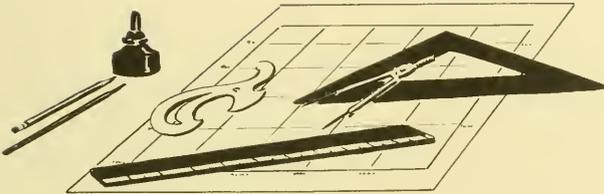


**ILLUSTRATIONS**  
in PUBLICATIONS of the  
**FISH AND WILDLIFE SERVICE**



**CIRCULAR 116**



**FISH AND WILDLIFE SERVICE**  
**U. S. DEPARTMENT OF THE INTERIOR**



ILLUSTRATIONS  
in PUBLICATIONS of the  
FISH AND WILDLIFE SERVICE

By Faxon W. Cook

Office of Information



CIRCULAR 116

FISH AND WILDLIFE SERVICE  
Clarence F. Pautzke, *Commissioner*

U. S. DEPARTMENT OF THE INTERIOR  
Stewart L. Udall, *Secretary*

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# ILLUSTRATIONS

## in PUBLICATIONS of the

### FISH AND WILDLIFE SERVICE

Illustrations include any pictorial devices, such as photographs, charts, graphs, maps, or other original art, that you as the author may use to present your ideas. Illustrations are justified if they enable the reader to grasp your thoughts more easily and clearly and if the cost of producing them is compatible with their value to the paper.

Original illustrations, as referred to in this publication, are of two types: the line drawing and the photograph. Line drawings include all illustrations made with pen and ink. They are generally reproduced as linecuts, giving clean, black lines. Photographs are usually reproduced as halftones and show shadings or gradations of black or sepia, due to the screen used in their reproduction.

The decision as to what illustrations are needed in any paper, especially one of a technical nature, rests largely with the author. Do you need certain graphs or charts to analyse your data? If so, you will prepare them before you begin to write your paper. It follows that if you need certain graphs to make your analyses the reader will probably need them, too. You will have to decide when a figure, as well as a table covering the same data, is needed. If you use both in the original analysis, likely both should be used in the paper. In statistical papers, relationships and trends are more easily grasped from a graph than from a table, but you may need to present the tabular data, too.

Photographs have their place in technical writing as well as in more popular forms of writing. They quickly present the arrangement or operation of complicated equipment, whether in the laboratory or in the field; they convey a feeling of reality and of genuineness hard to attain with words. Photographic records of a research project can be invaluable in presenting your findings to your readers, especially if you need to show progression or response in experimental studies.

# CHARACTERISTICS OF GOOD ILLUSTRATIONS

The reader's first impression of your paper is greatly influenced by the illustrations. It is your responsibility as the author to see that your line drawings meet five basic requisites: accuracy, completeness, legibility, uniformity, and conformance with standard practice in graphic presentation. If you are using photographs, submit only those of good quality. An otherwise excellent paper can be impaired by amateurish, substandard illustrations.

In the following sections we shall discuss briefly the characteristics of good charts and graphs, artist's illustrations, and photographs.

## Charts and Graphs

### ACCURACY

Accuracy is highly important in any publication and especially so in technical papers--an inaccurate graph can mislead your reader. Always recheck the data on the finished drawing; be certain the draftsman did not misinterpret some detail of your penciled sketch.

Watch for errors in scales and scale captions. In a series of figures in which the scale changes from millimeters to inches or from ounces to pounds, for example, errors easily creep in.

Doublecheck the references to the figures in the text. Revisions of the manuscript sometimes require renumbering the figures. Adding or deleting figures also encourages errors in the text references.

The figure legends must describe the figures accurately.

### COMPLETENESS

Give your illustrations the time and care they warrant. Be certain that they contain all the essentials needed to make them understandable, that drawings requiring labeling are adequately labeled, that all segments of a bar graph are given in the key, that all geographic features mentioned in text are shown on the map, and that appropriate scales are shown for drawings made to scale.

While completeness is desirable, unnecessary detail is not. Does the graph look cluttered and confused because

irrelevant data have been included? Unessential material is sometimes found in maps, where the author has retained outlying areas that have no bearing on the current subject. As a result, the map requires a greater reduction than is desirable from the standpoint of legibility. When tempted to use a completed figure or map that has too much detail or other impairing features, weigh the importance of the idea you wish to communicate and the needs of your readers against the cost of preparing a new illustration.

Number the text figures consecutively from 1 and refer to them in text by the figure number. Do not refer to figures as charts or graphs. Appendix figures are numbered independently of regular text figures. They may be designated as Appendix Figure 1 or Figure A-1, and so on.

