# HYDROGRAPHY IN FINLAND

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Southern Finland, which is inhabited by 90 % of the entire population, and which therefore is economically the most important part of the country, covers the peninsula between the Gulf of Finland and the Gulf of Bothnia which flow out of the Baltic Sea. Thus the sea-ways are by far its most important commercial fairways. Approximately 85 % of the foreign trade goes by sea. In addition there are, particularly in the eastern parts of Southern Finland, extensive inland waterways, along which the most important raw material, wood, is transported. The length of the inland fairways is approximately 6,600 km. Hence, safe navigation is of first-rate importance to the economic life of Finland.

Vast and labyrinthine archipelagoes formed of small islands are characteristic of the sea area. The coast of the Gulf of Bothnia is very shallow and reef-bound. There the 10 m. depth curve may in places run as much as 20 km. from the coast line. Then again in the Gulf of Finland and the northern parts of the Baltic proper there are in the bottom contours numerous sudden and unexpected changes. The fairways from the open sea to the most important harbours are long, e.g. to Turku about 55 naut. m. and to Vaasa 30 naut. m., and require reliable safety accessories and accurate charts. The post-glacial land upheaval which in the Bay of Bothnia is about 1 cm. a year and on the southern coast 0.3—0.6 cm. causes a shift in the coast line and to a certain extent also the best parts of the fairways change rapidly, especially on the shallow coasts of the Bay of Bothnia. Thus after each half a century control surveys and a thorough correction of the charts proves necessary. Owing to the freezing of the sea in winter the fairways can be kept open only by ice breakers and only along archipelagic routes as there the ice has the least tendency to pack. Thus the archipelagic fairways must be made passable even for large ships and the surveys must be carried out correspondingly, which would not perhaps otherwise be necessary. On the contrary in certain respects hydrographic surveying is easier in Finland than in the countries located on oceans. The tide in the Baltic Sea is negligible, so it need not be taken into consideration. Nor are there the unfavourable currents which it causes. Surveying conditions, particularly in the inner archipelago and the lakes are favourable, and the working area can be readily changed according to climatic conditions. The annual survey period is indeed brief, only 4-5 months.

On taking into consideration the above-mentioned facts it is not surprising that for centuries much attention has had to be paid to hydrography and the reproduction of charts. Without referring to the early history of hydrography in Finland it is justified to review the period, on the surveys of which the present charts are based.

## HISTORY.

*Russian Rule* 1809-1917.—After Finland was annexed to Russia in 1809 the Russian government reserved the right to perform surveys in the Gulf of Finland and Archipelago Sea. Between the years 1829-1917 the Russian Ministry of Marine did perform systematic surveys in these waters. The Finnish Pilot Service was allowed to survey only in the Gulf of Bothnia and the lakes after the year 1851. Before the year 1917 the entire Gulf of Bothnia and the most important lakes, Saimaa, Pielinen, Päijänne, Keitele and Oulujärvi were surveyed.

In order to get a geodetic base for the hydrographic surveys of the Gulf of Finland a triangulation covering the entire Gulf of Finland was carried out in 1820-1838. In addition several points of the Russian-Scandinavian triangle chain were used on Päijänne and Oulujärvi. On the other hand the defective triangle nets of the Gulf of Bothnia and Saimaa are based on astronomically determined points, and they form several independent local systems.

In order to make position-fixing easier so-called radial sounding was used. Around the 1850's it was developed by marking a regular square net into the sea by the aid of floating beacons from the corner points of which the sounding lines ran radially to the other corners. The position of an individual sounding was determined by the number of oar strokes. At about the same time the soundings were corrected by calculating from the mean sea level. At the end of the 19th century sounding along parallel lines was introduced. The sextant was taken into use in the determination of the points where floating beacons were to be placed. Taking into consideration the peculiar characteristic of the bottom of the sea the distances between the lines were too great to give reliable results. For the purpose of open sea sounding a steam ship, the "Sextant", was built in 1884. Besides sounding, the first sweepings of the fairways were also carried out with it. At the same time steam launches, which were replaced by motor boats around 1920, were brought into use to replace rowing boats used in the sounding of coastal waters. Charting was performed by the alidade and plane table. These methods were in use up to 1930.

The Russian Ministry of Marine published the coastal charts, and the lake charts were issued by the Finnish Pilot Service. The coastal waters were systematically surveyed and on this basis the charts were produced. It contained about 30 coastal charts on the scale about 1 : 50 000 and more than a dozen general charts, the scale of which varied from 1 : 100 000—1 : 350 000, and in addition about 50 plans on the scale 1 : 16 800 of the waters between Hanko and Helsinki. Had the charts been reliable, the chart situation would have been excellent. However, they were not, as later control and supplementary surveys have shown. There were altogether approximately 30 defective charts of the lakes on the scale 1 : 20 000—1 : 40 000.

