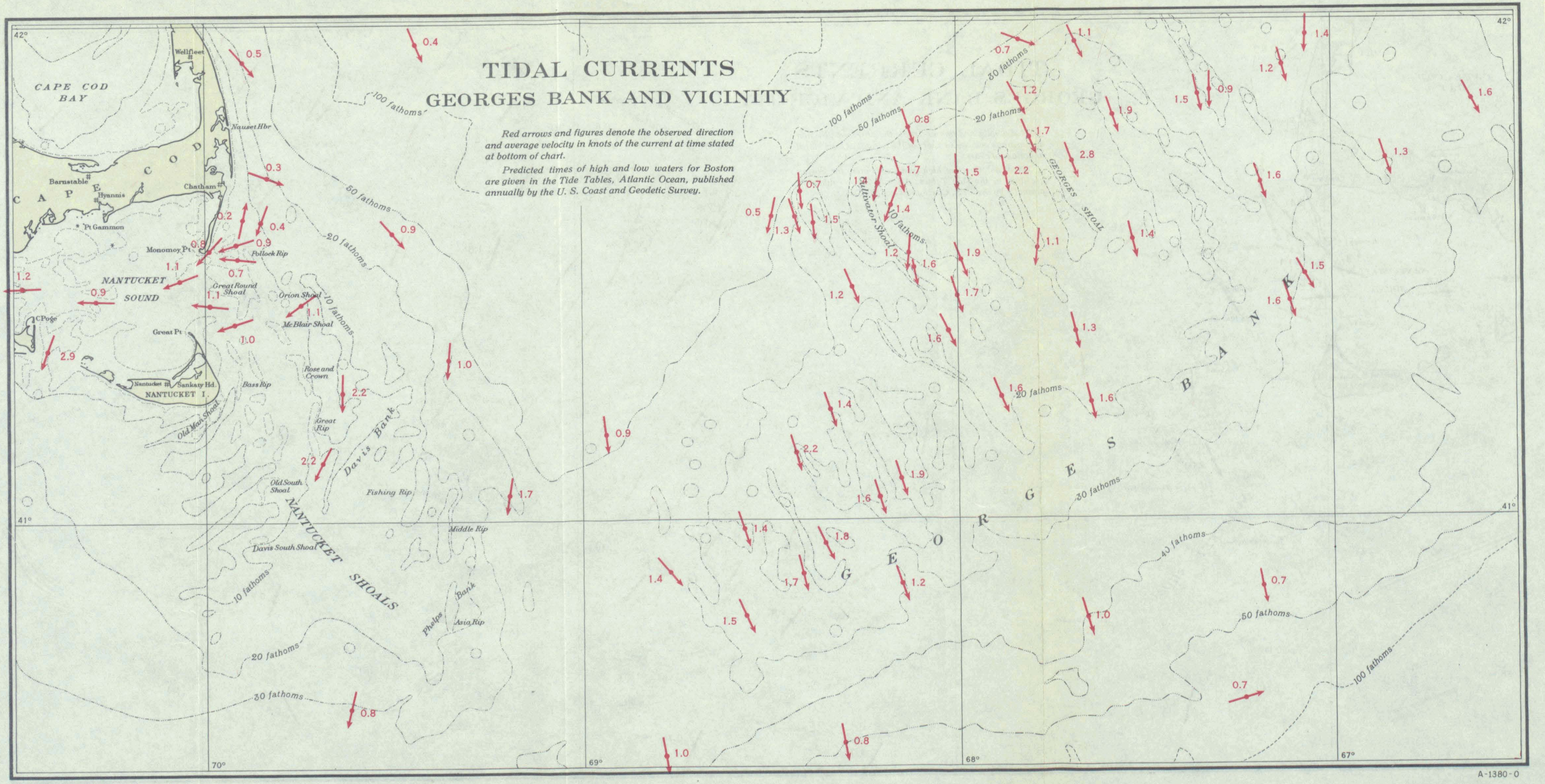


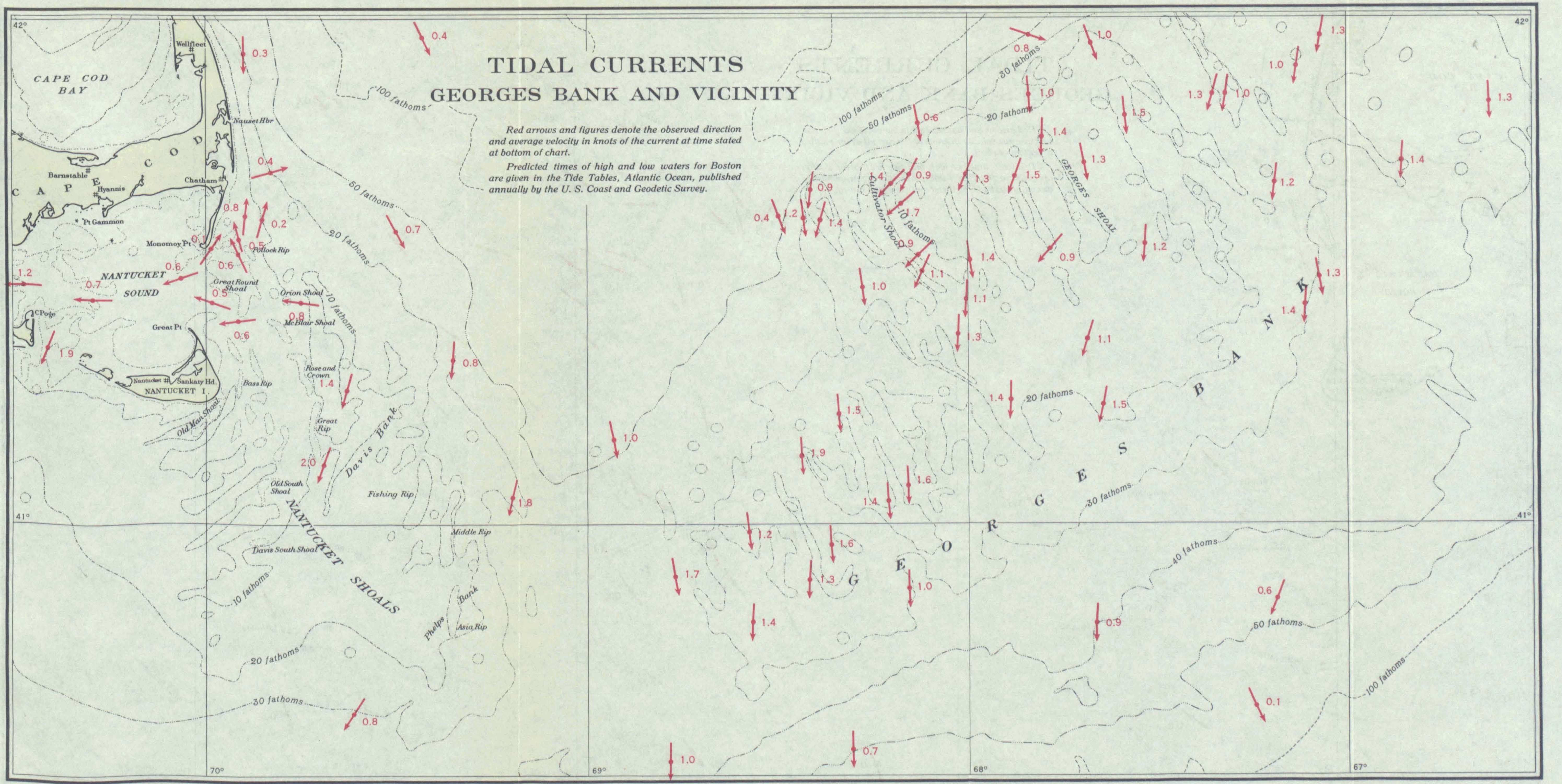
Fig. 29 Currents 6 hours after Greenwich transit (2 hours 15 minutes after high water at Boston).

A-1380-0



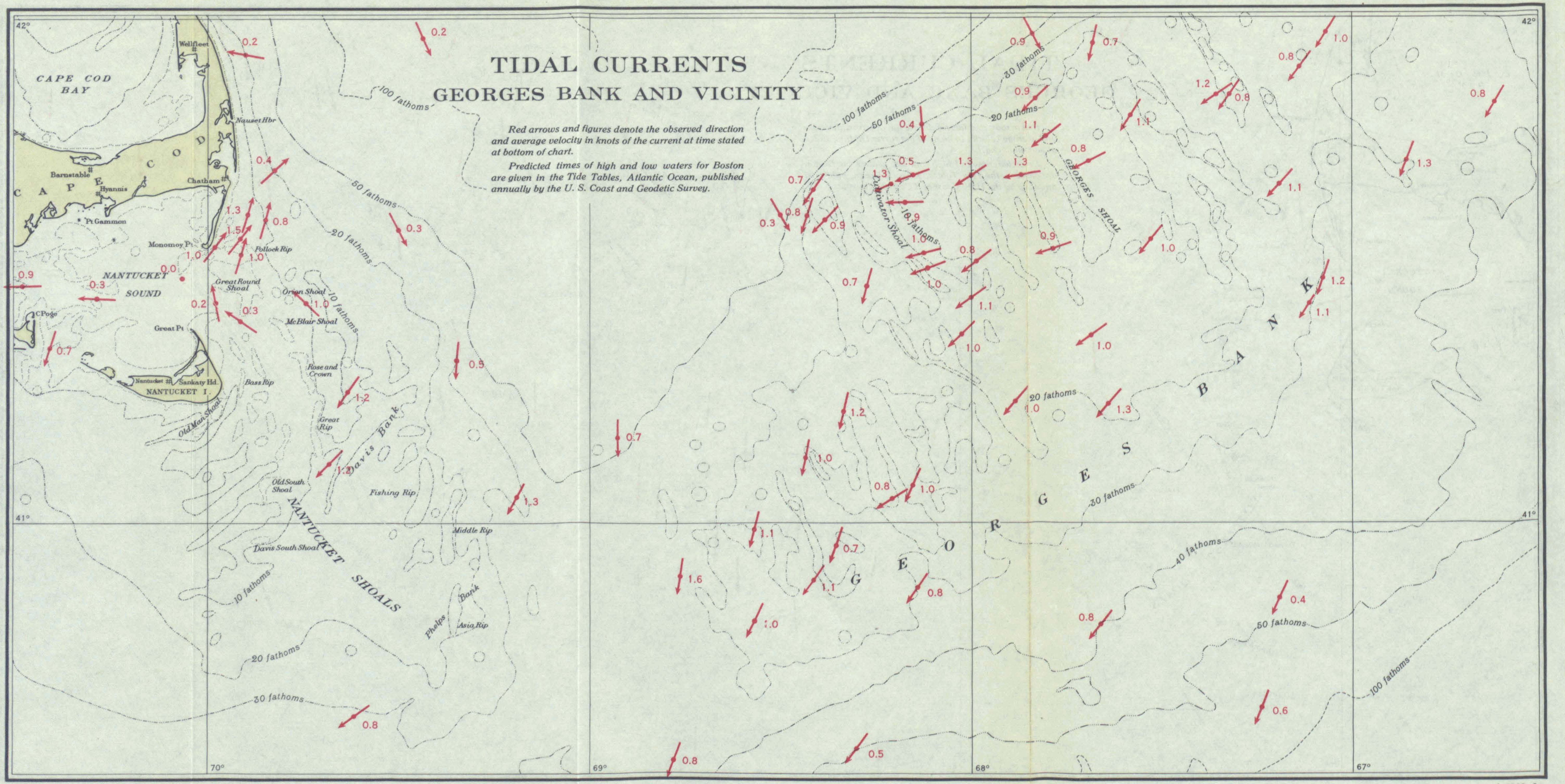
A-1380-0

Fig. 30 Currents 7 hours after Greenwich transit (2 hours 55 minutes before low water at Boston).



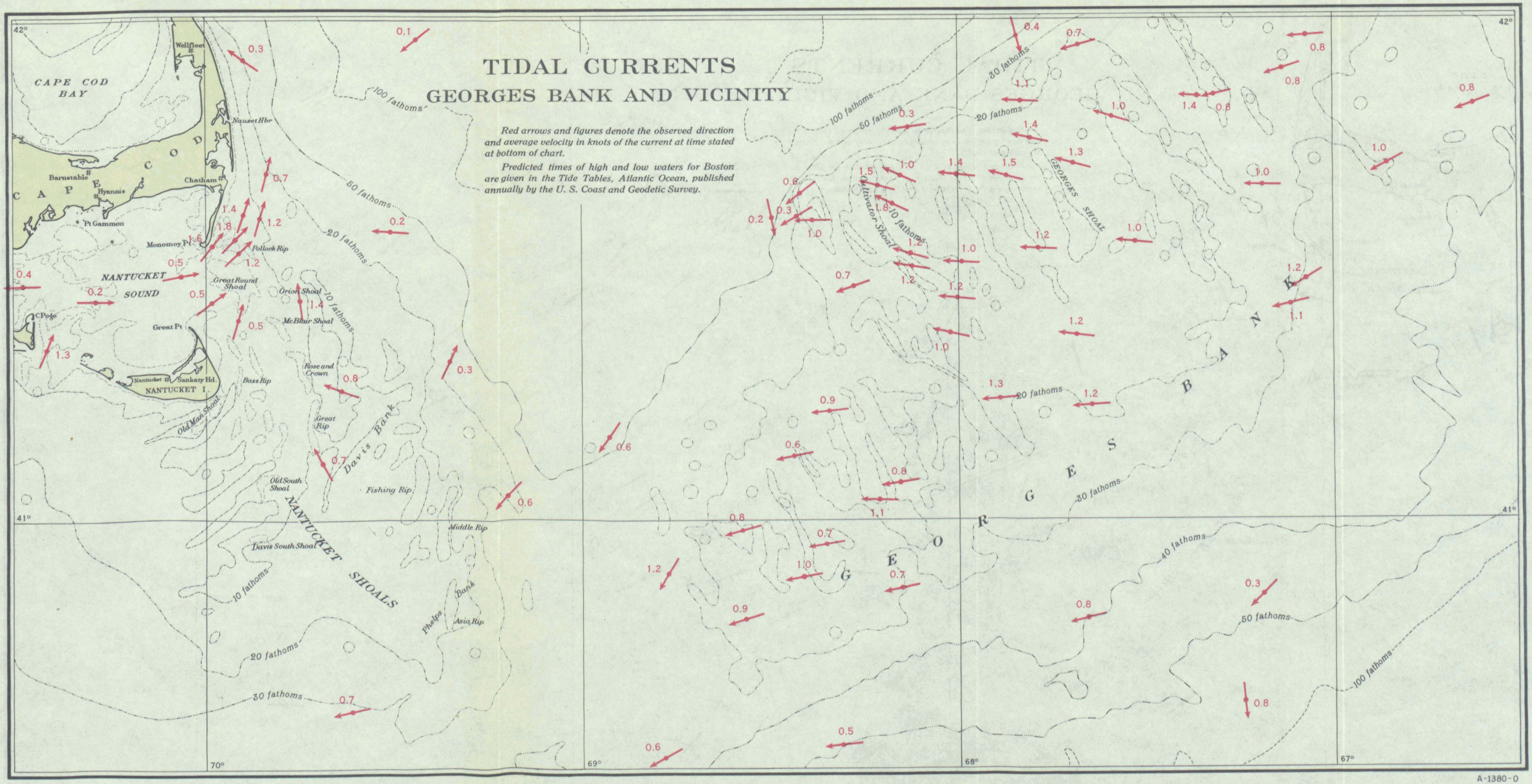
A-1380-0

Fig. 31 Currents 8 hours after Greenwich transit (1 hour 55 minutes before low water at Boston).



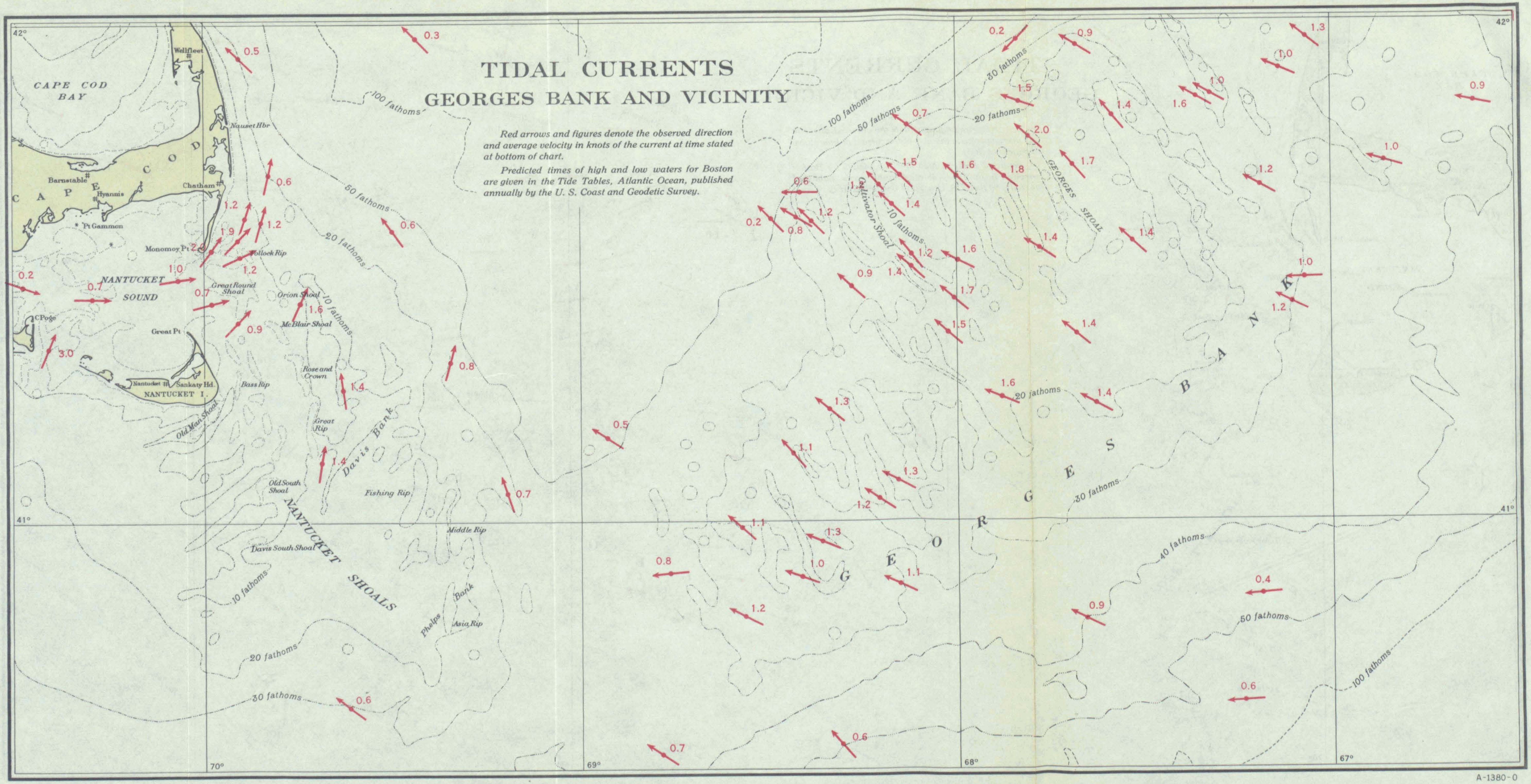
A-1380-0

Fig. 32 Currents 9 hours after Greenwich transit (55 minutes before low water at Boston).



A-1380-0

Fig. 33 Currents 10 hours after Greenwich transit (5 minutes after low water at Boston).



A-1380-0

Fig. 34 Currents 11 hours after Greenwich transit (1 hour 5 minutes after low water at Boston).

