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West Coast "Strata Lines"

A Computer Program Package for Defining Latitudinal/Bathymetric Groundfish Sampling Strata, 1983–85

July 1985

NOTICE

West Coast "Strata Lines": a Computer Program Package for Defining Latitudinal/Bathymetric Groundfish Sampling Strata, 1983-85

by

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ABSTRACT

The Resource Assessment and Conservation Engineering (RACE) Division's west coast subtask has completed three bottom trawl surveys from 1977-83. These surveys have been conducted on a triennial basis aimed at assessing groundfish resources in waters off California to British Columbia. To obtain proper abundance estimates for Pacific whiting (Merluccius productus), and important continental shelf rockfish species (genus Sebastes), a series of computer programs were assembled to provide accurate strata area computations. This computer program package simplifies stratum boundary definition, stratum area calculation, and graphical representation of the survey strata used by the west coast subtask. A step-by-step user guide for application of the strata line programs is provided. A detailed account of the equipment and procedures utilized in deriving the strata lines techniques is appended.

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INTRODUCTION

The Resource Assessment and Conservation Engineering (RACE) Division's west coast subtask has recently completed its 1983 triennial bottom trawl survey of groundfish resources in waters off California to British Columbia. The triennial surveys focus upon providing the Pacific Fishery Management Council (PFMC), the fishing industry, and scientific institutions with estimations of stock size and composition (Weinberg et al. 1984). Survey design and post-cruise analyses were based on a latitudinal/bathymetric stratification scheme to increase precision of abundance estimates and to provide information by International North Pacific Fisheries Commission (INPFC) management areas. Since 1980, the scheme has apportioned the survey region by INPFC statistical areas and by three depth strata: 30-100, 101-120, 121-200 fathoms (fm). In addition, a study of the upper continental slope was initiated in 1984 which involved sampling between the 60-100, 101-200, 201-300, 301-400, 401-500 fm depth zones. (Raymore and Weinberg 1985).

To estimate the abundance of groundfish resources using the "area swept" methodology, the surface area in square nautical miles (nm^2) of each stratum has to be calculated. Strata area computations were previously accomplished by planimetry which was time consuming and relatively imprecise. A series of RACE programs are now available which simplify the process of defining strata boundaries, calculating the surface area of a stratum, and producing graphic representations of the strata used by the west coast subtask. Depth contours can be digitized (electronically traced) from nautical charts, transformed into binary coded computer files (referred to hereafter as "strata lines files"), and manipulated by programs to yield area size calculations and computer-drawn maps.

The purpose of this document is to describe the use of the existing files of west coast strata lines and provide guidance to those needing to define different strata off the west coast or in other regions. The procedures are presented in a step-by-step fashion. Within this report, all program names are presented in upper case letters and file names are bound by quotation marks. User oriented documentation for all programs discussed herein are available as files on usercode (Race0360) on RACE disk. For each procedural step presented, consultation with the RACE user documentation is recommended. File titles for RACE documentation begin with the directory root-name DOC assigned to each program name (i.e., DOC/MAP). Copies of program documentation may be obtained by listing at your terminal or writing to the host printer the desired program [e.g., WRITE(RACE0360) DOC/MAP ON RACE]. A detailed account of the procedures discussed within this report are presented in an appendix.

USING THE WEST COAST STRATA LINES FILES

The manner in which the program package for the west coast strata lines files is utilized depends upon the final product desired by the user (Figure 1). The strata lines files contain line segments corresponding to the 30, 100, 120, 200 and 500 fm isobaths as presented on National Ocean Survey (NOS) nautical chart series 18000 and extends from Monterey Bay (36°48'N. lat.), California, to Estevan Point, Vancouver Island, (49°15'N. lat.), British Columbia. Also included in these files are line segments which correspond to sea bottom irregularities such as pinnacles, seamounts, or depressions. By using these files in conjunction with various RACE programs, strata area calculations or graphic representations of prominent features can be obtained.

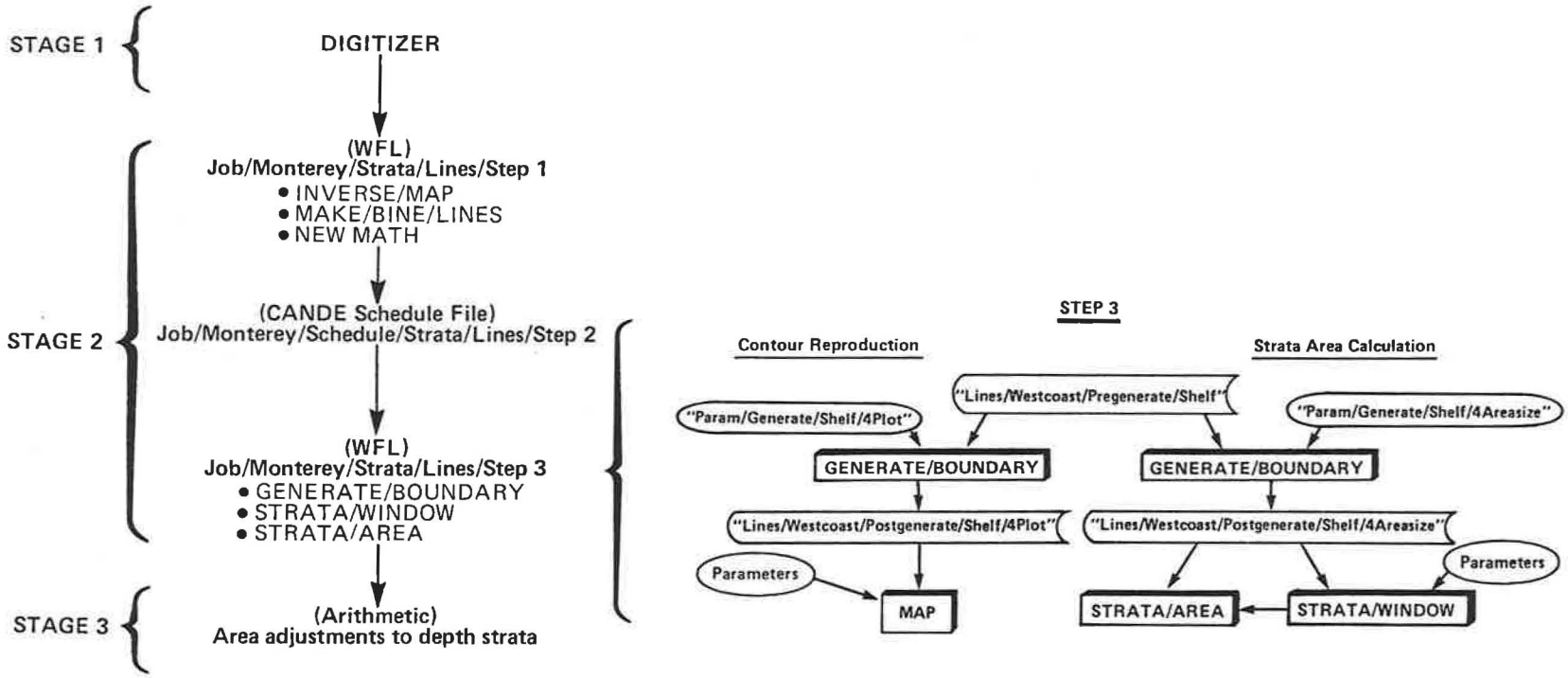


Figure 1.--Flowchart of steps and procedures involved in utilizing the west coast strata lines files.

Strata Area Calculations

To calculate the area (nm^2) of all strata used in the west coast survey area (36°48'N. to 49°15'N. lat.), proceed as follows:

1) Retrieve the binary lines file "(RACE0060)Lines/Westcoast/Postgenerate/Shelf/4Areasize" from library maintenance tape # 5118 where tape label = "Linestape" and put it on your disk usercode [e.g., RACE(PACK)].
2) Execute program (RACE0010) STRATA/WINDOW to define strata boundaries based on latitudes and longitudes.
3) Execute program (RACE0010) STRATA/AREA to compute the surface area of each stratum specified by the latitudinal and longitudinal boundaries in step 2 above.
4) Add or subtract from the major strata the surface areas corresponding to pinnacles, seamounts, and/or depressions within each stratum. Due to the extensive detail available with the west coast strata lines file, simple additions and/or deletions of areas associated with pinnacles, seamounts and depressions may have to be made to the major strata defined by the isobaths to obtain an accurate surface area measurement. Table 1 and Figures 2-6 will assist you in making adjustments to the calculated strata areas for each major stratum. These figures illustrate the major strata within which each pinnacle, seamount or depression is located, the associated line segment number and the depth that corresponds to each topographic feature. Table 1 shows the four major depth strata used by the west coast subtask and the total area (nm^2) of each before making adjustments for bottom irregularities. Table 1 also lists the pinnacles, seamounts, or depressions within the west coast survey region by line segment number; gives the surface area of each; the depth of each; and describes which arithmetic adjustments

Table 1.--Digitized line segment values, surface areas (nm^2), depths, and the arithmetic action to be taken for overall stratum area calculations within the 1983 west coast survey stratification scheme.

Stratum no.	Depth Range (fm)	Total Area (nm^2)
1	30 - 100	11,190.6006
2	101 - 120	796.7992
3	121 - 200	1,700.7593
4	201 - 500	6,132.8579

Line segment no.	Area (nm^2)	Depth (fm)	30-100 (fm)	101-120 (fm)	121-200 (fm)	201-500 (fm)
11	0.6945	120-200		-0.6945	+0.6945	
12	1.1383	100-120	-1.1383	+1.1383		
13	1.7863	247-344		-1.7863		
14	3.8439	179		-3.8439	+3.8439	
15	4.4042	120	-4.4042	+4.4042		
16	0.2351	98	+0.2351	-0.2351		
17	0.1743	25	-0.1743			
18	0.2397	25-28	-0.2397			
19	0.2334	445			+0.2334	
20	0.7558	421			+0.7558	
26	0.1716	28	-0.1716			
27	1.9252	22-30	-1.9252			
28	0.1189	30	-0.1189			
29	0.2228	20	-0.2228			
30	0.1096	28	-0.1096			
31	0.8444	10-18	-0.8444			
33	0.7272	19-26	-0.7272			
34	1.7613	16-30	-1.7613			
46	0.9782	24-28	-0.9782			
56	0.1468	192			+0.1468	-0.1468
57	0.8591	97-99	+0.8591	-0.8591		
81	0.9471	178			+0.9471	-0.9471
82	2.1221	166-173			+2.1221	-2.1221
83	1.6436	137			+1.6436	-1.6436
96	0.1355	83	+0.1355		-0.1355	
97	3.4518	384-454				-3.4518
106	0.1227	29	-0.1227			
107	0.1224	27	-0.1224			
108	2.0588	451-486				+12.0588
109	0.8978	447				+0.8978
110	1.4786	458				+1.4786
111	4.3522	331-493				+24.3522
112	6.4901	437-499				+6.4901
113	1.6743	471-482				+1.6743
146	0.1736	29	-0.1736			
147	0.2228	176			+0.2228	-0.2228
156	0.1132	27	-0.1132			

Table 1.--Continued.

Line segment no.	Area (nm^2)	Depth (fm)	30-100 (fm)	101-120 (fm)	121-200 (fm)	201-500 (fm)
157	0.1087	28	-0.1087			
166	3.2820	66-78	+3.2820	-3.2820		
167	6.1011	113-117		+6.1011	-6.1011	
168	0.2072	227			-0.2072	+0.2072
169	0.1648	215			-0.1648	+0.1648
-170, 185	27.1403	416-494				+27.1403
176	0.1232	26	-0.1232			
177	1.7972	113		+1.7972	-1.7972	
178	1.2179	150			+1.2179	-1.2179
179	0.2863	196			+0.2863	-0.2863
180	0.7903	190			+0.7903	-0.7903
181	0.4858	188			+0.4858	-0.4858
182	12.5224	192-197			+12.5224	-12.5224
184	0.1856	188			+0.1856	-0.1856
186	21.1292	142-197			+21.1292	-21.1292
187	10.6275	159-180			+10.6275	-10.6275
188	9.5919	147-184			+9.5919	-9.5919
189	0.9167	487				+0.9167
190	2.7886	210				+2.7886
196	0.2118	100	+0.2118	-0.2118		
197	0.1247	98	+0.1247	-0.1247		
198	0.3459	97	+0.3459	-0.3459		
199	3.9549	98-98	+3.9549	-3.9549		
200	0.9972	98-99	+0.9972	-0.9972		
201	1.3838	462				+1.3838
202	0.6733	492				+0.6733
203	0.1805	94	+0.1805	-0.1805		
204	0.3375	499				+0.3375
205	6.4948	400-500				+6.4948
207	3.0675	165-188			+3.0675	-3.0675
208	0.1610	197			+0.1610	-0.1610
218	0.2225	30	-0.2225			
221	1.4179	27-29	-1.4179			
222	8.5367	16-29	-8.5367			
223	0.6002	25-28	-0.6002			
242	0.4769	494				+0.4769
243	0.1181	94	+0.1181	-0.1181		
244	0.1094	93	+0.1094	-0.1094		
245	0.1411	493				+0.1411
286	0.2533	76	+0.2533	-0.2533		
287	0.3379	185	+0.3379		-0.3379	
288	9.5016	58-99	+9.5016	-9.5016		
289	0.3298	99	+0.3298	-0.3298		
290	0.1830	100	+0.1830	-0.1830		

Table 1.--Continued.

Line segment no.	Area (nm^2)	Depth (fm)	30-100 (fm)	101-120 (fm)	121-200 (fm)	201-500 (fm)
291	0.0951	96	+0.0951	-0.0951		
292	0.7195	73-95	+0.7195	-0.7195		
293	0.4096	83	+0.4096	-0.4096		
294	0.8770	78-90	+0.8770	-0.8770		
295	1.1874	71-97	+1.1874	-1.1874		
296, 333	1.9932	101-105	-1.9932	+1.9932		
298	0.1631	98	+0.1631	-0.1631		
299	0.1421	89	+0.1421	-0.1421		
300	1.0004	71-99	+1.0004		-1.0004	
301	0.0546	7	-0.0546			
302	0.7782	21-24	-0.7782			
303	0.2249	165		+0.2249		-0.2249
329	0.1137	27	-0.1137			
330	0.6555	102	-0.6555	+0.6555		
331	2.7872	29	-2.7872			
332	0.3270	102	-0.3270	+0.3270		
334	0.1673	106	-0.1673	+0.1673		
335, 392	2.2127	104-109	-2.2127	+2.2127		
336, 393	0.2468	122		-0.2468	+0.2468	
337	0.3935	488				+0.3935
338	1.1120	465-492				+1.1120
340	0.1613	100	-0.1613	+0.1613		
385	0.1899	29	-0.1899			
386	0.7300	28	-0.7300			
387	0.1674	27	-0.1674			
388	0.1197	30	+0.1197			
390	1.6610	104-123	-1.6610	+1.6610		
391	1.8676	104-117	-1.8676	+1.8676		
394	0.2402	101	-0.2402	+0.2402		
395	0.0855	103	-0.0855	+0.0855		
396	0.0857	30	-0.0857			
397	0.2891	31	-0.2891			

are needed to correct the major strata area computations. Figures 2-6 are presented by the following INPFC statistical areas: Monterey, Figure 2; Eureka, Figure 3; Columbia, Figure 4; Vancouver (U.S.), Figure 5; Vancouver (Can.), Figure 6.

To calculate the surface areas of the west coast strata, but within a specific latitudinal range (e.g., 40°30'N - 43°00'N lat.), proceed as follows:

1) Retrieve the binary lines file "(RACE0060)Lines/Westcoast/Pregenerate/Shelf" from library maintenance tape # 5118, where tape label = "Linestape", and put it onto your usercode [e.g., RACE(PACK)].
2) Execute program (RACE0010)GENERATE/BOUNDARY to create bathymetric boundaries for your strata from the line segments of interest.
3) Execute program (RACE0010)STRATA/WINDOW to define latitudinal/longitudinal boundaries of your strata.
4) Execute program (RACE0010)STRATA/AREA to compute the surface area of each stratum, and smaller topographical features.
5) Add or subtract from the major strata the surface areas corresponding to pinnacles, seamounts and/or depressions within each stratum.