*Period of Independence.*—After Finland became independant in 1917 the new political state and the rapid development of economic life placed new,

great demands on the nautical charts, which the existing charts could not meet. Both the charts and surveys had to be renewed immediately, but as a temporary arrangement the Russian coastal charts were copied simply by changing the fathoms and feet into metres and the Russian text into Finnish. This work was performed by the Hydrographic Office of the Pilot and Lighthouse Department of the Board of Navigation. The new survey which was undertaken immediately did not get into full swing until the 1930's, when the survey personnel was increased and improved survey methods were taken into use, as e.g. echo sounding, aerial photograph maps and rectangular co-ordinates. Up to the present time the northern part of the Bay of Bothnia, parts of the Vaasa archipelago and the Archipelago Sea as well as certain scattered fairways in the Gulf of Finland and the majority of the Saimaa water system have been re-surveyed. The charts of these areas are drawn on the scale 1 : 50 000. The second world war brought about an interruption in the work.

## PURPOSE AND ORGANIZATION OF PRESENT ACTIVITY.

*Present charts and surveying.*—General charts are needed for open sea navigation and for the planning of routes, while charts of the coasts and inland waters on a larger scale are used when coming from the open sea into the harbours and when running along archipelagic and lake fairways. It proved suitable to compile the former on a scale of 1 : 200 000 and the latter on 1 : 50 000. In addition, plans of the most important harbours and narrow passages, either on a scale 1 : 20 000 or 1 : 10 000 are needed. The increase in the size of the ships visiting Finland since the war demands deeper and straighter fairways. Before World War II fairways of a 7.3 m. depth were sufficient, now they must be 9 m. deep. This involves a control of the fairway examination even in such areas which are considered reliably surveyed.

On taking into consideration the present demands placed upon navigation it can be established that less than half of the water areas are adequately surveyed. Approximately 30 000 km² of the sea and lake areas have been sounded whereas about 45 000 km² are still unsounded. Of this area over a half is open sea. The supplementary chart graphically shows the present survey situation. As regards of charts the position is similar. Out of the 79 coastal charts on the scale 1 : 50 000 (on the lakes 1 : 40 000) 29 may be considered adequate, as to detailed information 10 are imperfect and 40 in view of their detailed information and geodetic basis poor. The general chart situation is better for we have 4 charts on the scale 1 : 200 000 of the Gulf of Finland, the Archipelago Sea and the South Quarken. Two general charts on the scale 1 : 500 000 of the entire Baltic are being completed. Four charts of the Gulf of Bothnia on the scale 1 : 200 000 and one of the Saimaa lake are still needed. We have two old charts on the scale 1 : 350 000 of the Gulf of Bothnia. Nautical charts of seas outside the Finnish boundaries or the Baltic are not made.

On attempting to complete surveys and renew charts attention must for the time be paid to the survey of the most important fairways leading into the harbours and the improvement of their charts, which will take several years. Not until then can the systematic sounding and the complete renewal of the corresponding charts of areas, of less importance from a navigation standpoint, come into question.

*Organization.*—The Pilot Service under Swedish and Russian rule, which partly carried out the hydrographic survey, was in independent Finland succeeded by the Board of Navigation which functions under the Ministry of Trade and Industry. This board attends to matters pertaining to mercantile navigation and its sub-divisions are the Navigation Department, the Pilot and Lighthouse Department, the Hydrographic Department and the Clerical Department. However the Hydrographic Department was not founded until 1937 by uniting the then existing Hydrographic Office of the Pilot and Lighthouse Department and the Hydrographic Survey Department of the Navy founded in 1927. Thus the hydrographic surveys and the preparation of charts is at present solely in the hands of civil authorities and not, as in many other countries, in those of the military authorities.

The Hydrographic Department consists of a Chief (Hydrographer) and three sections, the composition and duties of which are the following :—

1. The hydrographic section consists of a chief and six survey expeditions, of which two perform open sea soundings and the rest surveys of the archipelago, coast and inland waters. The employees in one expedition are a chief, 3-4 assistant surveyors, 1-2 cartographers, 3-4 draughtsmen and the crew of the ship, which is taken on as for merchant ship. The archipelago expeditions have a depot ship, a motor-launch for echo sounding, a sweeping vessel, boats for sounding by hand lead and for charting as well as auxiliary boats. The open sea expeditions have an echo sounding ship instead of a depot ship and no boats for sounding by hand lead or for charting. In the following table information about the surveying vessels is given.