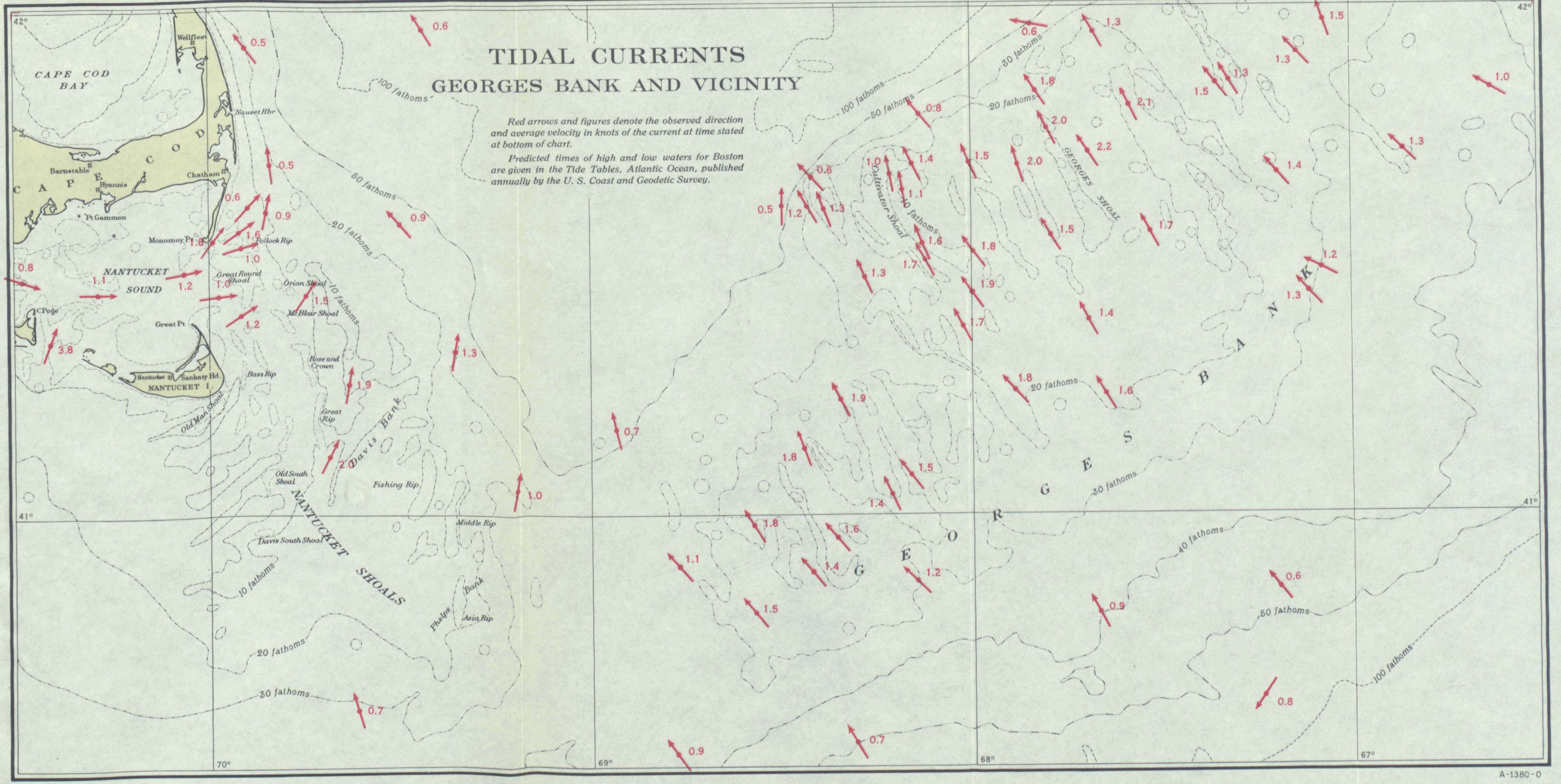


Fig. 35 Currents 12 hours after Greenwich transit (2 hours 5 minutes after low water at Boston).

TABLE 2.—***Observed Currents, Atlantic Coast Lightships, Strengths and Slacks***

[Referred to Greenwich transits]

Lightship and location	Observations		Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
	Date	Period		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
		Days	*Hours after G. T.*	*Hours after G. T.*	*Degrees*	*Knots*	*Hours*	*Hours after G. T.*	*Hours after G. T.*	*Degrees*	*Knots*	*Hours*	*Hours*
Pollock Rip Slue (41°36′.7 N., 69°53′.8 W.)	Dec. 1918–July, 1921	720	7.01	9.78	8	1.67	5.60	0.19	3.48	197	1.94	6.82	9.77
Pollock Rip (1934–35) (41°36′.1 N., 69°51′.1 W.)	Aug. 1934–Aug. 1935	388	7.63	10.61	16	1.25	5.89	1.10	4.24	202	1.33	6.53	10.55
Stone Horse Shoal (1934–36) (41°32′.8 N., 69°59′.1 W.)	Aug. 1934–Aug. 1936	748	7.86	11.25	37	1.98	6.54	1.98	4.76	226	1.78	5.88	11.12
Shovelful Shoal (41°32′.7 N., 69°59′.3 W.)	Sept.–Dec., 1913	87	8.13	11.26	52	1.98	6.23	1.94	4.95	227	2.29	6.19	11.23
Stone Horse Shoal (1918–19) (41°32′.4 N., 69°59′.2 W.)	Dec. 1918–Aug. 1919	255	8.07	11.37	60	2.55	6.56	2.21	5.04	240	2.44	5.86	11.33
Handkerchief (41°29′.3 N., 70°04′.0 W.)	June–Sept., 1911	87	8.96	12.34	94	1.76	6.35	2.89	5.55	243	1.66	6.07	12.09
	Aug. 1934–Aug. 1935	390	9.00	0.02	80	1.25	6.26	2.84	5.78	251	1.28	6.16	12.17
Cross Rip (41°26′.9 N., 70°17′.5 W.)	Sept.–Dec. 1913	87	9.84	0.77	102	1.35	6.61	4.03	6.86	271	0.98	5.81	0.72
	Aug. 1934–Aug. 1935	385	9.66	0.65	91	1.29	6.70	3.94	6.79	272	0.93	5.72	0.60
Hedge Fence (41°28′.3 N., 70°29′.0 W.)	Sept.–Dec., 1913	87	10.66	1.41	108	1.36	6.41	4.65	7.53	268	1.24	6.01	1.40
Brenton Reef (41°25′.9 N., 71°22′.6 W.)	Oct.–Dec., 1913	87	6.95	10.29	356	0.50	6.22	0.75	3.80	175	0.70	6.20	10.10
	June–Oct., 1919	120	6.71	10.31	353	0.46	6.54	0.83	3.70	156	0.53	5.88	10.04
	July 1930–July, 1931	370	6.83	10.83	343	0.35	6.22	0.63	3.73	174	0.60	6.20	10.16
Ram Island Reef (1913) (41°18′.2 N., 71°58′.5 W.)	Sept.–Dec., 1913	87	9.77	0.20	253	1.34	6.01	3.36	6.17	86	1.58	6.41	0.22
Ram Island Reef (1915) (41°18′.0 N., 71°58′.5 W.)	July–Oct., 1915	87	9.76	0.23	258	1.29	6.03	3.37	6.21	90	1.54	6.39	0.24
Bartlett Reef (41°16′.2 N., 72°07′.7 W.)	Sept.–Dec., 1913	87	9.74	0.35	260	1.21	6.20	3.52	6.65	112	1.47	6.22	0.41
	Aug. 1929–Mar. 1930	226	8.62	0.18	255	1.35	6.85	3.05	5.51	90	1.30	5.57	12.10
Cornfield Point (1913) (41°12′.9 N., 72°22′.6 W.)	Sept.–Dec., 1913	87	9.70	0.71	257	1.82	6.63	3.91	6.73	90	1.65	5.79	0.60
Cornfield Point (1922) (41°12′.9 N., 72°22′.2 W.)	Aug.–Nov. 1922	113	9.61	0.78	261	1.84	6.83	4.02	6.78	86	1.57	5.59	0.64
	Aug. 1929–Dec. 1930	510	9.74	0.76	254	1.99	6.71	4.03	6.65	98	1.76	5.71	0.64

TABLE 2.—*Observed Currents, Atlantic Coast Lightships, Strengths and Slacks*—Continued

Lightship and location	Observations		Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
	Date	Period		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
		Days	*Hours after G. T.*	*Hours after G. T.*	*Degrees*	*Knots*	*Hours*	*Hours after G. T.*	*Hours after G. T.*	*Degrees*	*Knots*	*Hours*	*Hours*
Overfalls (38°47'.9 N., 75°01'.4 W.)	Nov. 1912–Feb. 1913	87	8.88	11.65	326	2.01	5.76	2.22	5.59	136	2.32	6.66	11.74
	Sept. 1918–Dec. 1919	330	8.60	11.68	302	1.83	6.14	2.32	5.09	130	1.87	6.28	11.58
	Apr.–Dec., 1920	270	8.88	11.76	310	1.81	5.94	2.40	5.40	137	1.99	6.48	11.77
	Apr.–July, 1921	120	8.65	11.56	309	1.83	6.05	2.28	5.20	137	1.86	6.37	11.58
	Aug. 1924–May 1925	285	8.76	11.69	298	1.48	6.13	2.47	4.96	130	1.41	6.29	11.63
Tail of the Horseshoe (36°58'.8 N., 76°00'.4 W.)	June–Aug., 1912	87	11.22	1.64	301	1.04	5.60	4.40	7.88	122	1.55	6.82	1.63
	Aug.–Oct., 1915	73	11.10	1.45	305	0.92	5.46	4.14	7.74	129	1.44	6.96	1.45
	Apr.–Oct., 1919	160	11.29	1.62	312	0.96	5.35	4.22	7.84	126	1.50	7.07	1.58
Brunswick (31°00'.2 N., 81°09'.6 W.)	Jan. 1915–Mar. 1916	144	7.40	10.44	288	0.65	6.06	1.04	4.28	126	0.72	6.36	10.45

For reference to above table, see p. 20.

TABLE 3.—*Tidal Currents, Atlantic Coast Lightships, Strengths and Slacks*

[Referred to Greenwich Transits]

Lightship and location	Observations		Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
	Date	Period		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
		Days	*Hours after G. T.*	*Hours after G. T.*	*Degrees*	*Knots*	*Hours*	*Hours after G. T.*	*Hours after G. T.*	*Degrees*	*Knots*	*Hours*	*Hours*
Portland (43°31′.5 N., 70°05′.6 W.)	Oct. 1913–Jan. 1914	98	10.19	0.58	336	0.09	6.31	4.08	7.19	130	0.10	6.11	0.85
	June–Oct., 1919	145	9.99	0.98	335	0.13	6.51	4.08	7.29	147	0.14	5.91	0.93
Fire Island (40°28′.7 N., 73°11′.4 W.)	Nov. 1912–Jan. 1913	87	6.60	9.20	275	0.23	6.02	0.20	3.50	98	0.23	6.40	9.53
	July–Nov., 1922	130	6.16	9.16	275	0.18	6.23	12.39	3.57	95	0.20	6.19	9.37
	July 1938–July 1939	396	6.50	9.20	278	0.13	5.92	0.00	3.30	94	0.15	6.50	9.41
U. S. S. *Cardinal* (40°16′.0 N., 73°15′.5 W.)	Mar.–June, 1919	102	6.96	9.69	287	0.11	6.23	0.77	4.56	113	0.13	6.19	10.15
Ambrose Channel (1912–22) (40°28′.0 N., 73°50′.0 W.)	Nov. 1912–Jan. 1913	87	8.50	11.50	275	0.21	5.92	2.00	5.20	89	0.17	6.50	11.46
	Mar.–Aug., 1921	150	8.40	11.70	280	0.25	6.22	2.20	5.90	95	0.28	6.20	11.71
	July–Nov., 1922	130	8.10	11.40	281	0.22	6.02	1.70	5.00	99	0.21	6.40	11.21
Ambrose Channel (1936–8) (40°27′.1 N., 73°49′.4 W.)	Sept. 1936–Apr. 1937	240	8.50	11.20	282	0.14	5.72	1.80	5.30	105	0.14	6.70	11.36
	May–Sept., 1938	142	9.00	11.50	280	0.25	6.02	2.60	6.30	98	0.22	6.40	12.01
Cape Charles (37°05′.3 N., 75°43′.5 W.)	June–Aug., 1912	87	8.88	11.90	265	0.30	6.22	2.68	5.68	86	0.29	6.20	11.94
	Sept.–Oct., 1915	58	8.90	11.80	267	0.27	5.82	2.30	5.60	80	0.26	6.60	11.81
Chesapeake (36°58′.7 N., 75°42′.2 W.)	Mar. 1935–Mar. 1936	375	9.16	12.14	278	0.15	5.98	2.72	5.86	94	0.15	6.44	12.13
St. Johns (30°23′.5 N., 81°18′.0 W.)	Dec. 1933–Dec., 1934	375	7.40	10.50	334	0.16	6.32	1.30	4.40	149	0.19	6.10	10.56

For reference to above table, see p. 21.

429061—42——3

TABLE 4.—*Tidal Currents, Atlantic Coast Lightships, Strengths and Minimums*

[Referred to Greenwich transits]

Lightship and location	Observations		Minimum before flood			Flood strength			Minimum before ebb			Ebb strength			Mean current hour
	Date	Period	Time	True direction	Velocity	Time	True direction	Velocity	Time	True direction	Velocity	Time	True direction	Velocity	
		Days	*Hours after G. T.*	*Degrees*	*Knots*	*Hours after G. T.*	*Degrees*	*Knots*	*Hours after G. T.*	*Degrees*	*Knots*	*Hours after G. T.*	*Degrees*	*Knots*	*Hours*
U. S. S. *Easthampton* (42°24′.1 N., 70°23′.8 W.)	Mar.–May 1919	60	11.13	122	0.02	1.92	243	0.16	5.22	110	0.04	8.63	63	0.18	2.07
Boston (42°20′.4 N., 70°45′.4 W.)	Sept.–Dec. 1913	96	10.42	170	0.04	1.50	262	0.15	4.12	305	0.01	7.92	82	0.14	1.33
	June 1926–June 1927	388	9.97	120	0.01	0.55	267	0.08	3.87	50	0.01	7.17	88	0.08	0.73
Pollock Rip Slue (41°36′.7 N., 69°53′.8 W.)	June–Sept. 1911	87	7.02	260	0.18	10.13	12	1.58	0.71	122	0.45	4.02	200	1.36	10.13
	June–Dec. 1920	180	6.82	3	0.16	9.93	15	1.45	0.71	137	0.32	3.62	201	1.44	9.93
Pollock Rip (41°32′.1 N., 69°54′.8 W.)	June–Sept. 1911	87	7.70	318	0.60	10.80	59	1.25	1.70	152	0.40	4.70	230	1.21	10.88
Great Round Shoal (41°24′.2 N., 69°54′.9 W.)	June–Sept. 1911	87	9.20	317	0.26	0.30	64	1.26	3.00	159	0.48	5.90	248	1.31	12.36
Nantucket Shoals (40°37′.0 N., 69°37′.1 W.)	1911–24	1,100	11.13	313	0.62	1.82	34	0.84	4.92	126	0.61	8.03	215	0.83	1.82
Vineyard Sound (41°22′.8 N., 71°00′.0 W.)	Sept.–Dec. 1913	87	6.63	240	0.23	10.33	349	0.44	0.63	68	0.18	3.83	161	0.52	10.01
	Aug. 1930–Dec. 1931 [1]	510	6.43	241	0.14	9.73	334	0.29	0.63	65	0.13	3.83	158	0.35	9.81
Hen and Chickens (41°27′.0 N., 71°01′.1 W.)	Sept.–Dec. 1913	87	7.60	312	0.15	11.05	50	0.62	1.33	137	0.20	4.00	225	0.54	10.65
	Aug. 1930–Dec. 1931	510	7.93	315	0.15	11.43	55	0.42	1.33	137	0.17	4.23	228	0.44	10.89
Scotland (40°26′.6 N., 73°55′.2 W.)	Nov. 1912–Jan. 1913	87	8.60	225	0.14	11.10	298	0.43	2.30	42	0.13	6.50	128	0.52	11.78
	Mar.–July 1921	140	8.40	226	0.18	11.00	300	0.42	2.30	27	0.18	5.80	135	0.62	11.53
	July–Nov. 1922	130	8.20	221	0.04	11.20	295	0.42	2.40	48	0.13	5.80	132	0.54	11.56
	Sept. 1936–Mar. 1937	210	8.20	218	0.03	11.20	300	0.49	2.30	45	0.11	5.70	130	0.67	11.51
	May–Sept. 1938	140	8.30	235	0.12	11.10	308	0.53	2.30	34	0.14	5.80	140	0.70	11.53
Barnegat (39°45′.8 N., 73°56′.0 W.)	Oct. 1934–Mar. 1936	540	6.58	255	0.02	9.68	328	0.05	1.22	98	0.02	3.42	133	0.05	9.88
Northeast End (38°57′.8 N., 74°29′.6 W.)	Nov. 1912–Feb. 1913	87	7.50	225	0.07	10.20	293	0.19	1.00	40	0.05	4.10	112	0.19	10.36
	Sept. 1918–Oct. 1919	420	7.16	214	0.07	9.89	289	0.23	0.87	31	0.06	4.16	110	0.22	10.18
Five Fathom Bank (38°47′.3 N., 74°34′.6 W.)	Nov. 1912–Jan. 1913	87	7.66	196	0.10	10.69	294	0.32	1.27	29	0.05	4.66	110	0.30	10.73
Fenwick Island Shoal (38°27′.4 N., 74°46′.7 W.)	Nov. 1912–Jan. 1913	87	8.80	247	0.09	11.90	342	0.25	2.40	45	0.06	5.60	153	0.28	11.83
U. S. S. *Brant* (37°04′.6 N., 74°51′.1 W.)	Feb.–May 1919	98	6.30	205	0.11	9.80	285	0.17	0.20	10	0.08	3.60	98	0.20	9.63
Cape Lookout Shoals (1912) (34°20′.0 N., 76°25′.0 W.).	June–Aug. 1912	87	5.00	179	0.16	8.20	270	0.40	11.90	15	0.16	1.90	88	0.40	8.30
Cape Lookout Shoals (1918–19) (34°18′.4 N., 76°24′.3 W.).	Sept. 1918–Sept. 1919	390	5.40	177	0.07	8.80	279	0.17	11.80	1	0.08	2.50	90	0.19	8.68
Frying Pan Shoals (1912) (33°34′.0 N., 77°48′.7 W.).	June–Sept. 1912	87	5.50	201	0.28	8.30	290	0.45	11.80	29	0.23	2.80	118	0.46	8.65
Frying Pan Shoals (1918–21) (33°34′.1 N., 77°48′.8 W.).	Oct. 1918–July 1921	1,020	5.14	200	0.19	8.34	295	0.33	11.53	19	0.19	2.51	121	0.32	8.43
U. S. S. *Long Island* (32°42′.0 N., 79°06′.3 W.)	Feb.–May 1919	70	6.70	232	0.21	9.80	320	0.30	12.30	22	0.21	3.50	135	0.28	9.63
Charleston (1912) (32°41′.0 N., 79°43′.5 W.)	June–Sept. 1912	87	5.60	180	0.25	8.60	274	0.41	12.20	0	0.20	3.20	97	0.41	8.95
Charleston (1916) (32°41′.0 N., 79°43′.7 W.)	Dec. 1915–Feb. 1916	88	5.50	185	0.16	8.60	276	0.30	11.90	2	0.17	2.90	102	0.33	8.78
Charleston (1921) (32°40′.7 N., 79°42′.9 W.)	Apr.–Sept. 1921	160	5.61	200	0.16	8.21	267	0.31	12.23	15	0.14	3.01	95	0.30	8.82
Martins Industry (1912) (32°06′.2 N., 80°27′.8 W.)	June–Sept. 1912	87	6.70	184	0.16	9.70	283	0.52	0.60	10	0.15	3.80	102	0.53	9.86
Martins Industry (1916) (32°06′.2 N., 80°28′.0 W.)	Feb.–June 1916	140	6.56	180	0.14	9.56	278	0.44	0.44	0	0.10	3.66	101	0.48	9.71
Savannah (1925–26) (32°56′.7 N., 80°39′.8 W.)	Apr. 1925–Apr. 1926	375	7.06	200	0.11	10.16	291	0.41	0.74	13	0.11	4.06	117	0.45	10.16
Savannah (1934–35) (31°56′.6 N., 80°39′.8 W.)	Apr. 1934–Apr. 1935	375	7.36	214	0.11	10.16	290	0.29	0.94	12	0.06	4.26	113	0.32	10.34
Brunswick (1912) (31°00′.2 N., 81°09′.4 W.)	June–Sept. 1912	87	7.80	216	0.13	10.70	296	0.51	1.40	22	0.12	4.60	115	0.54	10.78
Brunswick (1918–21) (31°00′.2 N., 81°09′.6 W.)	Nov. 1918–July 1921	990	7.66	220	0.08	10.66	297	0.41	1.34	24	0.10	4.46	120	0.43	10.69

[1] Velocities from the 1913 series are considered more reliable than those from the 1930–31 series.

For reference to above table, see p. 21.