The GENERATE/BOUNDARY program is utilized to redefine the west coast strata based on bathymetric boundaries which are a subset of the existing strata tailored to the needs of the user. Figures 2-6 are used in determining the line segment numbers which correspond to the region of the west coast which interests you. The STRATA/WINDOW program defines the strata boundaries within the region of interest based on latitudinally determined stratum borders. If your strata is not bordered by straight latitudinal lines (e.g., U.S.-Canada international border), program STRATA/WINDOW cannot be employed. Instead, the bathymetric boundaries which were generated with program GENERATE/BOUNDARY are utilized in computing strata surface areas when program

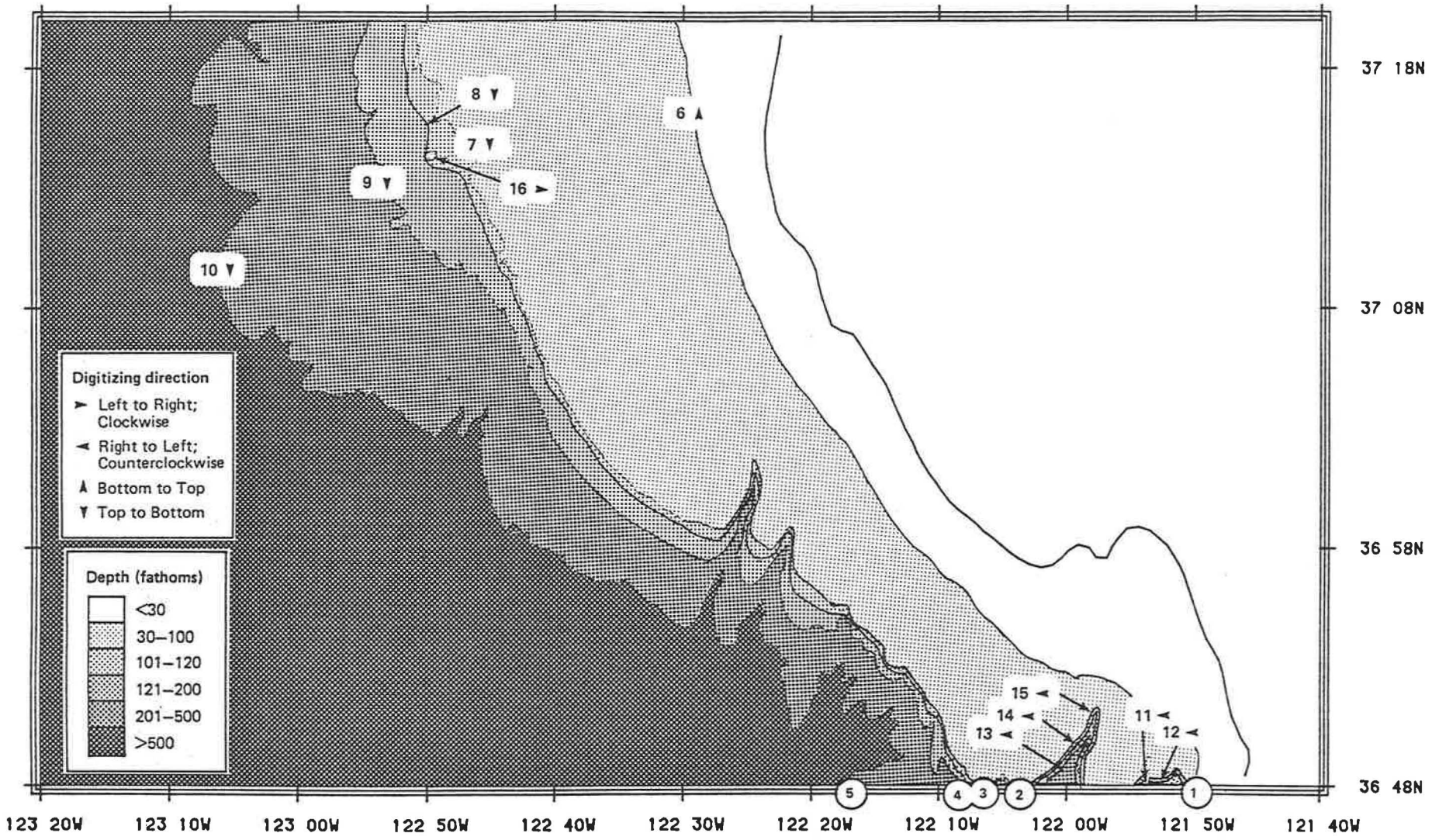
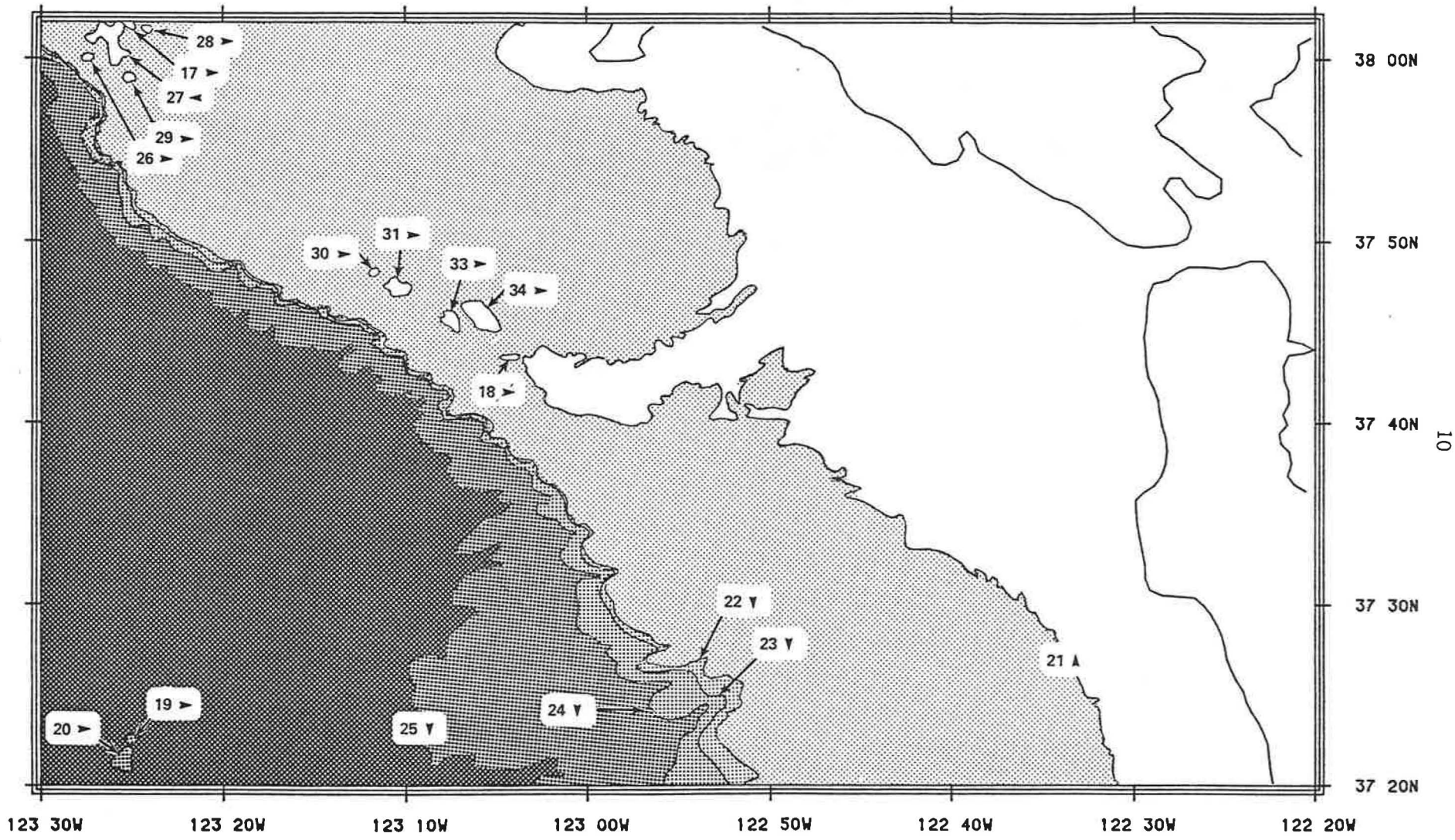


Figure 2.--Line segment values and depth strata for the Monterey International North Pacific Fisheries Commission statistical area as assigned within the west coast strata lines files.



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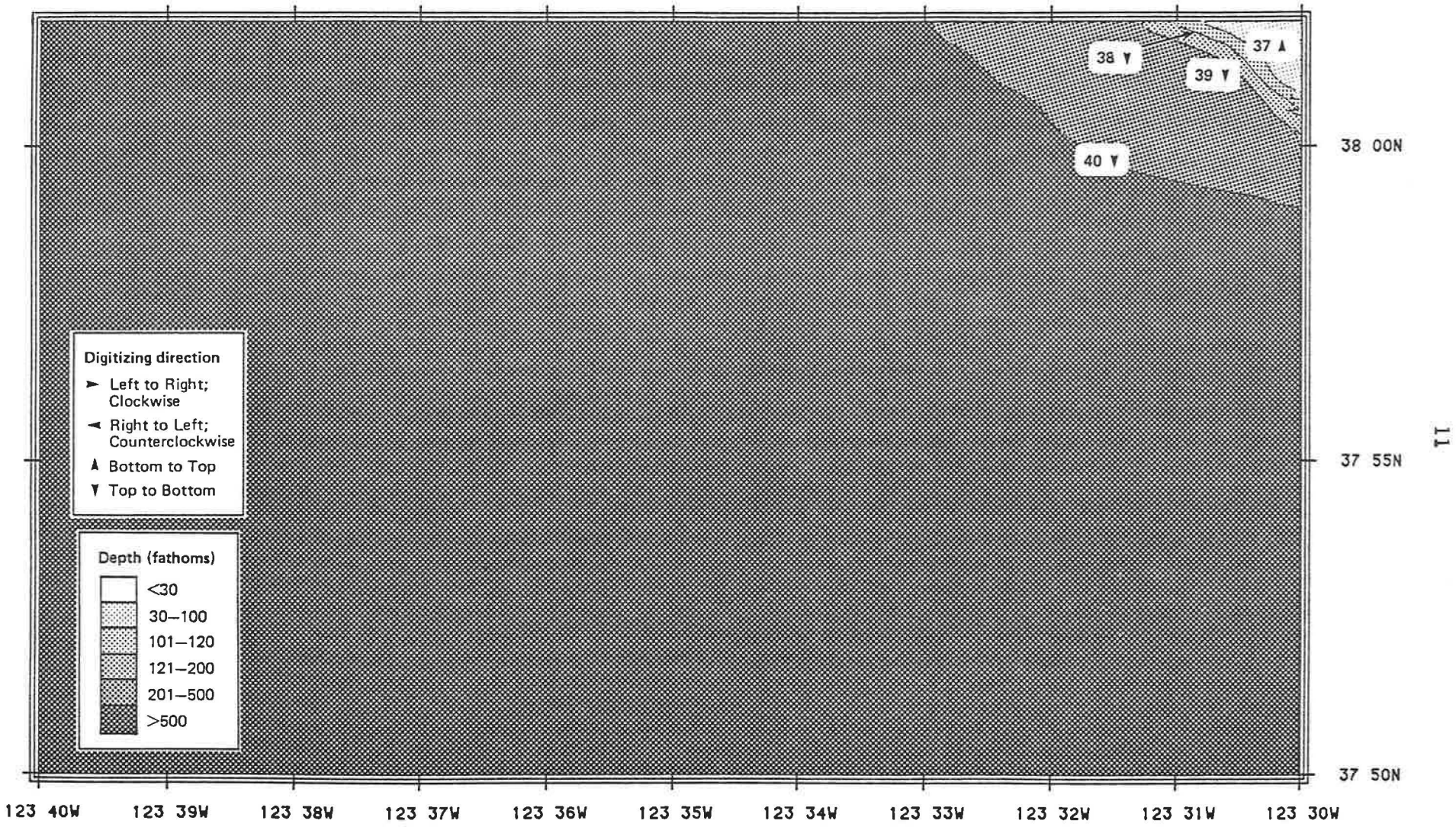

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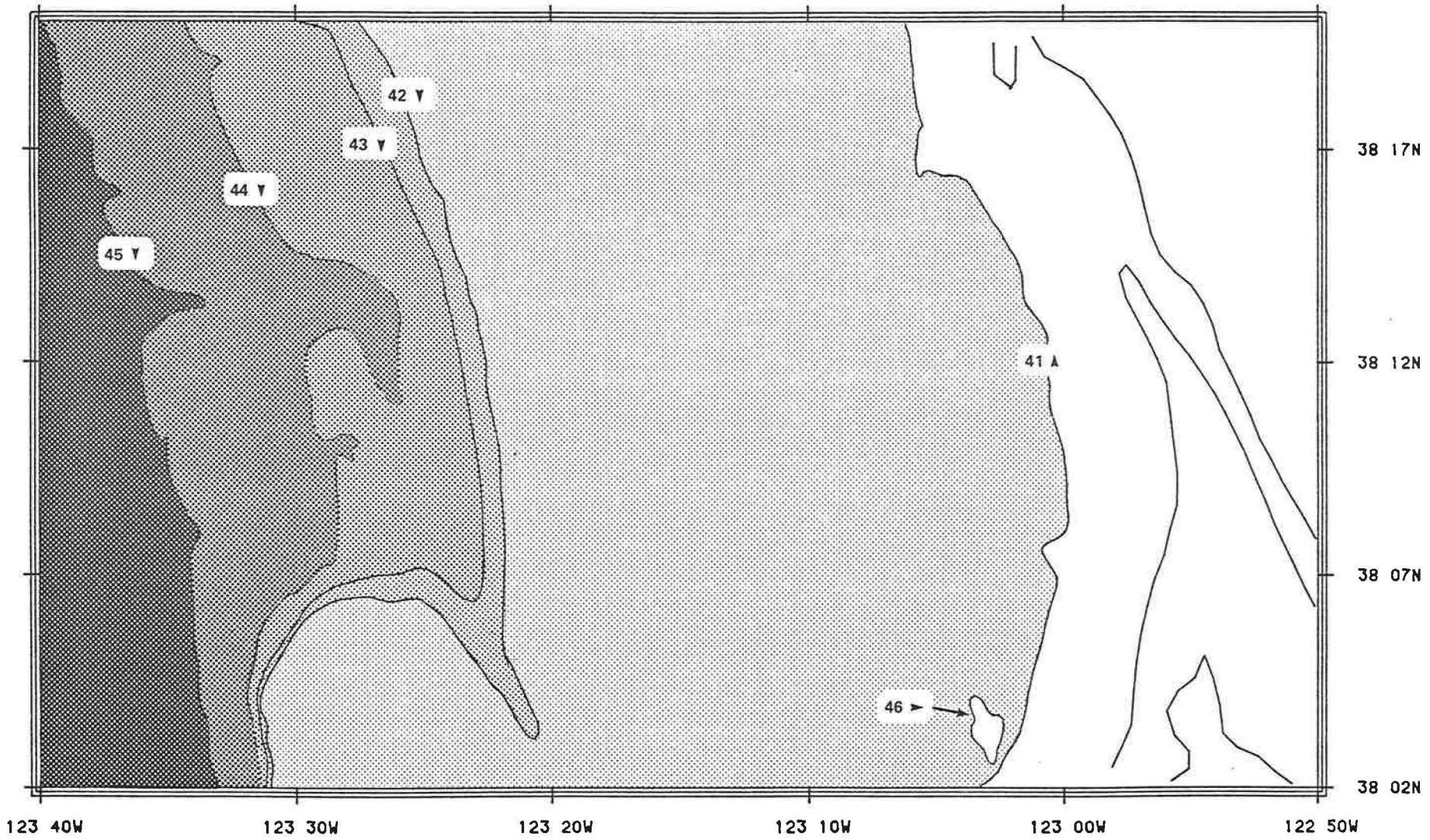

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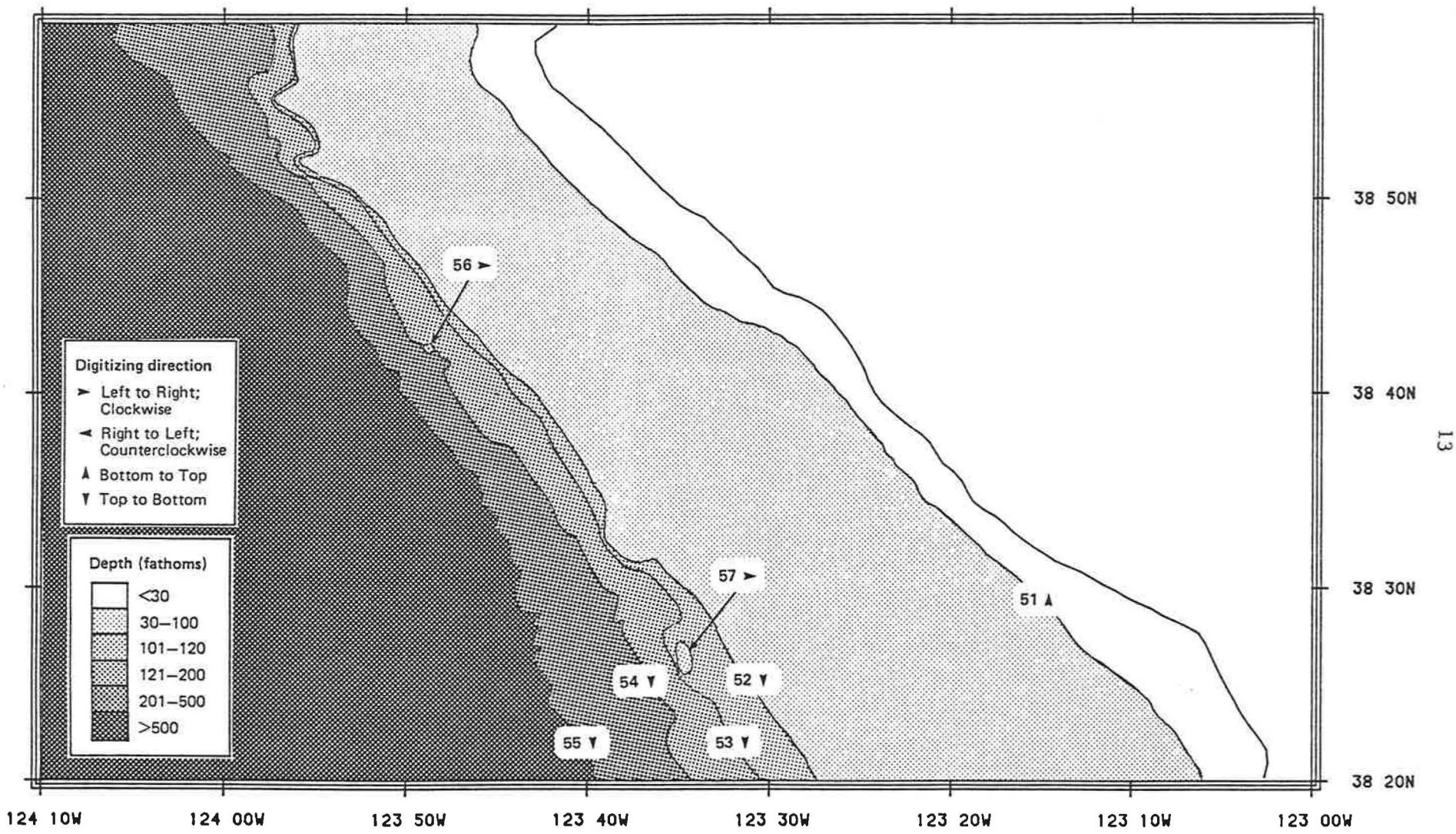