The legend is an important part of every illustration. Generally, the figure legend will show the "what," "how classified," "where," and "when," in that order. See that it contains all the information necessary to understand the figure without reference to text . . . that it explains the symbols used, as dashed lines, open circles, et cetera. The legend should be typed in the text near the point of reference to the figure and be separated from the text by horizontal lines.

Be sure to give credit when reproducing or adapting figures from the work of others. In giving credit, follow these regulations of the Joint Committee on Printing:

Courtesy credit lines are permissible for uncopyrighted material contributed or loaned by nongovernmental parties. When the department provides copy for such credit lines, they shall be set in the smallest practical type face so that they shall be subordinate both to text and illustration. No credit shall be given when such materials have been purchased by the agency.

No credit lines shall be permitted for any designer, typographer, or layout artist.

Copyright lines are permissible for copyrighted materials and the same provision regarding size of type shall apply.

When all such materials have come from a single nongovernmental source, credit shall be given in an undisplayed preliminary paragraph instead of being repeated on an individual basis.

When the size of signatures on art work is out of proportion or relation to the design, the copy shall be returned to the department as unacceptable unless the signature is removed or reduced by the Government Printing Office with the approval of the department.

Copyrighted illustrations may be used only after you have obtained written permission from the owner of the copyright. The description of the illustration must contain the completed statement "Copyright by \_\_\_ ; used with permission." Proof of written permission must be supplied the Editorial Office with the manuscript.

A reader can decipher a chart or graph only when he can understand it. For a figure to be understandable, all parts of it must be legible. It is your responsibility as the author to examine the original drawings and detect flaws that could reduce legibility of the printed figure. The flaws should be corrected before you submit the illustrations.

Legibility of an illustration is affected by the size and proportions of the drawing, and by the quality of the work, including such factors as scale, lines, letters, and symbols used.

### Proportions and Size

Although the data you wish to depict will affect the proportions of your drawing, the size and format of the type-page will determine the scale you use and the final size of the printed illustration. Thus, you need to know the publication series for which you are preparing the figures.

This brings us to the important decision of how large to make the original drawing. Many a headache has developed in the Editorial Office because the original drawings with a manuscript were large enough to cover the top of the desk when they should have been small enough to slip into a folder. Such large art is not only hard to handle and transport, but it is more subject to damage and poses a filing problem later. Probably even more important, the lettering invariably is not in proportion to the large size of the drawing and becomes illegible in the printed figure because of the great reduction necessary. Furthermore, the Government Printing Office has specifically stated that it does not wish to handle illustrations so large that they require rolling. Situations may arise in which an author must use a geodetic survey map of rather large size. These instances should be kept to the minimum, with the author making certain that smaller maps are not available which would serve his purpose equally well.

Since reduction tends to eliminate little imperfections, the original should be larger than the printed figure made from it. To determine the maximum size of the original drawing intended for a full-page illustration, measure the type-page of the publication, that is the area covered by type exclusive of running heads and page numbers; then double or triple those dimensions. Thus, for a publication in which the type covers a page area of approximately  $6\frac{1}{2}$  by  $8\frac{1}{2}$  inches, as in the Fishery Bulletin or Special Scientific Reports, the finished drawing should be no larger than about 18 by 24 inches and preferably no larger than 12 by 18 inches.