TABLE 5.—*Hourly Velocities and Directions of the Tidal Current, Atlantic Coast Lightships*—Continued

[Referred to Greenwich transits]

Lightship and location	Observations: Date	Observations: Period	Units	Velocities and true directions — Hours after Greenwich transit: 0	1	2	3	4	5	6	7	8	9	10	11	12
		Days														
U. S. S. *Falcon* (39°04′.5 N., 73°25′.5 W.)	Feb.–May 1919	75	Knots	0.06	0.06	0.04	0.04	0.05	0.06	0.05	0.04	0.06	0.07	0.04	0.04	0.06
			Degrees	15	29	59	91	147	146	183	221	240	259	293	302	0
Northeast End (38°57′.8 N., 74°29′.6 W.)	Sept. 1918–Oct. 1919	420	Knots	0.10	0.06	0.12	0.19	0.22	0.20	0.13	0.07	0.11	0.20	0.23	0.20	0.13
			Degrees	329	39	86	102	110	119	140	197	261	280	290	300	317
Five Fathom Bank (38°47′.3 N., 74°34′.6 W.)	Nov. 1912–Jan. 1913	87	Knots	0.22	0.06	0.11	0.23	0.29	0.30	0.26	0.15	0.10	0.20	0.29	0.32	0.26
			Degrees	304	5	73	99	103	112	125	158	217	268	284	295	301
Overfalls (38°47′.9 N., 75°01′.4 W.)	Aug. 1924–May 1925	285	Knots	1.37	0.85	0.38	0.32	1.21	1.40	1.23	0.88	0.44	0.25	0.92	1.38	1.43
			Degrees	306	317	15	87	117	126	131	136	173	252	297	300	303
Fenwick Island Shoal (38°27′.4 N., 74°46′.7 W.)	Nov. 1912–Jan. 1913	87	Knots	0.24	0.18	0.08	0.10	0.19	0.27	0.27	0.22	0.14	0.09	0.16	0.23	0.25
			Degrees	346	354	25	88	126	145	158	176	208	259	308	329	343
Winter-Quarter Shoal (37°55′.4 N., 74°56′.4 W.)	Nov. 1912–Jan. 1913	87	Knots	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.09	0.10	0.10	0.09
			Degrees	3	30	57	78	99	129	163	201	227	252	283	319	351
	Sept. 1918–Aug. 1920	690	Knots	0.07	0.06	0.06	0.06	0.05	0.06	0.07	0.06	0.06	0.06	0.06	0.06	0.06
			Degrees	0	30	62	90	121	154	185	206	235	266	290	323	350
U. S. S. *Brant* (37°04′.6 N., 74°51′.1 W.)	Feb.–May 1919	98	Knots	0.08	0.11	0.16	0.19	0.19	0.15	0.11	0.12	0.15	0.16	0.16	0.17	0.10
			Degrees	358	42	61	83	106	133	183	237	261	273	292	326	335
Cape Charles (37°05′.3 N., 75°43′.5 W.)	June–Aug. 1912	87	Knots	0.30	0.20	0.10	0.05	0.19	0.27	0.29	0.22	0.11	0.03	0.19	0.26	0.30
			Degrees	264	263	228	144	90	89	86	80	55	340	265	268	264
Chesapeake (36°58′.7 N., 75°42′.2 W.)	Mar. 1935–Mar. 1936	375	Knots	0.15	0.13	0.06	0.03	0.10	0.14	0.15	0.13	0.08	0.00	0.06	0.13	0.15
			Degrees	279	278	271	335	93	95	94	100	106	------	272	281	278
Tail of the Horseshoe [1] (36°58′.8 N., 76°00′.4 W.)	Apr.–Oct. 1919	160	Knots	0.56	0.90	0.95	0.64	0.12	0.50	1.04	1.40	1.50	1.29	0.85	0.21	0.36
			Degrees	312	312	312	312	312	126	126	126	126	126	126	126	312
Diamond Shoal (35°05′.3 N., 75°19′.7 W.)	Jan.–Dec. 1921	365	Knots	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03
			Degrees	35	72	116	140	165	205	237	266	293	321	337	341	24
Cape Lookout Shoals (1912) (34°20′.0 N., 76°25′.0 W.)	June–Aug. 1912	87	Knots	0.18	0.33	0.40	0.33	0.24	0.16	0.24	0.34	0.40	0.38	0.31	0.22	0.16
			Degrees	40	75	89	100	133	179	229	256	267	278	287	310	19
Cape Lookout Shoals (1918–19) (34°18′.4 N., 76°24′.3 W.)	Sept. 1918–Sept. 1919	390	Knots	0.10	0.14	0.18	0.18	0.12	0.07	0.08	0.13	0.16	0.17	0.15	0.10	0.08
			Degrees	33	67	82	98	120	155	207	248	270	280	292	315	12
Frying Pan Shoals (1912) (33°34′.0 N., 77°48′.7 W.)	June–Sept. 1912	87	Knots	0.27	0.35	0.43	0.46	0.39	0.30	0.30	0.38	0.45	0.43	0.37	0.28	0.23
			Degrees	55	84	102	120	143	179	225	265	285	302	324	350	38
Frying Pan Shoals (1918–21) (33°34′.1 N., 77°48′.8 W.)	Oct. 1918–July 1921	1020	Knots	0.22	0.27	0.31	0.31	0.25	0.19	0.22	0.27	0.32	0.31	0.27	0.20	0.20
			Degrees	57	91	112	129	157	197	241	272	291	309	324	356	41
U. S. S. *Long Island* (32°42′.0 N., 79°06′.3 W.)	Feb.–May, 1919	70	Knots	0.21	0.24	0.27	0.28	0.28	0.27	0.22	0.21	0.26	0.29	0.30	0.27	0.21
			Degrees	25	73	100	122	144	167	202	242	272	300	323	342	11
Charleston (1912) (32°41′.0 N., 79°43′.5 W.)	June–Sept. 1912	87	Knots	0.20	0.27	0.34	0.41	0.36	0.27	0.26	0.34	0.43	0.43	0.37	0.29	0.20
			Degrees	12	54	79	94	118	151	200	240	264	280	291	313	351
Charleston (1916) (32°41′.0 N., 79°43′.7 W.)	Dec. 1915–Feb. 1916	88	Knots	0.18	0.23	0.28	0.33	0.27	0.19	0.19	0.26	0.29	0.30	0.26	0.20	0.17
			Degrees	24	62	87	104	125	160	208	248	269	285	300	324	6
Charleston (1921) (32°40′.7 N., 79°42′.9 W.)	Apr.–Sept. 1921	160	Knots	0.14	0.20	0.27	0.30	0.25	0.18	0.18	0.25	0.31	0.28	0.24	0.18	0.14
			Degrees	25	61	80	95	123	164	213	246	263	278	292	322	7
Martins Industry (1912) (32°06′.2 N., 80°27′.8 W.)	June–Sept. 1912	87	Knots	0.19	0.16	0.31	0.48	0.53	0.43	0.25	0.17	0.36	0.50	0.51	0.43	0.26
			Degrees	332	45	85	98	105	116	143	203	257	276	283	292	316
Martins Industry (1916) (32°06′.2 N., 80°28′.0 W.)	Feb.–June 1916	140	Knots	0.11	0.14	0.30	0.45	0.47	0.36	0.18	0.18	0.30	0.42	0.42	0.33	0.17
			Degrees	337	43	78	95	104	115	152	211	255	274	282	290	317
Savannah (1925–26) (31°56′.7 N., 80°39′.8 W.)	Apr. 1925–Apr. 1926	375	Knots	0.18	0.13	0.25	0.38	0.45	0.38	0.23	0.11	0.23	0.35	0.41	0.36	0.24
			Degrees	333	35	83	104	117	127	148	205	266	282	291	301	320
Savannah (1934–35) (31°56′.6 N., 80°39′.8 W.)	Apr. 1934–Apr. 1935	375	Knots	0.15	0.06	0.16	0.27	0.32	0.29	0.20	0.11	0.15	0.25	0.29	0.27	0.19
			Degrees	320	20	77	102	112	120	138	194	250	278	289	298	313
Brunswick (1912) (31°00′.2 N., 81°09′.4 W.)	June–Sept. 1912	87	Knots	0.32	0.15	0.21	0.39	0.52	0.53	0.40	0.22	0.14	0.32	0.46	0.50	0.39
			Degrees	311	356	66	99	110	120	133	164	229	280	290	297	306
Brunswick (1918–21) (31°00′.2 N., 81°09′.6 W.)	Nov. 1918–July 1921	990	Knots	0.25	0.11	0.17	0.31	0.42	0.41	0.30	0.13	0.11	0.27	0.39	0.40	0.30
			Degrees	316	7	65	98	115	125	134	171	243	283	293	300	308
St. Johns (30°23′.5 N., 81°18′.0 W.)	Dec. 1933–Dec. 1934	375	Knots	0.10	0.04	0.08	0.15	0.19	0.19	0.12	0.03	0.05	0.11	0.16	0.16	0.12
			Degrees	323	345	137	147	149	150	155	168	324	334	334	334	328

[1] Observed current, nontidal current included. The current is mainly of the reversing type. The directions given are average observed directions of flood or ebb strength. Average direction for each hour of cycle was not computed.

For reference to above table, see p. 21.

TABLE 6.—*Times of High Water and Low Water at Locations Along the Atlantic Coast of the United States*

[Times in hours and hundredths are referred to Greenwich lunar transits]

Tide stations	High water occurs after Greenwich transit	Low water occurs after Greenwich transit	Tide stations	High water occurs after Greenwich transit	Low water occurs after Greenwich transit
	Hours	*Hours*		*Hours*	*Hours*
Portland, Maine	3.59	9.76	Breakwater Harbor, Del.	1.03	7.13
Boston, Mass.	3.76	9.93	Hampton Roads, Va.	1.70	8.00
Newport, R. I.	0.25	5.85	Charleston, S. C.	0.51	6.64
New London, Conn.	2.00	8.52	Tybee Light, Ga.	0.34	6.66
Sandy Hook, N. J.	0.32	6.68	Mayport, Fla.	0.93	7.04

For reference to above table, see p. 21.

TABLE 7.—*Current Harmonic Constants, Atlantic Coast Lightships*

[North and east components]

Constituent	North component (magnetic)			East component (magnetic)			North component (magnetic)			East component (magnetic)		
	Velocity H (knots)	Epoch: Local (κ) (degrees)	Epoch: Greenwich (degrees)	Velocity H (knots)	Epoch: Local (κ) (degrees)	Epoch: Greenwich (degrees)	Velocity H (knots)	Epoch: Local (κ) (degrees)	Epoch: Greenwich (degrees)	Velocity H (knots)	Epoch: Local (κ) (degrees)	Epoch: Greenwich (degrees)
	Boston Lightship 369 days beginning June 8, 1926. Magnetic variation 15° west						**Pollock Rip Slue Lightship** 369 days beginning June 5, 1920. Magnetic variation 15° west					
K_1	0.011	56	127	0.015	178	249	0.030	157	227	0.010	166	236
K_2	0.003	9	151	0.009	130	272	0.068	192	332	0.044	207	347
L_2	0.003	322	104	0.002	56	198	0.098	206	346	0.068	207	347
M_1	0.001	189	260	0.002	163	234	0.014	128	198	0.008	8	78
M_2	0.013	269	51	0.080	57	199	1,152	165	305	0.672	176	316
M_3	0.003	144	356	0.006	260	112	0.006	7	217	0.004	32	242
M_4	0.006	254	177	0.002	228	151	0.062	22	302	0.052	149	69
M_6	0.001	268	333	0.003	9	74	0.044	143	202	0.050	151	210
M_8	0.002	298	144	0.003	37	243	0.004	263	102	0.008	65	264
N_2	0.004	247	29	0.022	21	163	0.182	126	266	0.110	135	275
O_1	0.003	72	143	0.007	238	309	0.010	122	192	0.006	5	75
P_1	0.011	38	109	0.004	145	216	0.030	187	257	0.010	206	276
Q_1	0.008	71	142	0.002	203	274	0.006	129	199	0.008	12	82
S_1	0.022	74	145	0.024	164	235	0.024	83	153	0.012	132	202
S_2	0.003	221	3	0.016	75	217	0.124	179	319	0.084	192	332
Mu_2	0.003	222	4	0.003	63	205	0.052	0	140	0.032	348	128
Sa	0.033	152	152	0.021	35	35	0.024	145	145	0.064	307	307
Ssa	0.024	179	179	0.011	143	143	0.020	338	338	0.020	108	108
	Nantucket Shoals Lightship 369 days beginning September 27, 1913. Magnetic variation 14° west						**Nantucket Shoals Lightship** 369 days beginning April 16, 1921. Magnetic variation 14° west					
K_1	0.115	341	51	0.153	77	147	0.125	334	44	0.157	81	151
K_2	0.021	266	45	0.024	345	124	0.040	285	64	0.037	339	118
L_2	0.055	255	34	0.028	331	110	0.039	312	91	0.034	20	159
M_1	0.004	306	16	0.007	16	86	0.016	351	61	0.018	40	110
M_2	0.539	241	20	0.555	306	85	0.703	235	14	0.742	302	81
M_3	0.010	301	150	0.010	28	237	0.002	310	159	0.004	153	2
M_4	0.010	352	270	0 004	122	40	0.026	356	274	0.026	114	32
M_6	0.011	199	257	0.010	317	15	0.009	192	250	0.007	269	327
M_8	0.002	62	259	0.006	141	338	0.003	306	143	0.003	352	189
N_2	0.124	212	351	0.130	280	59	0.179	196	335	0.177	270	49
O_1	0.067	293	3	0.1 0	43	113	0.097	300	10	0.112	43	113
P_1	0.026	338	48	0.042	75	145	0.034	296	6	0.039	31	101
Q_1	0.004	313	23	0.007	3	73	0.034	212	282	0.023	332	42
S_1	0.017	303	13	0.013	57	127	0.029	295	5	0.034	124	194
S_2	0.087	277	56	0.096	341	120	0.111	261	40	0.127	333	112
Mu_2	0.022	130	269	0.010	250	29	0.012	105	244	0.016	167	306
Sa	0.098	113	113	0.071	339	339	0.123	125	125	0.137	287	287
Ssa	0.022	300	300	0.050	199	199	0.022	185	185	0.092	290	290

TABLE 7.—*Current Harmonic Constants, Atlantic Coast Lightships*—Con.

Constituent	North component (magnetic)			East component (magnetic)			North component (magnetic)			East component (magnetic)		
	Velocity H (knots)	Epoch: Local (κ) (degrees)	Epoch: Greenwich (degrees)	Velocity H (knots)	Epoch: Local (κ) (degrees)	Epoch: Greenwich (degrees)	Velocity H (knots)	Epoch: Local (κ) (degrees)	Epoch: Greenwich (degrees)	Velocity H (knots)	Epoch: Local (κ) (degrees)	Epoch: Greenwich (degrees)
	Hen and Chickens Lightship 369 days beginning September 1, 1930. Magnetic variation 14° west						**Brenton Reef Lightship** 369 days beginning July 28, 1930. Magnetic variation 14° west					
K_1	0.014	13	84	0.032	26	97	0.039	0	71	0.013	70	141
K_2	0.017	148	290	0.025	177	319	0.020	192	335	0.010	160	303
L_2	0.008	352	134	0.021	17	159	0.030	135	278	0.017	96	239
M_1	0.001	265	336	0.001	96	167	0.005	289	0	0.004	67	138
M_2	0.224	133	275	0.356	182	324	0.440	146	289	0.025	141	284
M_3	0.002	164	17	0.007	146	359	0.002	136	350	0.007	263	117
M_4	0.027	45	329	0.062	68	352	0.089	68	354	0.017	189	115
M_6	0.021	156	222	0.013	122	188	0.026	161	229	0.014	149	217
M_8	0.009	130	338	0.005	6	214	0.010	194	45	0.003	142	353
N_2	0.060	105	247	0.111	155	297	0.113	134	277	0.022	182	325
O_1	0.011	40	111	0.017	26	97	0.023	25	96	0.003	51	122
P_1	0.010	37	108	0.016	38	109	0.026	4	75	0.026	78	149
Q_1	0.002	135	206	0.006	40	111	0.011	5	76	0.004	65	136
S_1	0.027	64	135	0.011	90	161	0.017	37	108	0.031	81	152
S_2	0.060	155	297	0.085	192	334	0.102	164	307	0.022	183	326
Mu_2	0.021	81	223	0.032	123	265	0.021	146	289	0.003	62	205
Sa	0.019	186	186	0.047	260	260	0.051	110	110	0.059	181	181
Ssa	0.017	135	135	0.023	136	136	0.008	97	97	0.003	18	18
	Fire Island Lightship 369 days beginning July 2, 1938. Magnetic variation 12° west						**Barnegat Lightship** 369 days beginning February 1, 1935. Magnetic variation 10° west					
K_1	0.016	65	138	0.042	167	240	0.011	268	342	0.012	221	295
K_2	0.007	184	330	0.013	312	98	0.003	73	221	0.003	174	322
L_2	0.002	269	55	0.003	311	97	0.003	179	327	0.003	15	163
M_1	0.002	2	75	0.005	76	149	0.003	22	96	0.003	145	219
M_2	0.042	141	287	0.124	303	89	0.047	148	296	0.029	286	74
M_3	0.002	130	350	0.000			0.002	226	88	0.000		
M_4	0.004	206	139	0.009	6	299	0.002	122	58	0.005	332	268
M_6	0.003	54	133	0.004	54	133	0.002	93	177	0.001	3	87
M_8	0.001	312	178	0.002	12	238	0.002	4	235	0.001	304	175
N_2	0.007	106	252	0.033	282	68	0.007	144	292	0.004	203	351
O_1	0.011	100	173	0.027	143	216	0.016	156	230	0.012	182	256
P_1	0.016	12	85	0.028	108	181	0.007	45	119	0.011	142	216
Q_1	0.004	177	250	0.008	153	226	0.007	86	160	0.006	95	169
S_1	0.036	37	110	0.044	114	187	0.016	80	154	0.026	136	210
S_2	0.015	185	331	0.026	323	109	0.014	170	318	0.006	295	83
Mu_2	0.005	121	267	0.007	280	66	0.002	118	266	0.004	185	333
Sa	0.019	15	15	0.012	37	37	0.052	128	128	0.017	118	118
Ssa	0.023	145	145	0.081	204	204	0.013	295	295	0.017	213	213
	Northeast End Lightship 369 days beginning October 28, 1918. Magnetic variation 8° west						**Winter-Quarter Shoal Lightship** 369 days beginning January 1, 1919. Magnetic variation 7° west					
K_1	0.033	8	82	0.010	117	191	0.037	45	120	0.023	101	176
K_2	0.013	174	323	0.006	346	135	0.011	80	230	0.008	64	214
L_2	0.008	94	243	0.006	309	98	0.000			0.005	256	46
M_1	0.011	99	173	0.004	122	196	0.011	246	321	0.003	226	301
M_2	0.103	175	324	0.180	319	108	0.047	198	348	0.046	283	73
M_3	0.004	305	168	0.001	339	202	0.004	215	80	0.002	263	128
M_4	0.002	332	270	0.005	15	313	0.003	100	40	0.004	137	77
M_6	0.008	268	355	0.002	272	359	0.000			0.001	105	195
M_8	0.004	3	239	0.005	355	231	0.002	201	81	0.002	280	160
N_2	0.025	171	320	0.034	305	94	0.010	154	304	0.014	243	33
O_1	0.016	224	298	0.042	207	281	0.024	338	53	0.023	66	141
P_1	0.015	19	93	0.015	136	210	0.022	118	193	0.007	85	160
Q_1	0.009	90	164	0.014	139	213	0.007	159	234	0.007	302	17
S_1	0.025	90	164	0.033	165	239	0.033	140	215	0.019	218	293
S_2	0.024	178	327	0.031	339	128	0.006	208	358	0.005	345	135
Mu_2	0.001	210	359	0.004	14	163	0.004	122	272	0.004	247	37
Sa	0.065	125	125	0.021	105	105	0.101	122	122	0.019	254	254
Ssa	0.032	193	193	0.038	230	230	0.030	138	138	0.050	242	242

Table 7.—*Current Harmonic Constants, Atlantic Coast Lightships*—Con.