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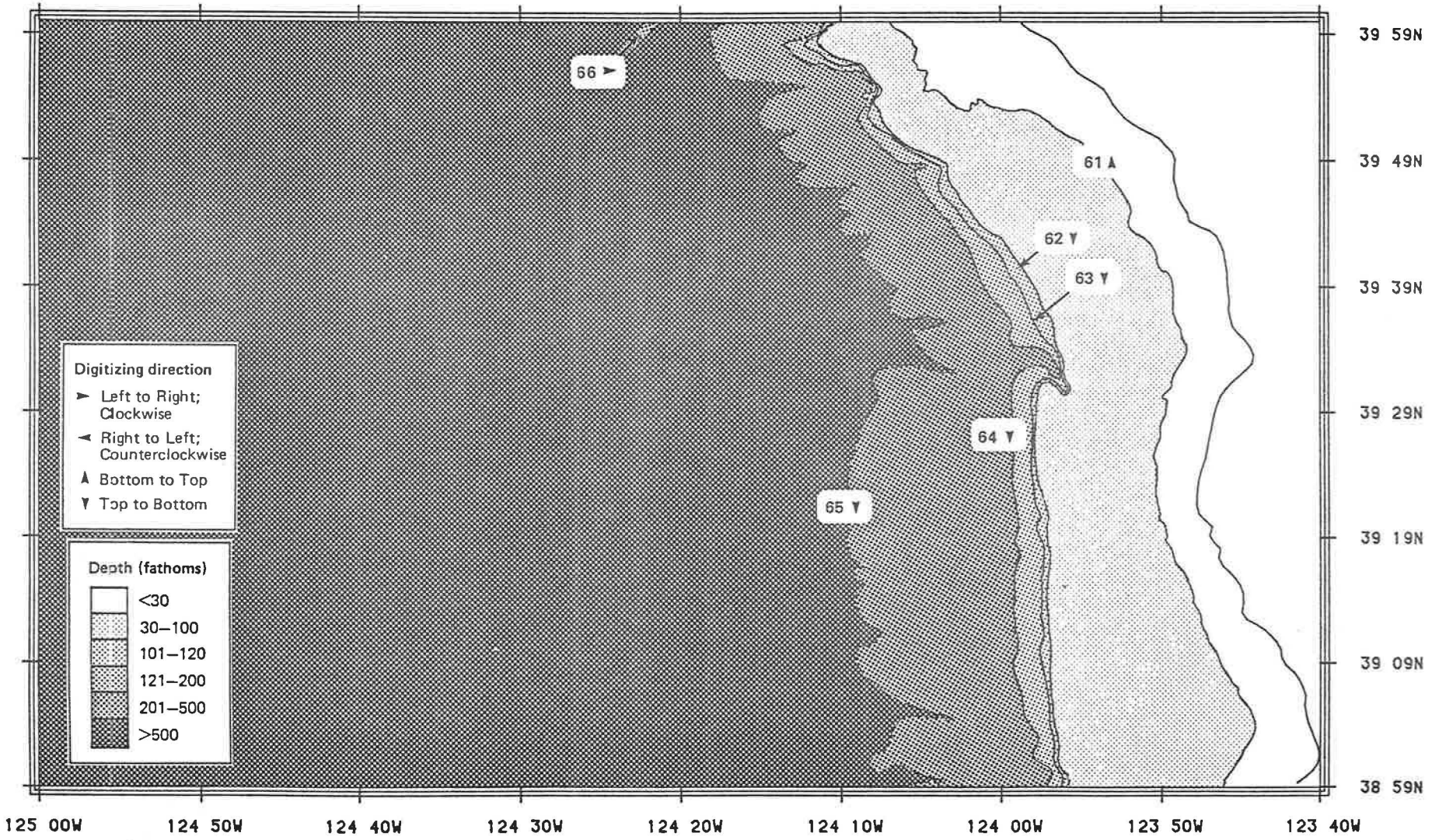

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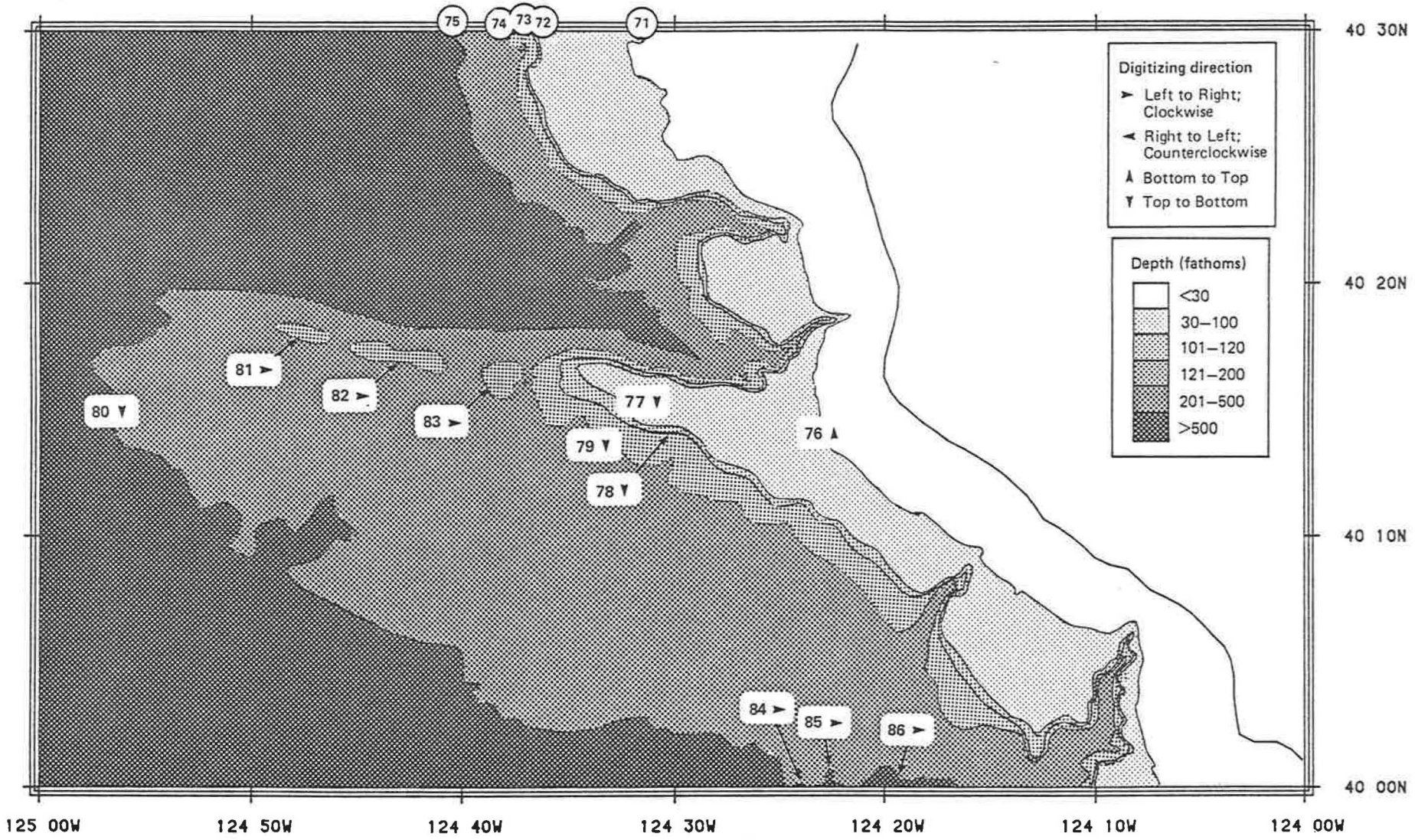

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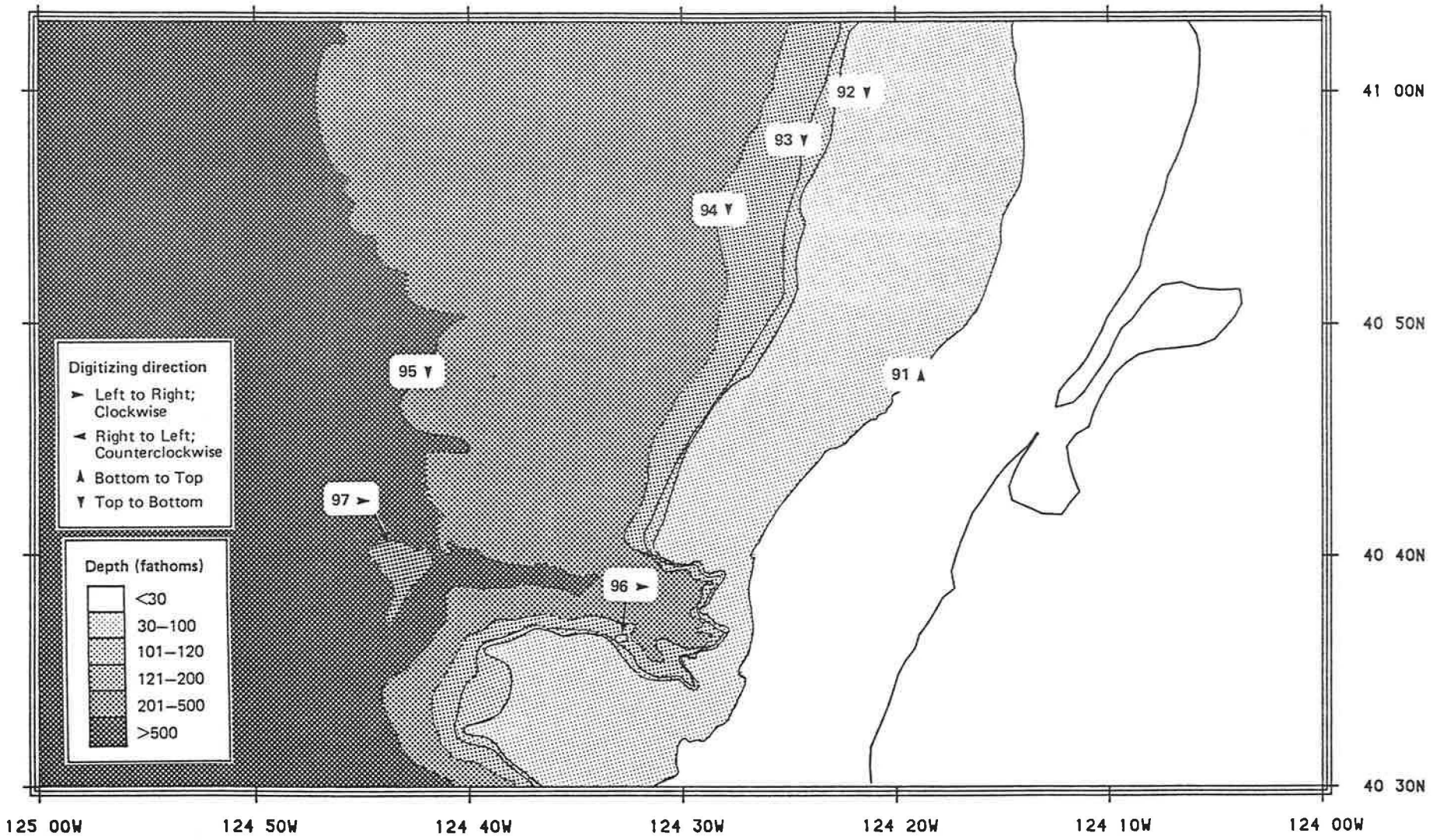
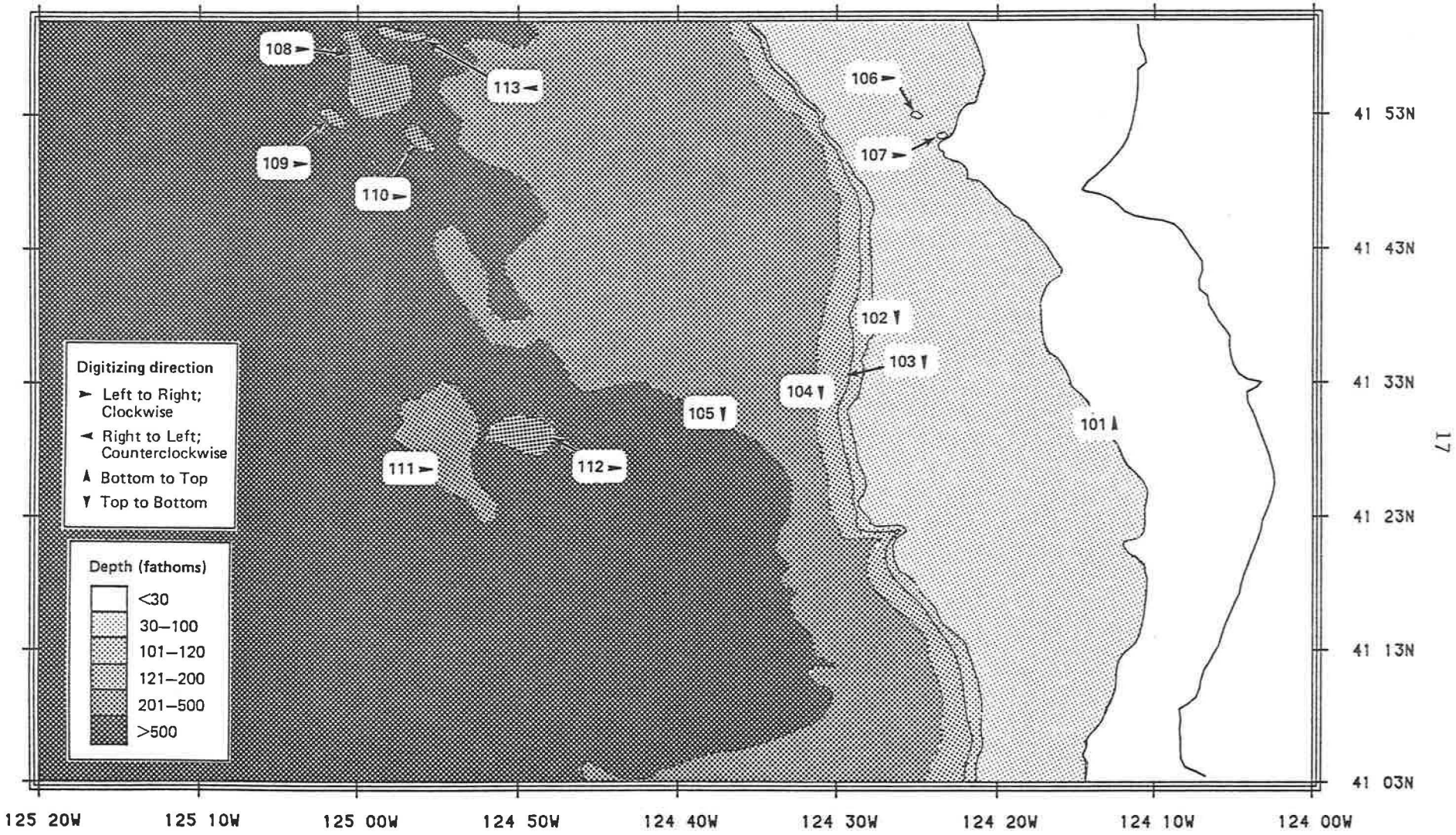


Figure 3.--Line segment values and depth strata for the Eureka International North Pacific Fisheries Commission statistical area as assigned within the west coast strata lines files.



