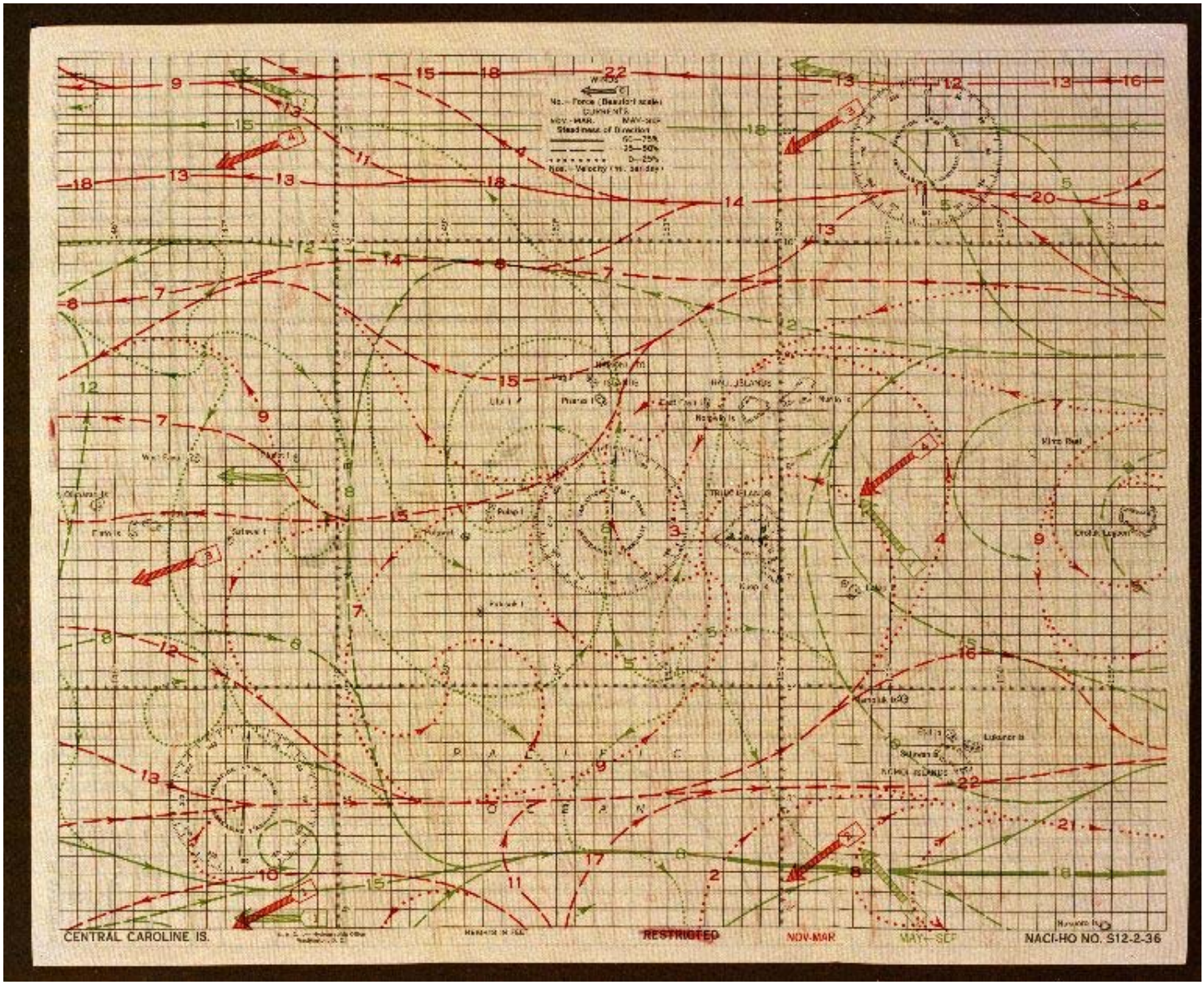
Cloth Survival Charts,
Also Called "Waterproof Handkerchiefs"