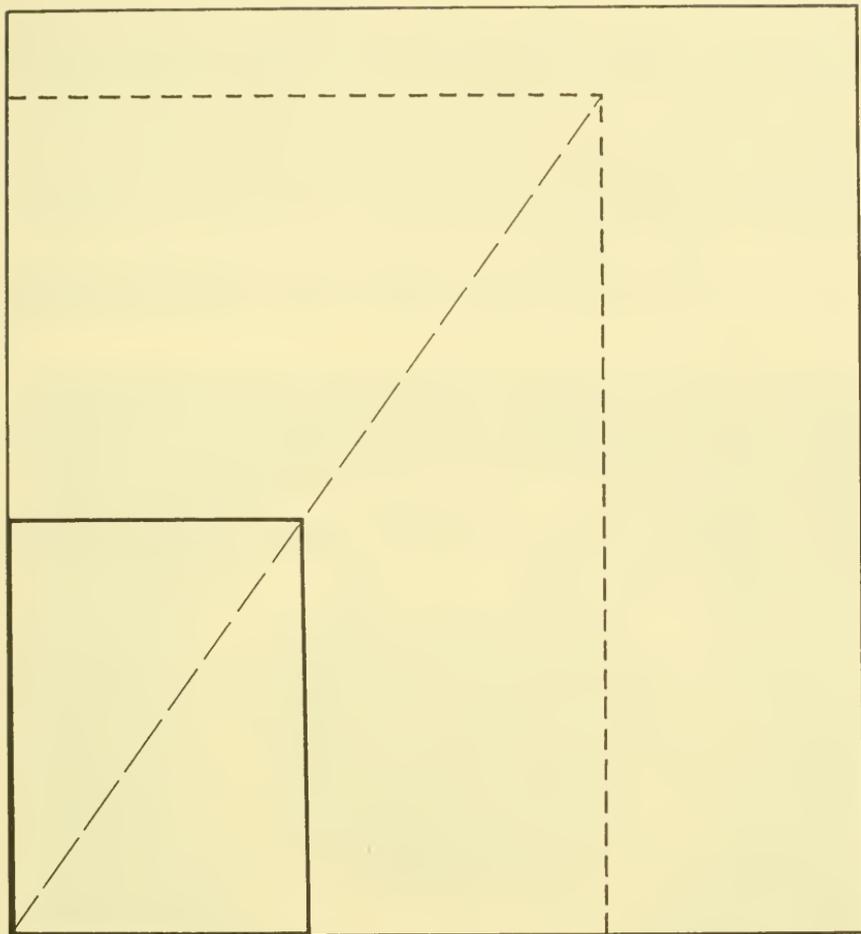


Figure 1.--A simple method of proportioning your original illustration.

In preparing art for publications having smaller page size, as the Research Reports and many Circulars, the original work should be no larger than 14 by 22 inches and preferably no larger than about 10 by 14 inches. As a rule, then, the drawing should be drafted about twice the size of the printed figure to give the draftsman a greater selection of line weights and lettering sizes. The line weights and lettering sizes must be large enough to stand the reduction to publication scale.

Your illustration should have the correct proportions to reduce to the size required by the format of the printed publication. The following four steps will help you proportion your drawings to page size (see also fig. 1):

1. In the lower left corner of a large sheet of heavy white paper, Bristol board, or railroad board, enclose the dimensions of the type page (the left side and bottom of the rectangle will be formed by the two outer edges of the sheet). This rectangle contains the maximum space available for a page-size figure and its legend, so you shorten the rectangle sufficiently to allow for a 2- or 3-line legend, usually not more than a half inch.

2. From the lower left corner draw a diagonal (long dashes in fig. 1) to the upper right corner of the rectangle and extend as far as you wish.

3. Double or triple the width of the rectangle (depending on whether you want the original drawing to be two or three times the size of the printed illustration), and erect a vertical (short dashes) that intersects the diagonal.

4. Complete the outline of the illustration by drawing a horizontal that passes through the intersection of the diagonal and vertical.

But the material you are presenting in a graph may not warrant page size. In technical publications such as the Fishery Bulletin, the Special Scientific Reports, or Research Report, always plan your figures for column width when the data permit. For column-width figures, follow the steps outlined for determining size and proportions of a drawing of page size, but limit the original to a size not greater than about three times the width of a column. Your drawing, then, would not be wider than about  $9\frac{1}{2}$  inches nor deeper than 24 inches.

Various devices will assist you in presenting complicated material in column-width figures. Try presenting your data in two or more figures, each limited to two or three variables. Use a series of graphs in one figure, designating the parts A, B, C, or I, II, III, as needed--each graph with its individual 0-line and limited to one or two variables--arranged vertically in the column.

If a long abscissa scale is required, you should plan a figure two columns wide. Only in extreme instances should an illustration go "broad," requiring the reader to turn the publication sideways to study the figure. (Note.-- The dependent variable is plotted on the ordinate ( $X$  or vertical axis), and the independent variable on the abscissa ( $Y$  or horizontal axis.)

Proportioning scales such as those shown in figure 2 may also be used in calculating reductions or enlargements of illustrations.

Be sure to tell the draftsman the size you want the original line drawing and the reduction you anticipate from that size, so he will know the appropriate size of letters and lines required to produce a legible figure. Figure 3, too, will aid you in deciding on the size of lettering needed for the reduction your line drawing requires.