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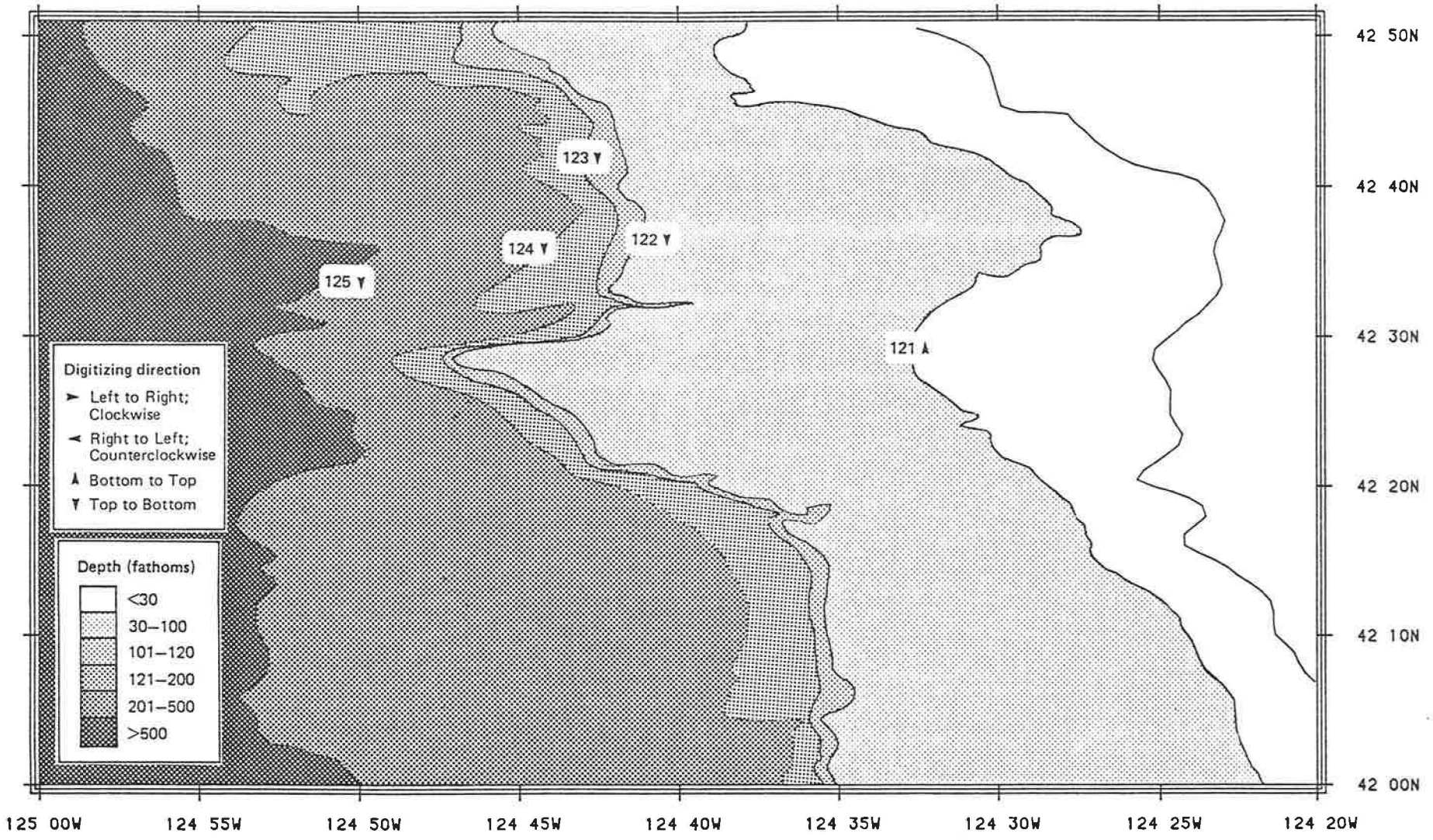

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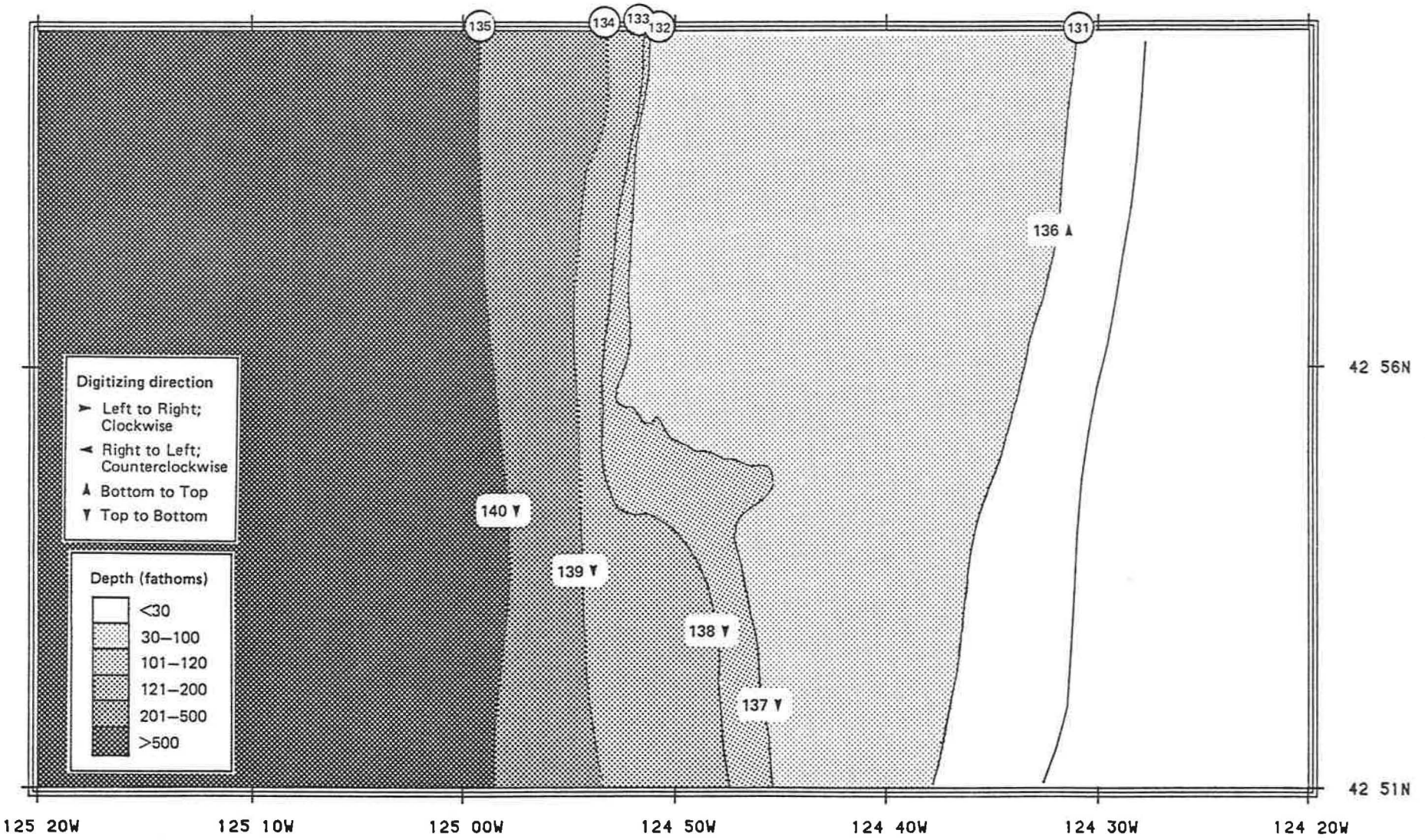

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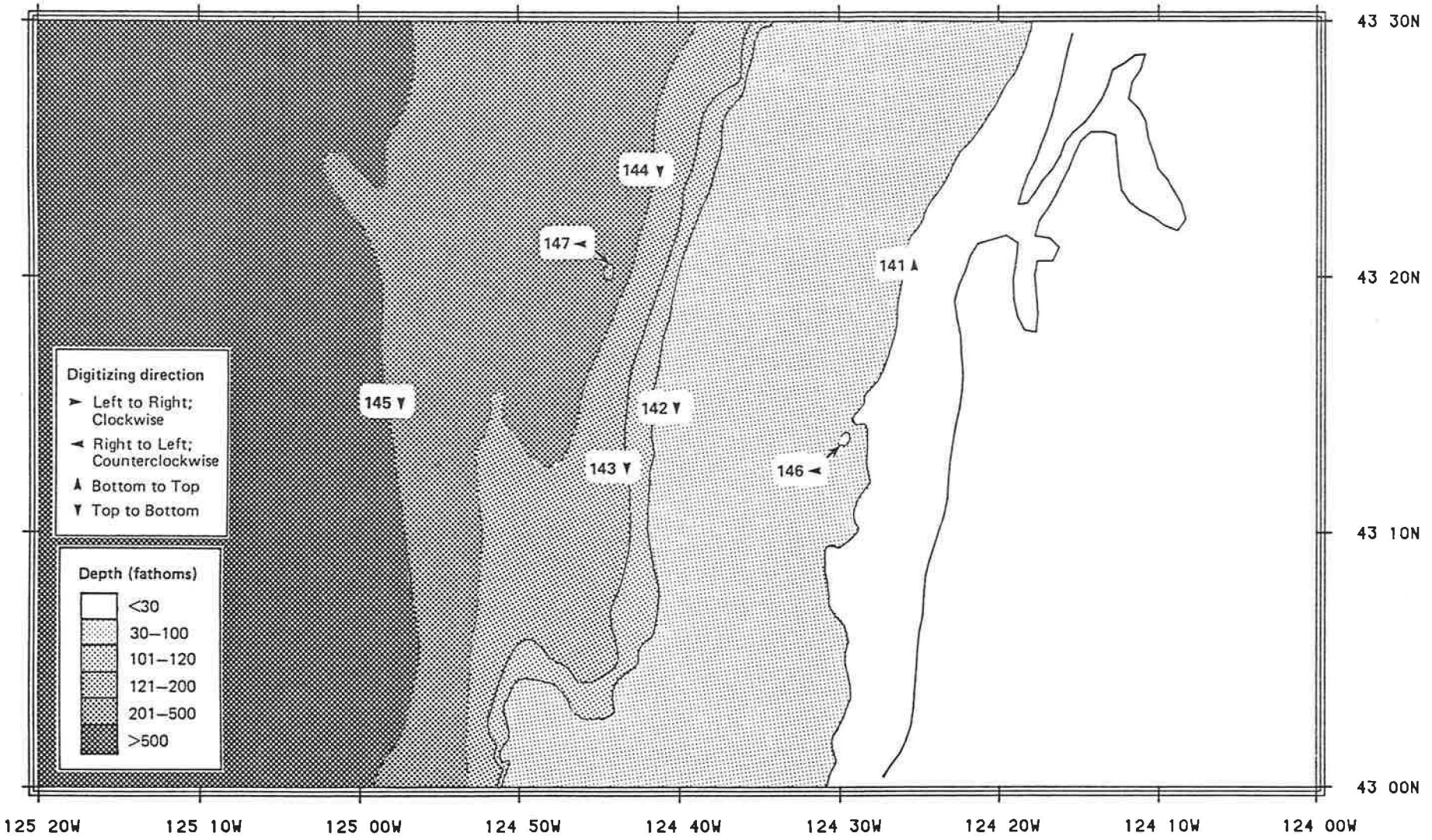
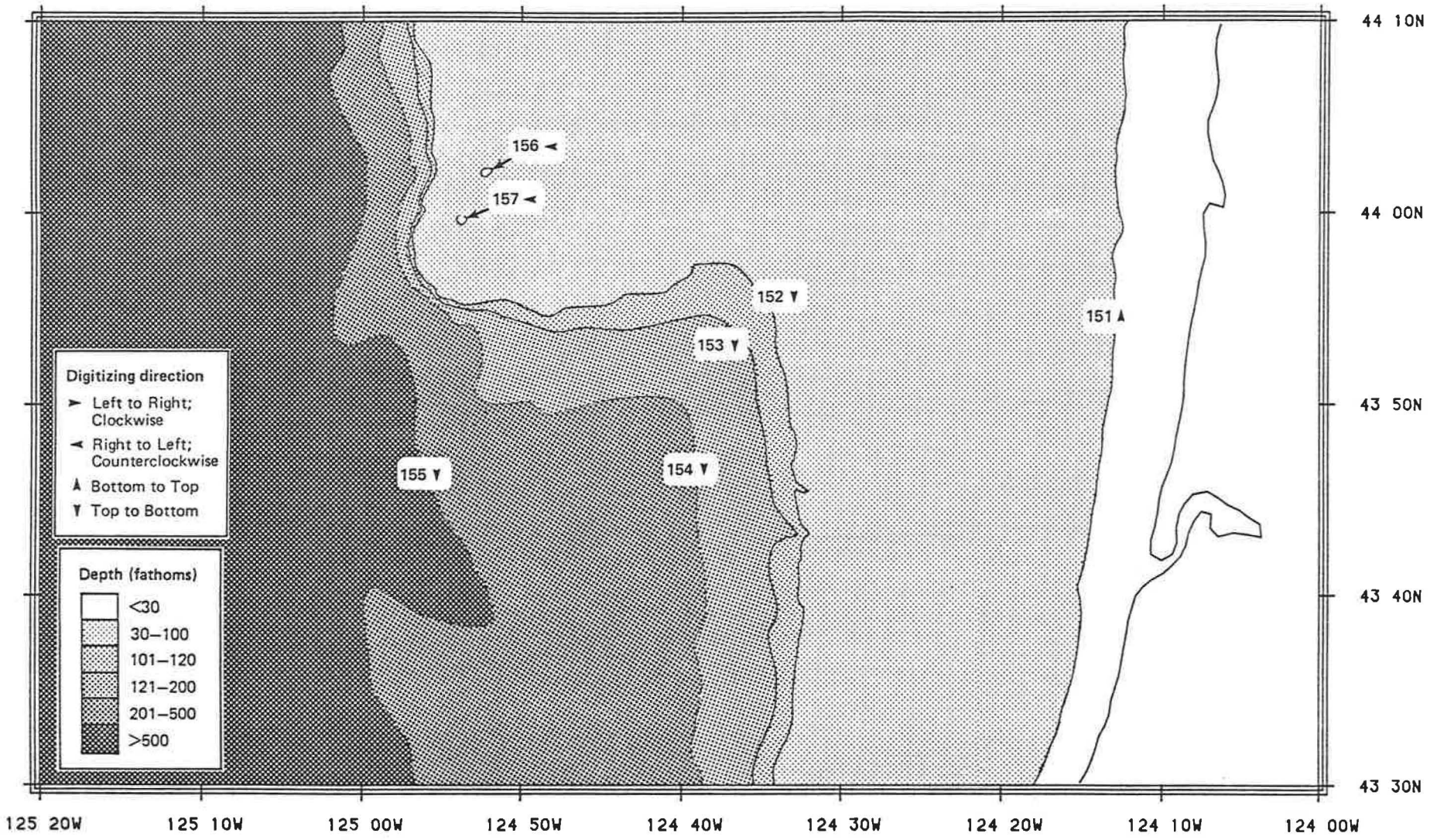


Figure 4.--Line segment values and depth strata for the Columbia International North Pacific Fisheries Commission statistical area as assigned within the west coast strata lines files.