| Vessel | Displacement metric tons | Dimensions: length, beam, draught in m. | | | Date launched | Maximum H.P. | Special person. | Crew |
|---|---|---|---|---|---|---|---|---|
| Echo sounding ships : | | | | | | | | |
| « Sextant » | 222 | 36.3 | 5.9 | 2.7 | 1884 | 200 | 6 | 15 |
| « Nautilus » | 235 | 27.4 | 6.1 | 3.6 | 1903 | 300 | 6 | 15 |
| Sweeping vessels : | | | | | | | | |
| « Airisto » | 85 | 21.3 | 4.7 | 1.8 | 1884 | 120 | 2 | 9 |
| « Åland » | 65 | 23.4 | 4.8 | 1.8 | 1872 | 125 | 1 | 9 |
| « MV 20 » | 10 | 12.0 | 3.0 | 1.0 | 1944 | 40 | 1 | 6 |
| « Ystävä » | 12 | 13.2 | 3.0 | 1.0 | 1907 | 25 | 1 | 4 |
| 3 depot ships | | | | | | | | |
| 6 echo sounding launches | | 10.3 | 3.1 | 0.9 | 1936-43 | 36-40 | 3 | 5 |
| 20 other survey motor-boats. | | 9.0 | 2.2 | 0.8 | 1928-48 | 10-20 | 1 | 4 |

The survey expeditions working in the same area are in close contact with each other, so that the greatest possible elasticity is attained. The expeditions perform all the field work with the exception of triangulation

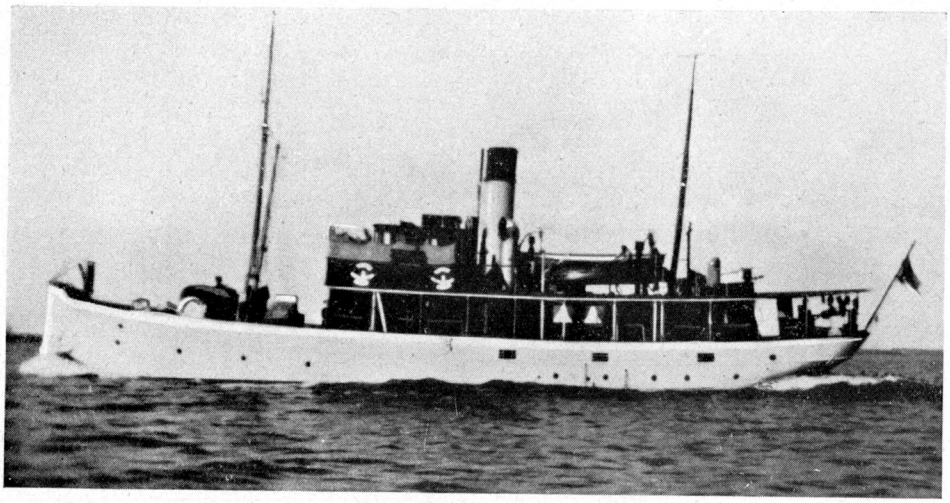


FIG. 1
Echo-sounding ship "Nautilus".

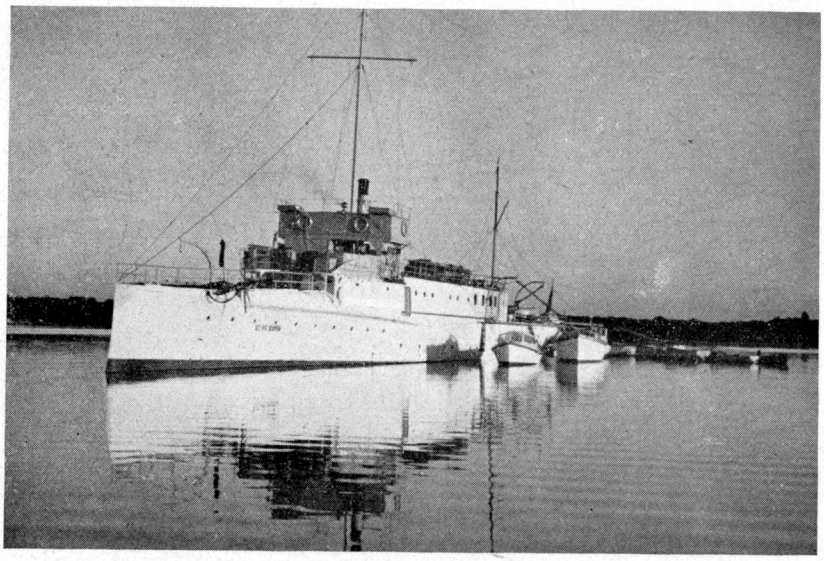


FIG. 2
Depot ship "Klas Horn" with echo sounding launch and other motor boats.