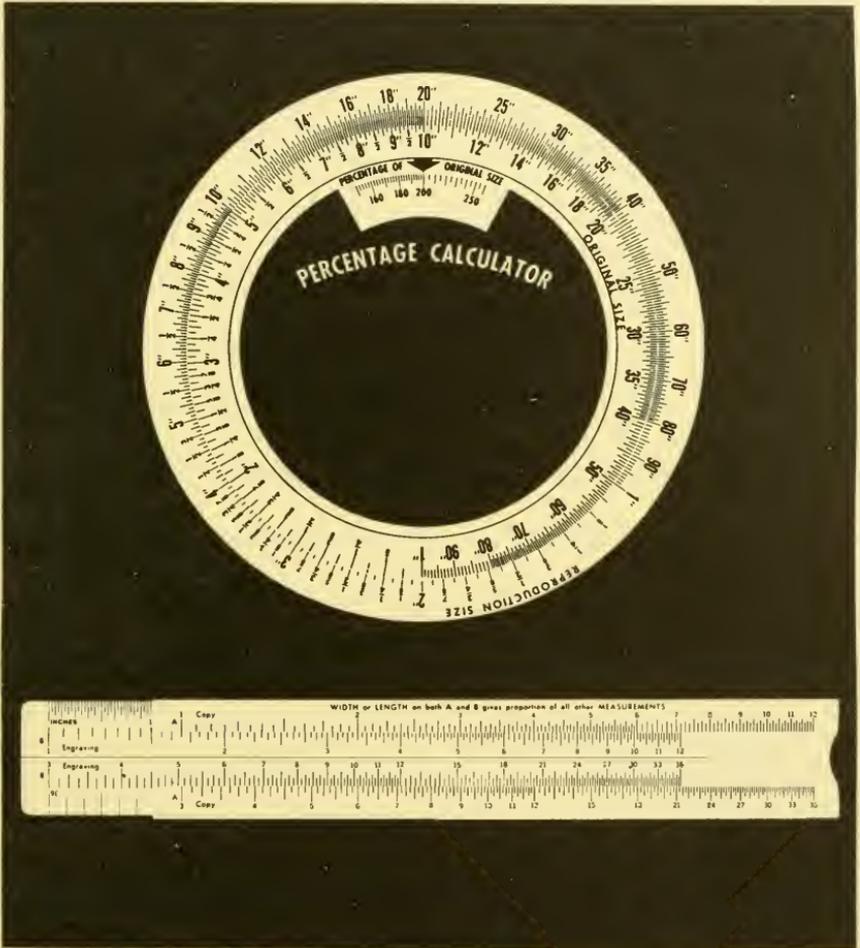


Figure 2.--Proportioning scales may be obtained at art-supply stores.  
(Courtesy U. S. Bureau of Mines.)

ORIGINAL SIZE

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Executive Type - 11 characters pe

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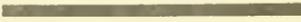
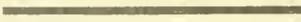
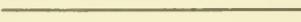
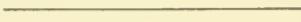
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Figure 3.--Effects of reduction on lettering, based on Leroy pen and template sizes. (Courtesy U. S. Bureau of Mines.)

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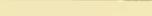
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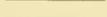
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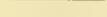
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## Quality

The quality of your printed illustration reflects the quality of your original art. Although reproduction may reduce some small imperfections, it may magnify others. For this reason, you should examine your original drawings critically. Submit originals for printing upon request; the photocopies you send in with your manuscript are for the use of reviewers.

Only line drawings made with the best materials reproduce well. Always use a waterproof India ink with a good black color and a good quality tracing cloth, tracing paper, white paper, or acetate. Extreme care must be taken when acetate is used. It is especially susceptible to finger prints and is easily charged with static electricity that attracts lint and dirt particles to the illustration.

Lettering and symbols (but not figure legends) are placed directly on the drawings. Pasted tabs may come loose or slip and cause needless delay and work, necessitating return of the illustration to the author for correction.

*Scales.*--The scale used will greatly affect the quality of your graphs and charts. Whether a chart will be easy to follow or crowded and hard to read is determined by the scale you select (figs. 4 and 5).

Three basic rules govern the selection of scales for graphs and charts:

(1) The scales should permit an accuracy of reading commensurate with the purpose of the illustration;

(2) They should keep the chart or graph within a size consistent with the data;

(3) They should produce a curve with a maximum slope of about 45 degrees.