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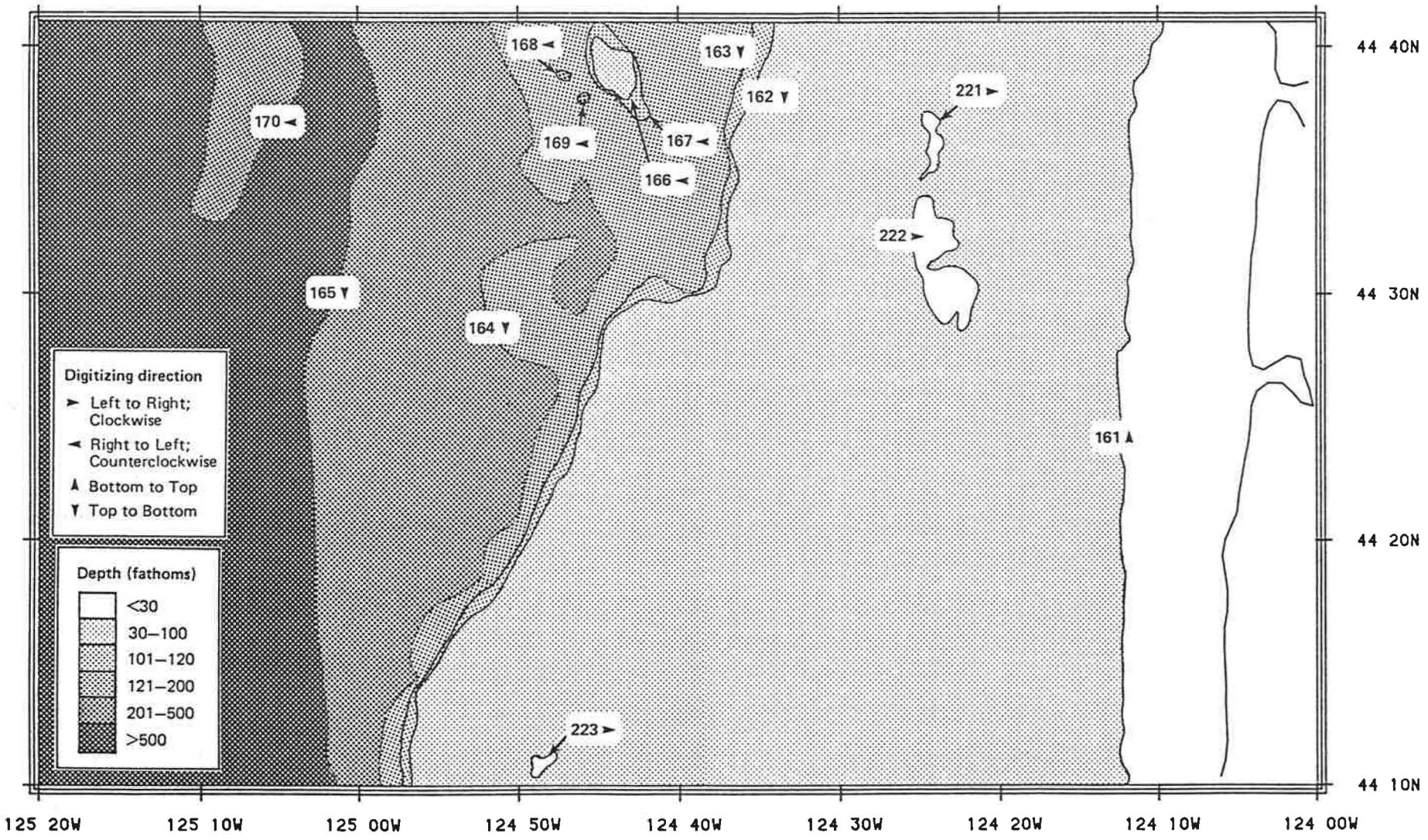

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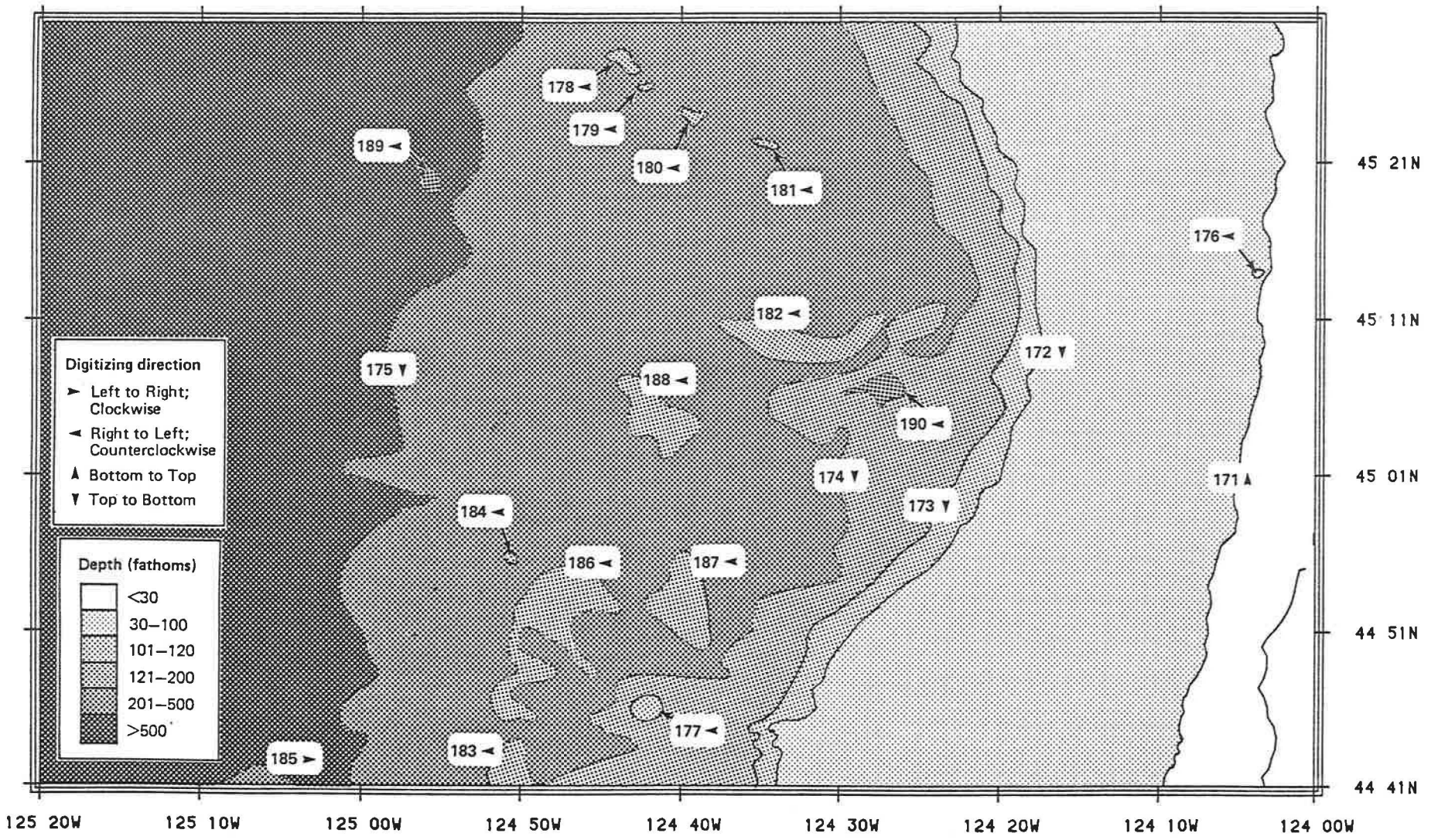

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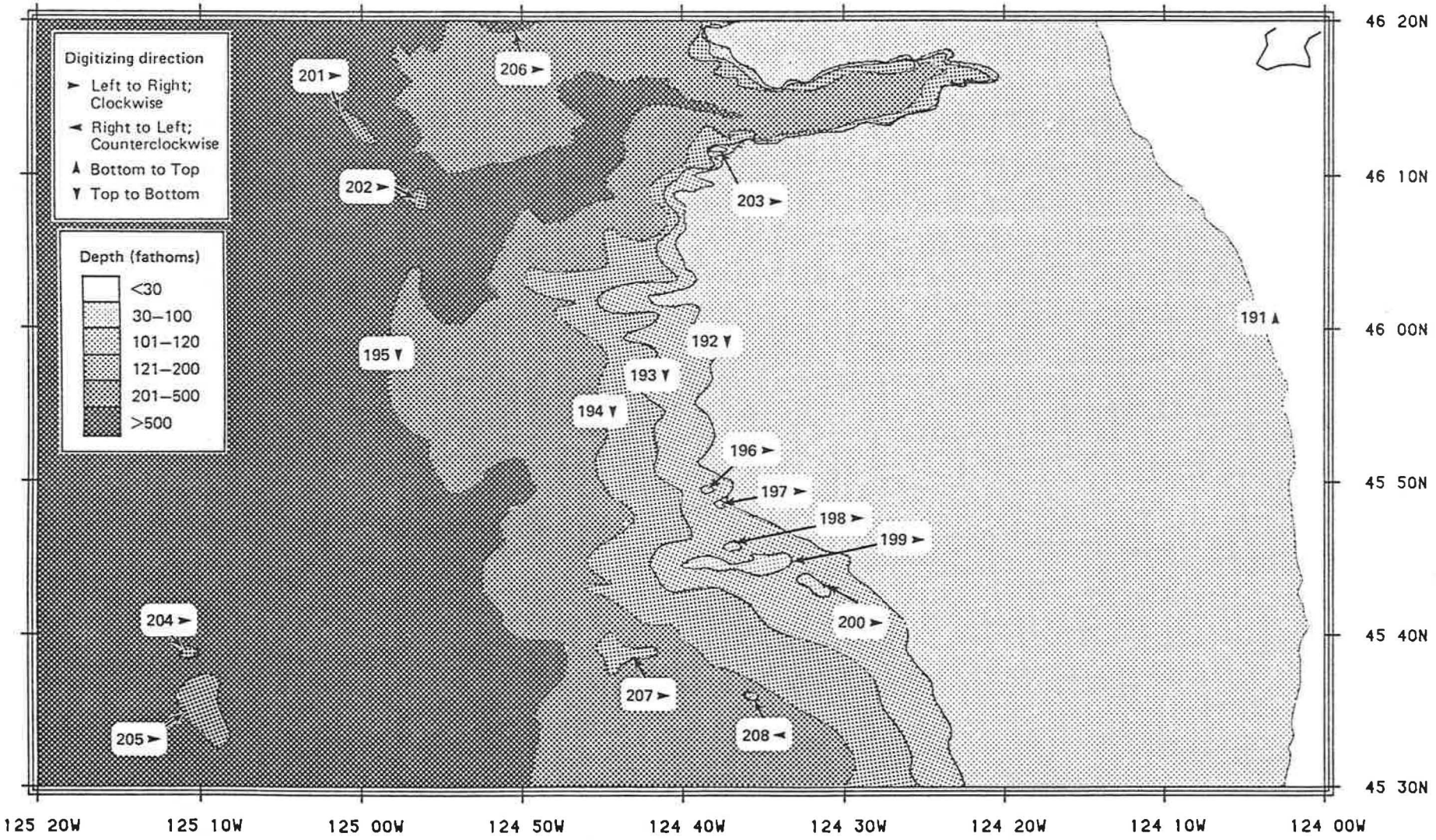

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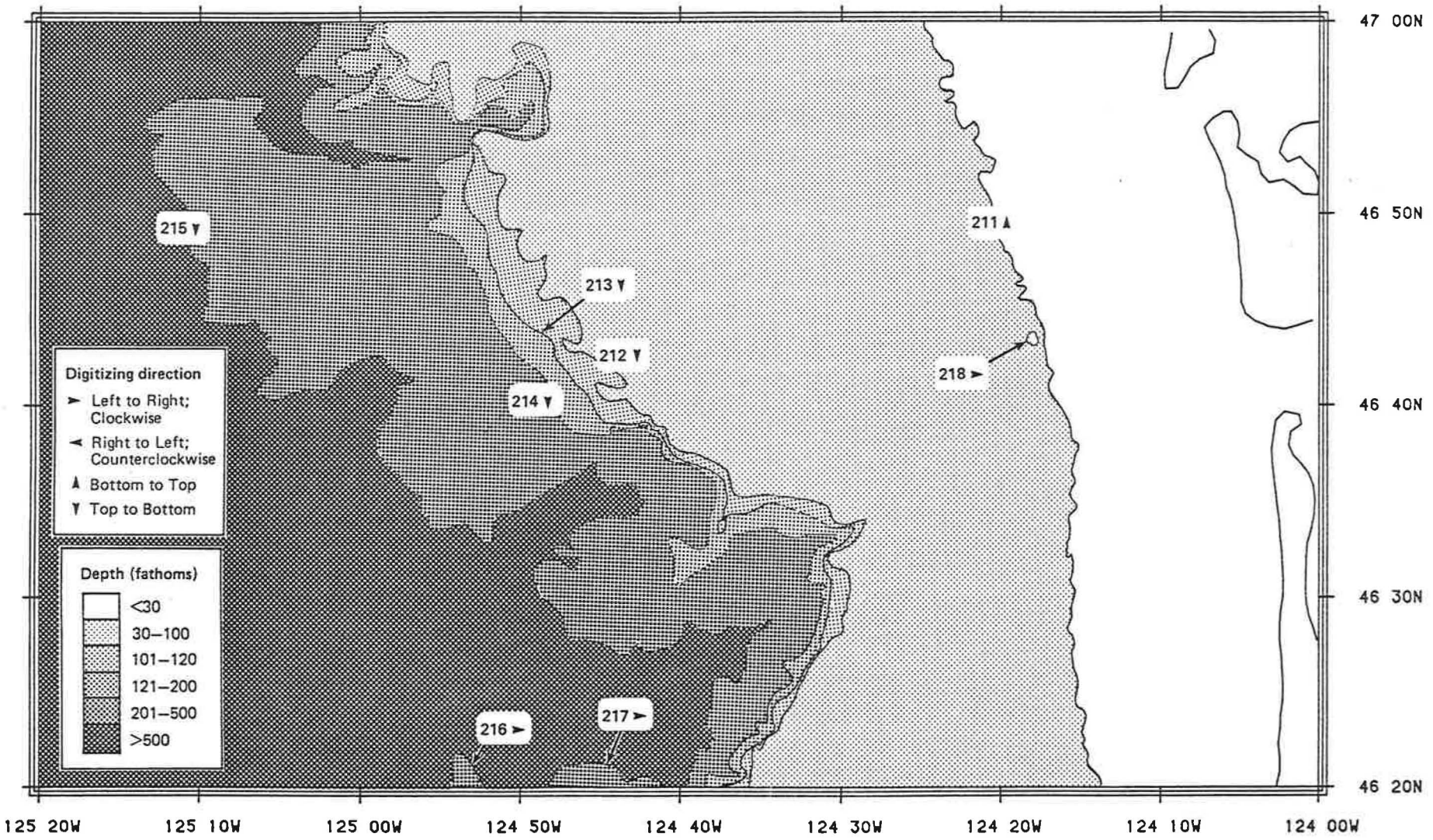

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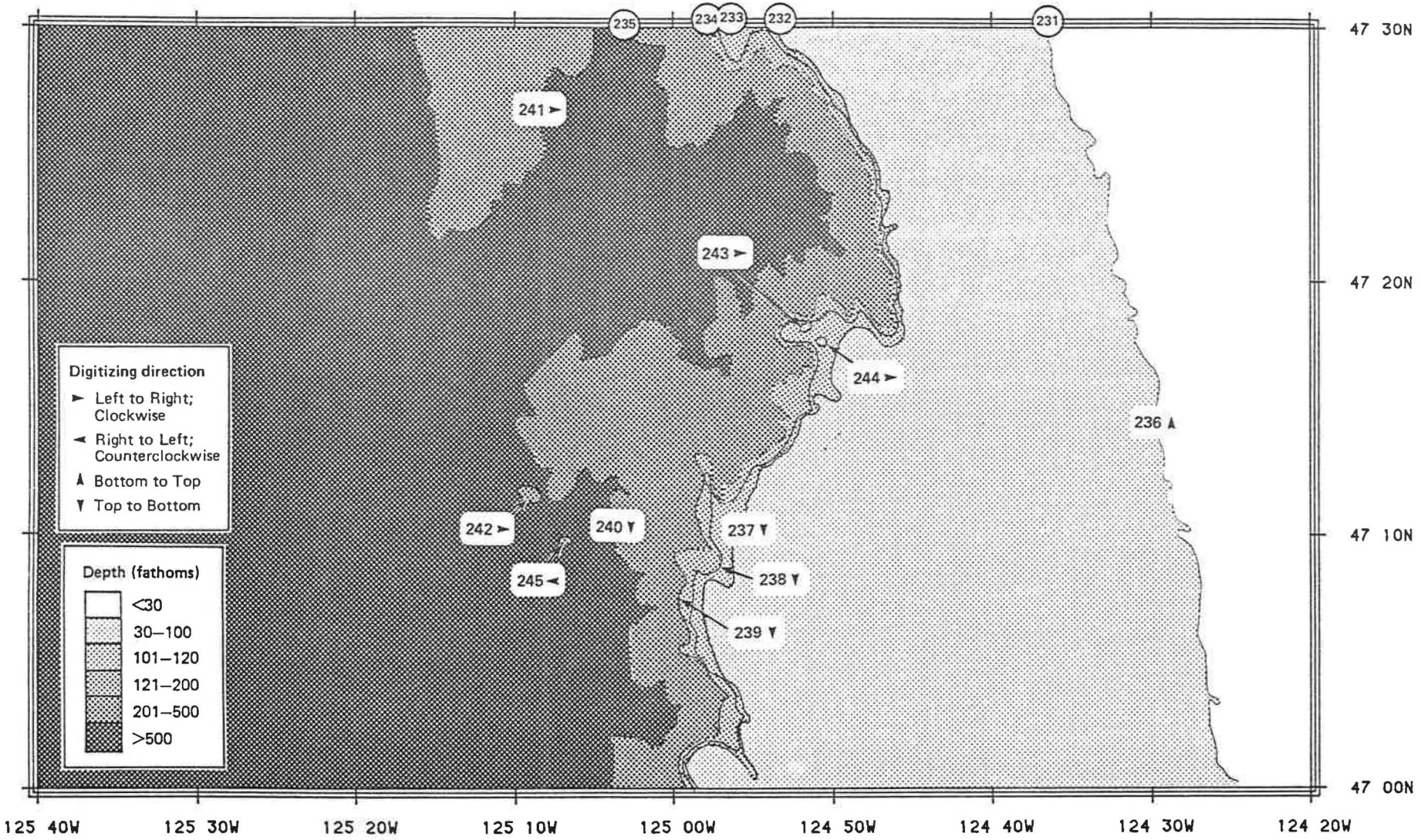