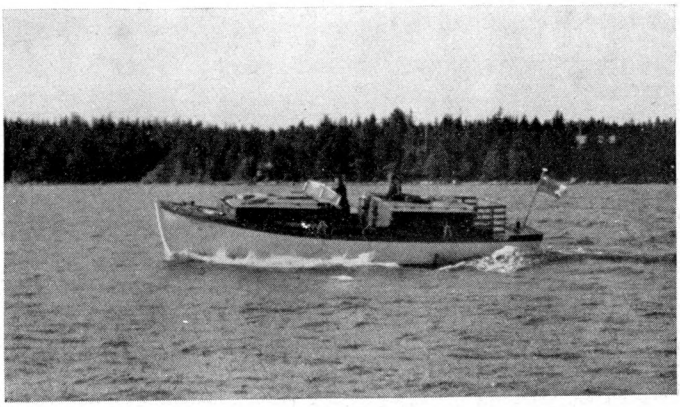


FIG. 3

Echo sounding launch " Kaiku 2 "
Length : 10,0 m. ; Draught : 1.2 m. ; Motor : Lister-Diesel 40 HP.

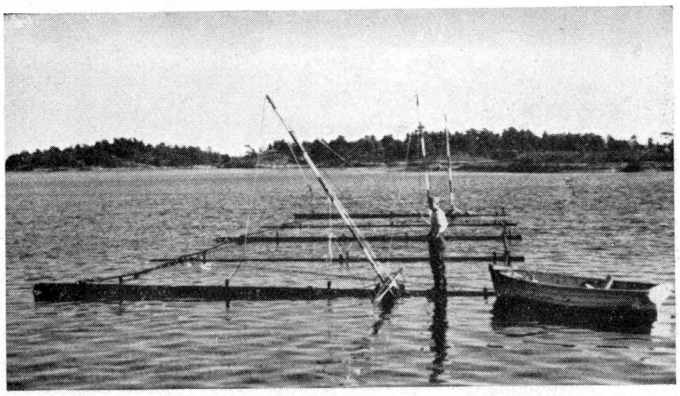


FIG. 4

Sweeping gear

and they make their material ready for the archives. During the winter the survey results of the preceding summer are arranged and the work for the following summer is planned. A part of the personnel works during the winter in other sections.

2. The chart section consists of a chief, who at the same time acts as geodesist, foremen of the drawing and printing offices, about 30 draughtmen, photographers and printers. The chart section plans nautical charts, draws, prints and corrects them. In addition the chief performs the necessary triangulations, attends to the purely geodetic and mathematical work of the Department as well as to the instruction of the personnel.

3. The general section has a chief, an editor of publications and his assistant, a keeper of the charts and office assistants. The section carries out the editing of publications, the administrative affairs and accounts of the Department as well as the sale of charts.

The entire personnel of the Hydrographic Department is shown by the following chart. The figures in brackets indicate the persons at work only in the summer.

| Title | Number | Title | Number |
|---|---|---|---|
| Hydrographer | 1 | Draughtmen | 25 (+15) |
| Section managers | 3 | Photographers | 3 |
| Office workers | 4 | Printers | 4 |
| Survey chiefs | 6 | Printers assistants | 3 |
| Assistant surveyors | 13 (+10) | Office assistants | 4 |
| Cartographers | 5 | Engineers | 9 |
| Keeper of charts | 1 | Boatswains | 5 |
| Archivist | 1 | Ships' crew | (125) |
| | | Total | 87 (+150) |

Certain technical matters are attended to outside the Hydrographic Department e.g. the repairs of vessels and the care of echo-sounders in other Departments of the Board of Navigation.

Some branches which form an important part of the work of the Hydrographic Offices of other countries, are not represented in the Hydrographic Department. The magnetic measurements of Finland are performed by the Central Meteorological Institute, and the inspection of nautical instruments is carried out by the other Departments of the Board of Navigation. Tide tables of Finnish waters are not needed.

The chief of the Hydrographic Department and the other officials in leading positions are either naval officers or sea captains, with the exception of the chief of the chart section, who must have graduated in mathematics and geodesy. For other positions practical experience is required. The employees also receive theoretical instruction in their branches.

*Expenditure.*—The expenditure of the Hydrographic Department is shown by the following figures. The total sums are in Finnish marks, 1000 marks corresponding to $ 6.25.

| | 1947 | 1948 | 1949 |
|---|---|---|---|
| Expenses for personnel working all the year round | 13,175,000 | 21,177,000 | 22,600,000 |
| Expenses for personnel working only in the summer | 8,272,000 | 12,542,000 | 15,000,000 |
| Expenses for vessels | 6,186,000 | 8,233,000 | 8,800,000 |
| Survey expenses | 1,532,000 | 697,000 | 1,600,000 |
| Printing expenses | 2,227,000 | 2,105,000 | 2,550,000 |
| TOTAL | 31,392,000 | 44,754,000 | 50,550,000 |

## HYDROGRAPHIC SURVEY.

*Phases of work.*—The various phases of hydrographic surveying are the same elsewhere in the world: triangulation, charting, recording of sea level, sounding, examination of shoals and the sweeping of fairways. Sounding on the ice is to be mentioned as a separate method.