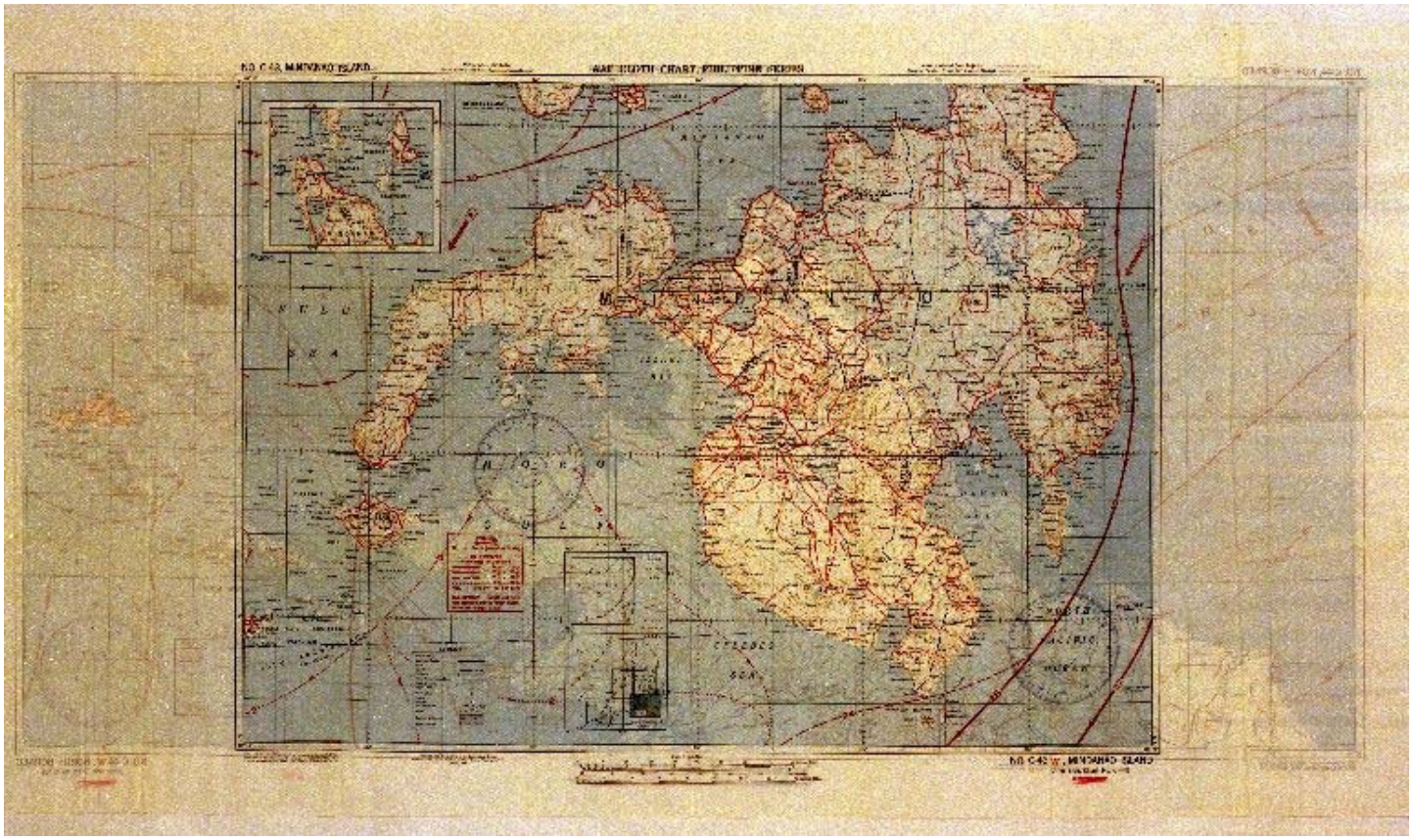
Deborah Day
Scripps Institution of Oceanography Archives
October 10, 1996

Cloth survival charts, also called "waterproof handkerchiefs" were used as survival gear in Asia and Europe during World War II.



Oral tradition at the Scripps Institution of Oceanography indicates that a set of these handkerchiefs were developed at Scripps Institution of Oceanography during WWII. Drift maps of relevant areas of the Pacific were printed on "silk" – that is

artificial silk or rayon, and the handkerchiefs were distributed to and worn by pilots flying over the Pacific during the war. The handkerchiefs were designed to be used by pilots in order to facilitate their survival and recovery should they be lost at sea. Dr. Walter Munk has noted that the handkerchiefs were not very successful. At the time it was believed that the ocean circulation was very steady, so that charts of the mean currents would provide much help. It has since been discovered that eddies in the oceans are much more common than had been thought, and sufficiently intense to greatly modify the currents, even reverse their direction. The handkerchiefs are therefore of limited use in retrospect.