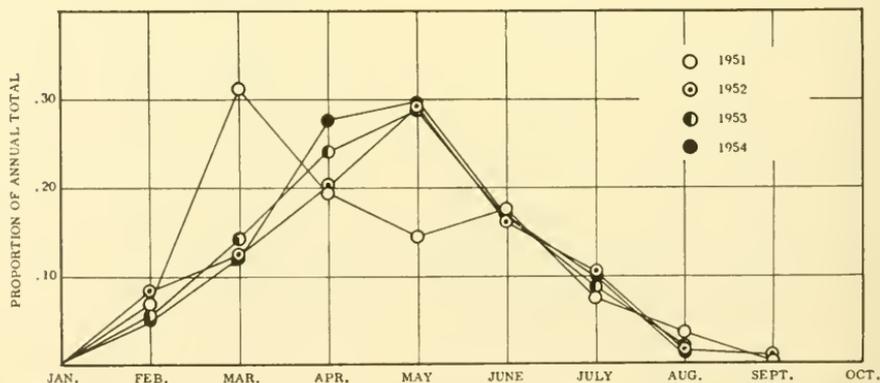


Figure 4.--The curves in this graph fall too close together and the patterns used are not easily distinguished. Rescaling would greatly improve this graph, as shown in figure 5.

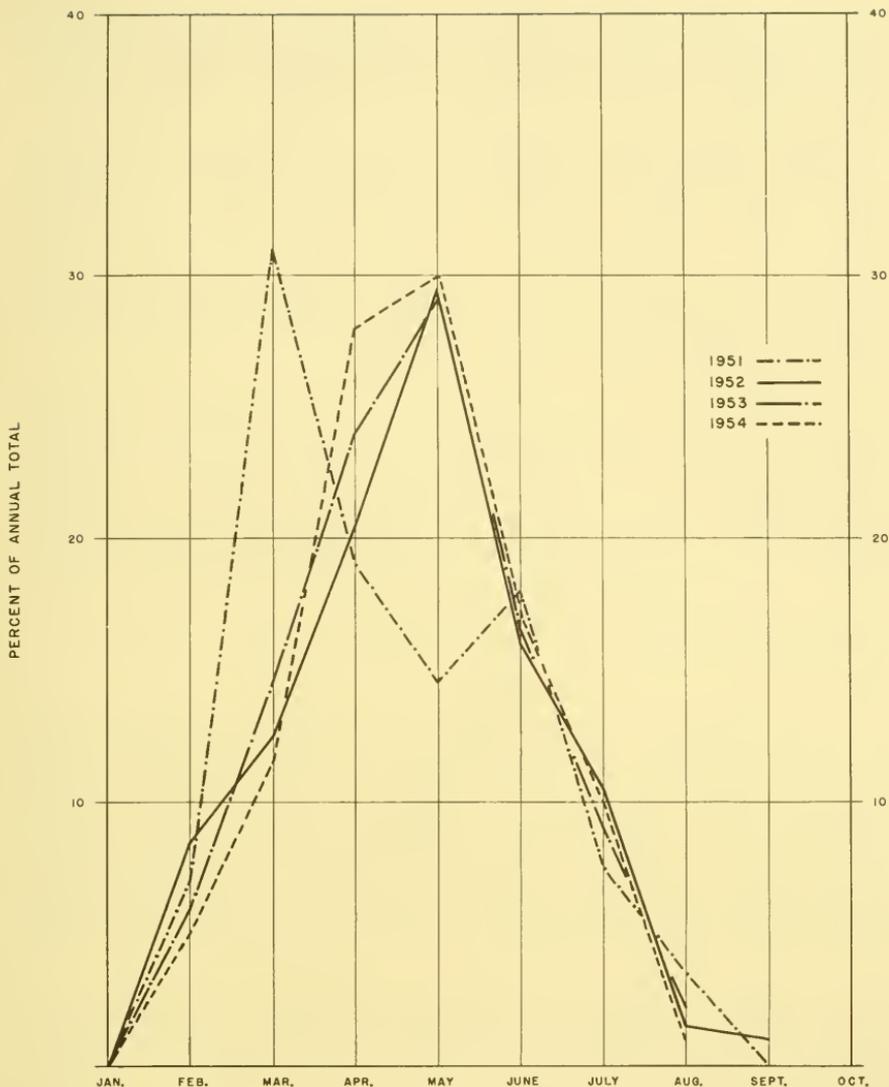


Figure 5.--Rescaling of the graph shown in figure 4 to deepen the curve and replacing the symbols with easy-to-follow patterns on the curve have produced a markedly improved illustration. (Drawn by E. W. Simpson.)

Rescaling enables you to transform a horizontal graph or chart into a vertical one. Thus, you avoid the awkward situation in which the reader must turn the publication on its side to see the illustration.

Scales of distance or size on illustrations change with reduction. Errors can be avoided if you indicate the scale of measurement on the graph, as commonly used in maps, as  $0 \quad 10 \quad 20$ . On photomicrographs, a scale might read  $1 \text{ mm.}$  or  $1 \mu$ .

*Lines.*-- Carefully examine the lines of your graphs: some lines may be so faint that they will disappear with reduction, some may be so heavy that they dominate the graph. Reject drawings in which the lines are wavy, jagged, or broken.