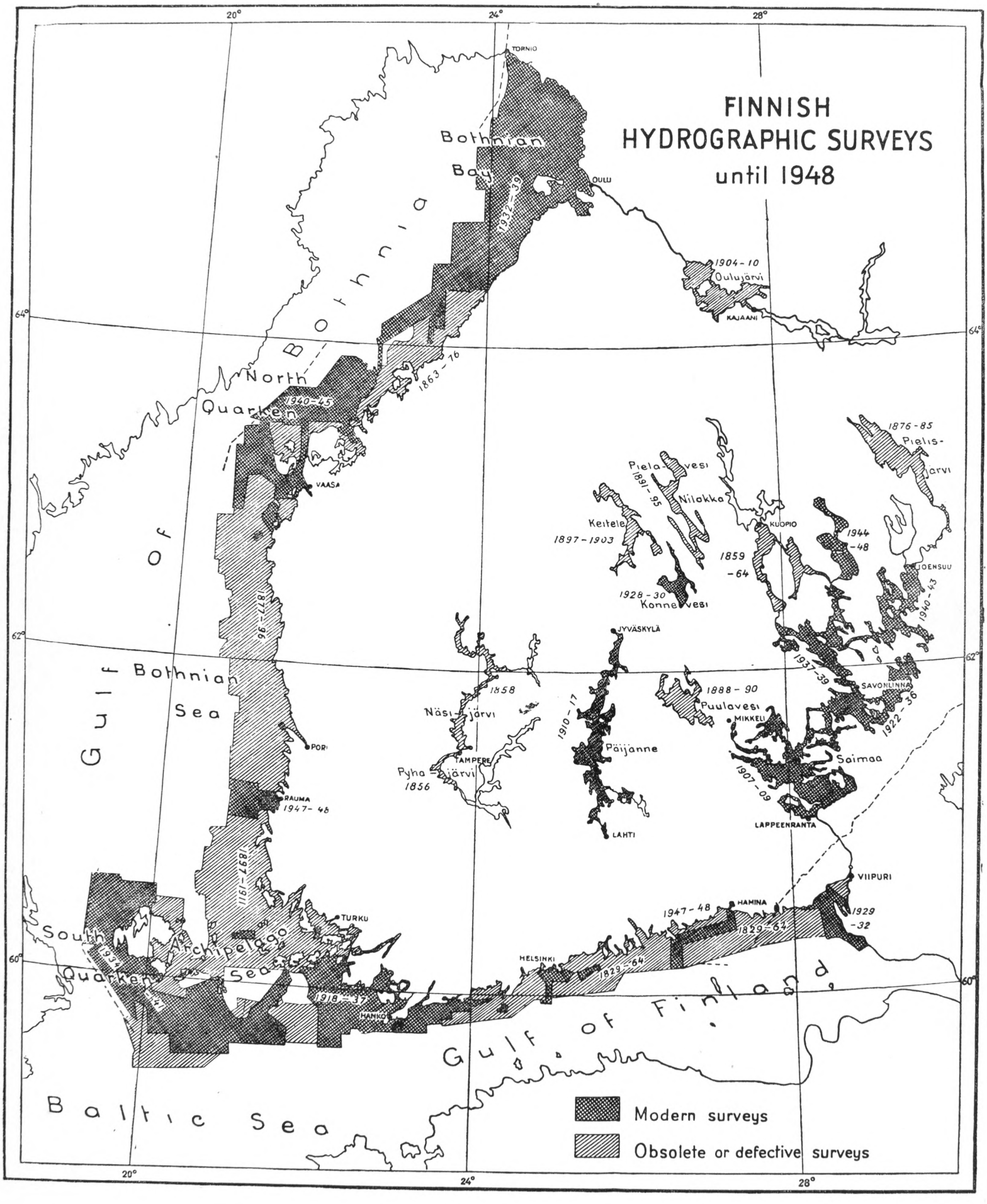
*Triangulation.*—The class I triangle net of the Geodetic Institute which has 8 closed triangle chain links, covers the whole of Southern Finland and stretches along the coast of the Gulf of Finland, the Archipelago Sea, the North Quarken and the Oulu region forms the geodetic foundation. Likewise there are class I triangle points on the Saimaa water system. This net has been made closer by the General Survey Office with class II and III points, so that the triangulation of the Hydrographic Department itself was to a great extent reduced to the addition of lower class points. This was done by the intersection of new individual points and by adjusting them graphically. It proved necessary to measure a main triangle net only in some parts of the Gulf of Bothnia. The point density is between 5-15 points to 100 km$^2$.

The Hayford ellipsoid is used as a reference ellipsoid, and the rectangular co-ordinates for the triangle points are calculated on the Gauss-Krüger projection, the entire country being divided into 4 strips of a width of 3° (the middle meridians 21°, 24°, 27°, 30° East of Greenwich, from which the longitudes are calculated). The co-ordinates are in the so-called Helsinki system the fixed point of which is the Kallio Church in Helsinki :

$$= 60° 11' 2'',33 \text{ N.}$$
$$= 24° 57' 8'',94 \text{ E.}$$

This system is also used in all other map-making in Finland.