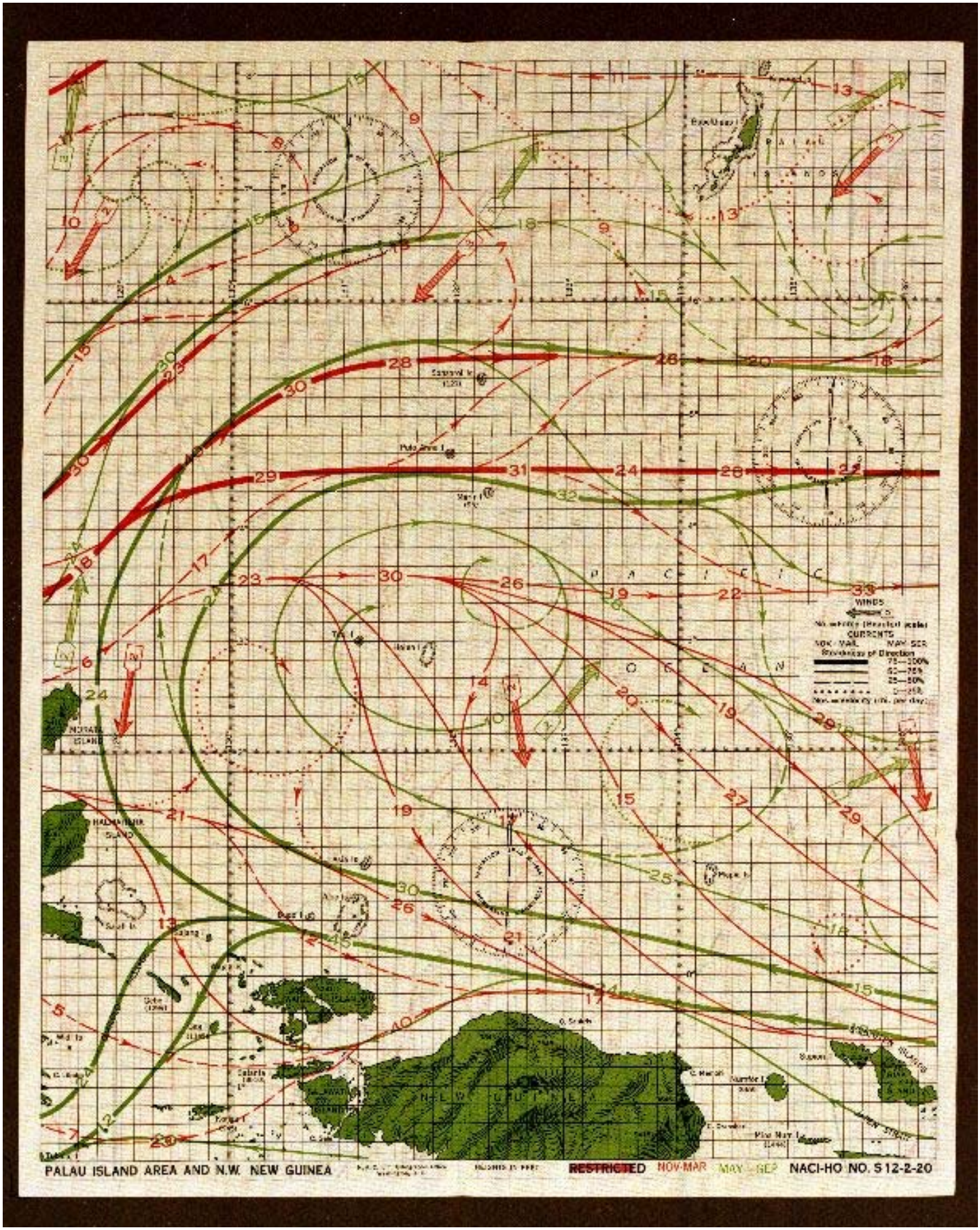


I telephoned Dr. Charles Bates to discuss the handkerchiefs. He says that SIO Director Harald Sverdrup personally designed the "waterproof handkerchief" for downed pilots. Bates was a wartime Sverdrup student who is now a historian of geophysics. He described the handkerchiefs in Charles C. Bates and Richard H. Fleming, "Oceanography in the Hydrographic office," *Military Engineer* v. 39 (1947): pp. 338-344. The article mentions that the 1942 effort to recover Capt. Eddie Rickenbacker when his plane was downed over the sea focus scientific attention on recovery of downed pilots and the study of drift currents. Quoting from page 342:

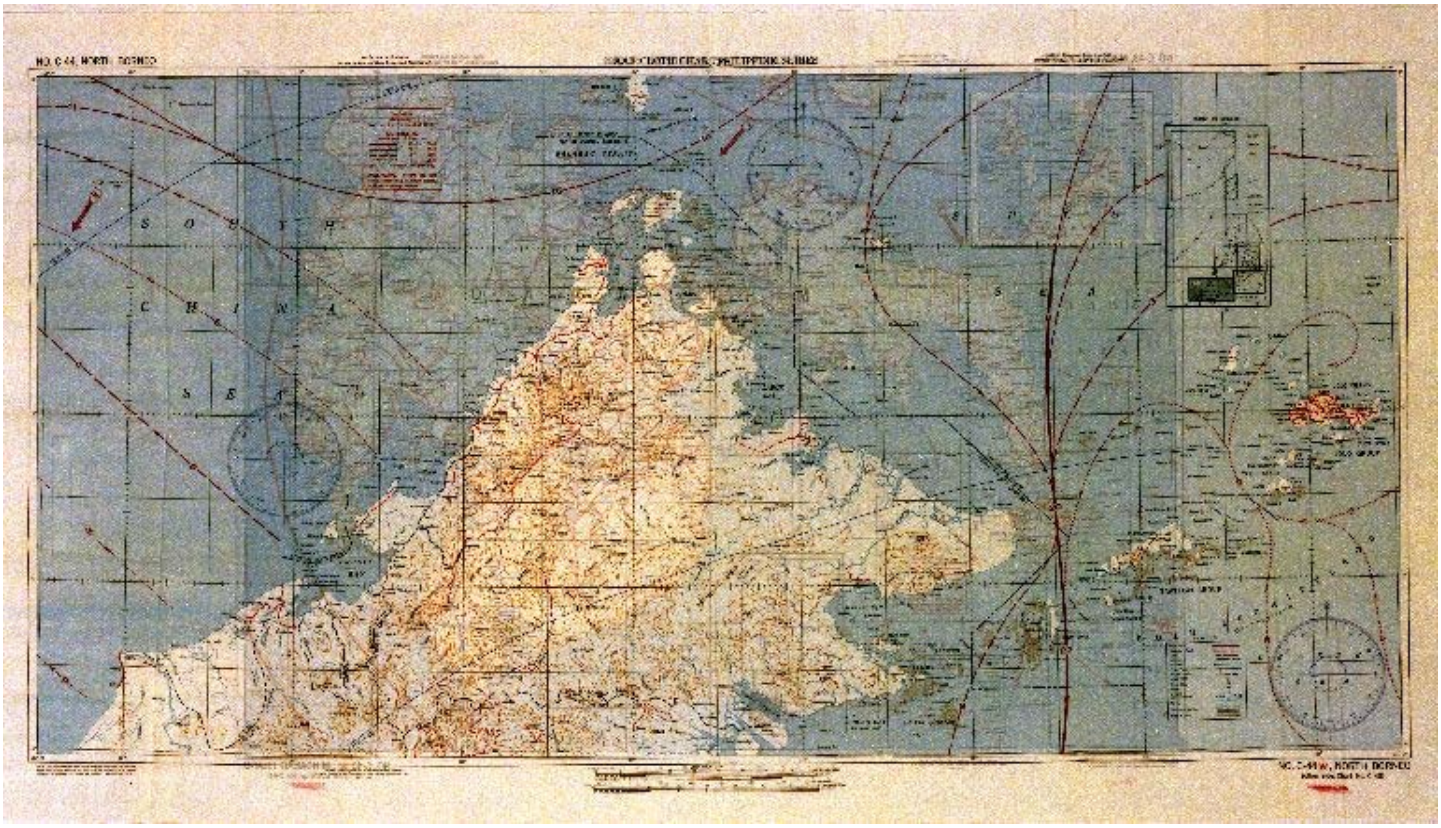
> During the early yeas of the war, applicable pilot charts printed on waterproof cloth were stowed in all life boats to help meet such emergencies. Detailed tests and studies were made on the drift of rubber rafts by the oceanographic institutions, and by 1944, sufficient data had been accumulated upon which to base the manual, *Methods for Locating Survivors Adrift at Sea in Rubber Rafts.* Once published, the methods were recommended by the Air Sea Rescue Agency as the approved search procedures over oceans and reports indicate that they were used successfully upon many occasions in the Pacific.