The weight of the lines has much to do with the pleasing appearance of your illustrations. Never enclose the graph in a heavy box or border, as it distracts the eye from the main part of the graph. The border or the ordinate and abscissa axes should be only a little heavier than the grid lines, when they are used. The slopes of the graph should be of a line weight sufficiently heavy enough to be the dominant feature in the illustration.

Lines within the graph should be distinctive, so that they are easily distinguished when the figure is reduced. In lines composed of both long and short dashes, make the long dashes at least three times the length of the short dashes. Be sure that there is adequate space left between dashes, since the spaces also become smaller with reduction. (You can check the adequacy of the spaces with a reducing glass.) Also, remember that broken lines appear heavier than solid lines, so a fine pen should be used to make the dashed or broken lines.

In complex graphs avoid intersecting lines that are hard to read or that fill with ink during printing. Sometimes grid lines are used when tick marks would be sufficient and in many instances omission of grid lines would produce a sharper, more legible drawing. When grid lines are necessary do not permit them to pass through symbols, lettering, or lines of the graph. If it is necessary to set off a key or explanations of the symbols from the main part of the graph, enclose them neatly in a box.

Outline bar graphs and histograms with a pen to ensure sharp, square corners. Different patterns of zipitone can then be used or the bars crosshatched, stippled, or filled solidly with ink. Caution: Avoid large areas of black, as such illustrations present an unpleasant contrast with other figures and with the printed page. Also, do not stipple so heavily and closely that the dots merge when the illustration is reduced. Select zipitone patterns that will be distinct after considerable reduction.

Curves should be well-drawn; freehand drawing is difficult and may give a careless appearance to the figure.

*Lettering.*-- San-serif lettering, such as that produced by a number of lettering sets available on the market, is preferred. It is more legible after reduction than is serif lettering, in which the letters are thin-stemmed and footed, as generally used in text. Well-formed letters are uniform

in weight, height, and slope. Ordinate captions are centered on the left side (reading from the bottom up) and abscissa captions are centered at the bottom of the graph. Both captions are in capitals. Lettering made by typewriter should be avoided. Not only is it less professional in appearance than that done with a lettering set, but it is more difficult to correct when additions or revisions are necessary.

The sizes and weights of the letters used in a graph strongly influence the quality of the published figure (fig. 6). Some of the letters may be so large that they dominate the graph, some so small that they will be illegible after reduction. You can determine the correct lettering size in two ways--one not so precise as the other, however. A reducing glass gives an approximate idea of the size and legibility of a line of lettering after reduction. Figure 3 shows you quite accurately how large lettering from a given pen and template size will be following a given reduction.

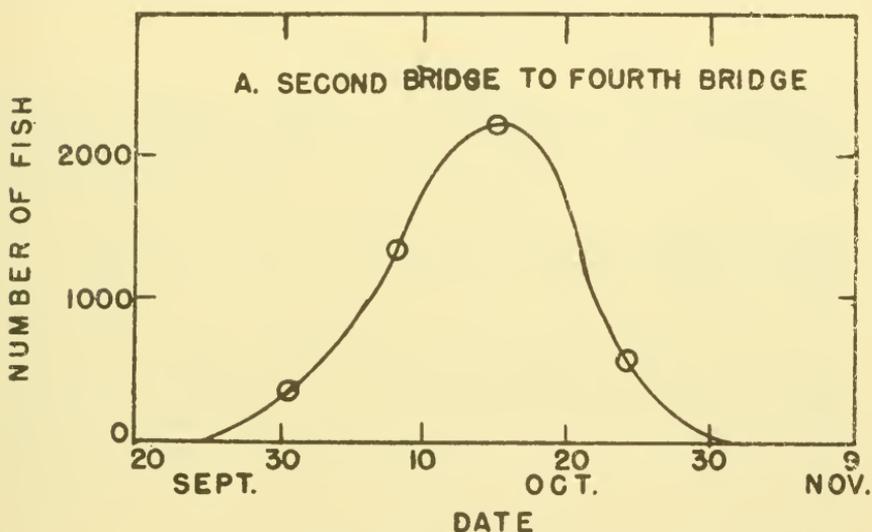


Figure 6.--The coarse black lines and heavy lettering in this illustration present an unpleasant contrast with the grayish hue of the printed page. The poorly placed, badly corrected legend and poorly drawn curve add to the unprofessional appearance of the figure.