The measuring results (soundings etc.) are inked on fair charts, which also are on the Gauss-Krüger projection and generally on the scale 1 : 20 000. They are aluminium plates covered with drawing paper, the drawing area being 50 × 50 cm$^2$ and corresponding to an area of 10 × 10 km$^2$ in actual size. The lay-out of the fair charts is arranged so that the 10 km. lines of the co-ordinate net form the borders of the charts. The parallels and meridians are for the transfer of the survey results to charts on the Mercator


FINNISH
HYDROGRAPHIC SURVEYS
until 1948
Bothnian Bay
Bothnia
Gulf Of
North Quarken
Gulf Bothnian
Sea
South Archipelago Sea
Quarken
Gulf of Finland
Baltic Sea
TORNIO
OULU
KAJAANI
VAASA
PORI
RAUMA
TURKU
HANKO
HELSINKI
LAHTI
TAMPERE
JYVÄSKYLÄ
KUOPIO
JOENSUU
MIKKELI
SAVONLINNA
LAPPEENRANTA
HAMINA
VIIPURI
1932–39
1904–10
Oulujärvi
1863–76
1940–45
1876–85
Pielis-
järvi
Pielavesi
1891–95
Nilakka
Keitele
1897–1903
1928–30
Konnevesi
1859
–64
1944
–48
1940–43
1937–39
1858
Näsijärvi
Pyhäjärvi
1856
1910–17
Päijänne
1888–90
Puulavesi
1922–36
Saimaa
1907–09
1947–48
1929
–32
1829–64
1829–64
1918–37
1877–96
1897–1911
1947–48
Modern surveys
Obsolete or defective surveys
20°
24°
28°
64°
62°
60°

projection also drawn on the fair charts. The surveys are carried out on the Gauss-Krüger projection in order to make the triangulation calculations and the construction of fair charts as simple as possible and because the land maps are also prepared on the same projection. The difficulty of transferring the survey results on to the final chart on the Mercator projection is negligible, for its scale is so big that the errors due to the difference between the projections has no practical significance, providing that the transfer takes place as rectangles of a suitable size.

*Charting.*—The coastline, rocks, lights, beacons, floating beacons and other topographical points, which are of significance to navigation, are charted on the scale 1 : 20 000. In Finland there are aerial photograph maps of the majority of the coast which have been prepared by the General Survey Office or the Topographic Department of the Army General Staff. As e.g. numerous floating beacons, submarine rocks etc. are not revealed by the aerial photograph maps, those areas as well as all the areas of which no aerial photograph maps exist are charted by the alidade and plane table. The plane table boundaries are planned on the basis of the areas to be charted and the triangle points, and they do not follow any pre-arranged plans.

*Sea level records.*—In Finland, where practically no tide exists the mean sea level has been chosen as the reference plane of depth measurements. It is determined by calculating the average of the sea level records during a period of 15-20 years prior to the year concerned, thus the height of the mean water is obtained in the middle of this period. The negative correction due to the post glacial land upheaval during the latter half of the said period is added to the value obtained. These measurements and calculations are made by the Institute for Marine Research. In lakes, in which the water level is regulated, the water level which corresponds to the lowest permitted depth in the nearest canal below the lake is chosen for the reference plane. Since chiefly due to meteorological reasons, the extent of the variation in sea level on the coast can during the same day be even more than a metre, the expeditions must continuously record the sea level, in order that the depth figures may be corrected to correspond to the reference plane. For observations a tide pole is placed according to a benchmark already in the vicinity or by making observations over a couple of weeks from a tide pole placed in a temporary position. By comparing these observations with those of its nearest tide gauge station the Institute for Marine Research determines which of the readings on the tide pole corresponds to the mean sea level. Each day the measured sounding figures are corrected so that they correspond to the reference plane when they are marked on the fair charts.

*Sounding.*—The purpose of sounding is to find out the general depth contours of the area in question. Owing to the shallowness of the water or to the great and often sudden variation in the contours of the bottom of the sea, the distances between the sounding lines are made to be as small as possible. In boat echo sounding it is generally 50 m. which on a fair chart with a scale 1 : 20 000 corresponds to 2.5 mm. Depth figures cannot be marked more densely. On the other hand in ship echo sounding

the distance between the lines can be greater. The said characteristics of the sea bottom also make it impossible to obtain reliable results by mere sounding, but it must be supplemented by other methods. On this basis it may be decided whether examinations of shoals or sweepings are necessary in areas important to navigation and in critical depths. Elsewhere sounding only is considered sufficient.