Dr. Bates further recalled that Major Seiwell (AAF representative to Scripps) asked Sverdrup to update the drift charts after the Rickenbacker rescue (this puts it as 1942-1943). Bates remembers seeing a big pattern chart of the Pacific on Sverdrup's desk at the Scripps Institution of Oceanography. As time allowed, Sverdrup updated this, and then used it to produce the handkerchiefs. Bates recalls that Sverdrup did this work alone.

The daughter of Scripps oceanographer Dr. Robert S. Arthur discovered a set of these charts among her father's papers after his death and donated four charts to Scripps Archives. These color charts are printed on both sides of a cloth square. She also held a set of instructions printed on cloth and labeled, "The Use of Cloth Survival Charts in the Navigation of Rubber Rafts," Air Intelligence Group, Division of Naval Intelligence, Office of the Chief of Naval Operations, Navy Department, Washington, D.C. OPNAV-16V#S109 July 1944 (Prepared by H.O.) Reproduced for Headquarters, Aeronautical Chart Service, Army Air Forces. See below.



PALAU ISLAND AREA AND N.W. NEW GUINEA RESTRICTED NOV-MAR MAY-SEP NACI-HO NO. S 12-2-20



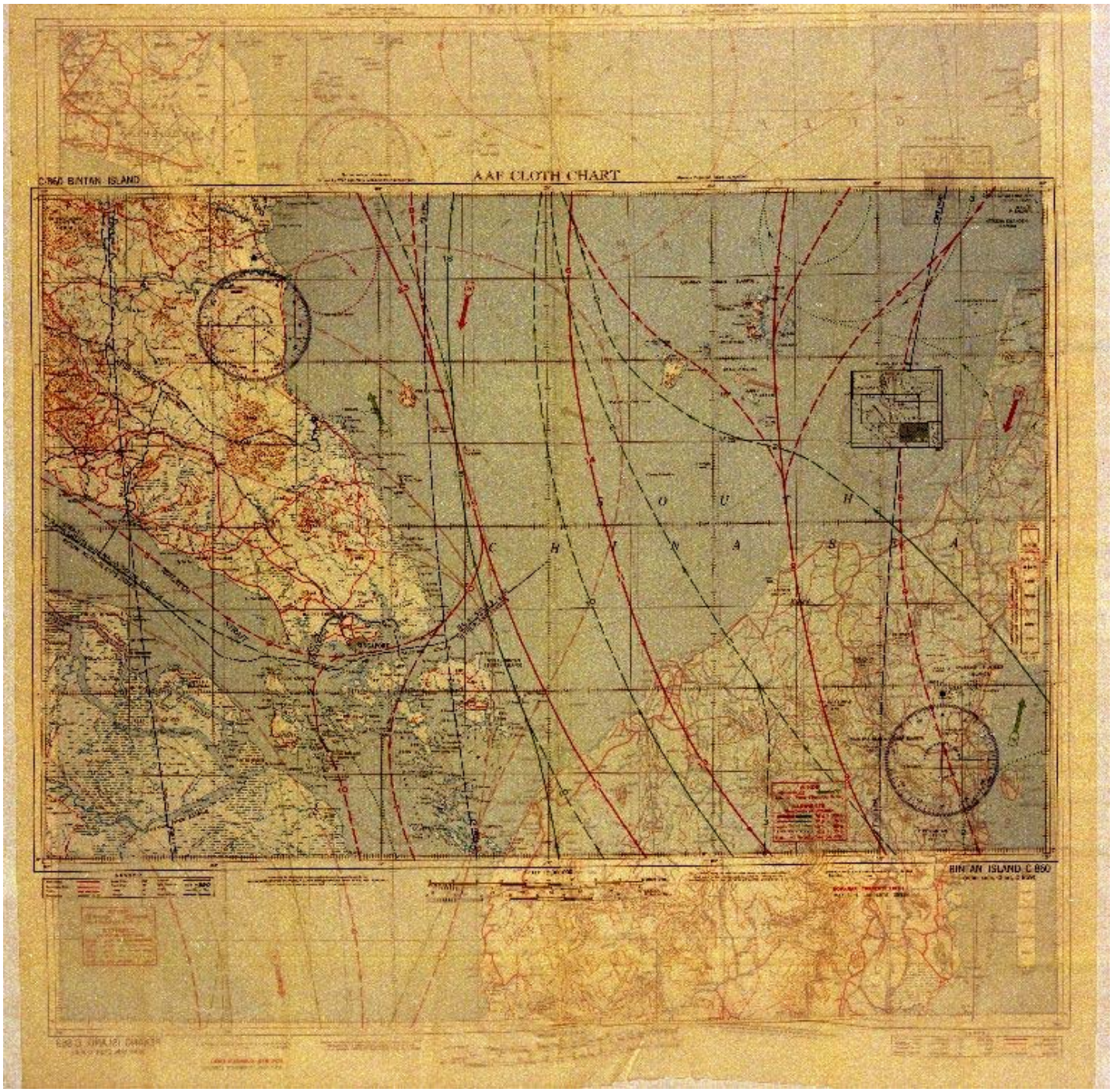
Two of the charts donated to Scripps Archives include a key, which allows us to reconstruct a list of the series. An asterisk (*) indicates the chart is held by Scripps Archives.

Number	Description
C-30	Andaman Sea
C-32	French Indochina
C-34	East China Sea
C-40	Philippine Islands
C-41	Philippine Islands
C-42	Philippine Islands
C-43	Mindanao Island*
C-44	North Borneo*
C-800	Straits of Malacca
C-859	South China Sea*
C-860	South China Sea/Malay Peninsula*
NACI-HO No. S12-2-20	Palau Island*
NACI-HO No. S12-2-40	West Caroline Islands*

NACI-HO No. S12-17 Marianas*
NACI-HO No. S12-2-36 Central Caroline Islands*

For more information on the history of survival charts, see John G. Doll, “Cloth Maps of World War II,” *Western Association of Map Libraries Information Bulletin*, v. 20, no. 1 (November 1988), pp. 23-35.