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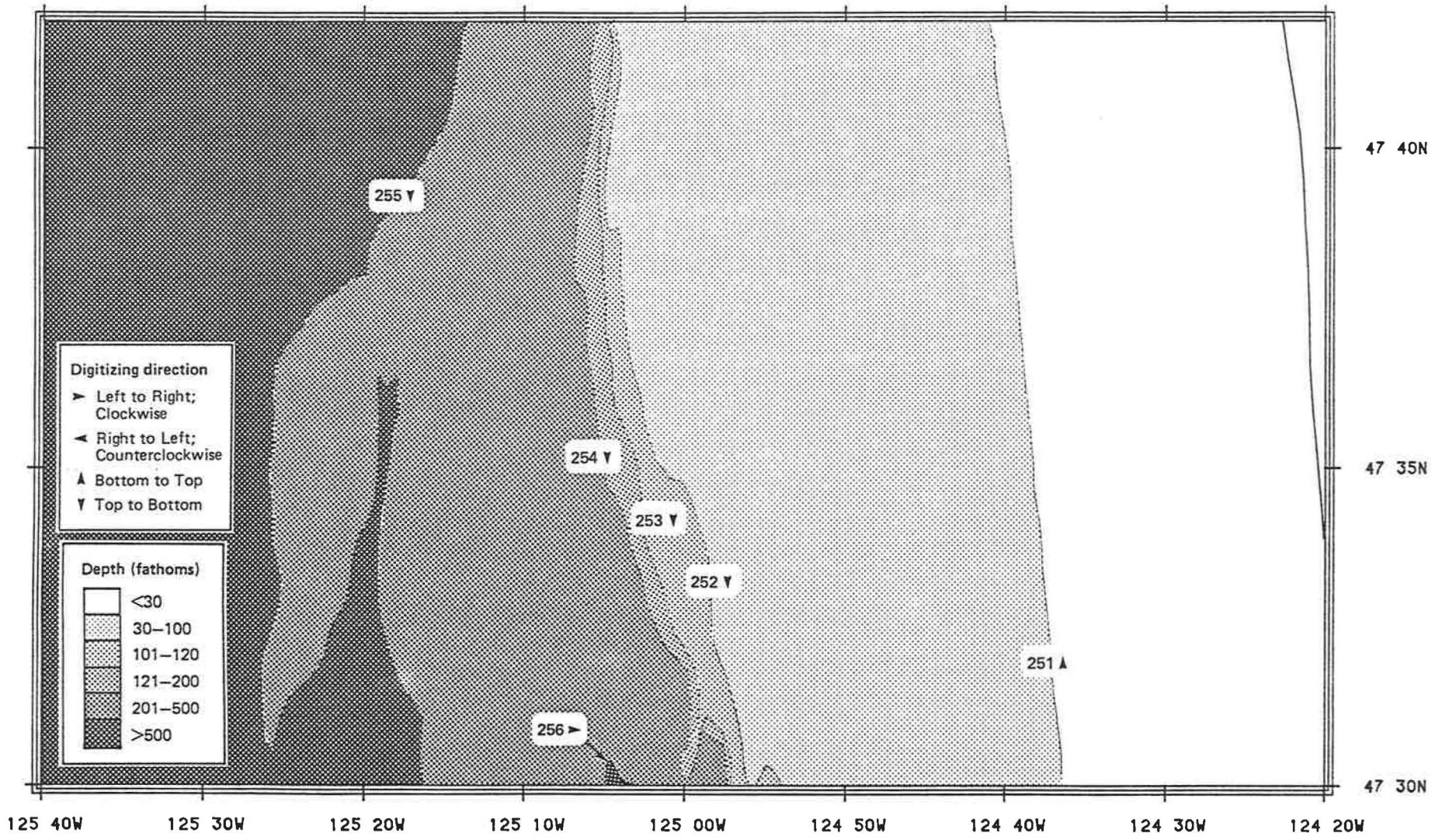
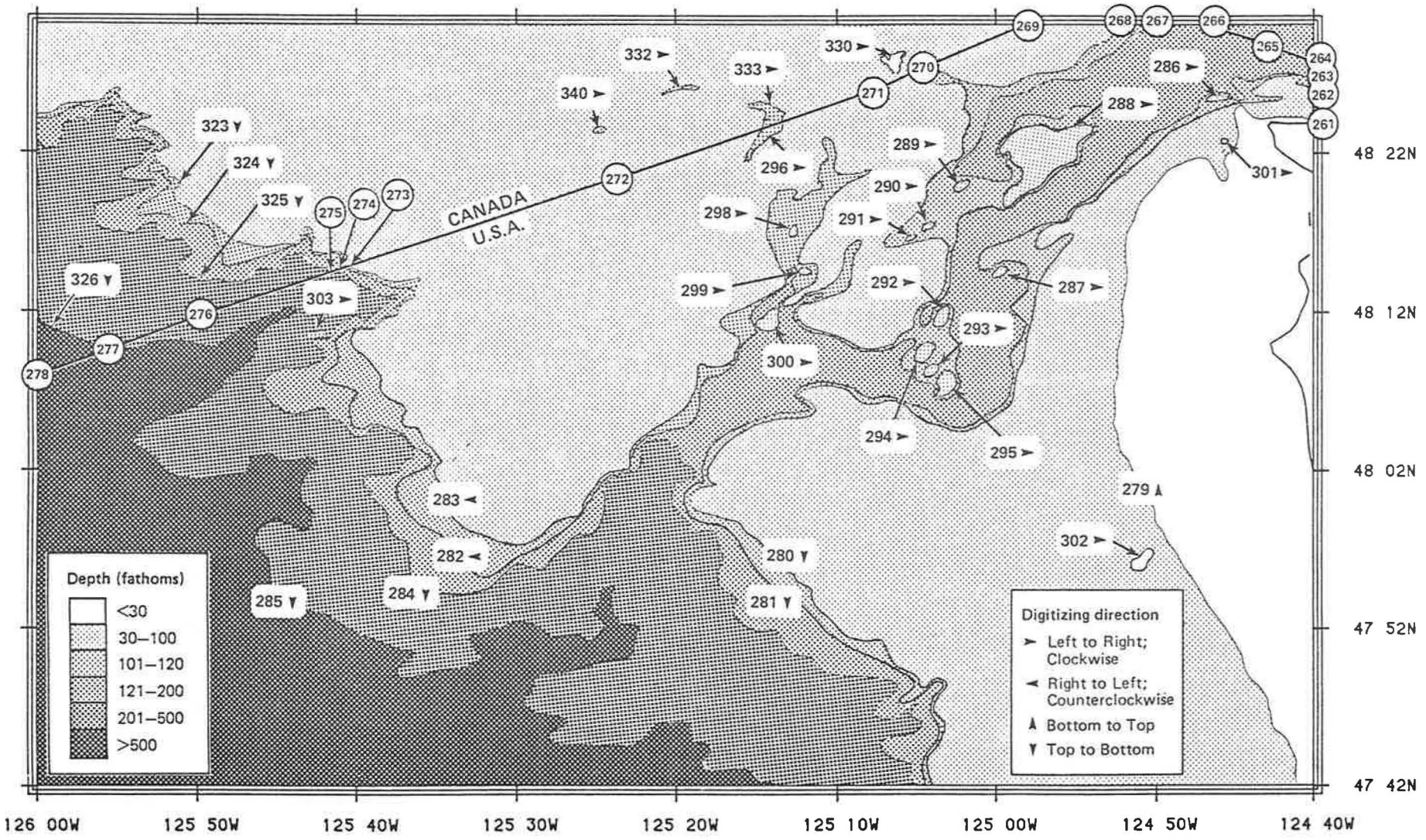


Figure 5.--Line segment values and depth strata for the Vancouver/U.S. International North Pacific Fisheries Commission statistical area as assigned within the west coast strata lines files.



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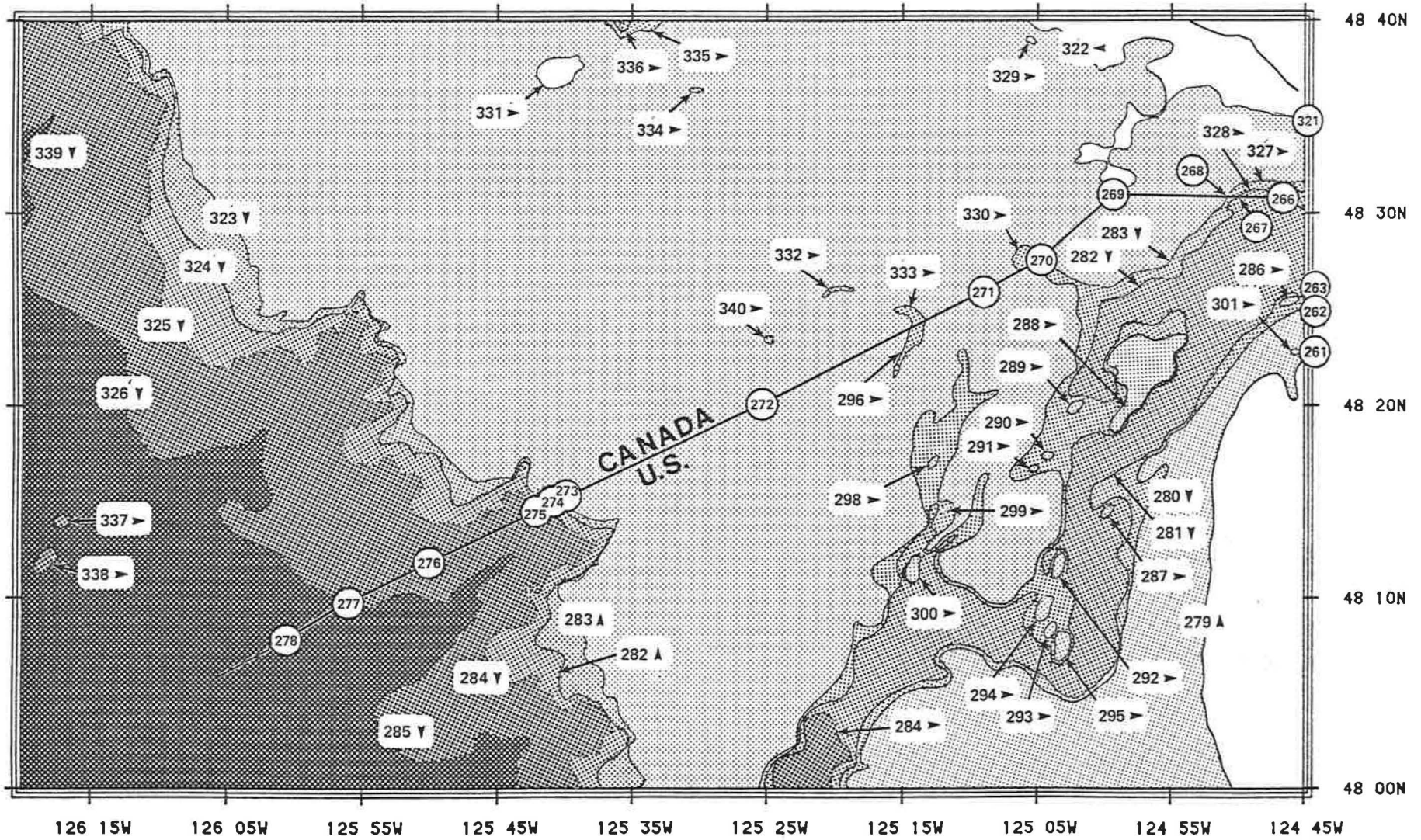
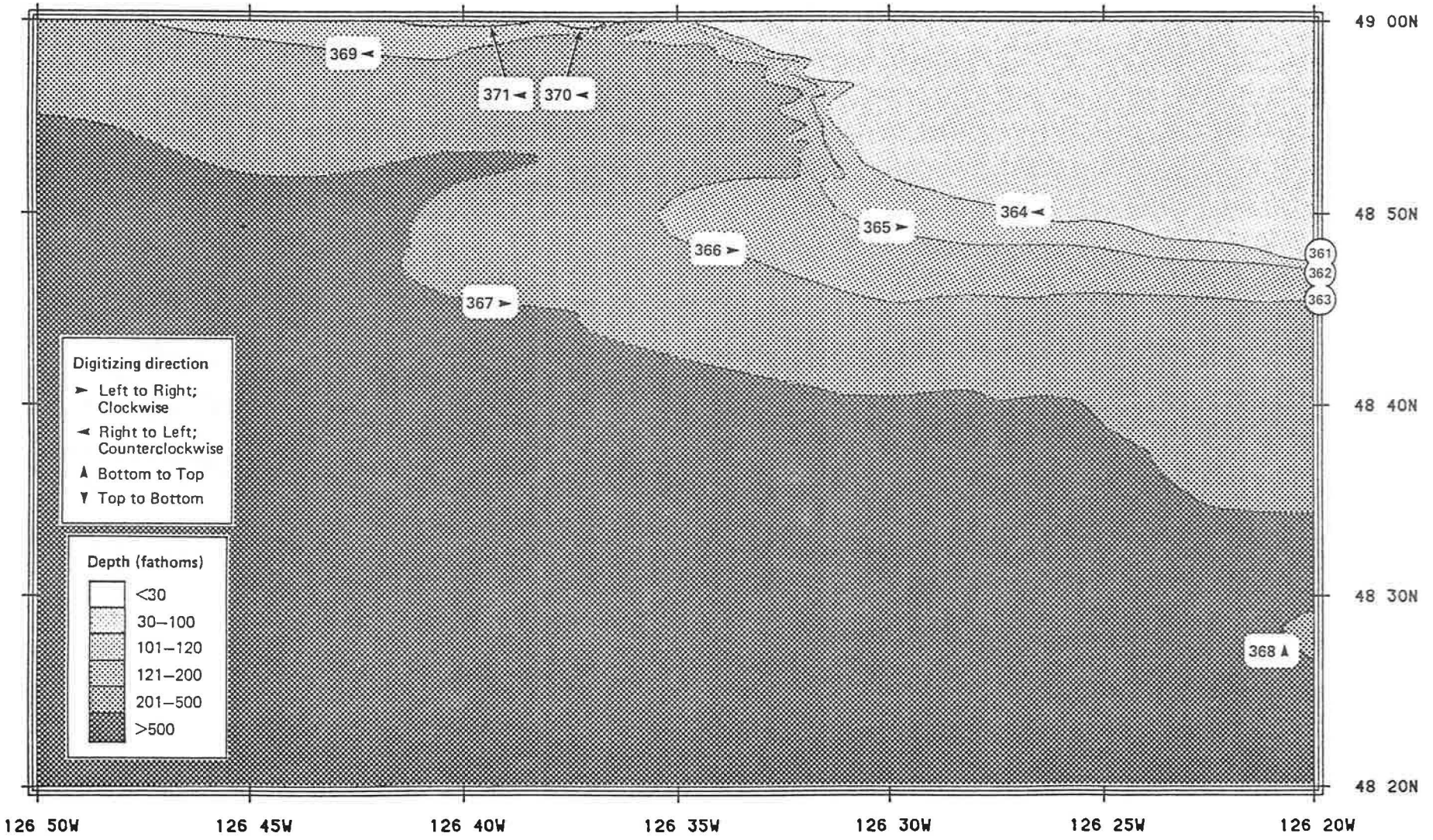


Figure 6.--Line segment values and depth strata for the Vancouver/Canada International North Pacific Fisheries Commission statistical area as assigned within the west coast strata lines files.