Constituent	North component (magnetic): Velocity H (knots)	North component (magnetic): Epoch, Local (κ) (degrees)	North component (magnetic): Epoch, Greenwich (degrees)	East component (magnetic): Velocity H (knots)	East component (magnetic): Epoch, Local (κ) (degrees)	East component (magnetic): Epoch, Greenwich (degrees)	North component (magnetic): Velocity H (knots)	North component (magnetic): Epoch, Local (κ) (degrees)	North component (magnetic): Epoch, Greenwich (degrees)	East component (magnetic): Velocity H (knots)	East component (magnetic): Epoch, Local (κ) (degrees)	East component (magnetic): Epoch, Greenwich (degrees)
	Chesapeake Lightship 369 days beginning March 29, 1935. Magnetic variation 7° west						**Diamond Shoal Lightship** 369 days beginning January 1, 1921. Magnetic variation 6° west					
K_1	0.047	103	179	0.048	206	282	0.018	63	138	0.029	5	80
K_2	0.008	292	83	0.016	23	174	0.003	162	313	0.010	60	211
L_2	0.015	158	309	0.009	267	58	0.009	93	244	0.011	62	213
M_1	0.004	39	115	0.003	72	148	0.015	66	141	0.013	162	237
M_2	0.036	207	358	0.151	22	173	0.034	155	306	0.027	253	44
M_3	0.003	63	290	0.004	48	275	0.006	263	129	0.008	212	78
M_4	0.003	338	281	0.005	283	226	0.004	110	51	0.005	158	99
M_6	0.004	306	40	0.002	152	246	0.004	125	217	0.004	1	93
M_8	0.003	30	276	0.004	18	264	0.005	181	64	0.005	151	34
N_2	0.006	152	303	0.040	355	146	0.028	139	290	0.015	238	29
O_1	0.023	66	142	0.010	270	346	0.030	215	290	0.038	285	0
P_1	0.030	104	180	0.028	188	264	0.021	243	318	0.014	218	293
Q_1	0.010	150	226	0.009	214	290	0.009	3	78	0.024	325	40
S_1	0.058	105	181	0.044	184	260	0.013	33	108	0.009	330	45
S_2	0.010	254	45	0.035	49	200	0.016	104	255	0.004	198	349
Mu_2	0.009	57	208	0.009	11	162	0.007	140	291	0.008	153	304
Sa	0.098	93	93	0.035	10	10	0.255	129	129	0.189	154	154
Ssa	0.028	272	272	0.024	190	190	0.033	316	316	0.036	159	159
	Diamond Shoal Lightship 369 days beginning January 1, 1922. Magnetic variation 6° west						**Cape Lookout Shoals Lightship** 369 days beginning September 27, 1918. Magnetic variation 4° west					
K_1	0.018	21	96	0.020	359	74	0.030	54	130	0.032	190	266
K_2	0.005	121	272	0.010	236	27	0.016	306	99	0.022	336	129
L_2	0.007	115	266	0.003	153	304	0.005	295	88	0.011	322	115
M_1	0.005	157	232	0.010	52	127	0.012	358	74	0.015	95	171
M_2	0.030	212	3	0.026	259	50	0.069	179	332	0.172	283	76
M_3	0.006	275	141	0.006	345	211	0.007	256	125	0.014	204	73
M_4	0.001	141	82	0.006	149	90	0.005	181	127	0.011	92	38
M_6	0.006	200	292	0.006	290	22	0.001	54	152	0.005	65	163
M_8	0.003	282	165	0.004	305	188	0.003	357	248	0.003	57	308
N_2	0.012	188	339	0.007	216	7	0.024	174	327	0.028	254	47
O_1	0.036	172	247	0.021	202	277	0.007	67	143	0.017	123	199
P_1	0.013	58	133	0.008	96	171	0.034	112	188	0.032	157	233
Q_1	0.016	161	236	0.014	302	17	0.016	10	86	0.013	26	102
S_1	0.032	67	142	0.016	54	129	0.046	124	200	0.044	198	274
S_2	0.015	230	21	0.007	231	22	0.021	173	326	0.025	295	88
Mu_2	0.003	22	173	0.007	78	229	0.013	4	157	0.010	287	80
Sa	0.526	64	64	0.325	57	57	0.074	85	85	0.091	116	116
Ssa	0.146	229	229	0.111	222	222	0.017	135	135	0.070	235	235
	Frying Pan Shoals Lightship 369 days beginning September 27, 1918. Magnetic variation 3° west						**Frying Pan Shoals Lightship** 369 days beginning January 1, 1920. Magnetic variation 3° west					
K_1	0.031	50	128	0.030	135	213	0.016	44	122	0.035	122	200
K_2	0.014	140	296	0.019	275	71	0.014	199	355	0.022	281	77
L_2	0.013	145	301	0.014	224	20	0.009	276	72	0.019	334	130
M_1	0.001	143	221	0.011	51	129	0.005	81	159	0.010	123	201
M_2	0.237	142	298	0.302	257	53	0.245	137	293	0.308	255	51
M_3	0.004	80	313	0.003	8	241	0.004	108	341	0.011	290	163
M_4	0.007	349	300	0.007	6	317	0.007	343	294	0.002	32	343
M_6	0.004	90	197	0.004	198	305	0.003	235	342	0.003	272	19
M_8	0.002	150	52	0.006	180	82	0.006	136	38	0.003	264	166
N_2	0.057	124	280	0.079	244	40	0.060	111	267	0.059	225	21
O_1	0.017	48	126	0.028	105	183	0.020	34	112	0.029	100	178
P_1	0.005	68	146	0.021	144	222	0.023	123	201	0.014	210	288
Q_1	0.003	129	207	0.004	352	70	0.009	348	66	0.007	285	3
S_1	0.053	97	175	0.047	174	252	0.054	108	186	0.052	183	261
S_2	0.054	160	316	0.068	270	66	0.053	162	318	0.061	272	68
Mu_2	0.016	48	204	0.005	79	235	0.007	139	295	0.014	187	343
Sa	0.036	95	95	0.101	116	116	0.035	128	128	0.069	105	105
Ssa	0.000	.....	.....	0.155	245	245	0.020	225	225	0.121	202	202

TABLE 7.—*Current Harmonic Constants, Atlantic Coast Lightships*—Con.

Constituent	North component (magnetic)			East component (magnetic)			North component (magnetic)			East component (magnetic)		
	Velocity *H* (knots)	Epoch		Velocity *H* (knots)	Epoch		Velocity *H* (knots)	Epoch		Velocity *H* (knots)	Epoch	
		Local (κ) (degrees)	Greenwich (degrees)		Local (κ) (degrees)	Greenwich (degrees)		Local (κ) (degrees)	Greenwich (degrees)		Local (κ) (degrees)	Greenwich (degrees)
	Savannah Lightship 369 days beginning April 27, 1925. Magnetic variation 0°						**Savannah Lightship** 369 days beginning April 17, 1934. Magnetic variation 0°					
K_1	0.032	56	137	0.031	176	257	0.016	80	161	0.026	193	274
K_2	0.009	209	10	0.021	319	120	0.013	168	329	0.015	323	124
L_2	0.001	180	341	0.013	264	65	0.007	140	301	0.011	276	77
M_1	0.006	163	244	0.014	215	296	0.007	359	80	0.003	72	153
M_2	0.192	167	328	0.374	306	107	0.145	173	334	0.289	312	113
M_3	0.004	236	118	0.016	40	282	0.004	223	105	0.011	44	286
M_4	0.014	129	92	0.011	332	295	0.009	228	191	0.010	320	283
M_6	0.008	69	193	0.003	273	37	0.004	74	198	0.005	256	20
M_8	0.001	231	156	0.009	121	46	0.006	324	249	0.003	331	256
N_2	0.049	155	316	0.088	293	94	0.028	155	316	0.059	295	96
O_1	0.011	81	162	0.025	242	323	0.008	95	176	0.015	158	239
P_1	0.020	136	217	0.026	229	310	0.027	135	216	0.024	196	277
Q_1	0.004	4	85	0.000			0.006	23	104	0.006	139	220
S_1	0.052	124	205	0.030	194	275	0.048	136	217	0.035	216	297
S_2	0.050	177	338	0.080	330	131	0.032	186	347	0.052	333	134
Mu_2	0.013	158	319	0.020	310	111	0.009	149	310	0.016	347	148
Sa	0.078	118	118	0.046	29	29	0.115	92	92	0.046	52	52
Ssa	0.042	218	218	0.024	240	240	0.029	246	246	0.042	237	237
	Brunswick Lightship 369 days beginning January 1, 1919. Magnetic variation 0°						**Brunswick Lightship** 369 days beginning January 1, 1920. Magnetic variation 0°					
K_1	0.024	111	192	0.027	229	310	0.016	107	188	0.020	218	299
K_2	0.018	209	11	0.020	330	132	0.014	232	34	0.027	325	127
L_2	0.012	240	42	0.013	8	170	0 009	165	327	0.017	318	120
M_1	0.003	102	183	0.003	117	198	0.012	274	355	0.006	287	8
M_2	0.184	186	348	0.337	333	135	0.203	166	328	0.354	314	116
M_3	0.005	227	110	0.002	44	287	0.010	205	88	0.004	19	262
M_4	0.016	182	147	0.004	116	81	0.012	162	127	0.005	352	317
M_6	0.012	172	299	0.009	259	26	0.007	123	250	0.008	227	354
M_8	0.001	271	200	0.003	300	229	0.003	101	30	0.001	133	62
N_2	0.044	152	314	0.081	309	111	0.042	151	313	0.082	301	103
O_1	0.026	101	182	0.021	183	264	0.025	62	143	0.019	193	274
P_1	0.014	144	225	0.016	234	315	0.023	124	205	0.018	242	323
Q_1	0.004	159	240	0.013	335	56	0.008	82	163	0.002	44	125
S_1	0.055	158	239	0.044	246	327	0.046	153	234	0.039	238	319
S_2	0 044	213	15	0.077	352	154	0.047	181	343	0.059	341	143
Mu_2	0.006	200	2	0.008	341	143	0.013	146	308	0.015	278	80
Sa	0.108	117	117	0.020	71	71	0.116	90	90	0.061	346	346
Ssa	0.032	157	157	0.025	242	242	0.092	244	244	0.058	262	262

TABLE 7.—*Current Harmonic Constants, Atlantic Coast Lightships*—Con.

Constituent	North component (magnetic)			East component (magnetic)		
	Velocity H (Knots)	Epoch		Velocity H (Knots)	Epoch	
		Local (κ) (Degrees)	Greenwich (Degrees)		Local (κ) (Degrees)	Greenwich (Degrees)
St. Johns Lightship						
369 days beginning December 23, 1933. Magnetic variation 1° east						
K_1	0.039	134	215	0.039	257	338
K_2	0.010	173	336	0.004	32	195
L_2	0.008	116	279	0.013	222	25
M_1	0.005	211	292	0.007	352	73
M_2	0.154	144	307	0.090	318	121
M_3	0.008	136	20	0.004	240	124
M_4	0.006	130	95	0.011	238	203
M_6	0.006	16	144	0.006	340	108
M_8	0.004	231	161	0.001	81	11
N_2	0.033	122	285	0.023	302	105
O_1	0.014	51	132	0.007	203	284
P_1	0.020	131	212	0.043	224	305
Q_1	0.016	46	127	0.009	174	255
S_1	0.079	142	223	0.098	241	322
S_2	0.035	180	343	0.022	337	140
Mu_2	0.011	193	356	0.011	290	93
Sa	0.125	99	99	0.042	124	124
Ssa	0.022	225	225	0.040	233	233
Portland Lightship						
163 days beginning May 20, 1919. Magnetic variation 16° west						
K_1	0.012	318	28	0.013	68	138
M_1	0.008	7	77	0.015	352	62
M_2	0.131	244	24	0.031	76	216
M_4	0.008	36	316	0.003	109	29
M_6	0.001	320	21	0.000	----	----
N_2	0.032	248	28	0.020	71	211
O_1	0.017	157	227	0.012	300	10
S_2	0.016	315	95	0.004	180	320
Pollock Rip Lightship (1911 Position)						
87 days beginning June 20, 1911. Magnetic variation 14° west						
K_1	0.039	149	219	0.095	295	5
M_2	0.650	135	275	1.186	191	331
M_4	0.126	225	145	0.039	17	297
M_6	0.021	303	2	0.032	32	91
M_8	0.025	96	295	0.018	44	243
O_1	0.016	69	139	0.030	226	296
S_2	0.095	164	304	1.153	216	356
S_4	0.008	354	274	0.017	313	233
Great Round Shoal Lightship						
87 days beginning June 20, 1911. Directions are true						
K_1	0.003	58	128	0.101	341	51
M_2	0.621	191	331	1.150	232	12
M_4	0.126	83	3	0.143	187	107
M_6	0.021	15	75	0.041	306	6
M_8	0.020	2	201	0.024	246	85
O_1	0.011	246	316	0.105	264	334
S_2	0.108	219	359	0.231	259	39
S_4	0.011	177	97	0.007	75	355

TABLE 7.—*Current Harmonic Constants, Atlantic Coast Lightships*—Con.

Constituent	North component (magnetic)			East component (magnetic)		
	Velocity H (Knots)	Epoch		Velocity H (Knots)	Epoch	
		Local (κ) (Degrees)	Greenwich (Degrees)		Local (κ) (Degrees)	Greenwich (Degrees)
Vineyard Sound Lightship						
Two 29-day series, 1913. Magnetic variation 13° west						
M_2	0.449	153	295	0.169	252	34
M_4	0.034	92	16	0.029	259	183
Bartlett Reef Lightship						
87 days beginning September 27, 1913. Magnetic variation 11° west						
K_1	0.023	89	161	0.065	187	259
M_2	0.409	251	35	1.102	44	188
M_4	0.162	260	189	0.039	65	354
M_6	0.002	346	59	0.035	113	186
N_2	0.096	226	10	0.220	17	161
O_1	0.018	87	159	0.042	198	270
S_2	0.090	291	75	0.199	54	198
Ambrose Channel Lightship (1912–22 position)						
87 days beginning November 5, 1912. Magnetic variation 10° west						
M_2	0.045	157	305	0.197	2	150
M_4	0.007	58	353	0.012	147	82
M_6	0.008	135	218	0.011	318	41
S_2	0.039	188	336	0.044	8	156
S_4	0.009	314	249	0.011	196	131
Scotland Lightship						
87 days beginning November 6, 1912. Magnetic variation 10° west						
M_2	0.350	201	349	0.383	348	136
M_4	0.068	263	199	0.034	54	350
M_6	0.038	316	40	0.023	152	236
S_2	0.044	181	329	0.053	358	146
S_4	0.009	83	19	0.018	158	94
Fenwick Island Shoal Lightship						
87 days beginning November 5, 1912. Magnetic variation 7° west						
M_2	0.260	194	344	0.117	320	110
M_4	0.009	242	181	0.021	322	261
M_6	0.008	256	345	0.012	285	14
S_2	0.054	208	358	0.023	354	144
S_4	0.002	341	280	0.002	181	120
Cape Charles Lightship						
87 days beginning June 2, 1912. Directions are true						
K_1	0.138	118	194	0.172	211	287
M_2	0.036	50	201	0.301	9	160
M_4	0.018	143	86	0.005	207	150
M_6	0.014	220	314	0.005	80	174
N_2	0.012	345	136	0.070	354	145
O_1	0.053	46	122	0.046	250	326
S_2	0.016	163	314	0.065	10	161
S_4	0.003	190	133	0.001	267	210

Table 7.—*Current Harmonic Constants, Atlantic Coast Lightships*—Con.

Constituent	North component (magnetic)			East component (magnetic)		
	Velocity H (Knots)	Epoch		Velocity H (Knots)	Epoch	
		Local (κ) (Degrees)	Greenwich (Degrees)		Local (κ) (Degrees)	Greenwich (Degrees)
Charleston Lightship						
87 days beginning June 7, 1912. Magnetic variation 1° west						
K_1	0.052	124	204	0.064	196	276
M_2	0.216	179	338	0.416	280	79
M_4	0.012	231	190	0.025	296	255
M_6	0.003	121	239	0.009	256	14
N_2	0.048	163	322	0.087	260	59
O_1	0.032	85	165	0.015	158	238
S_2	0.026	165	324	0.055	294	93
S_4	0.007	347	306	0.010	49	8
Martins Industry Lightship						
87 days beginning June 17, 1912. Directions are true						
K_1	0.085	134	214	0.083	215	295
M_2	0.179	171	332	0.508	301	102
M_4	0.007	194	156	0.021	323	285
M_6	0.017	320	83	0.010	207	330
N_2	0.034	170	331	0.127	280	81
O_1	0.029	80	160	0.012	197	277
S_2	0.027	178	339	0.084	324	125
S_4	0.006	331	293	0.010	94	56

Epochs apply to times of maximum flow in a north or east direction. The local epochs refer to the local Meridan, Greenwich epochs to the Greenwich meridian.

For reference to above table, see p. 22.

TABLE 8.—*Current Harmonic Constants, Atlantic Coast Lightships*

[369-day series]

Constituent	Pollock Rip			Stone Horse Shoal			Stone Horse Shoal			Handkerchief			Cross Rip			Cornfield Point		
	Velocity	Epoch		Velocity	Epoch		Velocity	Epoch		Velocity	Epoch		Velocity	Epoch		Velocity	Epoch	
	H	Local (κ)	Greenwich	*H*	Local (κ)	Greenwich	*H*	Local (κ)	Greenwich	*H*	Local (κ)	Greenwich	*H*	Local (κ)	Greenwich	*H*	Local (κ)	Greenwich
	Knots	*Degrees*	*Degrees*	*Knots*	*Degrees*	*Degrees*	*Knots*	*Degrees*	*Degrees*	*Knots*	*Degrees*	*Degrees*	*Knots*	*Degrees*	*Degrees*	*Knots*	*Degrees*	*Degrees*
K_1	0.042	244	314	0.103	318	28	0.100	313	23	0.063	327	37	0.087	13	83	0.058	29	101
K_2	0.059	190	330	0.091	209	349	0.096	222	2	0.063	247	27	0.094	258	39	0.085	263	48
L_2	0.025	149	289	0.186	250	30	0.210	219	359	0.115	285	65	0.061	322	103	0.102	291	76
M_1	0.004	119	189	0.007	252	322	0.006	201	271	0.002	66	136	0.007	181	251	0.017	184	256
M_2	1.152	166	306	1.808	183	323	1.828	182	322	1.176	212	352	1.041	237	18	1.746	234	19
M_3	0.003	74	284	0.017	15	225	0.011	251	101	0.016	61	271	0.012	226	77	0.016	196	53
M_4	0.036	21	300	0.079	110	30	0.080	122	42	0.080	152	72	0.041	138	59	0.077	227	156
M_6	0.043	133	192	0.034	21	81	0.057	22	82	0.029	67	127	0.027	8	70	0.027	303	17
M_8	0.007	11	210	0.012	308	148	0.008	34	234	0.016	29	230	0.007	22	224	0.034	58	277
N_2	0.194	122	262	0.286	143	283	0.298	142	282	0.198	168	308	0.207	204	345	0.350	205	350
O_1	0.027	182	252	0.072	255	325	0.077	254	324	0.073	301	11	0.042	328	38	0.029	15	87
P_1	0.010	200	270	0.036	304	14	0.020	327	37	0.020	338	48	0.024	11	81	0.013	307	19
Q_1	0.003	269	339	0.008	271	341	0.012	204	274	0.008	284	354	0.000	----	----	0.022	87	159
S_1	0.046	101	171	0.021	77	147	0.014	90	160	0.011	182	252	0.014	104	174	0.038	270	342
S_2	0.179	197	337	0.279	216	356	0.262	216	356	0.160	240	20	0.190	264	45	0.301	259	44
Mu_2	0.043	334	114	0.075	346	126	0.064	340	120	0.063	30	170	0.013	134	275	0.073	28	173
Sa	0.036	94	94	0.052	99	99	0.075	90	90	0.023	4	4	0.015	320	320	0.062	63	63
Ssa	0.021	288	288	0.016	168	168	0.036	319	319	0.017	207	207	0.034	236	236	0.040	233	233
Series begins	Aug. 7, 1934			Aug. 7, 1934			Aug. 11, 1935			Aug. 7, 1934			Aug. 8, 1934			July 28, 1929.		
Direction of flood strength.	16° true			37° true			37° true			80° true			91° true			254° true.		
Direction of ebb strength	202° true			226° true			226° true			251° true			272° true			98° true.		

Epochs apply to the times of flood strength.
The local epochs refer to the local meridian, Greenwich epochs to the Greenwich meridian.
For reference to above table, see p. 22.

TABLE 9.—*Current Harmonic Constants, Atlantic Coast Lightships*

[Series less than 369 days in length]

Constituent	Ram Island Reef			Overfalls			Tail of the Horseshoe		
	Velocity	Epoch		Velocity	Epoch		Velocity	Epoch	
	H	Local (κ)	Greenwich	*H*	Local (κ)	Greenwich	*H*	Local (κ)	Greenwich
	Knots	*Degrees*	*Degrees*	*Knots*	*Degrees*	*Degrees*	*Knots*	*Degrees*	*Degrees*
K_1	0.068	21	93	0.141	55	130	0.156	179	255
K_2	0.109	259	43	0.095	220	10	0.068	326	118
L_2	----	----	----	0.131	240	30	----	----	----
M_1	0.004	148	220	0.015	215	290	0.017	194	270
M_2	1.433	224	8	1.708	188	338	1.101	253	45
M_3	----	----	----	0.010	193	58	----	----	----
M_4	0.062	194	122	0.020	308	248	0.042	55	359
M_6	----	----	----	0.025	181	271	0.007	34	130
M_8	----	----	----	0.005	99	339	0.010	41	289
N_2	0.293	202	346	0.290	156	306	0.254	227	19
O_1	0.028	62	134	0.096	56	131	0.176	134	210
P_1	----	----	----	0.036	39	114	----	----	----
S_2	0.228	245	29	0.201	202	352	0.236	278	70
S_4	0.006	259	187	0.009	270	210	0.014	350	294
S_6	----	----	----	0.002	180	270	0.004	110	206
Mu_2	----	----	----	0.045	356	146	----	----	----
Nu_2	----	----	----	0.068	181	331	----	----	----
Series begins.	Sept. 27, 1913			Mar. 21, 1920			Aug. 1, 1919.		
Length of series.	87 days			297 days			87 days.		
Direction of flood strength.	253° true			310° true			305° true.		
Direction of ebb strength.	86° true			135° true			125° true.		

Epochs apply to the times of flood strength.
The local epochs refer to the local meridian, Greenwich epochs to the Greenwich meridian.
For reference to above table, see p. 22.