Daniel M. Jansen, Archivist of the Cartographic and Architectural Records Branch of the National Archives and Records Administration in College Park, Maryland, notes that Archives II holds a large collection of such charts, and the records of the Army Map Service which details the history of the World War II charts. Perhaps these records contain correspondence between oceanographers and the Army Map Service that would provide more detail of this instance of early wartime cooperation between military and oceanographic institutions.



THE USE OF CLOTH SURVIVAL CHARTS IN THE NAVIGATION OF RUBBER RAFTS

The handkerchief charts give information on average currents and winds. This information can be used in two ways:

1. By men on rafts to estimate their drift from a known position and to help in choosing a course of action.

2. By officers directing air-sea rescue operations to help in choosing the search area and the method of search.

Rafts drift with both wind and current. They are carried along by the current and they are pushed by the wind. When there is a current, but no wind, a raft will drift in the direction of the current and at the same speed. If there is no current but a wind is blowing, a raft will drift approximately downwind.

For a loaded raft without a sea anchor or drogue, the drift speed through the water will vary from about one knot with a 20 knot wind (Beaufort force 6) to about half a knot with a 4 knot breeze (Beaufort force 2). If a drogue is used, the speed of drift of the raft will be considerably lower - less than 3% of the wind speed. The current drift will, of course, not be changed by using a drogue.

Ordinarily both wind and current are present, and the raft drift is a combination of wind drift and current drift.

WHAT THE CHARTS SHOW

The streamlines on the handkerchief charts show the average current near the surface. The arrows on the streamlines indicate the average direction of flow, and the numbers indicate the average speed of the current in nautical miles per day.

The heaviness of the streamlines shows the steadiness of the current, that is, the percentage of the time that the current actually flows in the average direction. The heavier and more solid the line, the more you can rely on the current which it shows.

The shaded arrows on the charts give the average wind direction for each area. The numbers on the arrows show the average Beaufort force of the wind.

The direction and speed of the current will vary somewhat with wind force and direction. When the wind has been blowing for several hours, with the direction and force indicated by the arrow nearest your position, the current will flow about as shown on the chart. If the wind has been blowing in a different direction or at a different speed, the actual current will be a combination of that shown on the chart with the current set up by the wind.

Currents near shore will usually differ in speed and direction from those prevailing offshore. Such currents nearly always flow parallel to the beach and are mainly due to the tide, that is, they fluctuate in speed and often reverse direction every 6 or 12 hours.

WHAT TO DO BEFORE THE FLIGHT

Before a flight over water, obtain definite instruction on when and for how long a drogue will be used by personnel on rafts. (If a fresh breeze is blowing, the drift speed of a raft is much greater without a drogue than with one.) The proper course under sail or oars if the raft is not found within a certain time should also be determined before the flight.

In navigating a raft you will need to estimate the wind force. Practice estimating wind force whenever you are near the ocean, using the Beaufort scale (see Table 1). Do not try to guess the wind speed in miles per hour. The appearance and size of the small waves, chop, and white caps on the sea surface is the best way of judging the wind.

Practice raft handling whenever possible. Rig and use a drogue, and also learn to row the raft. You may be able to learn to sail it, using a jury-rigged sail made from the raft cover or a poncho.

WHAT TO DO BEFORE DITCHING

1. If possible send the following information by radio:
   (a) Estimated ditching position (this should be as accurate as possible)
   (b) Wind direction and force at the sea surface
   (c) Whether use of a drogue will be attempted (if not decided prior to the flight)

2. Give the estimated ditching position to each member of the crew who has a handkerchief chart.

Remember that the wind speed and direction at the sea surface will be different from that aloft. Throw a smoke pot overboard and watch the direction of the smoke to determine wind direction. If this is not possible, observe the smallest waves, which will go with the wind. Estimate wind force from the white caps and wind streaks on the ocean surface using the Beaufort scale (see Table 1).

RIGGING A DROGUE

An effective drogue or sea anchor will not only greatly reduce drift but will keep the raft headed into the sea and help to prevent capsizing in heavy weather.

On rafts which have the cover attached to the tow by a bridle and line, the cover is designed to sink into the sea and serve as a sea anchor. Some rafts are equipped with a conical bag or a bucket rigged with bridle and tow line, for a drogue.

Make sure that the tow line is securely attached to the ring or loop on the bow of the raft. If this ring seems insecure, bring the end of the line aft and fasten it to the stern oarlock. Cut rid of air pockets in the drogue and be sure that it sinks so as to exert full resistance.

If the raft is not equipped with a drogue, a full emergency container on the end of a tow line will serve as an adequate sea anchor; or a drogue may be improvised from the raft cover or a leather jacket.

To rig a drogue from the raft cover, cut 4 three-foot lengths of line, knot one to each corner of the cover, and join the lines to a fifth line of the greatest length available.

To rig a drogue from a leather jacket, fasten the two lower corners of the jacket to an oar with a stout cord. Tie short lines to the sleeves and to the ends of the oar, joining the four lines to a tow line. Any heavy object can be used to weight this improvised drogue will help to keep it submerged and functioning.

Watch out for chafing and wear near the point where the line to the sea anchor is attached to the raft.

Except in very rough weather, use the largest drogue available; in most rafts this will be the raft cover or cover.