Watch for letters that are broken, ragged, or improperly spaced. Equal spacing makes slender letters look poorly spaced. Letters drawn freehand can give an amateurish appearance to the drawing. Sometimes a worn template causes a line of lettering to slip. Keep lines of lettering parallel in a block of copy unless they are slanted for a special reason. Labels placed in a horizontal position on

drawings and maps are much more easily read and more orderly in appearance than are labels placed at various angles.

Never letter the figure legend directly on the illustration.

*Symbols.*-- Use symbols only when they are necessary to an understanding of the figure. Do not use symbols that become illegible when printed, such as partly filled circles or squares (◐ ◑ ◒ ◓), circles or squares with crosses or dots in them (⊕ ⊖ ⊗ ⊞), or crosses or X's used alone (+ ×). If only two symbols are needed use circles, open and solid. If additional symbols are required, use squares, open and solid, and triangles, open and solid, in that order.

Symbols must be large enough on the original drawing to reproduce properly. A good rule in deciding how large a symbol should be is to make its diameter about the same as the height of the medium-sized letters in the graph.

## UNIFORMITY

Uniformity within a series of charts or graphs is highly desirable, since it improves the general tone of the report. While a lack of uniformity may not affect the legibility of the drawings, it does give an impression of careless, unprofessional work. On the other hand, real confusion could result from inconsistent use of symbols or patterns in a series of curves for the same variable.

Lack of uniformity sometimes results from the illustrations being prepared by different draftsmen or at different times, but a little forethought can avoid inconsistency in their design. After the first illustration in the series has been suitably planned, you should make certain that all other drawings in the series harmonize with it. Uniform illustrations permit the same reduction, promote consistency in lettering, lines, and other features of the drawings, simplify makeup, and result in an improved format.

Follow the accepted abbreviations, spelling, and use of numerals given in the Government Printing Office Style Manual to avoid variations between text and illustrations and even among the illustrations. If you are preparing illustrations for outside journals, follow their style; but if you decide later to use the same illustrations in a Service publication, modify them to meet Service specifications.

## CONFORMITY WITH GRAPHIC STANDARDS

Since the graphic presentation of data is an important part of most technical papers, the illustrations submitted

with your manuscript should exhibit a high degree of professional skill and an exactness fitting the technical paper.

You may refer to many manuals for guidelines to good graphic presentation, but we shall include some of the more important fundamentals here.

When illustrations meet graphic standards, they harmonize with each other and with the printed page in size and density of lines and lettering (see fig. 5). Heavy tones in letters and rules are avoided, and the importance of the various parts of the line drawing is shown by the variation in weight and size of letters and thickness of lines. The lettering should not be less than 8 points nor more than 12 points after reduction. (A convenient place to find type sizes is in Webster's New International Dictionary or in the New Collegiate Dictionary.)

## Artist's Illustrations

Artists often can produce a drawing that will be more graphic than a chart or a photograph. In instances when photographs are not available, a good drawing or painting is very useful.

Such illustrations should be in black and white. Pen and ink, brush and ink, or scratchboard drawings reproduce as linecuts; wash drawings reproduce as halftones. Pencil drawings, oil paintings, and color work do not as a rule reproduce effectively and should not be used.

Unless you are a competent artist, do not attempt to produce such illustrations, but rather have such work done for you by qualified illustrators.

## Photographs

Photographic illustrations may be valuable supplements to the text. They help the reader gain an understanding of the subject more rapidly and more easily. Effective planning requires a number of photographs from which to choose your illustrations. Submit only good quality photographs that have a close relation to your subject. Occasionally, you may need to use a photograph of lesser quality but of historical value. Study publications of the Service and of outside organizations to see how photography was used to emphasize and clarify the subject.

Although you are concerned primarily with subject matter when selecting photographs, you must give thought

to whether they also show good composition and technique. A photograph exhibits good composition when it has a principal point of interest to which the eye of the reader is immediately attracted; when it is simply composed, so that your purpose in using it is easily recognized by the reader; and when it is well balanced, presenting a harmonious whole.

Good technique results in sharp, clear, and properly contrasted photographs. Technically good illustrations are free of mars, stains, scratches, lines, or other blemishes. They are sharp enough to be clear after reduction and the softening that results from the process of reproduction.