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TABLE 10.—*Hourly Directions and Velocities of the Solar Diurnal Current, Atlantic Coast Lightships*

[Derived graphically from results of harmonic analyses of current observations]

Hour of the day (75th meridian time)	True direction (Degrees)	Velocity (Knots)	True direction (Degrees)	Velocity (Knots)	True direction (Degrees)	Velocity (Knots)	True direction (Degrees)	Velocity (Knots)	True direction (Degrees)	Velocity (Knots)	True direction (Degrees)	Velocity (Knots)	True direction (Degrees)	Velocity (Knots)	True direction (Degrees)	Velocity (Knots)
Lightship station	Boston		Pollock Rip Slue		Nantucket Shoals		Hen and Chickens		Brenton Reef		Fire Island		Barnegat		Northeast End	
Years of observations	1		1		2		1		1		1		1		1	
Midnight	93	0.024	109	0.009	140	0.010	169	0.014	192	0.016	139	0.034	90	0.018	83	0.032
1	107	0.023	142	0.012	183	0.003	177	0.019	208	0.022	159	0.035	109	0.015	96	0.029
2	122	0.023	160	0.016	280	0.007	181	0.024	217	0.027	178	0.036	137	0.012	112	0.026
3	138	0.022	170	0.020	294	0.014	184	0.027	223	0.031	194	0.039	170	0.013	131	0.024
4	154	0.022	177	0.023	299	0.020	186	0.029	229	0.034	208	0.042	194	0.017	152	0.023
5	170	0.022	182	0.025	301	0.025	189	0.028	234	0.034	220	0.045	209	0.021	173	0.024
6	187	0.022	187	0.025	303	0.029	191	0.026	239	0.031	231	0.046	220	0.024	192	0.027
7	203	0.023	192	0.024	304	0.030	195	0.022	245	0.028	242	0.046	227	0.027	207	0.029
8	218	0.023	199	0.021	306	0.029	200	0.016	254	0.023	254	0.044	234	0.028	220	0.032
9	232	0.024	207	0.018	308	0.027	212	0.010	268	0.017	267	0.041	241	0.027	231	0.034
10	246	0.024	221	0.013	310	0.023	256	0.005	297	0.012	282	0.038	248	0.026	241	0.034
11	260	0.024	247	0.009	313	0.017	329	0.007	341	0.011	299	0.035	258	0.022	252	0.034
Noon	273	0.024	289	0.009	320	0.010	349	0.014	12	0.016	319	0.034	270	0.018	263	0.032
13	287	0.023	322	0.012	3	0.003	357	0.019	28	0.022	339	0.035	289	0.015	276	0.029
14	302	0.023	340	0.016	100	0.007	1	0.024	37	0.027	358	0.036	317	0.012	292	0.026
15	318	0.022	350	0.020	114	0.014	4	0.027	43	0.031	14	0.039	350	0.013	311	0.024
16	334	0.022	357	0.023	119	0.020	6	0.029	49	0.034	28	0.042	14	0.017	332	0.023
17	350	0.022	2	0.025	121	0.025	9	0.028	54	0.034	40	0.045	29	0.021	353	0.024
18	7	0.022	7	0.025	123	0.029	11	0.026	59	0.031	51	0.046	40	0.024	12	0.027
19	23	0.023	12	0.024	124	0.030	15	0.022	65	0.028	62	0.046	47	0.027	27	0.029
20	38	0.023	19	0.021	126	0.029	20	0.016	74	0.023	74	0.044	54	0.028	40	0.032
21	52	0.024	27	0.018	128	0.027	32	0.010	88	0.017	87	0.041	61	0.027	51	0.034
22	66	0.024	41	0.013	130	0.023	76	0.005	117	0.012	102	0.038	68	0.026	61	0.034
23	80	0.024	67	0.009	133	0.017	149	0.007	161	0.011	119	0.035	78	0.022	72	0.034

TABLE 10.—*Hourly Directions and Velocities of the Solar Diurnal Current, Atlantic Coast Lightships*—Continued

Hour of the day (75th meridian time)	True direction (Degrees)	Velocity (Knots)	True direction (Degrees)	Velocity (Knots)	True direction (Degrees)	Velocity (Knots)	True direction (Degrees)	Velocity (Knots)	True direction (Degrees)	Velocity (Knots)	True direction (Degrees)	Velocity (Knots)	True direction (Degrees)	Velocity (Knots)	True direction (Degrees)	Velocity (Knots)
Lightship station	Winter-Quarter Shoal		Chesapeake		Diamond Shoal		Cape Lookout Shoals		Frying Pan Shoals		Savannah		Brunswick		St. Johns	
Years of observations	1		1		2		1		2		2		2		1	
Midnight	24	0.029	63	0.046	211	0.015	53	0.049	71	0.051	37	0.045	18	0.050	31	0.077
1	36	0.025	82	0.043	205	0.019	66	0.046	86	0.048	50	0.040	31	0.049	50	0.080
2	52	0.022	103	0.042	201	0.022	81	0.043	103	0.045	67	0.035	44	0.046	66	0.086
3	75	0.019	123	0.044	198	0.023	97	0.041	123	0.044	89	0.031	59	0.044	80	0.092
4	101	0.019	141	0.047	195	0.024	116	0.038	141	0.046	113	0.031	76	0.042	93	0.097
5	126	0.021	156	0.052	191	0.022	135	0.038	160	0.048	136	0.034	94	0.041	105	0.099
6	144	0.024	169	0.056	187	0.019	154	0.040	175	0.051	154	0.039	112	0.041	116	0.098
7	158	0.028	181	0.058	181	0.015	172	0.041	189	0.054	168	0.044	130	0.043	128	0.095
8	168	0.031	192	0.059	170	0.010	186	0.046	201	0.056	179	0.048	146	0.045	141	0.091
9	177	0.033	202	0.058	141	0.006	199	0.049	213	0.057	188	0.050	160	0.047	156	0.085
10	185	0.033	214	0.055	77	0.006	211	0.051	224	0.056	197	0.050	174	0.049	173	0.080
11	194	0.032	227	0.051	44	0.010	222	0.050	237	0.054	206	0.049	186	0.050	192	0.077
Noon	204	0.029	243	0.046	31	0.015	233	0.049	251	0.051	217	0.045	198	0.050	211	0.077
13	216	0.025	262	0.043	25	0.019	246	0.046	266	0.048	230	0.040	211	0.049	230	0.080
14	232	0.022	283	0.042	21	0.022	261	0.043	283	0.045	247	0.035	224	0.046	246	0.086
15	255	0.019	303	0.044	18	0.023	277	0.041	303	0.044	269	0.031	239	0.044	260	0.092
16	281	0.019	321	0.047	15	0.024	296	0.038	321	0.046	293	0.031	256	0.042	273	0.097
17	306	0.021	336	0.052	11	0.022	315	0.038	340	0.048	316	0.034	274	0.041	285	0.099
18	324	0.024	349	0.056	7	0.019	334	0.041	355	0.051	334	0.039	292	0.041	296	0.098
19	338	0.028	1	0.058	1	0.015	352	0.043	9	0.054	348	0.044	310	0.043	308	0.095
20	348	0.031	12	0.059	350	0.010	6	0.046	21	0.056	359	0.048	326	0.045	321	0.091
21	357	0.033	22	0.058	321	0.006	19	0.049	33	0.057	8	0.050	340	0.047	336	0.085
22	5	0.033	34	0.055	257	0.006	31	0.051	44	0.056	17	0.050	354	0.049	353	0.080
23	14	0.032	47	0.051	224	0.010	42	0.050	57	0.054	26	0.049	6	0.050	12	0.077

For reference to above table, see p. 22.

TABLE 11.—*Nontidal Currents by Months, Atlantic Coast Lightships*

[Directions are true]

Lightship and location	Observations		Units	Velocities and true directions												
				Months												
	Date	Period (months)		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average all months
Portland (43°31'.5 N., 70°05'.6 W.)	Oct.-Dec., 1913	3	Knots										0.28	0.12	0.17	
			Degrees										227	98	147	
	June-Oct., 1919	5	Knots						0.14	0.10	0.07	0.02	0.07			
			Degrees						215	63	254	47	58			
	1913-1919	8	Knots						0.14	0.10	0.07	0.02	0.11	0.12	0.17	0.05
			Degrees						215	63	254	47	221	98	147	164
U.S.S. *Easthampton* (42°24'.1 N., 70°23'.8 W.)	Mar.-May 1919	2	Knots													[1] 0.11
			Degrees													[1] 170
Boston (42°20'.4 N., 70°45'.4 W.)	Oct.-Dec. 1913, June 1926	4	Knots						0.07				0.05	0.05	0.04	
			Degrees						75				177	357	110	
	July 1926-June 1927	12	Knots	0.03	0.03	0.06	0.10	0.04	0.02	0.05	0.00	0.01	0.00	0.02	0.03	
			Degrees	120	165	114	136	41	345	38		345		12	120	
	1913-1927	16	Knots	0.03	0.03	0.06	0.10	0.04	0.04	0.05	0.00	0.01	0.02	0.04	0.04	0.02
			Degrees	120	165	114	136	41	56	38		345	177	0	117	97
Pollock Rip Slue (41°36'.7 N., 69°53'.8 W.)	June-Aug. 1911, Dec. 1918	4	Knots						0.23	0.24	0.27				0.20	
			Degrees						225	240	237				233	
	Jan.-Dec. 1919	11	Knots	0.10	0.20	0.29	0.17	0.08		0.23	0.30	0.29	0.27	0.27	0.20	
			Degrees	246	180	242	245	180		255	250	254	253	222	246	
	Jan.-Dec. 1920	11	Knots	0.25	0.33	0.21	0.20	0.28	0.22	0.15	0.25		0.15	0.09	0.18	
			Degrees	241	229	293	259	180	233	239	236		232	191	205	
	Jan.-July 1921	7	Knots	0.13	0.21	0.12	0.13	0.26	0.19	0.18						
			Degrees	219	221	250	243	231	192	218						
	1911-1921	33	Knots	0.16	0.23	0.19	0.17	0.18	0.21	0.20	0.27	0.29	0.21	0.17	0.18	0.20
			Degrees	235	214	261	249	202	219	239	241	254	247	215	229	235
Pollock Rip (1934-35) (41°36'.1 N., 69°51'.1 W.)	Aug. 1934-Aug. 1935	13	Knots	0.11	0.05	0.06	0.14	0.07	0.22	0.13	[2] 0.19	0.20	0.09	0.12	0.20	0.08
			Degrees	158	191	180	270	225	297	309	289	270	192	261	153	250

See footnotes at end of table.

TABLE 11.—*Nontidal Currents by Months, Atlantic Coast Lightships*—Continued

[Directions are true]

Lightship and location	Observations		Units	Velocities and true directions												
				Months												
	Date	Period (months)		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average all months
Stone Horse Shoal (41°32′.8 N., 69°59′.1 W.)	Aug.-Dec. 1934	5	Knots								0.09	0.20	0.14	0.35	0.17	
			Degrees								49	0	335	336	346	
	Jan.-Dec. 1935	12	Knots	0.22	0.24	0.27	0.16	0.24	0.32	0.33	0.32	0.17	0.16	0.12	0.10	
			Degrees	326	325	343	60	78	346	348	330	17	333	290	127	
	Jan.-Aug. 1936	8	Knots	0.10	0.13	0.33	0.24	0.27	0.28	0.25	0.28					
			Degrees	79	321	331	327	334	334	346	348					
	1934-1936	25	Knots	0.10	0.19	0.30	0.14	0.15	0.30	0.29	0.21	0.18	0.15	0.22	0.05	0.18
			Degrees	354	324	337	0	337	340	348	346	6	337	326	22	343
Shovelful Shoal (41°32′.7 N., 69°59′.3 W.)	Oct.-Dec. 1913	3	Knots										0.20	0.14	0.21	0.17
			Degrees										225	188	185	200
Stone Horse Shoal (1918-19) (41°32′.4 N., 69° 59′.2 W.).	Dec. 1918-Aug. 1919	9	Knots	0.04	0.25	0.10	0.15	0.22	0.13	0.24	0.20				0.02	0.06
			Degrees	154	152	0	113	95	51	355	330				180	64
Pollock Rip (1911) (41°32′.1 N., 69°54′.8 W.)	July-Sept. 1911	3	Knots							0.38	0.43	0.40				0.41
			Degrees							148	147	147				147
Great Round Shoal (41°24′.2 N., 69°54′.9 W.)	July-Sept. 1911	3	Knots							0.09	0.15	0.07				0.10
			Degrees							108	127	124				121
Nantucket Shoals (40°37′.0 N., 69°37′.1 W.)	July-Aug. 1911	2	Knots							0.09	0.09					
			Degrees							325	311					
	Oct. 1913-Sept. 1914	12	Knots	0.10	0.07	0.02	0.07	0.11	0.08	0.16	0.17	0.21	0.18	0.05	0.10	
			Degrees	220	140	50	284	306	347	310	323	276	260	235	130	
	Dec. 1918-Nov. 1919	10	Knots		0.08	0.14	0.13	0.26	0.19		0.19	0.15	0.13	0.07	0.09	
			Degrees		197	265	299	275	344		338	294	284	249	113	
	Mar.-Sept. 1920	7	Knots			0.05	0.04	0.14	0.18	0.11	0.22	0.09				
			Degrees			279	13	302	328	36	325	244				
	Jan.-Nov. 1921	9	Knots	0.09	0.06			0.30	0.07	0.27	0.06	0.09	0.04	0.15		
			Degrees	132	198			271	321	316	329	326	32	336		
	Jan.-Nov. 1922	10	Knots	0.22	0.18	0.20		0.09	0.16	0.19	0.15	0.21	0.10	0.08		
			Degrees	128	80	110		340	343	322	339	280	281	167		
	Feb.-Dec. 1923 [3]	11	Knots		0.10	0.04	0.10	0.05	0.13	0.26	0.11	0.17	0.13	0.28	0.06	
			Degrees		203	290	309	357	327	311	312	301	289	256	246	
	Jan.-Dec. 1924 [3]	10	Knots	0.02	0.13	0.12	0.11		0.21	0.24	0.18	0.22		0.08	0.15	
			Degrees	346	189	171	346		315	318	306	299		46	108	
	Jan.-July 1925 [3]	7	Knots	0.04	0.12	0.10	0.06	0.13	0.11	0.22						
			Degrees	200	332	273	275	301	1	322						
	1911-1925	78	Knots	0.07	0.04	0.03	0.08	0.14	0.14	0.18	0.14	0.16	0.10	0.06	0.08	0.06
			Degrees	150	167	211	311	292	334	321	324	289	280	268	124	300
Handkerchief (41°29′.3 N., 70°04′.0 W.)	July-Sept. 1911	3	Knots							0.41	0.51	0.48				
			Degrees							164	162	163				
	Aug. 1934-Aug. 1935	13	Knots	0.13	0.12	0.05	0.10	0.07	0.05	0.06	0.06 [4]	0.08	0.31	0.08	0.19	[5] 0.10
			Degrees	184	149	143	233	146	180	162	165	194	165	166	174	172
Cross Rip (41°26′.9 N., 70°17′.5 W.)	Oct.-Dec. 1913	3	Knots										0.21	0.23	0.25	
			Degrees										143	90	143	
	Aug. 1934-Aug. 1935	13	Knots	0.22	0.16	0.24	0.16	0.18	0.16	0.27	0.17 [4]	0.22	0.13	0.15	0.25	
			Degrees	112	101	80	101	56	63	59	80	90	141	106	104	
	1913-1935	16	Knots	0.22	0.16	0.24	0.16	0.18	0.16	0.27	0.17	0.22	0.17	0.18	0.24	0.18
			Degrees	112	101	80	101	56	63	59	80	90	142	96	123	91
Hedge Fence (41°28′.3 N., 70°29′.0 W.)	Oct-Dec. 1913	3	Knots										0.29	0.21	0.22	.024
			Degrees										180	157	180	173
Vineyard Sound (41°22′.8 N., 71°00′.0 W.)	Oct.-Dec. 1913	3	Knots										0.18	0.06	0.12	
			Degrees										263	67	142	
	Aug.-Dec. 1930	5	Knots								0.14	0.08	0.03	0.02	0.02	
			Degrees								301	279	256	103	166	
	Jan.-Dec. 1931	12	Knots	0.06	0.02	0.12	0.06	0.15	0.23	0.18	0.14	0.05	0.04	0.04	0.09	
			Degrees	121	193	246	355	214	279	312	295	309	90	49	103	
	1913-1931	20	Knots	0.06	0.02	0.12	0.06	0.15	0.23	0.18	0.13	0.06	0.06	0.04	0.06	0.06
			Degrees	121	193	246	355	314	279	312	297	289	260	63	129	291
en and Chickens (41°27′.0 N., 71°01′.1 W.)	Oct.-Dec. 1913	3	Knots										0.15	0.10	0.15	
			Degrees										183	130	139	
	Aug.-Dec. 1930	5	Knots								0.07	0.08	0.08	0.09	0.11	
			Degrees								117	111	152	94	117	
	Jan.-Dec. 1931	12	Knots	0.13	0.11	0.15	0.09	0.05	0.11	0.05	0.08	0.10	0.11	0.10	0.15	
			Degrees	98	144	186	130	129	176	166	189	149	102	100	113	
	1913-1931	20	Knots	0.13	0.11	0.15	0.09	0.05	0.11	0.05	0.06	0.08	0.09	0.09	0.13	0.09
			Degrees	98	114	186	130	129	176	166	162	135	148	109	122	143
Brenton Reef (41°25′.9 N., 71°22′.6 W.)	Oct.-Dec. 1913	3	Knots										0.13	0.13	0.10	
			Degrees										219	138	169	
	July-Oct. 1919	3	Knots							0.08	0.04		0.03			
			Degrees							76	42		311			
	Aug. 1930-July 1931	12	Knots	0.12	0.13	0.19	0.03	0.01	0.10	0.04	0.01	0.10	0.10	0.04	0.10	
			Degrees	151	194	234	175	346	225	312	256	87	155	206	184	
	1913-1931	18	Knots	0.12	0.13	0.19	0.03	0.01	0.10	0.03	0.02	0.10	0.07	0.08	0.10	0.05
			Degrees	151	194	234	175	346	225	45	26	87	196	150	180	183
Ram Island Reef: (41°18′.2 N., 71°58′.5 W.) (1913); (41°18′.0 N., 71°58°.5 W.) (1915)	Oct.-Dec. 1913; July-Sept. 1915	6	Knots							0.23	0.21	0.14	0.18	0.19	0.25	0.20
			Degrees							142	137	124	131	125	140	134

See footnotes at end of table.

TABLE 11.—*Nontidal Currents by Months, Atlantic Coast Lightships*—Continued

[Directions are true]