RAFT NAVIGATION

In determining the course of a raft by dead reckoning, regular wind observations every 6 hours are necessary. Keep a record of the following:

Wind direction	Whether a drogue is used	Estimated speed
Wind force	Use of oars or sail	

TABLE 1

PREDICTION OF SURFACE WIND FORCE FROM APPEARANCE OF SEA SURFACE

Wind (Beaufort Scale)	Wind Speed (Knots)	Surface Condition as Seen from the Air*	Surface Condition as seen from the Sea Surface**
0	Less than 1	Smooth, slick sea.	Sea like a mirror.
1	1-3	Small ripples with few calm areas.	Ripples - no foam crests.
2	4-6	Ripples everywhere, or well defined waves which are smooth and do not break.	Small wavelets; crests have a glassy appearance and do not break.
3	7-10	Occasional whitecaps.	Large wavelets; crests begin to break; scattered whitecaps.
4	11-16	Pronounced waves, frequent whitecaps; slight to clearly defined wind streaks whose lengths may be equal to about 10 wave lengths.	Small waves becoming longer; frequent whitecaps.
5	17-21	Long, well defined wind streaks with waves and streaks coming from same direction.	Moderate waves, taking a more pronounced long form; many whitecaps, some spray.
6	22-27	Large seas with waves forming on them; wind picks up and carries occasional wave crest.	Large waves begin to form; extensive whitecaps everywhere; some spray.
7	28-33	Heavy seas; pronounced streaks; wind picks up and carries most wave crests; breaking, rolling waves are forming.	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.
Over 7	More than 33	Continual rolling waves; well defined waves form on some or all of the heavy seas; wind carries along all wave crests for a distance equal to at least one-half wave length; scud or foam streaks.	Moderately high to high waves of greater length; edges of crests break into spindrift and spray may affect visibility; well marked or dense streaks of foam along the direction of the wind.

* From "Aleutian Seas", Training Div., Bu. Aer., U.S.N.
** From U. S. Navy Deck Log Book (revised 1 January 1944).

To estimate wind direction hoist a light streamer on a mast or an oar. Repeat at intervals to get a fair average. (No wind is ever really steady and a single test may be misleading.)

To estimate the wind force, study the sea surface and use the Beaufort scale given in Table 1.

To plot your position at the end of 24 hours, proceed as follows:

1. If the current steadiness is greater than 25%, lay off a line from the estimated ditching position in the direction of the nearest current streamline shown on the chart. Make the length of the line equal to the current velocity, estimated from the numbers given on the chart.

   Do not draw this line if the current steadiness is less than 25%.

2. If the observed wind direction is more than 45° from the average wind direction shown by the nearest shaded arrow on the chart plot a line downwind from the end of the current line plotted in step 1. Find the length of the line from Table 2, using the observed wind force over the past 24 hours. This line represents the current caused by the wind which is known as the wind current; this is combined with the average current shown on the chart. In determining the wind force and direction, average the four wind estimates made over the 24 hour period.

   If the current steadiness is less than 25%, draw a line in the downwind direction from the estimated ditching position even when the observed wind is the same as the average wind shown on the chart.

TABLE 2 - VELOCITY OF THE WIND CURRENT IN MILES PER DAY

Wind (Beaufort Scale)	Wind Current (Miles per day)	Wind (Beaufort Scale)	Wind Current (Miles per day)
1	2	5	16
2	4	6	23
3	7	7	32
4	11		

3. From Table 3 determine the amount of drift due to the leeway of the raft under the influence of the wind over the past 24 hours. Draw a line of corresponding length in the downwind direction from the end of the line plotted in step 2 (or step 1, if step 2 is omitted).

TABLE 3 - LEEWAY OF RAFTS IN MILES PER DAY

Wind (Beaufort Scale)	Leeway	
	With drogue	Without drogue
1	2	8
2	4	13
3	6	19
4	8	23
5	11	24
6	16	24
7	22	28

Your probable position is the point at the end of the line drawn in step 3. Your course under the combined action of wind and current is given by the line connecting the estimated ditching position with the final position.

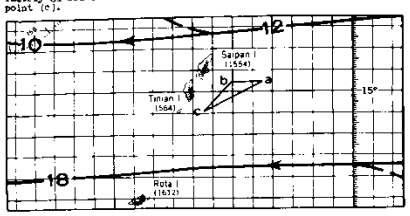
To find your position after 48 hours, proceed as before, starting from the estimated position at the end of 24 hours.

EXAMPLE

Time of year: July
Estimated ditching position: 15°05' N., 156°15' E.
Drogue used.
Average current: Direction 270°
Velocity about 15 miles per day
Steadiness 50-75%
Wind during past 24 hours: Direction from 045°
Force Beaufort 4

From Table 2: Wind current 11 miles per day
From Table 3: Leeway 8 miles per day

Draw a line 15 miles long, due west from the estimated ditching position (a). From the end of this line (b), draw a line 11 miles long directed toward 225°. Continue this line another 8 miles toward 228°. The point at the end of this second line (c) is the probable position at the end of 24 hours. The raft has drifted approximately 31 nautical miles in a direction of 245° from point (a) to point (c).



Considerable error (probably about 25-30%) in judging wind force is likely. Also the currents shown on the charts may vary. Both of these errors will tend to cancel out after a few days, but at best your dead reckoning fix will only be approximate and should be checked in as many ways as possible.

If using oars or sail or if a fresh breeze is blowing, you can obtain a good estimate of your speed of movement through the water in the following way. Tie a small piece of wood or other floating object to the end of a fish line, throw it overboard, and measure the time required for a certain length of line to pay out. If you are going one mile an hour through the water, 100 feet of line will be pulled out in a minute. To your speed through the water obtained in this fashion, there must of course be added the estimated current drift.

When in sight of the beach, estimate your drift by watching the changing position of points on shore, rather than by relying on the charts.

The charts do not apply during October and March. For these months estimates of the currents can often be made by comparing the winter and summer charts for the same region. Where the two charts agree moderately well, a reliable estimate of the current can be obtained. In other regions, conditions are too variable during these months to allow accurate current predictions. In such areas use only the wind force (assume a current steadiness of less than 25%) in dead reckoning navigation.