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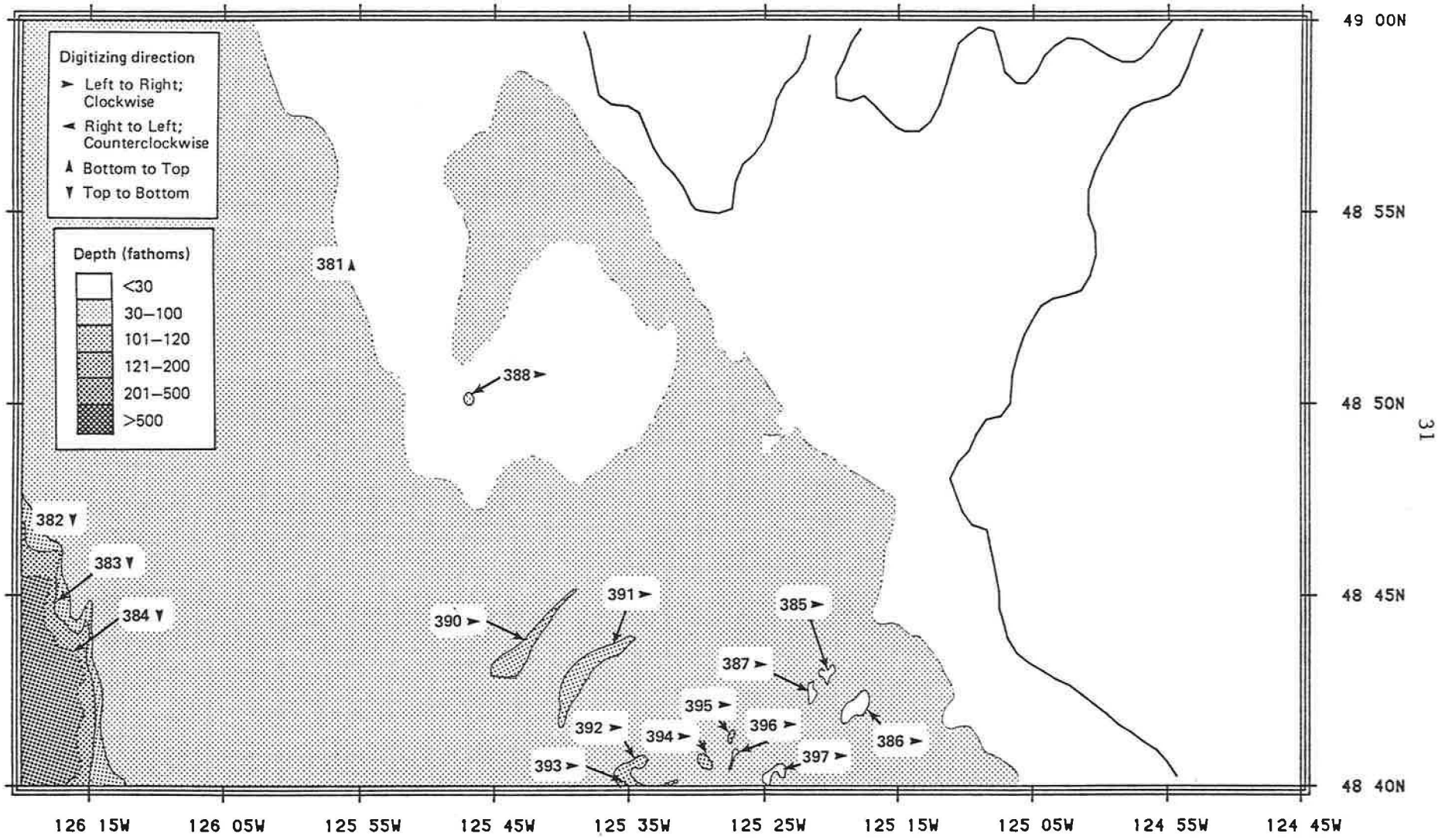

Figure 6.--Continued

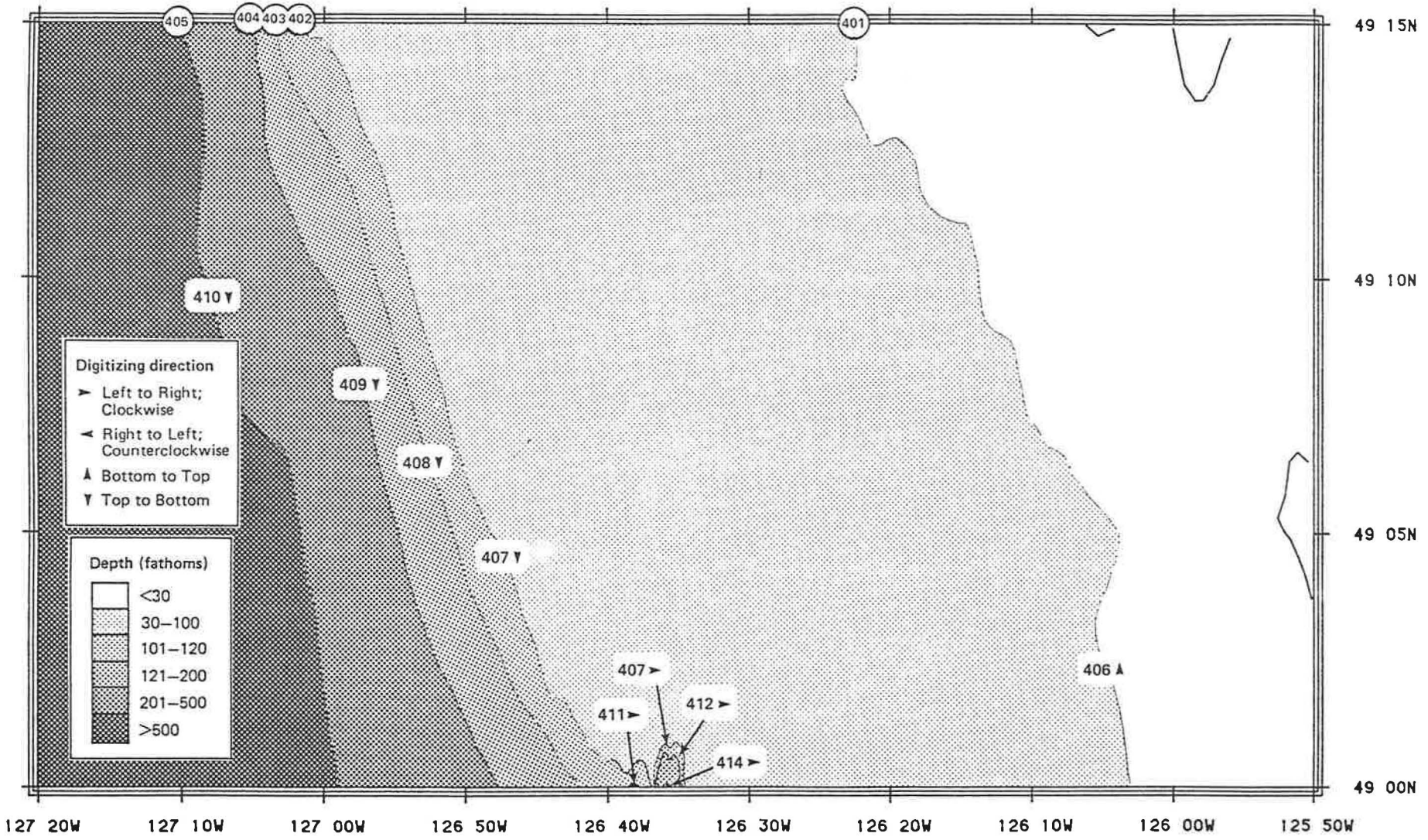

Figure 6.--Continued

STRATA/AREA is executed. For further discussion on this topic, see STAGE 2 of the appendix. Arithmetic adjustments to the major strata are completed by referring to Figures 2-6 and Table 1 as mentioned previously.

Graphic Representation of West Coast Survey Strata

The program package will provide charts (plots) of all strata within the survey region with or without pinnacles, seamounts, or depressions. It is also possible to plot selected depth strata and any specified portion of the entire survey region.

To produce plots of the entire west coast stratification scheme, proceed as follows:

1) Retrieve the binary lines file on usercode RACE0060 called "(RACE0060) Lines/Westcoast/Postgenerate/Shelf/4Plot" from library maintenance tape # 5118, where tape label = "Linestape", and put it onto your usercode [e.g., RACE(PACK)].
2) Execute program (RACE0010)MAP to draw the plot. Program MAP documentation will assist you in creating an appropriate parameter file. Be sure to specify latitudes and longitudes which will cover the survey region. The "Lines" parameter should also be included to direct the program to input the binary strata lines file "Lines/ Westcoast/Postgenerate/Shelf/4Plot" (Mintel, and Oda 1983).

To produce plots depicting a portion of the survey region, only some of the depth strata, or only some of the bottom irregularities, proceed as follows:

1) Retrieve the binary lines file on usercode RACE0060 called "(RACE0060) Lines/Westcoast/Postgenerate/Shelf/4Plot" from library maintenance tape # 5118, where tape label = "Linestape", and place it onto your usercode [e.g., RACE(PACK)].

2) Execute program (RACE0010)SELECT to select those pinnacles, seamounts, or depressions you want to be drawn. Selections are based upon line segment numbers (binary word 4 of each binary lines file record).

3) Input "selected" binary lines file with program (RACE0010)MAP to draw plots.

In the case where the desired output is a plot showing all strata and all digitized pinnacles, seamounts, and depressions but only for a part of the survey region, execute program MAP with the strata lines file as input and specify the latitude and longitude parameters for the region of interest. If only a few isobaths are desired on the plot, in addition to all the pinnacles, seamounts and depressions within the region of interest, refer to Figures 2-6 and select those line segment numbers of interest. This information in the form of a binary lines file is inputted to program MAP and the "Lines" parameter specified. If a plot is desired with only the depth contours drawn, an input lines file is not needed. Execute program MAP and specify those depth contours of interest with the "Depth" parameter within your parameter file.

CREATING YOUR OWN STRATA LINES FILES

You may find that the west coast strata lines file currently available does not satisfy your specific needs. Your particular stratification scheme may include different isobaths or may relate to a different survey region (e.g., the Bering Sea or the Gulf of Alaska). If this is the case, you will have to create lines files to suit your needs; this section will briefly describe the necessary steps. For a more detailed description of this process refer to the Appendix.

If you wish to include additional line segments off the west coast (i.e., 300 and 400 fm isobaths), you may supplement the existing west coast strata lines files in the following manner:

1) Obtain nautical charts which correspond to the latitudinal and longitudinal range within which the desired strata are located and clearly define (i.e., highlight) the new line segments including pinnacles, seamounts, or depressions.
2) Make a drawing of the new isobaths on a separate piece of paper (one sketch per digitizing session). On each sketch, number each line segment consecutively beginning with number one, note the geographic boundaries of each and indicate the direction in which each line segment is to be digitized (Figure A-1).
3) Execute program (RACE0010)DIGITIZER to electronically trace the new depths from the nautical chart(s). Use your sketch(es) to aid you in digitizing the line segments in the right sequential order and in the proper direction (clockwise/counter clockwise, top-to-bottom, or bottom-to-top).
4) Execute program (RACE0010)INVERSE/MAP to convert digitized points into corresponding latitudes and longitudes. The "High" and "Wide" parameters required by this program are obtained from the output of program DIGITIZER.
5) Execute program (RACE0010)MAKE/BINE/LINES to convert your lines file into a standard format binary coded file ("binary lines" format).
6) Execute program (RACE0010)NEW/MATH to add a numerical constant to each new line segment number (binary word 4). Extreme caution must be exercised here to prevent duplication of line segment values already specified in the existing west coast strata lines file. Line segment values 1-414 have been incorporated by the west coast strata lines files already, and are represented in Figures 2-6 and Table 1.

7) Retrieve the binary file on RACE0060 usercode called "(RACE0060)Lines/Westcoast/Pregenerate/Shelf" from library maintenance tape # 5118, where tape label = "Linestape", and put onto your usercode.

8) Refer to Figures 2-6 for line segment numbers which correspond to those regions of the west coast you wish to include in your stratification scheme.

9) Execute program (RACE0010)SELECT to acquire those line segment values desired from the west coast strata lines files.

10) Insert new lines (output from program NEW/MATH) at the end of the file containing your selected line segments from the existing west coast stratification scheme (output from program SELECT).

11) Execute program (RACE0010)GENERATE/BOUNDARY to connect isobaths between adjoining chart sections that were digitized separately thus creating bathymetric boundaries.

12) Execute program (RACE0010)MAP to produce plots of your stratification scheme.

13) Execute program (RACE0010)STRATA/WINDOW (if applicable) to establish the latitudinal boundaries of the strata for which you desire area calculations.

14) Execute program (RACE0010)STRATA/AREA to compute surface areas for your strata.

15) Make adjustments to stratum area values to account for pinnacles, seamounts, or depressions.

If you intend to produce plots or calculate surface areas of your new strata, it is highly recommended that you sketch the region of interest and number each line segment consecutively prior to executing program DIGITIZER.

You may have to digitize your survey region in more than one session due to the dimensions of the digitizer "tablet" (see Appendix A). When digitizing, it is important to trace each line segment in the order described on your sketches. The direction in which each line segment is to be digitized must also be noted. This step is imperative to the successful execution of program GENERATE/BOUNDARY.

Programs GENERATE/BOUNDARY, STRATA/WINDOW, and STRATA/AREA all require that unique line segment numbers be assigned to each line segment. This is accomplished by adding a constant to binary word 4 of your lines file through program NEW/MATH. When you are adding new line segments to the existing west coast strata lines files, you must not duplicate values assigned in Figures 2-6. Following the assignment of a unique value to each line segment, merge your chart "sections" together using the Burroughs CANDE "INSERT" command, then merge your supplementary lines file with the "(RACE0060)/Lines/Westcoast/Pregenerate/Shelf" strata lines file. These files consume a very large amount of disk space so in consideration of other computer users, they should remain on disk no longer than necessary. Transfer your binary lines files to a library maintenance tape and delete them from your disk when they are not being used.

Once all contours have been merged together into one file, execute program GENERATE/BOUNDARY. Refer to program documentation to construct the necessary parameter file. Separate parameter files and separate executions of the program GENERATE/BOUNDARY are necessary to plot strata and to calculate surface areas. Figures 2-6 and your sketches will aid in creating these parameters. Again, pay strict attention to the direction in which line segments were digitized. Program GENERATE/BOUNDARY labels each stratum, depth contour, or sea bottom irregularity with a "Boundary" number. Do not confuse these "Boundary" numbers

with line segment numbers (several "line segments" may constitute a "Boundary"). A "closed" boundary parameter is required for surface area calculations. An "open" boundary, usually for depth contours (isobaths), is necessary for plotting routines. Pinnacles, seamounts, and depressions used in area computations and plots must always have "closed" boundaries. Complete the remainder of the steps as described previously. A more detailed explanation is provided in Appendix A.

GLOSSARY OF TERMS

Arithmetic adjustments to area: action taken to correct stratum area (square nautical miles: nm^2) calculations due to pinnacles, seamounts, or depressions.

Boundary: a parameter command that specifies which line segments and/or points are to be included within the stratum area calculation or plot. It is referred to primarily in reference to the GENERATE/BOUNDARY and STRATA/WINDOW programs.

Boundary intersection point: those line segment values which are on a common border between line sections and are shared by those line sections involved. It is from these points that three or more lines radiate.

Boundary segment: a series of points and line segments digitized with a single execution of the DIGITIZER program.

Boundary transformation: the insertion of line segment values from individual line sections, International North Pacific Fisheries Commission (INPFC) areas, etc., into one lines file in preparation of boundary generation via GENERATE/BOUNDARY or STRATA/WINDOW.

Depth strata: that region within the confines of specified depth contours which is of interest to the user and is based upon the stratification scheme designed by the user.

Digitizer: the instrument employed in tracing (digitizing) line segments and points from bathymetric charts and storing this information on disk for further use.

Last assigned value (LAV): a numerical value which corresponds to the final line segment value assigned to each chart subdivision by the addition of a constant via the NEW/MATH program.

Line section: a subdivision of a strata scheme.

Line segment: one or more points of a boundary segment which were digitized during one execution of program DIGITIZER.

Line segment value: a numerical value which is sequentially assigned to each line segment and/or point. It is to this value that a numeric constant is added to prevent line segment duplication.

Tablet: the surface upon which charts (chart subdivisions) are affixed for digitizing.

ACKNOWLEDGMENTS

We wish to thank the RACE programming staff, in particular Mike McPhail and Ralph Mintel, for their assistance. Also, the Northwest and Alaska Fisheries Center's (NWAFC) graphic support team for their contribution in figure construction, and the RACE typing pool.

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Weinberg, K. L., M. E. Wilkins, and T. A. Dark. 1984. The 1983 Pacific west coast bottom trawl survey of groundfish resources: estimates of distribution, abundance, age and length composition. U.S. Dep. Commer., NOAA Tech. Memo. NMFS, F/NWC-70, 376 p.

Raymore, P. A., and K. L. Weinberg. 1985. Bottom trawl survey of groundfish resources on the west coast's upper continental slope, 1984. U.S. Dep. Commer., NOAA Tech. Memo, NMFS, F/NWC. In press.

APPENDIX A

Equipment and procedures involved in creating the west coast strata lines package.

Appendix A describes how the west coast strata lines package was put together. Provided herein is an overall description of equipment and detailed procedural steps, in addition to an explanation of the RACE computer programs employed in developing the west coast strata lines package.

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Figure A-3. CANDE schedule file for the Monterey statistical area of the International North Pacific Fisheries Commission utilized in creating the west coast strata lines files 58

Figure A-4. Parameter file utilized in contour reproduction for the west coast strata lines package 60

Figure A-5. Parameter file utilized in strata area calculation for the west coast strata scheme 63

Description of Equipment

The equipment used in developing the west coast strata lines files consisted of the Summagraphics Digitizer and the Textronix 4051 graphics computer terminal used in conjunction with the Burroughs' Corp. B7800 mainframe computer. Instructions on how to use this apparatus to digitize can be found by referring to the RACE program documentation for program DIGITIZER. The Tektronix 4051 graphics terminal was also employed for previewing plots before routing them to the Calcomp plotter.

The nautical charts utilized for digitizing depth contours are listed in Table A-1. Digitized depth contours included the 30, 100, 120, 200, and 500 fm isobaths. All of these isobaths were printed on the U.S. charts (printed by NOAA-National Ocean Survey, 1976-1980) with the exception of the 120 fm isobath, which was interpolated and hand-drawn onto the charts before the digitizing process. On the Canadian charts (printed by the Canadian Hydrographic Service, 1981) depth contours were printed in meters, therefore, it was necessary to convert fathoms to meters, interpolate the position of the isobaths, and superimpose them onto the charts. The "Master" chart series for the west coast (36°48'N-49°15'N lat.) are stored by the west coast subtask. The software used in completing this project consisted of several programs maintained in the RACE program library [RACE0010 usercode, RACE(PACK)].

Procedures

Figure 1 demonstrates the sequence of steps and programs required to develop and utilize the west coast strata lines program package. There were three operational stages:

Table A-1. Nautical charts utilized in "digitizing " the west coast isobaths.