Lightship and location	Observations: Date	Observations: Period (months)	Units	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average all months
Bartlett Reef (41°16′.2 N., 72°07′.7 W.)	Oct.–Dec. 1913	3	Knots										0.21	0.21	0.24	
			Degrees										198	155	169	
	Aug. 1929–Mar. 1930	8	Knots	0.27	0.25	0.22					0.22	0.08	0.09	0.09	0.23	
			Degrees	185	180	151					183	207	183	197	179	
	1913–1930	11	Knots	0.27	0.26	0.22					0.22	0.08	0.14	0.14	0.24	0.19
				185	180	151					183	207	192	168	175	178
Cornfield Point: (41°12′.9 N., 72°22′.6 W.) (1913)	Oct.–Dec. 1913	3	Knots										0.18	0.25	0.28	
			Degrees										207	205	186	
(41°12′.9 N., 72°22′.2 W.) (1922–30)	Aug.–Nov. 1922	4	Knots								0.13	0.31	0.18	0.30		
			Degrees								256	265	219	200		
	July–Dec. 1929	6	Knots							0.37	0.51	0.42	0.50	0.52	0.42	
			Degrees							186	192	188	184	193	189	
	Jan.–Dec. 1930	12	Knots	0.45	0.41	0.50	0.52	0.37	0.27	0.32	0.33	0.32	0.44	0.44	0.47	
			Degrees	200	194	187	193	210	195	189	187	176	188	195	191	
	1913–1930	25	Knots	0.45	0.41	0.50	0.52	0.37	0.27	0.34	0.29	0.29	0.32	0.38	0.38	0.38
			Degrees	200	194	187	193	210	195	187	198	205	193	197	189	195
U. S. S. *Finch* (40°04′.3 N., 72°43′.4 W.)	Mar.–May 1919	3	Knots			0.16	0.05	0.02								0.05
			Degrees			231	127	352								216
Fire Island (40°28′.7 N., 73°11′.4 W.)	Nov. 1912–Jan. 1913	3	Knots	0.05										0.15	0.23	
			Degrees	117										91	67	
	Aug.–Nov. 1922	4	Knots								0.11	0.16	0.16	0.15		
			Degrees								120	229	90	95		
	July 1938–July 1939	13	Knots	0.05	0.01	0.01	0.04	0.07	0.05	[6]0.14	0.06	0.16	0.10	0.05	0.04	
			Degrees	157	112	213	213	250	67	82	186	223	241	100	105	
	1912–1939	20	Knots	0.05	0.04	0.01	0.01	0.07	0.05	0.14	0.07	0.16	0.04	0.12	0.13	0.04
			Degrees	143	112	213	213	250	67	82	146	223	117	95	72	124
U. S. S. *Cardinal* (40°16′.0 N., 73°15′.5 W.)	Mar.–June 1919	4	Knots			0.09	0.09	0.02	0.03							0.04
			Degrees			232	155	326	212							202
Ambrose Channel (1912–22) (40°28′.0 N., 73°50′.0 W.).	Nov. 1912–Jan. 1913, Mar.–July 1921, Aug.–Nov. 1922	12	Knots	0.14		0.12	0.10	0.08	0.13	0.06	0.08	0.09	0.18	[7]0.20	0.26	0.13
			Degrees	76		94	80	80	61	41	73	48	77	93	91	79
Ambrose Channel (1936–38) (40°27′.1 N., 73°49′.4 W.).	Sept. 1936–Apr. 1937	8	Knots	0.12	0.17	0.11	0.15					0.04	0.10	0.17	0.11	
			Degrees	149	145	131	158					315	79	96	159	
	May–Sept. 1938	5	Knots					0.07	0.09	0.22	0.15	0.15				
			Degrees					169	100	101	121	127				
	1936–1938	13	Knots	0.12	0.17	0.11	0.15	0.07	0.09	0.22	0.15	0.05	0.10	0.17	0.11	0.11
			Degrees	149	145	131	158	169	100	101	121	127	79	96	159	126
Scotland (40°26′.6 N., 73°55′.2 W.)	Nov. 1912–Jan. 1913, Mar.–July 1921	8	Knots	0.27		0.24	0.22	0.19	0.17	0.16				0.21	0.13	
			Degrees	162		146	167	179	160	184				145	128	
	Aug.–Nov. 1922	4	Knots								0.20	0.22	0.16	0.16		
			Degrees								181	191	170	159		
	Sept. 1936–Mar. 1937	7	Knots	0.24	0.32	0.19						0.16	0.11	0.18	0.22	
			Degrees	145	166	157						176	154	140	159	
	May–Sept. 1938	5	Knots					0.24	0.16	0.16	0.25	0.16				
			Degrees					169	155	126	137	173				
	1912–1938	24	Knots	0.25	0.32	0.21	0.22	0.22	0.16	0.13	0.21	0.18	0.14	0.18	0.17	0.20
			Degrees	154	166	151	167	175	158	153	157	180	163	146	147	160
Barnegat (39°45′.8 N., 73°56′.0 W.)	Oct.–Dec. 1934, Jan.–Mar. 1936	6	Knots	0.07	0.08	0.04							0.15	0.06	0.06	
			Degrees	136	170	204							154	125	139	
	Jan.–Dec. 1935	12	Knots	0.08	0.10	0.04	0.10	0.06	0.06	0.09	0.01	0.03	0.02	0.10	0.07	
			Degrees	170	170	136	187	49	139	44	35	80	53	176	170	
	1934–1936	18	Knots	0.07	0.09	0.04	0.10	0.06	0.06	0.09	0.01	0.03	0.07	0.07	0.06	0.04
			Degrees	154	170	180	187	49	139	44	35	80	146	153	162	141
U. S. S. *Falcon* (39°04′.5 N., 73°25′.5 W.)	Feb.–May 1919	4	Knots		0.05	0.22	0.06	0.06								0.07
			Degrees		171	211	300	270								225
Northeast End (38°57′.8 N., 74°29′.6 W.)	Nov. 1912–Jan. 1913	3	Knots	0.06										0.09	0.16	
			Degrees	102										104	61	
	Sept.–Dec. 1918	4	Knots									0.06	0.04	0.06	0.07	
			Degrees									51	116	133	145	
	Jan.–Oct. 1919	10	Knots	0.13	0.16	0.15	0.10	0.05	0.04	0.14	0.05	0.05	0.18			
			Degrees	109	172	180	161	150	186	65	109	109	201			
	1912–1919	17	Knots	0.09	0.16	0.15	0.10	0.05	0.04	0.14	0.05	0.05	0.10	0.07	0.09	0.06
			Degrees	106	172	180	161	150	186	65	109	79	186	117	84	138
Five Fathom Bank (38°47′.3 N., 74°34′.6 W.)	Nov. 1912–Jan. 1913	3	Knots	0.07										0.13	0.14	0.11
			Degrees	98										115	99	104
Overfalls (38°47′.9 N., 75°01′.4 W.)	Nov. 1912–Jan. 1913	3	Knots	0.18										0.35	0.32	
			Degrees	161										66	86	
	Sept.–Nov. 1918, Apr.–July 1921	7	Knots				0.22	0.18	0.15	0.08		0.12	0.13	0.12		
			Degrees				175	218	254	270		305	321	260		
	Mar.–Dec. 1919	8	Knots			0.18	0.04			0.16	0.24	0.18	0.19	0.21	0.33	
			Degrees			206	297			158	175	199	212	199	191	
	Apr.–Dec. 1920	9	Knots				0.24	0.29	0.22	0.16	0.25	0.13	0.04	0.13	0.06	
			Degrees				150	205	175	173	206	219	154	219	149	
	Sept. 1924–May 1925	9	Knots	0.18	0.10	0.13	0.17	0.10				0.06	0.11	0.00	0.02	
			Degrees	201	233	211	221	250				217	221		172	
	1912–1925	36	Knots	0.17	0.10	0.16	0.14	0.18	0.14	0.10	0.23	0.09	0.07	0.04	0.11	0.12
			Degrees	180	233	210	180	218	205	180	190	229	236	166	142	197

See footnotes at end of table.

TABLE 11.—*Nontidal Currents by Months, Atlantic Coast Lightships*—Continued

[Directions are true]

Lightship and location	Observations: Date	Observations: Period (months)	Units	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average all months
Fenwick Island Shoal (38°27'.4 N., 74°46'.7 W.).	Nov. 1912-Jan. 1913	3	Knots	0.12										0.11	0.07	0.09
			Degrees	138										110	83	116
Winter-Quarter Shoal (37°55'.4 N., 74°56'.4 W.).	Nov. 1912-Jan. 1913	3	Knots	0.04										0.08	0.07	
			Degrees	128										97	75	
	Sept.-Dec. 1918 / Jan.-Aug. 1920	11	Knots	0.20	0.05	0.07	0.04	0.18	0.09		0.08	0.05	0.14	0.12	0.16	
			Degrees	179	184	157	187	214	56		213	94	198	153	170	
	Jan.-Dec. 1919	12	Knots	0.28	0.26	0.11	0.08	0.03	0.05	0.11	0.03	0.04	0.13	0.06	0.09	
			Degrees	135	171	178	180	244	195	42	64	147	182	155	185	
	1912-1920	26	Knots	0.16	0.16	0.08	0.06	0.10	0.03	0.11	0.03	0.04	0.13	0.08	0.09	0.07
			Degrees	150	173	166	180	217	90	42	180	117	189	140	160	161
U. S. S. *Brant* (37°04'.6 N., 74°51'.1 W.)	Feb.-May 1919	4	Knots		0.13	0.24	0.04	0.05								0.11
			Degrees		211	207	155	180								201
Cape Charles (37°05'.3 N., 75°43'.5 W.)	June-Aug. 1912 / Sept.-Oct. 1915	5	Knots						0.11	0.18	0.06	0.05	0.04			0.08
			Degrees						5	34	39	73	84			37
Chesapeake (36°58'.7 N., 75°42'.2 W.)	Apr. 1935-Mar. 1936	12	Knots	0.15	0.15	0.14	0.16	0.05	0.12	0.10	0.03	0.06	0.08	0.19	0.22	0.09
			Degrees	136	169	75	158	105	52	54	191	182	150	173	151	138
Tail of the Horseshoe (36°58'.8 N., 76°00'.4 W.).	June-Aug. 1912 / Sept.-Oct. 1915	5	Knots						0.27	0.30	0.22	0.25	0.30			
			Degrees						126	118	130	135	143			
	Apr.-Oct. 1919	6	Knots				0.24	0.31	0.49		0.26	0.31	0.23			
			Degrees				132	113	83		111	128	134			
	1912-1919	11	Knots				0.24	0.31	0.32	0.30	0.23	0.28	0.27			0.27
			Degrees				132	113	101	118	121	131	138			121
Diamond Shoal: (35°05'.1 N., 75°19'.6 W.) (1909-18)	1909-1918	66	Knots	0.31	0.29	0.32	0.33	0.54	0.56	0.48	0.31	0.06	0.24	0.47	0.26	
			Degrees	47	52	52	45	44	45	44	44	30	51	44	64	
(35°05'.3 N., 75°19'.7 W.) (1919-28)	1919-1928	109	Knots	0.32	0.32	0.46	0.35	0.50	0.72	1.06	0.61	0.16	0.24	0.23	0.36	
			Degrees	75	70	61	59	52	47	42	47	72	66	85	75	
	1909-1928	175	Knots	0.31	0.30	0.41	0.34	0.51	0.66	0.83	0.50	0.13	0.24	0.30	0.32	0.40
			Degrees	65	63	59	54	49	47	43	47	70	60	63	72	54
Cape Lookout Shoals (1918-19) (34°18'.4 N., 76°24'.3 W.).	Sept. 1918-Sept. 1919	13	Knots	0.23	0.16	0.28	0.22	0.24	0.32	0.51	0.38	[8] 0.17	0.21	0.15	0.16	0.16
			Degrees	117	154	206	81	67	204	89	81	180	141	155	180	128
Cape Lookout Shoals (1912) (34°20'.0 N., 76°25'.0 W.).	June-Aug. 1912	3	Knots						0.39	0.96	0.54					0.63
			Degrees						93	89	77					86
Frying Pan Shoals: (33°34'.0 N., 77°48'.7 W.) (1912) / (33°34'.1 N., 77°48'.8 W.) (1918-21)	July-Sept. 1912 / Oct.-Dec. 1918	6	Knots							0.47	0.46	0.17	0.17	0.10	0.08	
			Degrees							91	95	80	284	214	191	
	Jan.-Dec. 1919	12	Knots	0.18	0.02	0.22	0.14	0.08	0.22	0.47	0.35	0.05	0.09	0.28	0.10	
			Degrees	87	267	243	75	42	249	80	90	230	46	241	214	
	Jan.-Dec. 1920	12	Knots	0.03	0.12	0.07	0.09	0.26	0.31	0.41	0.04	0.16	0.07	0.11	0.14	
			Degrees	222	186	95	74	231	74	88	24	240	193	97	95	
	Jan.-July 1921	7	Knots	0.08	0.05	0.06	0.09	0.06	0.12	0.49						
			Degrees	207	214	15	18	132	96	73						
	1912-1921	37	Knots	0.05	0.05	0.04	0.10	0.06	0.07	0.45	0.28	0.03	0.04	0.10	0.06	0.06
			Degrees	127	202	243	61	219	90	82	90	180	284	217	162	106
U. S. S. *Long Island* (32°42'.0 N., 79°06'.3 W.)	Mar.-May 1919	3	Knots			0.10	0.08	0.01								0.01
			Degrees			263	75	179								270
Charleston: (32°41'.0 N., 79°43'.5 W.) (1912) / (32°41'.0 N., 79°43'.7 W.) (1915-16)	June-Aug. 1912 / Dec. 1915-Feb. 1916	6	Knots	0.09	0.05				0.12	0.14	0.27				0.01	
			Degrees	237	126				30	53	56				89	
(32°40'.7 N., 79°42'.9 W.) (1921)	Apr.-Sept. 1921	6	Knots				0.11	0.02	0.10	0.34	0.11	0.03				
			Degrees				51	89	60	52	62	44				
	1912-1921	12	Knots	0.09	0.05		0.11	0.02	0.11	0.24	0.19	0.03			0.01	0.07
			Degrees	237	126		51	89	45	53	58	44			89	58
Martins Industry: (32°06'.2 N., 80°27'.8 W.) (1912)	June-Aug. 1912	3	Knots						0.19	0.19	0.31					
			Degrees						39	55	58					
(32°06'.2 N., 80°28'.0 W.) (1916)	Feb.-June 1916	5	Knots		0.13	0.19	0.05	0.17	0.24							
			Degrees		81	65	53	40	38							
	1912-1916	8	Knots		0.13	0.19	0.05	0.17	0.22	0.19	0.31					0.18
			Degrees		81	65	53	40	38	55	58					55
Savannah: (31°56'.7 N., 80°39'.8 W.) (1925-26)	May 1925-Apr. 1926	12	Knots	0.07	0.13	0.10	0.15	0.02	0.17	0.20	0.03	0.07	0.01	0.09	0.09	
			Degrees	153	103	143	132	90	45	45	199	45	90	199	122	
(31°56'.6 N., 80°39'.8 W.) (1934-35)	May 1934-Apr. 1935	12	Knots	0.13	0.08	0.09	0.13	0.00	0.23	0.16	0.15	0.01	0.11	0.07	0.11	
			Degrees	152	135	84	58		45	40	42	180	202	172	158	
	1925-1935	24	Knots	0.09	0.11	0.09	0.11	0.01	0.20	0.18	0.06	0.03	0.05	0.08	0.10	0.06
			Degrees	153	112	117	100	90	45	43	45	45	202	187	143	95
Brunswick: (31°00'.2 N., 81°09'.4 W.) (1912)	June-Aug. 1912	3	Knots						0.12	0.07	0.21					
			Degrees						24	74	25					

See footnotes at end of table.

TABLE 11.—*Nontidal Currents by Months, Atlantic Coast Lightships*—Continued

[Directions are true]

Lightship and location	Observations: Date	Observations: Period (months)	Units	Velocities and true directions — Months: Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average all months
Brunswick—Continued. (31°00′.2 N., 81°09′.6 W.) (1915–21)	Jan.-July 1915	4	Knots	0.28	0.37	0.13	------	------	------	0.12	------	------	------	------	------	------
			Degrees	201	202	189	------	------	------	31	------	------	------	------	------	------
	Mar. 1916 Nov.-Dec. 1918	3	Knots	------	------	0.11	------	------	------	------	------	------	------	0.12	0.05	------
			Degrees	------	------	38	------	------	------	------	------	------	------	211	169	------
	Jan.-Dec. 1919	12	Knots	0.15	0.10	0.22	0.03	0.08	0.12	0.21	0.11	0.19	0.10	0.10	0.13	------
			Degrees	203	174	201	342	353	228	11	27	227	336	217	207	------
	Jan.-Dec. 1920	12	Knots	0.05	0.13	0.06	0.04	0.16	0.12	0.17	0.14	0.10	0.23	0.21	0.06	------
			Degrees	169	132	149	27	220	355	357	348	225	214	205	171	------
	Jan.-July 1921	7	Knots	0.13	0.14	0.11	0.01	0.06	0.09	0.23	------	------	------	------	------	------
			Degrees	209	201	221	270	239	339	7	------	------	------	------	------	------
	1912–1921	41	Knots	0.15	0.16	0.08	0.02	0.05	0.06	0.16	0.15	0.14	0.09	0.14	0.08	0.04
			Degrees	200	187	187	0	248	342	15	16	225	238	210	187	221
St. Johns (30°23′.5 N., 81°18′.0 W.)	Jan.-Dec. 1934	12	Knots	0.18	0.16	0.10	0.04	0.10	0.21	0.15	0.15	0.06	0.18	0.11	0.13	0.08
			Degrees	159	163	170	46	152	36	83	59	110	162	171	155	128

[1] Series broken. Nontidal current computed for entire series.
[2] The nontidal current for August 1934 was the same as for August 1935.
[3] From Oct. 27, 1923, to July 21, 1925, observations were taken 4 hours apart.
[4] Average of 2 months, August 1934 and August 1935.
[5] The 1911 values are not included in the average as they are inconsistent with those from the longer series which are considered more reliable.
[6] Average of 2 months, July 1938 and July 1939.
[7] Average of 2 months, November 1912 and November 1922.
[8] Average of 2 months, September 1918 and September 1919.

For reference to above table, see p. 23.

Table 12.—*Wind Currents, Atlantic Coast Lightships*

[All directions are true]

Wind from—	Current			Current			Current			Current			Current			Average of velocities			Average of current directions (degrees)	Current sets to right of wind (degrees)
	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Wind (m. p. h.)	Current (knots)	Ratio (C/W)		
Boston Lightship, 1926–27, 1 year																				
Wind velocity, statute miles per hour	*10*			20			30			40			50							
N																(22)	(0. 12)		(187)	
NNE	270	0. 05	225	299	0. 09	215	154	0. 12	199	27	0. 26	164				25	0. 13	0. 005	201	−1
NE																(22)	(0. 11)		(235)	
ENE	196	0. 05	269	103	0. 13	265	19	0. 09	274							20	0. 09	0. 004	269	21
E																(20)	(0. 10)		(296)	
ESE	406	0. 07	329	231	0. 10	313	33	0. 16	330							20	0. 11	0. 006	324	32
SE																(20)	(0. 11)		(346)	
SSE	332	0. 08	7	181	0. 12	8	15	0. 14	7							20	0. 11	0. 006	7	29
S																(20)	(0. 12)		(24)	
SSW	656	0. 07	40	350	0. 09	35	100	0. 26	51							20	0. 14	0. 007	42	20
SW																(20)	(0. 11)		(56)	
WSW	490	0. 06	67	249	0. 06	67	75	0. 12	76							20	0. 08	0. 004	70	2
W																(22)	(0. 13)		(100)	
WNW	601	0. 07	130	680	0. 09	139	291	0. 19	132	48	0. 37	124				25	0. 18	0. 007	131	19
NW																(22)	(0 14)		(152)	
NNW	199	0. 04	171	120	0. 10	168	47	0. 17	181							20	0. 10	0. 005	173	15
Average		0. 06			0. 10			0. 16			0. 32							0. 006		17
Ratio C/W		0. 006			0. 005			0. 005			0. 008									

TABLE 12.—***Wind Currents; Atlantic Coast Lightships***—Continued

[All directions are true]

Wind from—	Current			Current			Current			Current			Current			Average of velocities			Average of current directions (degrees)	Current sets to right of wind (degrees)
	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Wind (m. p. h.)	Current (knots)	Ratio (C/W)		
Pollock Rip Slue Lightship, 1920-21, 1 year																				
Wind velocity, statute miles per hour	10			20			30			40			50							
N	106	0.24	188	37	0.70	182	43	0.76	187							20	0.57	0.028	186	6
NNE	213	0.40	210	281	0.34	214	342	0.44	215	71	0.68	199	35	0.78	199	30	0.53	0 018	207	5
NE	86	0.22	221	44	0.24	258	31	0.32	320							20	[1] 0.20	0.010	[1] 273	48
ENE	100	0.28	211	95	0.44	217	57	0.26	295	11	0.92	190				25	[1] 0.40	0.016	[1] 210	−38
E	63	0.20	230	57	0.50	346	35	0.26	260							20	[1] 0.21	0.010	[1] 300	30
ESE	186	0.26	220	159	0.32	243	60	0.30	284	10	0.96	208				25	0.46	0.018	239	−53
SE	49	0.32	335	27	0.42	245	37	0.38	304							20	[1] 0.30	0.015	[1] 291	−24
SSE	287	0.14	274	159	0.26	234	81	0.22	281							20	0.21	0.010	263	−75
S	312	0.18	317	163	0.14	337	96	0.46	350							20	0.26	0.013	335	−25
SSW	670	0.16	217	479	0.18	212	296	0.06	138							20	0.13	0.006	189	167
SW	192	0.10	57	72	0.26	184	85	0.20	62							20	[1] 0.09	0.004	[1] 115	70
WSW	141	0.22	167	151	0.06	112	187	0.14	101							20	0.14	0.007	127	59
W	62	0.14	157	21	0.18	145	42	0.12	126	12	0.22	77				25	0.16	0.006	126	36
WNW	248	0.06	157	154	0.14	183	297	0.32	164	27	0.40	146	19	0.54	174	30	0.29	0.010	165	53
NW	95	0.06	139	56	0.34	161	64	0.28	166							20	0.23	0.012	155	20
NNW	150	0.38	182	132	0.38	169	159	0.42	171	50	0.50	183	21	0.72	180	30	0.48	0.016	177	19
Average		0.21			0.31			0.31			0.61			0.68				0.012		19
Ratio C/W		0.021			0.016			0.010			0.015			0.014						

Nantucket Shoals Lightship, 1913–25, 5½ years

Wind velocity, statute miles per hour	15			25			35			45			55							
N	295	0.37	228	490	0.38	216	96	0.62	220	29	0.45	231				50	0.46	0.015	224	44
NNE	695	0.40	269	850	0.43	253	152	0.52	244	114	0.64	230	24	0.50	246	35	0.50	0.014	248	46
NE	311	0.47	269	374	0.55	256	101	0.60	257	57	0.58	252	25	0.77	233	35	0.59	0.017	253	28
ENE	498	0.36	286	440	0.28	286	95	0.54	271	69	0.39	244				30	0.39	0.013	272	24
E	208	0.53	295	197	0.40	292	42	0.45	251	28	0.51	277				30	0.42	0.014	279	9
ESE	543	0.36	302	532	0.30	301	96	0.44	314	43	0.43	315				30	0.38	0.013	308	16
SE	206	0.28	336	198	0.30	329	45	0.43	317							25	0.34	0.014	327	12
SSE	641	0.27	340	632	0.31	309	62	0.35	7	47	0.20	347				30	0.28	0.009	341	3
S	461	0.12	9	601	0.40	5	98	0.11	73	24	0.47	12				30	0.28	0.009	25	25
SSW	1,306	0.18	7	1,504	0.23	30	179	0.56	33	51	0.43	18				30	0.35	0.012	22	0
SW	695	0.14	47	833	0.28	55	114	0.45	63	31	0.45	39				30	0.33	0.011	51	6
WSW	844	0.09	95	948	0.25	94	189	0.47	93	63	0.50	61	17	0.38	88	35	0.34	0.010	86	18
W	264	0.15	174	387	0.27	99	184	0.37	113	161	0.46	105	27	0.32	109	35	0.31	0.009	120	30
WNW	675	0.12	163	1,014	0.32	163	449	0.32	134	271	0.64	166	28	0.42	131	35	0.36	0.010	151	39
NW	217	0.22	185	524	0.23	156	340	0.48	173	240	0.44	191				30	0.34	0.011	176	41
NNW	509	0.25	222	853	0.27	203	206	0.31	206	137	0.39	195				30	0.30	0.010	206	48
Average		0.26			0.32			0.44			0.47			0.48				0.012		24
Ratio C/W		0.017			0.013			0.013			0.010			0.009						

Hen and Chickens Lightship, 1931, 1 year

Wind velocity statute miles per hour	10			20			30			40			50							
N	325	0.20	194	439	0.23	182	64	0.41	196	18	0.38	212				25	0.30	0.012	196	16
NNE	96	0.19	219	139	0.24	206	13	0.47	224							20	0.30	0.015	216	14
NE	201	0.15	232	365	0.25	227	145	0.37	228	22	0.25	186				25	0.26	0.010	218	−7
ENE	198	0.14	245	238	0.20	229	24	0.24	242	13	0.29	272				25	0.22	0.009	247	−1
E	44	0.13	258	29	0.19	255										15	0.16	0.011	256	−14
ESE	208	0.14	262	114	0.13	298	13	0.34	326							20	0.20	0.010	295	3
SE	113	0.17	250	51	0.17	301										15	0.17	0.011	276	−39
SSE	250	0.04	280	160	0.09	315	16	0.22	312							20	0.12	0.006	302	−36
S	151	0.13	27	121	0.13	21	16	0.14	27							20	0.13	0.006	25	25
SSW	713	0.08	96	768	0.10	77	130	0.23	59							20	0.14	0.007	77	55
SW	179	0.12	91	314	0.18	86	93	0.23	65	26	0.18	76				25	0.18	0.007	80	35
WSW	237	0.12	118	312	0.19	95	74	0.25	81							20	0.19	0.010	98	30
W	80	0.16	124	142	0.18	100	55	0.24	107							20	0.19	0.010	110	20
WNW	320	0.14	156	663	0.21	123	239	0.29	116	29	0.31	118				25	0.24	0.010	128	16
NW	113	0.18	164	198	0.20	152	43	0.26	137							20	0.21	0.010	151	16
NNW	229	0.22	169	300	0.22	159	51	0.35	169	14	0.31	169				25	0.28	0.011	166	8
Average		0.14			0.18			0.29			0.29							0.010		9
Ratio C/W		0.014			0.009			0.010			0.007									

See footnotes at end of table.