SHAPING A COURSE

After about 48 hours, or whatever time is specified in your instructions, the drogue should be hauled in and a course should be shaped toward a friendly coast. Every advantage should be taken of wind and current. Do not paddle or row the raft more than a few minutes at a time; remember that strength must be conserved at all costs.

When drifting without a drogue, turn the raft end for end with the oars every few hours; this will prevent "sailing" on one tack longer than on another.

Put out the drogue in rough weather to keep the raft headed into the sea and to avoid capsizing.

Do not attempt to use a jury-rigged sail if the wind is more than force 4, because of the danger of capsizing.

When near a friendly coast, paddle or row toward shore. Unless the wind is blowing onshore the current will cause the raft to drift parallel to the beach.

In sailing or rowing toward an island shore, direct your course to the windward end. This will prevent your being swept past the island end will enable you to drift along shore to find the best place for a landing - a cove, beach, or gap in a reef where there is the least surf.

DRIFT OF PARTLY LOADED AND EMPTY RAFTS

Two or three rafts of different sizes and types, all with normal loading, will soon separate owing to their slightly different drift rate. Rafts of the same size and type, if not connected by a line, are likely to separate within 12 hours owing to slight differences in loading. If both use efficient drogues, they will stay together for a longer time.

In a force 4 wind (11-16 knots) an empty raft without a drogue will drift so rapidly that even an expert swimmer will have a hard time overtaking it. An empty raft will travel almost directly downwind at nearly twice the speed of a loaded raft.

AIR INTELLIGENCE GROUP
DIVISION OF NAVAL INTELLIGENCE — OPNAV-16-V #8109
OFFICE OF THE CHIEF OF NAVAL OPERATIONS, NAVY DEPARTMENT, JULY 1944
WASHINGTON, D.C. (Prepared by H.O.)

REPRODUCED FOR HEADQUARTERS AERONAUTICAL CHART SERVICE ARMY AIR FORCES

Blow-up of this text for reading follows:

THE USE

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1. By men on rafts to estimate their drift from a known position and to help in choosing a course of action.

2. By officers directing air-sea rescue operations to help in choosing the search area and the method of search.

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For a loaded raft without a sea anchor or drogue, the drift speed through the water will vary from about one knot with a 20 knot wind (Beaufort force 5) to about half a knot with a 4 knot breeze (Beaufort force 2). If a drogue is used, the speed of drift of the raft will be considerably lower - less than 3% of the wind speed. The current drift will, of course, not be changed by using a drogue.

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In navigating a raft you will need to estimate the wind force. Practice estimating wind force whenever you are near the ocean, using the Beaufort scale (see Table 1). Do not try to guess the wind speed in miles per hour. The appearance and size of the small waves, chop, and white caps on the sea surface is the best way of judging the wind.

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Make sure that the tow line is securely attached to the ring or loop on the bow of the raft. If this ring seems insecure, bring the end of the line aft and fasten it to the stern oarlock. Get rid of air pockets in the drogue and be sure that it sinks so as to exert full resistance.

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Watch out for chafing and wear near the point where the line to the sea anchor is attached to the raft.

Except in very rough weather, use the largest drogue available; in most rafts this will be the raft case or cover.

RAFT NAVIGATION

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OF CLOTH SURVIVAL CHARTS IN THE NAVIGATION OF RUBB

TABLE 1

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7	28-33	Heavy seas; pronounced streaks; wind picks up and carries most wave crests; breaking, rolling waves are forming.	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.
Over 7	More than 33	Continual rolling waves; well defined waves form on some or all of the heavy seas; wind carries along all wave crests for a distance equal to at least one-half wave length; scud or foam streaks.	Moderately high to high waves of greater length; edges of crests break into spindrift and spray may affect visibility; well marked or dense streaks of foam along the direction of the wind.

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To estimate the wind force, study the sea surface and use the Beaufort scale given in Table 1.

To plot your position at the end of 24 hours, proceed as follows:

1. If the current steadiness is greater than 25%, lay off a line from the estimated ditching position in the direction of the nearest current streamline shown on the chart. Make the length of the line equal to the current velocity, estimated from the numbers given on the chart.

Do not draw this line if the current steadiness is less than 25%.

2. If the observed wind direction is more than 45° from the average wind direction shown by the nearest shaded arrow on the chart plot a line downwind from the end of the current line plotted in step 1. Find the length of the line from Table 2, using the observed wind force over the past 24 hours. This line represents the current caused by the wind which is known as the wind current; this is combined with the average current shown on the chart. In determining the wind force and direction, average the four wind estimates made over the 24 hour period.

If the current steadiness is less than 25%, draw a line in the downwind direction from the estimated ditching position even when the observed wind is the same as the average wind shown on the chart.

TABLE 2 - VELOCITY OF THE WIND CURRENT IN MILES PER DAY

Wind (Beaufort Scale)	Wind Current (miles per day)	Wind (Beaufort Scale)	Wind Current (miles per day)
1	2	5	16
2	4	6	21
3	7	7	26
4	11		

3. From Table 3 determine the amount of drift due to the leeway of the raft under the influence of the wind over the past 24 hours. Draw a line of corresponding length in the downwind direction from the end of the line plotted in step 2 (or step 1, if step 2 is omitted).