The English sounding apparatus produced by Hughes & Sons, which is a self-recording echo sounder, is used. As sounding vessels in the archipelago motor-launches are used and in the open sea steamships. Sounding by hand lead which was carried out up to the 1930's is now used only in shallow and narrow lake areas, where it is difficult to use heavy echo sounding launches effectively. In echo-launch sounding the positions are fixed with intervals of 2.5 min. by the three-point fixing method. They are marked on a plotting chart on the scale 1 : 20 000. Simultaneously with the fixing of the points the man in charge of the echo sounder makes a mark on the diagram giving it the ordinal number of the fixing and this number is also marked on the plotting chart next to the fixed point. On the basis of these markings the depths measured from the diagram and depth figures corrected according to the mean sea level are inserted on the fair chart. In open sea sounding point-fixing is carried out only every 5 min. Big floating beacons, the co-ordinates of which are determined by intersecting them with the theodolite from the triangle points on land in lines parallel with the sounding lines are used as survey marks where landmarks are no longer visible. The distance between the floating beacon lines is about 7 km. and between the individual floating beacons about 3.5 km. Thus it is possible to sound open sea areas at a distance of from 35 to 40 km. from the outermost islands and capes.

In sounding by hand lead, point fixing is often performed by a rectangular floating beacon net, of which the points of the ground floating beacons are determined by the three-point fixing method or by intersecting them on a plane table.

*Shoal examination.*—Areas dangerous to navigation are sounded more accurately by shoal examination. By examining the depth figures obtained by sounding and marked on the fair chart one can establish the places where it is necessary to carry out the examination of shoals. If the depth of the water is less than 20 m. in the fairways or near them and if it proves to vary, there is reason to suspect the existence of shallower points than what has been revealed by sounding and in this case sounding must be performed at closer distances. Vast shoals are examined by floating beacon sounding. Four surveying-beacons are placed around the area to be examined. They form as regular a rectangle or square as possible and their positions are determined by the three-point fixing method. Temporary beacons are placed between these surveying-beacons at equal distances on two opposite sides of the area. By the aid of these beacons the echo sounding launch moves along the lines at distances of 5-10 m. The results of the sounding do not fit on the fair chart, so a sketch of the area is first made on a millimetre paper on the scale 1 : 2 000, and only the depth figures and curves which characte-

rize the contour of the bottom are transferred to the fair chart. Small shoals with an area of not more than 300 m. in diameter are examined by radial sounding with a hand lead.

*Sweeping.*—If the bottom of the fairway is very uneven and the mean depth of the water is about the same as that of the planned fairway, sweeping must also be performed in certain places in addition to shoal examination. The sweeping gear used in Finland consists of three vertical bars supported by five floaters. The lower ends of the bars are connected by a stretched wire 28 m. in length. When, at a certain depth, this wire touches the bottom the nearest bar turns over. The wire is placed at a depth which in the archipelago is 0.6-1.5 m. and in the open sea 2.0 m. greater than the planned official depth of the fairway. Thus the fairway is safe also during low water and when the sea is rough. As sweeping is expensive, it must be considered where it is to be done and where a dense shoal examination suffices.

*Sounding on the ice.*—Sounding on the ice is a method particularly suitable for conditions in Finland. It is used in narrow passages, bays and harbours. One condition is that the ice is stationary and that the waters are shallow enough for sounding by hand lead without trouble, or at the most 20 m. The area to be sounded is divided into rectangles 400×600 m2 by lines connected with the triangle points. From the lines the sounding points are measured with two 200 m. long steel tapes usually at a distance of 20 m. from each other in both directions. At these points holes are drilled into the ice and the soundings are taken. With hand drills constructed for this special purpose a hole can be drilled into ice 50-70 cm. thick in 15 seconds. The sounding results are written on millimetre paper on the scale 1 : 2 000, on which the coastline and rocks are also marked. The sounding density can easily be increased if it proves necessary for the acquirement of a reliable picture. The results are transferred on a reduced scale to the fair charts. The sounding group consists of a chief, a clerk, 5 hole drillers, 4 sounders and one mover of the measuring wire.

*Statistics of measuring results.*—The following table shows the combined results obtained by all the measuring units both from the years just before the war and from certain years subsequent to it :

| Year | Charted coastline, km. | Distance Sounded | Area Sounded km2 | Examined shoals, number | Swept km2 |
|---|---|---|---|---|---|
| 1937 | 1340 | 41 600 | 3740 | 772 | 48.8 |
| 1938 | 1440 | 33 700 | 3840 | 894 | 34.0 |
| 1939 | 1840 | 48 700 | 4650 | 975 | 71.8 |
| 1945 | 850 | 14 700 | 680 | 757 | 1.7 |
| 1946 | 170 | 14 600 | 440 | 496 | 28.0 |
| 1947 | 270 | 8 850 | 270 | 247 | 10.1 |
| 1948 | 1180 | 15 700 | 910 | 439 | 28.1 |

The decrease in the working results since the war is due to the shortening of the working day from 10 hours to 8, to the post-war fairway examination, which replaced the previous systematic sounding, when naturally the areas surveyed were larger, and to the slight decrease in personnel and the decline in standard after the war.