Table 12.—*Wind Currents, Atlantic Coast Lightships*—Continued

[All directions are true]

Wind from—	Current			Current			Current			Current			Current			Average of velocities			Average of current directions (degrees)	Current sets to right of wind (degrees)
	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Wind (m. p. h.)	Current (knots)	Ratio (C/W)		
Brenton Reef Lightship, 1930–31, 1 year																				
Wind velocity, statute miles per hour	10			20			30			40			50							
N	275	0. 23	217	392	0. 23	215	141	0. 28	204	13	0. 38	232	20	0. 40	203	30	0. 30	0. 010	214	34
NNE	150	0. 30	221	283	0. 28	232	150	0. 36	228							20	0. 31	0. 016	227	25
NE	220	0. 20	248	318	0. 30	254	160	0. 41	267	22	0. 57	222	10	0. 32	246	30	0. 36	0. 012	247	22
ENE	136	0. 19	243	146	0. 30	265	53	0. 39	279				14	0. 57	280	28	0. 36	0. 013	267	19
E	77	0. 19	302	57	0. 26	283	11	0. 67	301							20	0. 37	0. 019	295	25
ESE	169	0. 10	291	131	0. 21	295										15	0. 16	0. 011	293	1
SE	73	0. 18	314	60	0. 16	302										15	0. 17	0. 011	308	−7
SSE	217	0. 10	327	110	0. 18	342	13	0. 50	8							20	0. 26	0. 013	346	8
S	118	0. 13	5	83	0. 20	37	10	0. 14	25	11	0. 12	41				25	0. 15	0. 006	27	27
SSW	762	0. 09	48	664	0. 24	74	132	0. 33	88							20	0. 22	0. 011	70	48
SW	214	0. 08	56	257	0. 22	91	124	0. 28	76				16	0. 42	51	28	0. 25	0. 009	68	23
WSW	320	0. 10	137	317	0. 20	107	46	0. 24	98	16	0. 27	95				25	0. 20	0. 008	109	41
W	116	0. 16	146	248	0. 23	139	103	0. 35	138	18	0. 34	109	20	0. 62	122	30	0. 34	0. 011	131	41
WNW	381	0. 17	163	622	0. 22	157	207	0. 34	142	51	0. 36	117	36	0. 54	138	30	0. 33	0. 011	143	31
NW	265	0. 18	181	374	0. 22	176	104	0. 32	146	33	0. 38	124	16	0. 46	154	30	0. 31	0. 010	156	21
NNW	83	0. 04	217	186	0. 25	178	34	0. 26	151							20	0. 18	0. 009	182	24
Average		0. 15			0. 23			0. 35			0. 35			0. 48				0. 011		24
Ratio C/W		0. 015			0. 012			0. 012			0. 009			0. 010						

Fire Island Lightship, 1938–39, 1 year

Wind velocity, statute miles per hour.	10			20			30			40			50							
N	155	0.23	217	68	0.27	209	15	0.39	218							20	0.30	0.015	215	35
NNE	294	0.21	231	115	0.34	225	101	0.39	224	22	0.50	221				25	0.36	0.014	225	23
NE	147	0.26	244	52	0.21	240	15	0.40	235	25	0.49	239				25	0.34	0.014	240	15
ENE	220	0.20	263	101	0.33	257	27	0.34	248							20	0.29	0.014	256	8
E	174	0.15	271	13	0.12	272										15	0.14	0.009	272	2
ESE	228	0.11	286	24	0.11	275	15	0.18	264							20	0.13	0.006	275	−17
SE	96	0.08	315	14	0.18	16										15	0.13	0.009	346	31
SSE	285	0.09	27	42	0.11	41	15	0.26	32							20	0.15	0.008	33	55
S	240	0.07	41	50	0.24	38										15	0.16	0.011	40	40
SSW	738	0.13	72	241	0.27	64	132	0.35	52							20	0.25	0.012	63	41
SW	240	0.15	84	73	0.22	78	27	0.35	65							20	0.24	0.012	76	31
WSW	304	0.10	85	88	0.22	84	77	0.26	79	19	0.38	80				25	0.24	0.010	82	14
W	156	0.08	113	63	0.21	93	57	0.24	85	30	0.38	71	23	0.37	79	30	0.26	0.009	88	−2
WNW	342	0.09	145	212	0.16	143	171	0.17	108	37	0.15	76	10	0.39	87	30	0.19	0.006	112	0
NW	202	0.15	174	36	0.14	170	33	0.17	137							20	0.15	0.008	160	25
NNW	265	0.14	203	59	0.20	188	48	0.19	194							20	0.18	0.009	195	37
Average		0.14			0.21			0.28			0.38			0.38				0.010		21
Ratio C/W		0.014			0.010			0.009			0.010			0.008						

Ambrose Channel Lightship, 19[illegible]1–38, 1 year

Wind velocity, statute miles per hour.	10			20			30			40			50							
N	336	0.12	215	90	0.15	200	22	0.16	232							20	0.14	0.007	216	36
NNE	298	0.11	236	103	0.30	244	32	0.24	245							20	0.22	0.011	242	40
NE	311	0.13	241	136	0.17	257	80	0.21	241							20	0.17	0.008	246	21
ENE	111	0.05	281	25	0.19	245	28	0.30	270	11	0.29	241				25	0.21	0.008	259	11
E	195	0.07	315	54	0.09	264	59	0.23	285							20	0.13	0.006	288	18
ESE	124	0.07	16	34	0.17	320	22	0.12	35							20	0.12	0.006	4	72
SE	167	0.05	349	39	0.11	334										15	0.08	0.005	342	27
SSE	130	0.01	90													10	0.01	0.001	90	112
S	431	0.12	76	95	0.37	92	14	0.62	77							20	0.37	0.018	82	82
SSW	409	0.27	96	150	0.43	97	41	0.49	84							20	0.40	0.020	92	70
SW	493	0.25	111	97	0.40	104										15	0.32	0.021	108	63
WSW	274	0.30	123	68	0.53	103	17	0.62	117							20	0.48	0.024	114	46
W	286	0.26	140	79	0.41	133	37	0.48	107							20	0.38	0.019	127	37
WNW	275	0.24	142	94	0.36	128	64	0.55	133							20	0.38	0.019	134	22
NW	420	0.19	155	239	0.28	150	127	0.29	168							20	0.25	0.012	158	23
NNW	273	0.15	180	139	0.19	186	87	0.28	170							20	0.21	0.010	179	21
Average		0.15			0.28			0.35			0.29							0.012		44
Ratio C/W		0.015			0.014			0.012			0.007									

See footnotes at end of table.

TABLE 12.—*Wind Currents, Atlantic Coast Lightships*—Continued

[All directions are true]

Scotland Lightship, 1921–38, 1 year

Wind from—	Current			Current			Current			Current			Current			Average of velocities			Average of current directions (degrees)	Current sets to right of wind (degrees)
	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Wind (m. p. h.)	Current (knots)	Ratio (C/W)		
Wind velocity, statute miles per hour	10			20			30			40			50							
N	186	0.30	192	66	0.48	192	33	0.57	204							20	0.45	0.022	196	16
NNE	174	0.33	187	66	0.56	190	18	0.40	193							20	0.43	0.022	190	−12
NE	298	0.37	186	122	0.39	211	46	0.63	201							20	0.46	0.023	199	−26
ENE	141	0.36	194	70	0.37	221	38	0.35	222							20	0.36	0.018	212	−36
E	123	0.33	183	58	0.24	204	76	0.33	218				15	0.50	231	28	0.35	0.012	209	−61
ESE	104	0.23	209	31	0.16	288	29	0.28	272							20	0.22	0.011	256	−36
SE	158	0.09	206	43	0.16	176	12	0.30	287							20	0.18	0.009	223	−92
SSE	120	0.11	175	31	0.16	202										15	0.14	0.009	188	−150
S	662	0.14	124	237	0.17	83	34	0.24	62							20	0.18	0.009	90	90
SSW	269	0.06	18	148	0.18	61	23	0.24	87							20	0.16	0.008	55	33
SW	366	0.21	125	88	0.33	119										15	0.27	0.018	122	77
WSW	193	0.24	102	83	0.34	122										15	0.29	0.019	112	44
W	283	0.22	133	99	0.33	99	46	0.31	99	12	0.58	88				25	0.36	0.014	105	15
WNW	354	0.31	147	96	0.25	137	67	0.31	142							20	0.29	0.014	142	30
NW	374	0.33	162	278	0.42	166	214	0.35	165	26	0.19	155				25	0.32	0.013	162	27
NNW	197	0.44	169	80	0.55	179	31	0.66	170	12	0.90	166				25	0.64	0.026	171	13
Average		0.25			0.32			0.38			0.56			0.50				0.015		−4
Ratio C/W		0.025			0.016			0.013			0.014			0.010						

Barnegat Lightship, 1934–36, 1½ years

Wind velocity, statute miles per hour	10			20			30			40			50							
N	206	0.07	180	233	0.17	205	110	0.31	189	28	0.48	172				25	0.26	0.010	186	6
NNE	206	0.13	212	247	0.21	211	71	0.31	201	16	0.46	205				25	0.28	0.011	207	5
NE	262	0.11	218	321	0.19	218	95	0.33	212	25	0.34	208	10	0.36	206	30	0.27	0.009	212	−13
ENE	189	0.09	249	141	0.19	242	49	0.28	232	10	0.39	232				25	0.24	0.010	239	−9
E	233	0.03	278	166	0.14	236	48	0.21	247							20	0.13	0.006	254	−16
ESE	173	0.04	304	49	0.08	300	10	0.06	252							20	0.06	0.003	285	−7
SE	215	0.02	0	68	0.10	349	10	0.10	336							20	0.07	0.004	348	33
SSE	228	0.04	34	69	0.16	30										15	0.10	0.007	32	54
S	320	0.07	56	95	0.17	54										15	0.12	0.008	55	55
SSW	461	0.07	64	208	0.21	55	18	0.38	37							20	0.22	0.011	52	30
SW	738	0.11	68	401	0.21	62	12	0.27	48							20	0.20	0.010	59	14
WSW	311	0.09	77	159	0.16	76	25	0.26	76							20	0.17	0.008	76	8
W	208	0.08	113	121	0.15	94	59	0.25	64							20	0.16	0.008	90	0
WNW	212	0.07	135	284	0.10	107	180	0.16	135	32	0.21	79	10	0.25	79	30	0.16	0.005	107	−5
NW	457	0.07	172	565	0.12	156	384	0.15	149	81	0.22	154	49	0.25	149	30	0.16	0.005	156	21
NNW	256	0.09	192	359	0.18	186	241	0.24	184							20	0.17	0.008	187	29
Average		0.07			0.16			0.24			0.35			0.29				0.008		13
Ratio C/W		0.007			0.008			0.008			0.009			0.006						

Northeast End Lightship, 1913–19, 1 year

Wind velocity, statute miles per hour	10			20			30			40			50							
N	185	0.25	207	156	0.36	210	162	0.65	212							20	0.42	0.021	210	30
NNE	52	0.27	219	81	0.38	221	87	0.68	207							20	0.44	0.022	216	14
NE	299	0.31	233	164	0.33	230	186	0.62	215	13	0.87	220	24	0.98	213	30	0.62	0.021	222	−3
ENE	101	0.26	239	67	0.45	241	69	0.77	230							20	0.49	0.024	237	−11
E	191	0.24	255	119	0.29	248	37	0.39	246							20	0.31	0.016	250	−20
ESE	71	0.28	247	35	0.22	265	25	0.29	272							20	0.26	0.013	261	−31
SE	169	0.25	252	50	0.26	298	15	0.27	268							20	0.26	0.013	273	−42
SSE	84	0.13	288	19	0.24	285	13	0.32	356							20	0.23	0.012	310	−28
S	308	0.07	34	127	0.28	39	34	0.26	39							20	0.20	0.010	37	37
SSW	209	0.13	81	234	0.09	69	171	0.23	49							20	0.15	0.008	66	44
SW	616	0.17	83	343	0.36	63	151	0.43	64							20	0.32	0.016	70	25
WSW	166	0.22	95	55	0.21	76										15	0.22	0.015	86	18
W	278	0.17	103	88	0.23	105	43	0.26	83							20	0.22	0.011	97	7
WNW	55	0.29	160	30	0.24	109	87	0.35	114							20	0.29	0.014	128	16
NW	272	0.18	167	234	0.26	167	458	0.28	153	43	0.36	156	10	0.29	158	30	0.27	0.009	160	25
NNW	80	0.22	172	57	0.24	182	101	0.33	173							20	0.26	0.013	176	18
Average		0.22			0.28			0.41			0.62			0.64				0.015		6
Ratio C/W		0.022			0.014			0.014			0.016			0.013						

See footnotes at end of table.

TABLE 12.—*Wind Currents, Atlantic Coast Lightships*—Continued

[All directions are true]

Wind from—	Current			Current			Current			Current			Current			Average of velocities			Average of current directions (degrees)	Current sets to right of wind (degrees)
	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Wind (m. p. h.)	Current (knots)	Ratio (C/W)		
Overfalls Lightship, 1920–25, 1 year																				
Wind velocity, statute miles per hour	10			20			30			40			50							
N	163	0.26	201	236	0.31	195	98	0.46	243				15	0.70	205	28	0.43	0.015	211	31
NNE	71	0.44	155	99	0.30	189	81	0.38	220				11	0.71	151	28	0.46	0.016	179	−23
NE	253	0.17	193	242	0.36	228	96	0.58	193	33	0.70	262	13	0.61	243	30	0.48	0.016	224	−1
ENE	52	0.50	282	47	0.68	273	39	0.50	223	16	0.91	268				25	0.65	0.026	262	14
E	235	0.21	225	193	0.30	237	37	0.56	185	24	0.54	194	13	0.63	221	30	0.45	0.015	212	−58
ESE	125	0.29	268	62	0.19	201										15	0.24	0.016	234	−58
SE	292	0.10	241	68	0.26	268										15	0.18	0.012	254	−61
SSE	148	0.37	313	51	0.34	326										15	0.36	0.024	320	−18
S	745	0.04	45	397	0.20	84	95	0.41	23							20	0.22	0.011	51	51
SSW	167	0.11	15	163	0.27	39	42	0.11	45							20	0.16	0.008	33	11
SW	518	0.09	6	257	0.23	18	30	0.43	97							20	[1] 0.19	0.010	[1] 63	18
WSW	135	0.32	134	30	0.10	29	11	0.83	120							20	[1] 0.38	0.019	[1] 119	51
W	267	0.17	156	145	0.21	104	42	0.15	340							20	[1] 0.08	0.004	[1] 107	17
WNW	105	0.26	148	59	0.41	137	23	0.65	151	15	0.55	125				25	0.47	0.019	140	28
NW	291	0.08	225	225	0.06	239	189	0.30	138	42	0.31	153	39	0.32	131	30	[1] 0.19	0.006	[1] 150	15
NNW	111	0.30	182	133	0.25	244	53	0.33	207	10	0.28	219	27	0.08	220	30	0.25	0.008	214	56
Average		0.23			0.28			0.44			0.55			0.51				0.014		5
Ratio C/W		0.023			0.014			0.015			0.014			0.010						

Winter Quarter Shoal Lightship, 1918–20, 2 years

Wind velocity, statute miles per hour	10			15			25			35			45							
N	233	0.19	205	844	0.25	202	526	0.42	197	142	0.54	198	67	0.49	190	26	0.38	0.015	198	18
NNE	18	0.23	178	94	0.33	203	64	0.46	213	16	0.51	211				21	0.38	0.018	201	−1
NE	344	0.24	228	878	0.31	220	449	0.49	221	161	0.77	219	94	0.99	210	26	0.56	0.022	220	−5
ENE	68	0.22	231	51	0.23	223	35	0.37	226							17	0.27	0.016	227	−21
E	255	0.15	238	424	0.17	246	100	0.33	244							17	0.22	0.013	243	−27
ESE	25	0.07	244	32	0.28	264	15	0.26	264							17	0.20	0.012	257	−35
SE	251	0.09	264	480	0.08	315	135	0.20	284	16	0.22	300	15	0.13	315	26	0.14	0.005	296	−19
SSE	24	0.08	337	32	0.10	61	10	0.28	350							17	0.15	0.009	9	31
S	349	0.09	26	680	0.18	43	265	0.31	36	57	0.44	26	17	0.35	345	26	0.27	0.010	23	23
SSW	37	0.10	66	127	0.25	50	60	0.43	40	14	0.31	11				21	0.27	0.013	42	20
SW	709	0.13	63	1,541	0.16	47	676	0.38	47	125	0.57	50	17	0.76	40	26	0.40	0.015	49	4
WSW	40	0.09	90	56	0.17	93	16	0.52	64							17	0.26	0.015	82	14
W	269	0.12	85	431	0.17	87	128	0.22	141	22	0.37	76	12	0.56	106	26	0.29	0.011	99	9
WNW	29	0.13	123	40	0.20	162	52	0.27	92	13	0.24	102				21	0.21	0.010	120	8
NW	226	0.10	151	653	0.16	180	722	0.39	177	226	0.48	157	172	0.38	148	26	0.30	0.012	163	28
NNW	30	0.14	168	104	0.20	183	165	0.39	189	45	0.66	188	25	0.39	199	26	0.36	0.014	185	27
Average		0.14			0.20			0.36			0.46			0.51				0.013		5
Ratio C/W		0.014			0.013			0.014			0.013			0.011						

Chesapeake Lightship, 1935–36, 1 year

Wind velocity, statute miles per hour	10			20			30			40			50							
N	297	0.27	197	145	0.43	196	115	0.48	194	16	0.56	204				25	0.44	0.018	198	18
NNE	235	0.24	202	143	0.31	205	119	0.44	201	10	0.53	193				25	0.38	0.015	200	−2
NE	373	0.19	223	110	0.23	228	126	0.31	233	12	0.57	221	17	0.37	202	30	0.33	0.011	221	−4
ENE	174	0.09	238	86	0.23	250	35	0.24	270							20	0.19	0.010	253	5
E	307	0.07	270	23	0.18	257										15	0.12	0.008	264	−6
ESE	188	0.10	315													10	0.10	0.010	315	23
SE	270	0.07	34				13	0.40	22							20	0.24	0.012	28	73
SSE	237	0.14	39	54	0.38	61	22	0.35	46							20	0.29	0.014	49	71
S	563	0.18	56	113	0.36	60	33	0.58	55							20	0.37	0.018	57	57
SSW	522	0.18	54	126	0.40	63	47	0.53	64							20	0.37	0.018	60	38
SW	549	0.19	65	97	0.35	75	55	0.54	77							20	0.36	0.018	72	27
WSW	194	0.19	93	13	0.25	101	25	0.49	89							20	0.31	0.016	94	26
W	231	0.16	104	44	0.17	100	34	0.38	133							20	0.24	0.012	112	22
WNW	166	0.19	133	43	0.28	148	82	0.42	135				12	0.62	105	28	0.38	0.014	130	18
NW	275	0.20	165	139	0.35	160	232	0.42	153	20	0.41	141	14	0.49	131	30	0.37	0.012	150	15
NNW	159	0.25	182	136	0.38	187	154	0.48	172							20	0.37	0.018	180	22
Average		0.17			0.31			0.43			0.52			0.49				0.014		25
Ratio C/W		0.017			0.016			0.014			0.013			0.010						

See footnotes at end of table.