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Wind (Beaufort Scale)	Leeway	
	With drogue	Without drogue
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3	6	19
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6	16	24
7	20	28

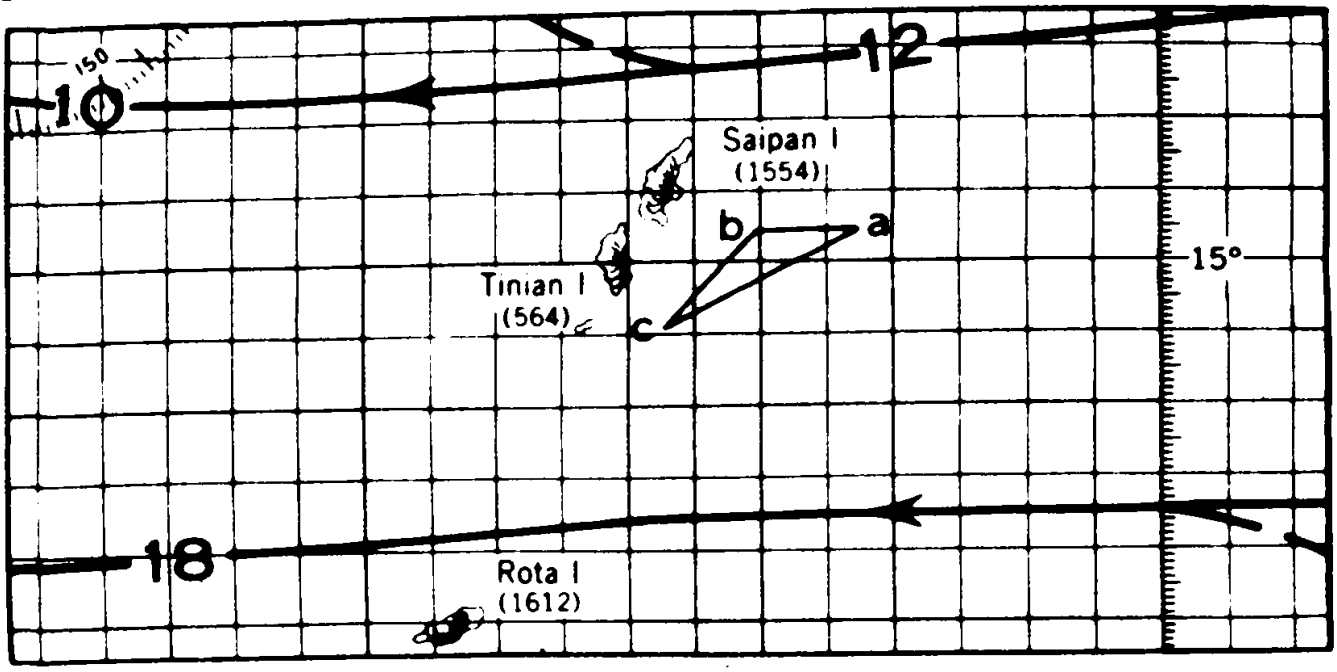
Your probable position is the point at the end of the line drawn in step 3. Your course under the combined action of wind and current is given by the line connecting the estimated ditching position with the final position.

To find your position after 48 hours, proceed as before, starting from the estimated position at the end of 24 hours.

EXAMPLE

Time of year: July
Estimated ditching position: 15°05' N., 156°15' E.
Drogue used.
Average current: Direction 270°
Velocity about 15 miles per day
Steadiness 50-75%
Wind during past 24 hours: Direction from 045°
Force Beaufort 4
From Table 2: Wind current 11 miles per day
From Table 3: Leeway 8 miles per day

Draw a line 15 miles long, due west from the estimated ditching position (a). From the end of this line (b), draw a line 11 miles long directed toward 225°. Continue this line another 8 miles toward 225°. The point at the end of this second line (c) is the probable position at the end of 24 hours. The raft has drifted approximately 31 nautical miles in a direction of 245° from point (a) to point (c).



Considerable error (probably about 20-30%) in judging wind force is likely. Also the currents shown on the charts may vary. Both of these errors will tend to cancel out after a few days, but at best your dead reckoning fix will only be approximate and should be checked in as many ways as possible.

If using oars or sail or if a fresh breeze is blowing, you can obtain a good estimate of your speed of movement through the water in the following way. Tie a small piece of wood or other floating object to the end of a fish line, throw it overboard, and measure the time required for a certain length of line to pay out. If you are going one mile an hour through the water, 100 feet of line will be pulled out in a minute. To your speed through the water obtained in this fashion, there must of course be added the estimated current drift.

When in sight of the beach, estimate your drift by watching the changing position of points on shore, rather than by relying on the charts.

The charts do not apply during October and March. For these months estimates of the currents can often be made by comparing the winter and summer charts for the same region. Where the two charts agree moderately well, a reliable estimate of the current can be obtained. In other regions, conditions are too variable during these months to allow accurate current predictions. In such areas use only the wind force (assume a current steadiness of less than 25%) in dead reckoning navigation.

SHAPING A COURSE

After about 48 hours, or whatever time is specified in your instructions, the drogue should be hauled in and a course should be shaped toward a friendly coast. Every advantage should be taken of wind and current. Do not paddle or row the raft more than a few minutes at a time; remember that strength must be conserved at all costs.

When drifting without a drogue, turn the raft end for end with the oars every few hours; this will prevent "sailing" on one tack longer than on another.

Put out the drogue in rough weather to keep the raft headed into the sea and to avoid capsizing.

Do not attempt to use a jury-rigged sail if the wind is more than force 4, because of the danger of capsizing.

When near a friendly coast, paddle or row toward shore. Unless the wind is blowing onshore the current will cause the raft to drift parallel to the beach.

In sailing or rowing toward an island shore, direct your course to the windward end. This will prevent your being swept past the island and will enable you to drift along shore to find the best place for a landing - a cove, beach, or gap in a reef where there is the least surf.

DRIFT OF PARTLY LOADED AND EMPTY RAFTS

Two or three rafts of different sizes and types, all with normal loading, will soon separate owing to their slightly different drift rate. Two rafts even of the same size and type, if not joined by a line, are likely to separate within 12 hours owing to slight differences in loading. If both use efficient drogues, they will stay together for a longer time.

In a force 4 wind (11-16 knots) an empty raft without a drogue will drift so rapidly that even an expert swimmer will have a hard time overtaking it. An empty raft will travel almost directly downwind at nearly twice the speed of a loaded raft.

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