In order to obtain a general idea of the most important measuring unit, the work efficiency of one echo sounding launch, may be mentioned in the following figures. It sounds on an average a length of 45 kms or 2.4 km2 a day and performs 80-100 point fixings. When it carries out shoal examinations it is able to examine two average-sized shoals and to sound a length of 40 kms or 0,41 km2 and fix the position of 10-12 floating surveying beacons. One month has from 21-23 sounding days. In addition to Sundays, on an average 3-4 " free " days also occur each month, owing to weather conditions or the repair of machines.

## THE PREPARATION OF NAUTICAL CHARTS.

*Drawing.*—The following report on the drawing of charts concerns the making of coastal charts on the scale 1 : 50 000 and on the basis of the results of previous measurement. The general charts are drawn according to the same method with the exception that both Finnish and foreign coastal charts on the scales 1 : 50 000 and 1 : 100 000 are used as material.

The Finnish charts are constructed on the Mercator projection. The middle latitude of all the charts of the Gulf of Finland, the Archipelago Sea and the South Quarken is 60° 20', whereas the charts of all the other areas have their own middle latitude.

The coastal charts are redrawn on a scale larger than the final one, usually 1 : 35 000, in order to smooth out drawing irregularities. The most important material is formed by the fair charts from which the measuring results are reduced by photography in rectangles. A rectangle must be so small (4' in latitude, 8' in longitude) that its form is sufficiently same both on the Gauss-Krüger projection and on the Mercator. The fair charts themselves are not photographed directly, but instead tracings made from them, on which the terrain and only those depth figures which will be marked on the final chart, and possibly other information obtained from other material as e.g. aerial photograph maps, topographic maps, town-planning maps, etc. The positive films of the rectangles are fixed on a glass plate by means of a graduation on the Mercator projection made on the plate in advance. The glass plate thus covered is copied on to a zinc plate and a blue copy is printed on an aluminium sheet covered with drawing paper, which will be the basis of the final chart. This is drawn with black ink. The making of tracings demands a skilled draughtsman, whereas the final drawing is mechanical and for that cheaper workers may be used. When the final drawing is made the chart is divided into 4 parts. Thus inconvenient, large drawing sheets need not be handled.

*Printing.*—The charts are printed in offset-machine in 5 colours. The contour is black, the land areas grey-brown, the water less than 10 m. deep, yellow and the lights red and green.

The finished drawing is reduced to its final scale by photography and on this basis a copy is made for each of the five colours on glass plates from which they are copied on to corresponding printing-plates. The copies on these are of exactly the same size since they are copied from glass plate drawing of an equal size. The fitting of the colours into each other when they are printed depends only on whether the chart paper shrinks or not. Finally the chart is printed, one colour after another. The number of charts to be printed depends naturally on the demand for them and whether they are from areas where changes in the accessories needed for safe navigation often take place. The complicated glass plate method has the advantage that in order to prevent the correction by hand of large editions already printed small editions can often be taken. The glass plate corresponding to the black colour can easily be kept up-to-date and copies on printing-plates are quickly obtained from the transparent glass plates.

*Statistics.*—The following table gives information about the number of nautical charts which have been published, printed and corrected by hand during recent years.

| Year | New charts published, number | New editions, number | Printed charts, total number | Various kinds of corrections, number | Corrections by hand total number |
|---|---|---|---|---|---|
| 1945 | 10 | 132 | 44 047 | 432 | 26 285 |
| 1946 | 10 | 98 | 36 251 | 353 | 30 351 |
| 1947 | 2 | 85 | 26 004 | 332 | |
| 1948 | 5 | 77 | 22 344 | 225 | |

## PUBLICATIONS.

Besides suveying and making of nautical charts the Hydrographic Department issues publications necessary for safe navigation.

"Notices to Mariners" are published every 10 days and contain information about Finnish coastal and inland waters as well as about the whole of the Baltic Sea, Danish waters and the North Sea.

The publication "List of Finnish Lights" contains a list of the lights, radio beacons and fog signal stations on the Finnish coast. It is published every third year (e.g. in 1949, an additional pamphlet every year). A list of the lights on lakes is also issued.

Characteristic of the situation in Finland is that in general the sea and lake areas in which navigation takes place have been once surveyed and charts of the corresponding areas have been made. However the measurements were to a great extent made during the sailing ship period and their standard

does not meet the present demands, e.g. shoal examinations absolutely necessary on Finnish waters are still to be made. Therefore the aim of the Hydrographic Department is to resurvey the areas sounded earlier and to make new charts of these areas. Since World War II new navigation accessories and the greater size of the vessels which frequent Finnish waters place new demands on hydrographic survey and charts. The work will, however, be made easier by the recent improvements in survey technique, cartography and printing technique, of which use will as far as possible be made in Finland also.