TABLE 12.—*Wind Currents, Atlantic Coast Lightships*—Continued

[All directions are true]

Diamond Shoal Lightship, 1919–28, 9 years

Wind from—	Current			Current			Current			Current			Current			Average of velocities			Average of current directions (degrees)	Current sets to right of wind (degrees)
	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Wind (m. p. h.)	Current (knots)	Ratio (C/W)		
Wind velocity, statute miles per hour	15			25			35			45			55							
N	2,592	0.23	173	2,132	0.45	189	545	0.65	193	399	0.84	194	86	1.10	205	35	0.65	0.019	191	11
NNE	1,494	0.19	198	1,021	0.42	204	175	0.41	208	73	0.88	202	10	1.04	213	35	0.59	0.017	205	3
NE	2,170	0.15	208	1,220	0.45	219	393	0.85	220	201	1.13	224	33	1.51	238	35	0.82	0.023	222	−3
ENE	127	0.39	31	58	0.54	250	11	0.53	276							25	[1] 0.29	0.012	[1] 284	36
E	407	0.28	10	178	0.49	23	39	0.60	280	14	0.50	329				30	[1] 0.35	0.012	[1] 335	65
ESE	136	0.55	33	48	1.06	14	13	0.44	347	15	0.99	45				30	0.76	0.025	20	88
SE	1,003	0.52	23	292	0.75	29	75	0.62	35	53	0.45	29				30	0.58	0.019	29	74
SSE	202	0.84	32	84	1.14	27	28	1.12	32							25	1.03	0.041	30	52
S	1,156	0.88	40	602	1.20	39	143	1.28	40	103	1.35	43	12	1.61	39	35	1.26	0.036	40	40
SSW	862	1.20	42	453	1.46	44	66	1.45	45	53	1.35	43				30	1.36	0.045	44	22
SW	4,175	1.06	51	2,283	1.32	52	431	1.32	55	207	1.54	52	43	1.90	48	35	1.43	0.041	52	7
WSW	1,022	1.06	55	435	1.13	57	84	1.38	60	34	1.49	62				30	1.26	0.042	58	−10
W	1,264	0.67	66	603	0.90	73	121	1.16	75	93	1.14	76	21	1.52	95	35	1.08	0.031	77	−13
WNW	297	0.70	71	166	0.62	83	46	1.08	95	27	0.76	132				30	0.79	0.026	95	−17
NW	1,388	0.38	85	945	0.45	119	298	0.57	137	150	0.84	89	31	0.59	122	35	0.57	0.016	110	−25
NNW	256	0.38	104	221	0.46	155	91	0.57	129	48	0.72	156	11	0.75	196	35	[1] 0.50	0.014	[1] 154	−4
Average		0.59			0.80			0.88			1.00			1.25				0.026		20
Ratio C/W		0.039			0.032			0.025			0.022			0.023						

Cape Lookout Shoals Lightship, 1918–19, 1 year

Wind velocity, statute miles per hour	10			20			30			40			50							
N	255	0.52	209	98	0.36	222	102	0.48	184	18	0.70	222	12	0.97	214	30	0.61	0.020	210	30
NNE	90	0.49	237	16	0.57	237	51	0.34	208				23	0.81	221	28	0.55	0.020	226	24
NE	797	0.42	227	176	0.52	227	215	0.50	227	89	0.68	227	143	0.91	226	30	0.61	0.020	227	2
ENE	45	0.41	257				11	0.89	242							20	0.65	0.032	250	2
E	96	0.13	241													10	0.13	0.013	241	−29
ESE																				
SE	159	0.15	0	28	0.33	314	24	0.38	335							20	0.29	0.014	336	21
SSE	26	0.49	58													10	0.49	0.049	58	80
S	192	0.52	55	35	0.64	50	58	0.59	47				12	0.92	63	28	0.67	0.024	54	54
SSW	47	0.76	63				15	0.61	48				14	0.88	48	30	0.75	0.025	53	31
SW	721	0.59	79	90	0.72	76	120	0.82	72	11	0.73	83	34	0.79	74	30	0.73	0.024	77	32
WSW	39	0.61	89	11	0.55	78	14	0.84	100							20	0.67	0.034	89	21
W	212	0.53	88	39	0.62	96	62	0.69	87	20	0.94	94	21	0.84	97	30	0.72	0.024	92	2
WNW	31	0.38	130													10	0.38	0.038	130	18
NW	207	0.41	133	50	0.30	134	51	0.57	134	11	0.59	186	16	1.08	113	30	0.59	0.020	140	5
NNW	39	0.43	143	16	0.34	135	18	0.22	180							20	0.33	0.016	153	−5
Average		0.46			0.50			0.58			0.73			0.90				0.025		19
Ratio C/W		0.046			0.025			0.019			0.18			0.018						

Frying Pan Shoals Lightship, 1919–20, 2 years

Wind velocity, statute miles per hour	10			20			30			40			50							
N	616	0.17	204	544	0.31	222	241	0.40	221	147	0.58	222	10	0.68	202	30	0.43	0.014	214	34
NNE	353	0.22	231	448	0.42	243	232	0.53	238	133	0.68	231	39	0.80	235	30	0.53	0.018	236	34
NE	1,322	0.22	246	1,161	0.46	247	677	0.59	243	200	0.65	236	37	0.85	243	30	0.55	0.018	243	18
ENE	231	0.23	263	134	0.36	252	52	0.36	247							20	0.32	0.016	254	6
E	587	0.18	273	148	0.40	270	20	0.40	273							20	0.33	0.016	272	2
ESE	114	0.17	301	36	0.21	289	13	0.35	312							20	0.24	0.012	301	9
SE	406	0.13	347	186	0.16	4	55	0.24	345	14	0.20	37				25	0.18	0.007	3	48
SSE	135	0.16	22	115	0.29	41	57	0.38	39	10	0.41	29				25	0.31	0.012	33	55
S	500	0.29	52	424	0.45	55	156	0.54	43	33	0.64	44				25	0.48	0.019	48	48
SSW	383	0.34	73	302	0.63	70	107	0.66	63	18	0.45	35				25	0.52	0.021	60	38
SW	1,195	0.39	81	814	0.58	76	267	0.70	73	75	0.71	62	10	0.90	61	30	0.66	0.022	71	26
WSW	298	0.46	91	331	0.59	85	82	0.71	77	27	0.76	73				25	0.63	0.025	82	14
W	565	0.31	92	449	0.46	89	124	0.61	83	70	0.86	77	22	0.87	72	30	0.62	0.021	83	−7
WNW	107	0.25	113	124	0.41	105	50	0.62	89	39	0.64	94				25	0.48	0.019	100	−12
NW	419	0.24	114	263	0.32	112	153	0.47	110	64	0.58	103	10	0.58	100	30	0.44	0.015	108	−27
NNW	126	0.14	141	71	0.30	153	35	0.31	161	18	0.27	153				25	0.26	0.010	152	−6
Average		0.24			0.40			0.49			0.57			0.78				0,017		18
Ration C/W		0.024			0.020			0.016			0.014			0.016						

See footnotes at end of table.

TABLE 12.—*Wind Currents, Atlantic Coast Lightships*—Continued

[All directions are true]

Savannah Lightship, 1925–35, 2 years

Wind from—	Current			Current			Current			Current			Current			Average of velocities			Average of current directions (degrees)	Current sets to right of wind (degrees)
	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Number of observations	Velocity (knots)	Direction (degrees)	Wind (m. p. h.)	Current (knots)	Ratio (C/W)		
Wind velocity, statute miles per hour	10			20			30			40			50							
N	464	0.17	188	144	0.24	212	39	0.28	206				12	0.50	162	28	0.30	0.011	192	12
NNE	291	0.19	204	176	0.27	208	77	0.39	230							20	0.28	0.014	214	12
NE	1,095	0.19	215	579	0.27	218	558	0.36	221	20	0.53	212				25	0.34	0.014	216	−9
ENE	242	0.17	224	212	0.23	231	109	0.43	236							20	0.28	0.014	230	−18
E	410	0.12	242	167	0.21	250	35	0.22	249							20	0.18	0.009	247	−23
ESE	159	0.10	278	80	0.14	264	15	0.28	197							20	0.17	0.008	246	−46
SE	613	0.08	27	155	0.10	312	12	0.16	297							20	0.11	0.006	332	17
SSE	350	0.19	28	90	0.20	12	14	0.38	45							20	0.26	0.013	28	50
S	1,512	0.20	42	630	0.24	35	141	0.42	53							20	0.29	0.014	43	43
SSW	621	0.24	42	440	0.30	40	140	0.47	34							20	0.34	0.017	39	17
SW	1,246	0.25	52	474	0.33	58	98	0.43	46							20	0.34	0.017	52	7
WSW	241	0.18	53	197	0.26	73	51	0.37	55							20	0.27	0.014	60	−8
W	486	0.19	83	188	0.25	81	99	0.25	77							20	0.23	0.012	80	−10
WNW	158	0.21	118	124	0.27	121	70	0.27	118							20	0.25	0.012	119	7
NW	509	0.14	153	211	0.21	152	121	0.18	145							20	0.18	0.009	150	15
NNW	132	0.18	164	43	0.19	195	18	0.15	214							20	0.17	0.008	191	33
Average		0.18			0.23			0.32			0.53			0.50				0.012		6
Ratio C/W		0.018			0.012			0.011			0.013			0.010						

Brunswick Lightship, 1919–20, 2 years

Wind velocity, statute miles per hour	15			25			35			45			55							
N	406	0.26	193	196	0.38	198	57	0.56	196	22	0.58	200				30	0.44	0.015	197	17
NNE	415	0.30	195	290	0.42	211	96	0.53	199	49	0.66	195				30	0.48	0.016	200	−2
NE	1,638	0.29	216	1,232	0.40	217	430	0.47	215	102	0.64	212	46	0.64	215	35	0.49	0.014	215	−10
ENE	525	0.26	233	189	0.36	217	26	0.46	210							25	0.36	0.014	220	−28
E	1,048	0.17	242	239	0.24	258	48	0.22	257							25	0.21	0.008	252	−18
ESE	369	0.13	279	57	0.12	265	14	0.19	270							25	0.15	0.006	271	−21
SE	1,591	0.15	337	252	0.27	6										20	0.21	0.010	352	37
SSE	893	0.24	5	285	0.40	7	16	0.53	9							25	0.39	0.016	7	29
S	1,483	0.27	20	327	0.40	21	25	0.55	28							25	0.41	0.016	23	23
SSW	610	0.26	29	143	0.29	20										20	0.28	0.014	24	2
SW	941	0.25	47	176	0.37	29	17	0.28	77							25	0.30	0.012	51	6
WSW	230	0.20	63	65	0.35	31										20	0.28	0.014	47	−21
W	492	0.19	93	162	0.21	68	27	0.27	45							25	0.22	0.009	69	−21
WNW	206	0.22	120	133	0.20	99	46	0.26	79	20	0.33	44				30	0.25	0.008	86	−26
NW	494	0.19	146	367	0.22	153	110	0.20	153	38	0.29	151				30	0.22	0.007	151	16
NNW	202	0.23	165	151	0.32	187	56	0.46	175							25	0.34	0.014	176	18
Average		0.23			0.31			0.38			0.50			0.64				0.012		0
Ratio C/W		0.015			0.012			0.011			0.011			0.012						

St. Johns Lightship, 1934, 1 year

Wind velocity, statute miles per hour.	10			20			30			40			50							
N	262	0.25	175	89	0.33	186	91	0.42	187							20	0.33	0.016	183	3
NNE	260	0.23	187	172	0.34	192	216	0.52	190							20	0.36	0.018	190	−12
NE	523	0.22	193	124	0.31	192	243	0.49	198	10	0.78	211				25	0.45	0.018	198	−27
ENE	197	0.14	200	19	0.25	202	21	0.39	200							20	0.26	0.013	201	−47
E	479	0.09	195	21	0.22	177										15	0.16	0.011	186	−84
ESE	163	0.09	322													10	0.09	0.009	322	30
SE	772	0.15	348	45	0.28	352										15	0.22	0.015	350	35
SSE	206	0.24	2	20	0.33	7										15	0.28	0.019	4	26
S	484	0.28	32	19	0.29	33	14	0.33	13							20	0.30	0.015	26	26
SSW	170	0.31	49													10	0.31	0.031	49	27
SW	480	0.27	59	44	0.46	47	20	0.52	33							20	0.42	0.021	46	1
WSW	154	0.23	92	20	0.26	76										15	0.24	0.016	84	16
W	347	0.20	97	78	0.27	100	37	0.32	48							20	0.26	0.013	82	−8
WNW	131	0.22	130	23	0.19	105	18	0.28	50							20	0.23	0.012	95	−17
NW	218	0.22	141	142	0.20	139	98	0.28	142							20	0.23	0.012	141	6
NNW	107	0.23	154	90	0.30	173	93	0.34	170							20	0.29	0.014	166	8
Average		0.21			0.29			0.39			0.078							0.016		−1
Ratio C/W		0.021			0.014			0.013			0.020									

[1] Resultant velocity and direction. Current directions for the several wind velocities differ considerably.

Values in parentheses are means of adjacent values.
For reference to above table, see p. 23.

TABLE 13.—*Average Current Velocities Accompanying Various Wind Velocities, Atlantic Coast Lightships*

Wind velocity (statute miles per hour)	10	15	20	25	30	35	40	45	50	55
Lightship station	*Knots*	*Knots*	*Knots*	*Knots*	*Knots*	*Knots*	*Knots*	*Knots*	*Knots*	*Knots*
Boston	0.06	------	0.10	------	0.16	------	0.32	------	------	------
Pollock Rip Slue	0.21	------	0.31	------	0.31	------	0.61	------	0.68	------
Nantucket Shoals	(0.20)	0.26	(0.29)	0.32	(0.38)	0.44	(0.46)	0.47	(0.48)	0.48
Hen and Chickens	0.14	------	0.18	------	0.29	------	0.29	------	------	------
Brenton Reef	0.15	------	0.23	------	0.35	------	0.35	------	0.48	------
Fire Island	0.14	------	0.21	------	0.28	------	0.38	------	0.38	------
Ambrose Channel	0.15	------	0.28	------	0.35	------	0.29	------	------	------
Scotland	0.25	------	0.32	------	0.38	------	0.56	------	0.50	------
Barnegat	0.07	------	0.16	------	0.24	------	0.35	------	0.29	------
Northeast End	0.22	------	0.28	------	0.41	------	0.62	------	0.64	------
Overfalls	0.23	------	0.28	------	0.44	------	0.55	------	0.51	------
Winter-Quarter Shoal	0.14	0.20	(0.28)	0.36	(0.41)	0.46	(0.48)	0.51	------	------
Chesapeake	0.17	------	0.31	------	0.43	------	0.52	------	0.49	------
Diamond Shoal	(0.49)	0.59	(0.70)	0.80	(0.84)	0.88	(0.94)	1.00	(1.12)	1.25
Cape Lookout Shoals	0.46	------	0.50	------	0.58	------	0.73	------	0.90	------
Frying Pan Shoals	0.24	------	0.40	------	0.49	------	0.57	------	0.78	------
Savannah	0.18	------	0.23	------	0.32	------	0.53	------	0.50	------
Brunswick	(0.19)	0.23	(0.27)	0.31	(0.34)	0.38	(0.44)	0.50	(0.57)	0.64
St. Johns	0.21	------	0.29	------	0.39	------	0.78	------	------	------
Average	0.21	------	0.30	------	0.39	------	0.51	------	0.59	------
Ratio C/W	0.021	------	0.015	------	0.013	------	0.013	------	0.012	------

Values in parentheses are inferred.
For reference to above table, see p. 24.

TABLE 14.—*Average Deviation of Current Direction to Right of Wind Direction, Atlantic Coast Lightships*

Wind from—	Boston	Pollock Rip Slue	Nantucket Shoals	Hen and Chickens	Brenton Reef	Fire Island	Ambrose Channel	Scotland	Barnegat	Northeast End	Overfalls	Winter-Quarter Shoal	Chesapeake	Diamond Shoal	Cape Lookout Shoals	Frying Pan Shoals	Savannah	Brunswick	St. Johns	Average deviation to right of wind
	Deg.	*Deg.*	*Deg.*	*Deg.*	*Deg.*	*Deg.*	*Deg.*	*Deg.*	*Deg.*	*Deg.*	*Deg.*	*Deg.*	*Deg.*	*Deg.*	*Deg.*	*Deg.*	*Deg.*	*Deg.*	*Deg.*	*Deg.*
N	......	6	44	16	34	35	36	16	6	30	31	18	18	11	30	34	12	17	3	22
NNE	−1	5	46	14	25	23	40	−12	5	14	−23	−1	−2	3	24	34	12	−2	−12	10
NE	......	48	28	−7	22	15	21	−26	−13	−3	−1	−5	−4	−3	2	18	−9	−10	−27	3
ENE	21	−38	24	−1	19	8	11	−36	−9	−11	14	−21	5	36	2	6	−18	−28	−47	−3
E	......	30	9	−14	25	2	18	−61	−16	−20	−58	−27	−6	65	−29	2	−23	−18	−84	−11
ESE	32	−53	16	3	1	−17	72	−36	−7	−31	−58	−35	23	88	......	9	−46	−21	30	−2
SE	......	−24	12	−39	−7	31	27	−92	33	−42	−61	−19	73	74	21	48	17	37	35	7
SSE	29	−75	3	−36	8	55	112	−150	54	−28	−18	31	71	52	80	55	50	29	26	18
S	......	−25	25	25	27	40	82	90	55	37	51	23	57	40	54	48	43	23	26	40
SSW	20	167	0	55	48	41	70	33	30	44	11	20	38	22	31	38	17	2	27	38
SW	......	70	6	35	23	31	63	77	14	25	18	4	27	7	32	26	7	6	1	26
WSW	2	59	18	30	41	14	46	44	8	18	51	14	26	−10	21	14	−8	−21	16	20
W	......	36	30	20	41	−2	37	15	0	7	17	9	22	−13	2	−7	−10	−21	−8	10
WNW	19	53	39	16	31	0	22	30	−5	16	28	8	18	−17	18	−12	7	−26	−17	12
NW	......	20	41	16	21	25	23	27	21	25	15	28	15	−25	5	−27	15	16	6	15
NNW	15	19	48	8	24	37	21	13	29	18	56	27	22	−4	−5	−6	33	18	8	20
Average	17	19	24	9	24	21	44	−4	13	6	5	5	25	20	19	18	6	0	−1	14

• For reference to above table, see p. 24.

TABLE 15.—*Average Ratio of Current Velocity in Knots to Wind Velocity in Statute Miles Per Hour, Atlantic Coast Lightships*

Wind from—	Boston	Pollock Rip Slue	Nantucket Shoals	Hen and Chickens	Brenton Reef	Fire Island	Ambrose Channel	Scotland	Barnegat	Northeast End	Overfalls	Winter-Quarter Shoal	Chesapeake	Diamond Shoal	Cape Lookout Shoals	Frying Pan Shoals	Savannah	Brunswick	St. Johns	Average
N	......	.028	.015	.012	.010	.015	.007	.022	.010	.021	.015	.015	.018	.019	.020	.014	.011	.015	.016	.016
NNE	.005	.018	.014	.015	.016	.014	.011	.022	.011	.022	.016	.018	.015	.017	.020	.018	.014	.016	.018	.016
NE	......	.010	.017	.010	.012	.014	.008	.023	.009	.021	.016	.022	.011	.023	.020	.018	.014	.014	.018	.016
ENE	.004	.016	.013	.009	.013	.014	.008	.018	.010	.024	.026	.016	.010	.012	.032	.016	.014	.014	.013	.015
E	......	.010	.014	.011	.019	.009	.006	.012	.006	.016	.015	.013	.008	.012	.013	.016	.009	.008	.011	.012
ESE	.006	.018	.013	.010	.011	.006	.006	.011	.003	.013	.016	.012	.010	.025	......	.012	.008	.006	.009	.011
SE	......	.015	.014	.011	.011	.009	.005	.009	.004	.013	.012	.005	.012	.019	.014	.007	.006	.010	.015	.011
SSE	.006	.010	.009	.006	.013	.008	.001	.009	.007	.012	.024	.009	.014	.041	.049	.012	.013	.016	.019	.015
S	......	.013	.009	.006	.006	.011	.018	.009	.008	.010	.011	.010	.018	.036	.024	.019	.014	.016	.015	.014
SSW	.007	.006	.012	.007	.011	.012	.020	.008	.011	.008	.008	.013	.018	.045	.025	.021	.017	.014	.031	.015
SW	......	.004	.011	.007	.009	.012	.021	.018	.010	.016	.010	.015	.018	.041	.024	.022	.017	.012	.021	.016
WSW	.004	.007	.010	.010	.008	.010	.024	.019	.008	.015	.019	.015	.016	.042	.034	.025	.014	.014	.016	.016
W	......	.006	.009	.010	.011	.009	.019	.014	.008	.011	.004	.011	.012	.031	.024	.021	.012	.009	.013	.013
WNW	.007	.010	.010	.010	.011	.006	.019	.014	.005	.014	.019	.010	.014	.026	.038	.019	.012	.008	.012	.014
NW	......	.012	.011	.010	.010	.008	.012	.013	.005	.009	.006	.012	.012	.016	.020	.015	.009	.007	.012	.011
NNW	.005	.016	.010	.011	.009	.009	.010	.026	.008	.013	.008	.014	.018	.014	.016	.010	.008	.014	.014	.012
Average	.006	.012	.012	.010	.011	.010	.012	.015	.008	.015	.014	.013	.014	.026	.025	.017	.012	.012	.016	.014

For reference to above table, see p. 24.

INDEX

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