Photographing laboratory equipment requires special effort to bring out the details clearly. Select a neutral background and a point of view that eliminates unnecessary details. Shadows play an important part in helping the reader interpret the shape of things, so good lighting and proper exposure are essential (fig. 7). When taking pictures of mechanical devices be sure that no strong masses of



Figure 7.--The emphasis is on the main subject. The picture shows action: you can see what the man is doing. Arrangement of the objects and the lighting tend to present a pleasant, instructive picture.

light or shade or sharply lighted or objectionable details appear in the background. A person or an animal unobtrusively introduced adds interest and helps the reader interpret the size of objects (fig. 8). Avoid upended pictures, such as can result when you photograph from a point above the subject (fig. 9). Keep the horizon on even keel in outdoor shots, and do not permit horizontal lines, as where sky and earth or sky and sea meet, to divide your photograph in half. Avoid taking a picture so that your subject appears to be transfixed by a vertical line.

Submit your photographs on glossy paper, preferably 8-by-10-inch enlargements. Do not trim the photographs, but indicate the cropping you think desirable along the white edges of the print. Photographs may be attached along their upper edge to a heavy paper or cardboard by means of acetate tape. They must not be pasted down.



Figure 8.--The photographer has largely eliminated extraneous details by a critically sharp focus and position of the dominant subject. The picture shows action, includes a human figure for interest and scale, but does not detract from the main purpose--the pump and distribution of water. The horizon has been kept high and does not divide the picture in half, and the background is subdued.

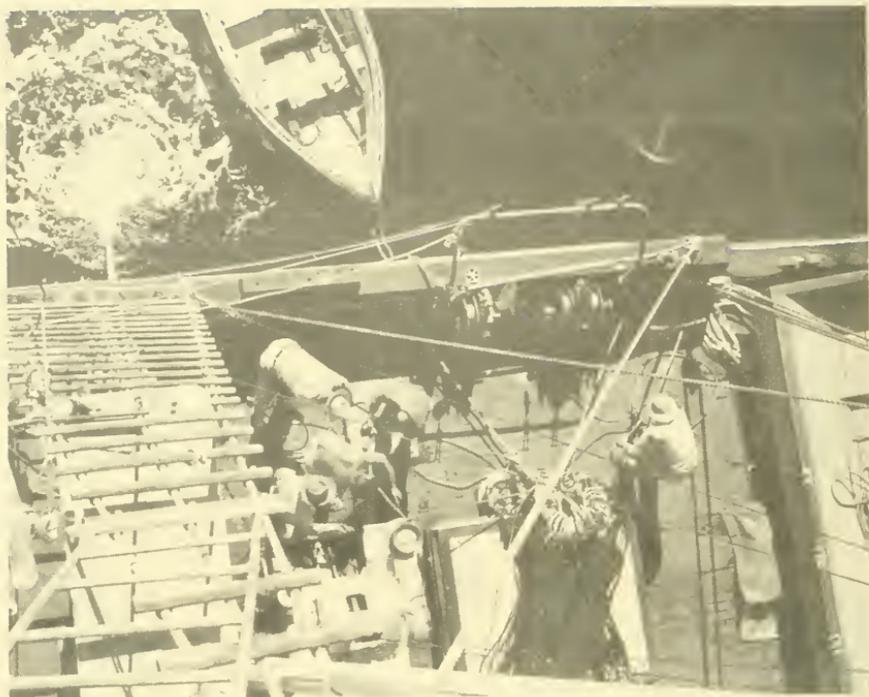


Figure 9.--This picture violates most of the rules governing a good photograph. The position of the boat emphasizes the unconventional viewpoint from which the photograph was taken. The light areas and confusing shapes and lines draw the reader's attention from the main subject--the purse-seine rings in the foreground. Photographs should always have a point of view that eliminates such conflict between the main subject and its surroundings.

Each print should be correctly numbered and properly identified. Never type or write across the back of a print: it indents the paper and the marks may show in reproduction; instead, type the figure legend on a strip of paper and attach it to the bottom edge of the print with acetate tape. The legend should carry all the information necessary to an understanding of the photograph.

Handle the prints carefully avoiding smudges from your fingers. Caution: Never use paper clips on your photographs.

## MAILING INSTRUCTIONS

Submit photocopies of your illustrations with your manuscript when you send it in for review. The original art should be held by you until it is asked for.

When mailing the illustrations, both line drawings and photographs should be placed between sheets of heavy cardboard or corrugated paper, wrapped in a flat package,

and marked "Photographs." The cardboard should be larger than the drawings or photographs to prevent damage to the edges of the illustrations.

If the illustrations of necessity are very large, and on tracing paper, they may be rolled and mailed in a mailing tube.

Each original must carry the figure number, title of the manuscript, and the author's name on the outer edge of the drawing or pasted to the print, for proper identification.

## REFERENCES

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1943 (reaffirmed 1947). Engineering and scientific graphs for publications. American Society of Mechanical Engineers, Publisher, New York. 28 p.  
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