Chart No.	Printing date	Latitude range
18680 (U.S.)	1978	36°48'N-38°02'N
18640 (U.S.)	1979	37°50'N-38°59'N
18620 (U.S.)	1978	38°59'N-41°03'N
18600 (U.S.)	1976	41°03'N-42°51'N
18580 (U.S.)	1978	42°51'N-44°41'N
18520 (U.S.)	1978	44°41'N-46°20'N
18500 (U.S.)	1980	46°20'N-47°42'N
18480 (U.S.)	1978	47°42'N-U.S./Can. Border
LC3602 (Can.)	1981	U.S./Can. Border-49°00'N
LC3603 (Can.)	1981	49°00'N-49°15'N

1) digitization of the line segments and points;

2) execution of programs via CANDE and WFL;

3) calculation of surface areas and/or generating maps.

STAGE 1

Contours were digitized by individual International North Pacific Fisheries Commission (INPFC) statistical area and processed through Stages 2 and 3 (Fig. 1) separately. It should be noted that the maximum size of the digitizing table (referred to as the "tablet") is approximately 34 in. wide x 25 in. high. Therefore, if you are working with charts that are larger than these dimensions, they should be subdivided into workable portions (i.e., chart 18640 was subdivided into three sections which fit onto the tablet). Twenty-four such sections were digitized for the entire west coast survey area (36°48'N to 49°15'N latitude).

Once the chart sections were established, corresponding rough sketches were drawn. On each sketch, all boundary intersection points and line segments were numbered sequentially beginning with number 1. The line segments were digitized following this numerical sequence. The direction in which each line segment was digitized (clockwise/counterclockwise, top to bottom, or bottom to top) was also indicated with arrows.

Reference latitude and longitude lines were placed at the top, bottom, left and right margins of each sketch. Examples of such sketches for the INPFC Monterey statistical area are shown in Figs. A-1a thru A-1g. Boundary intersection points were those at the southern-most and northern-most boundaries of each INPFC stastistical area. These points corresponded to intersection points 1-5 in Figs. A-1a and A-1g for the Monterey area. All line segments were digitized between these northern and southern limits within each INPFC statistical area, not inclusive of the boundary intersection points (thus avoiding retracing). Line segments were later joined together at boundary

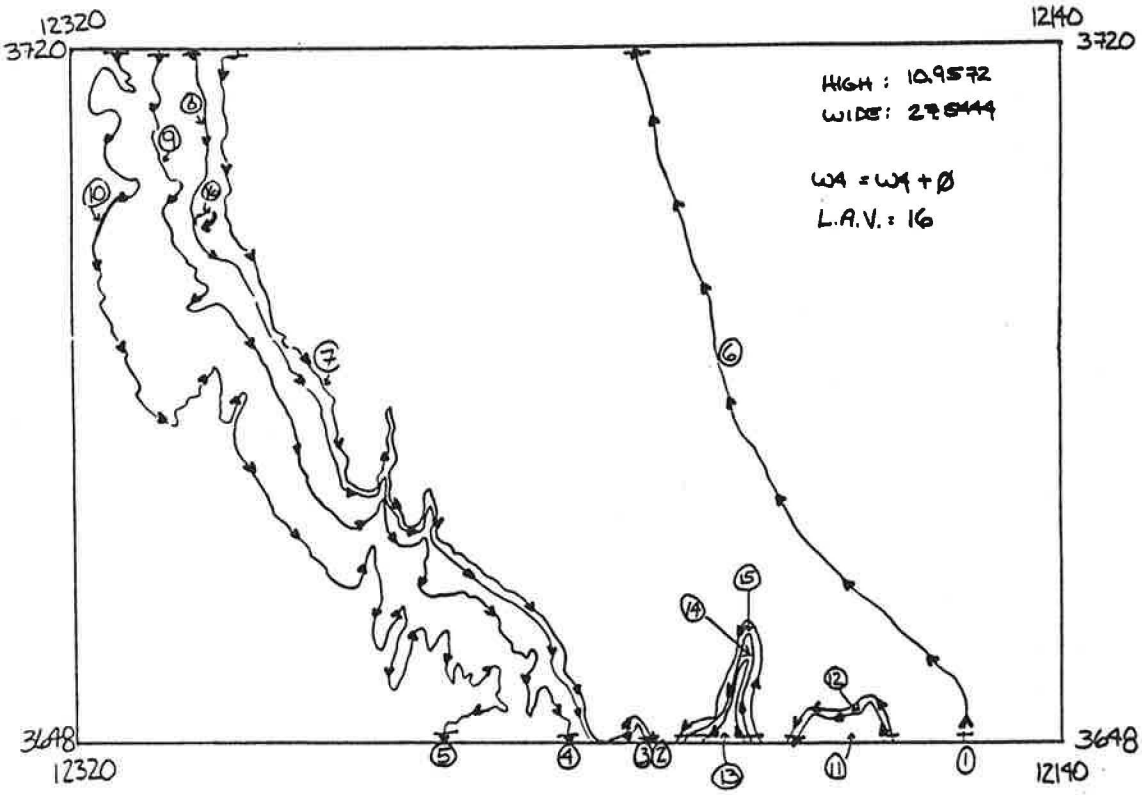

Figure A-1a.--Sketch indicating the preliminary assignment of segment values prior to execution of program DIGITIZER from 36°48' N to 37°20' N latitude.

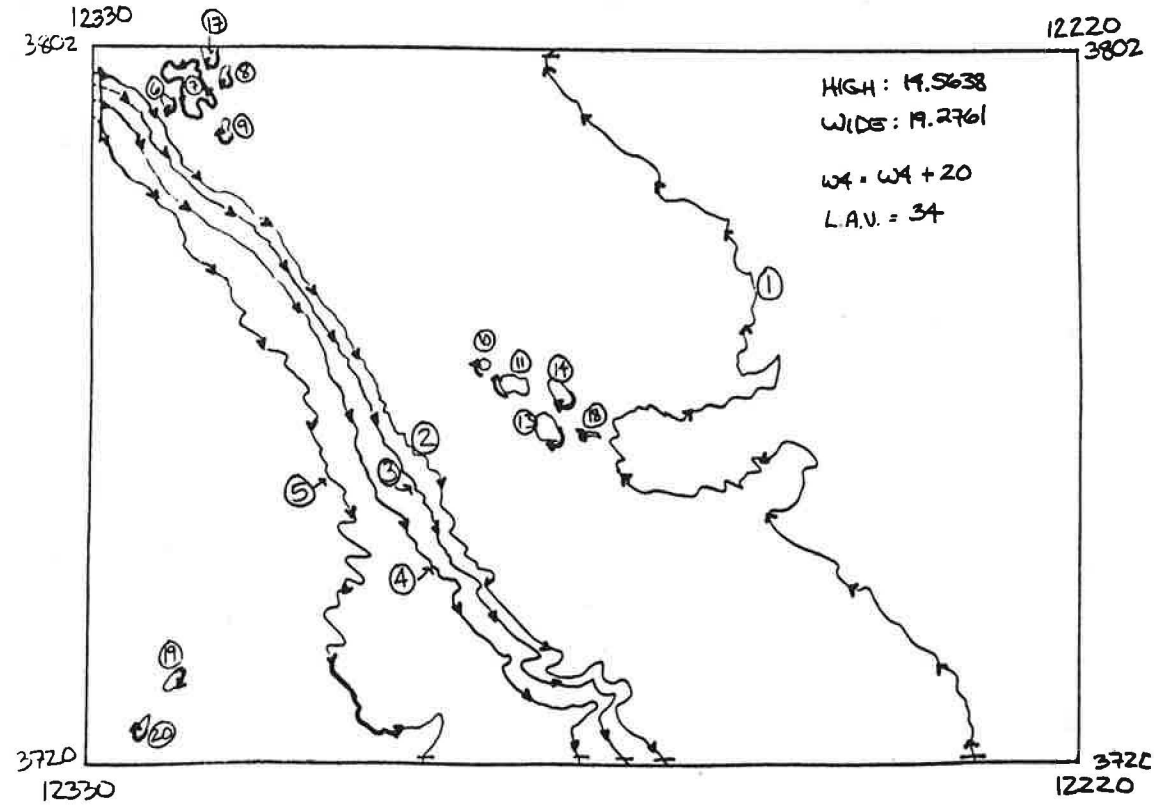

Figure A-1b.--Sketch indicating the preliminary assignment of segment values prior to execution of program DIGITIZER from 37°20' N to 38°02' N latitude.

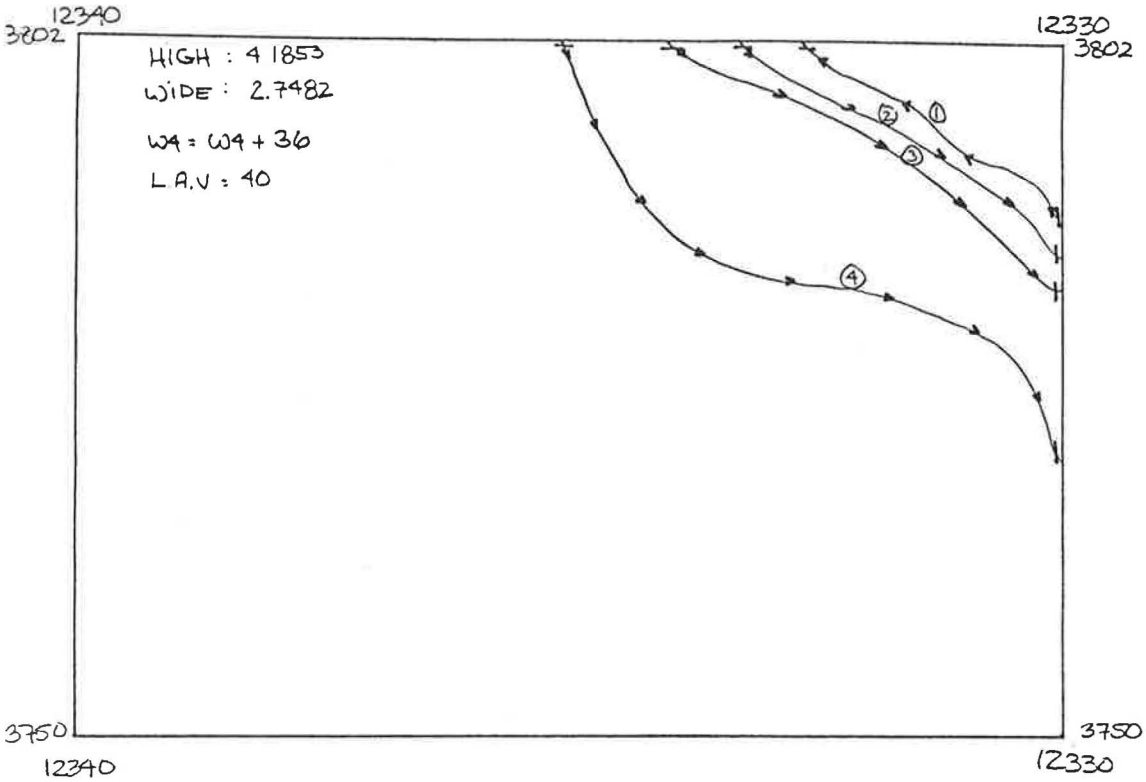

Figure A-1c.--Sketch indicating the preliminary assignment of segment values prior to execution of program DIGITIZER from 37°50' N to 38°02' N latitude.

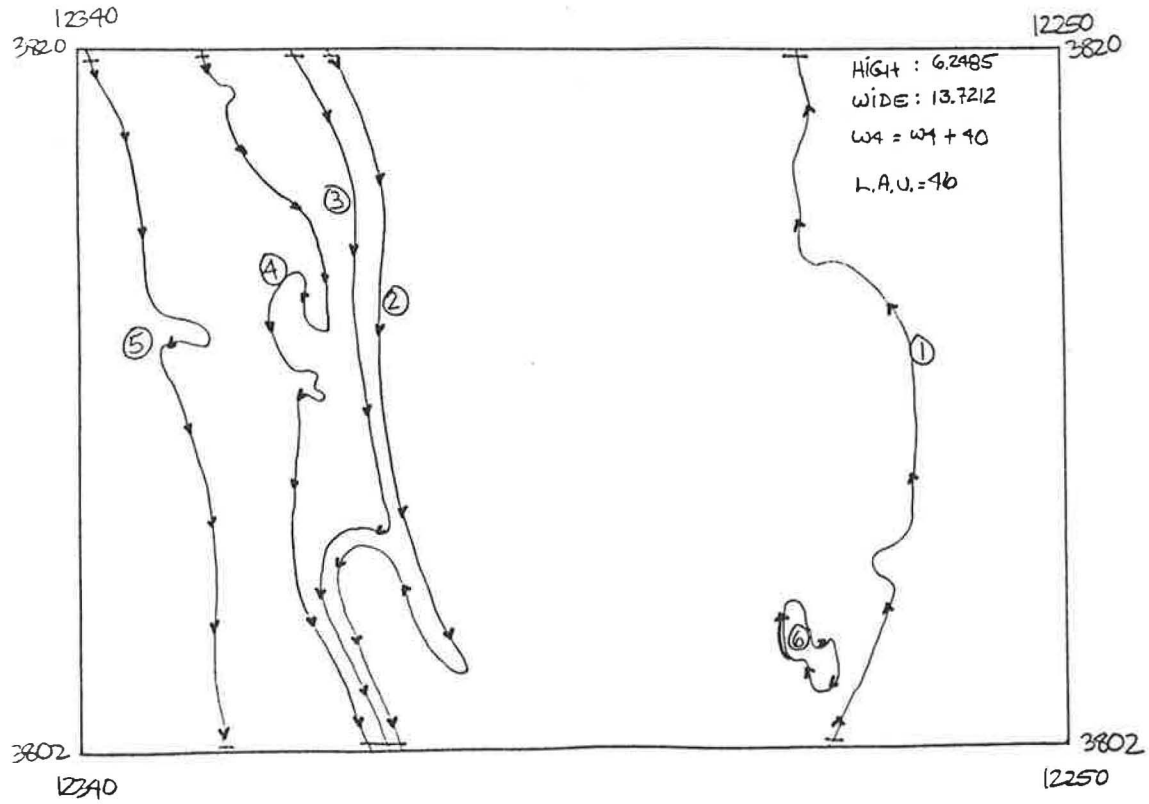

Figure A-1d.--Sketch indicating the preliminary assignment of segment values prior to execution of program DIGITIZER from 38°02' N to 38°20' N latitude.

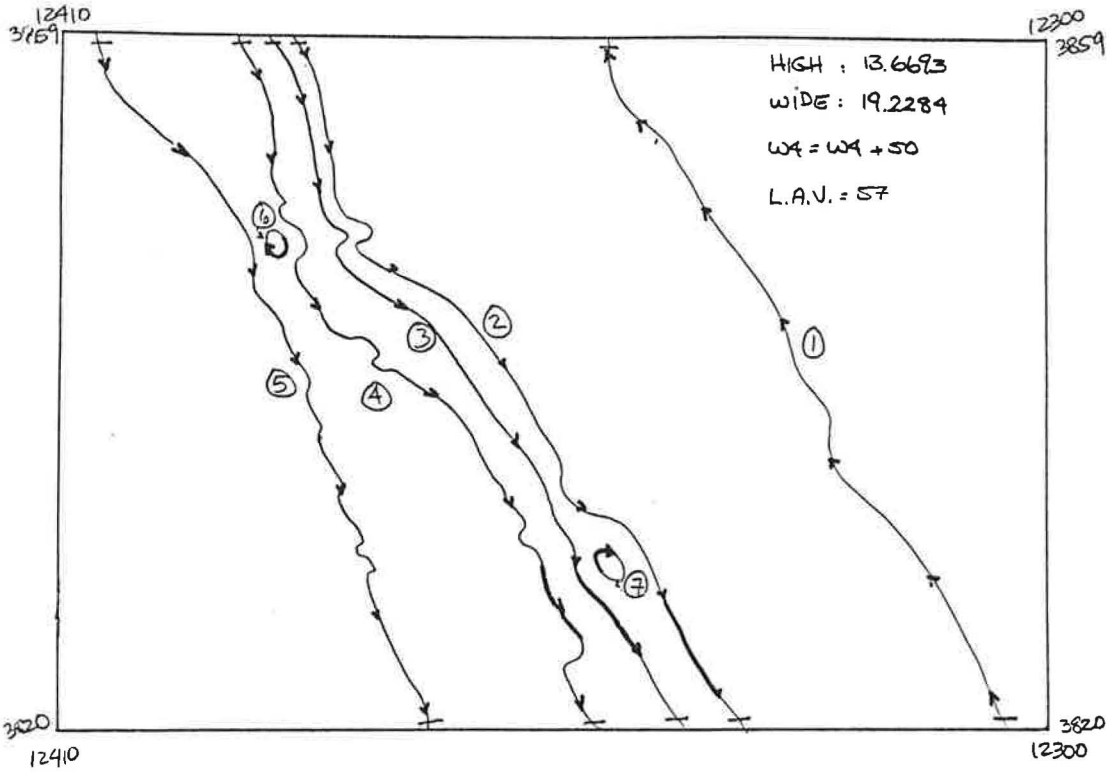

Figure A-1e.--Sketch indicating the preliminary assignment of segment values prior to execution of program DIGITIZER from 38°20' N to 38°59' N latitude.

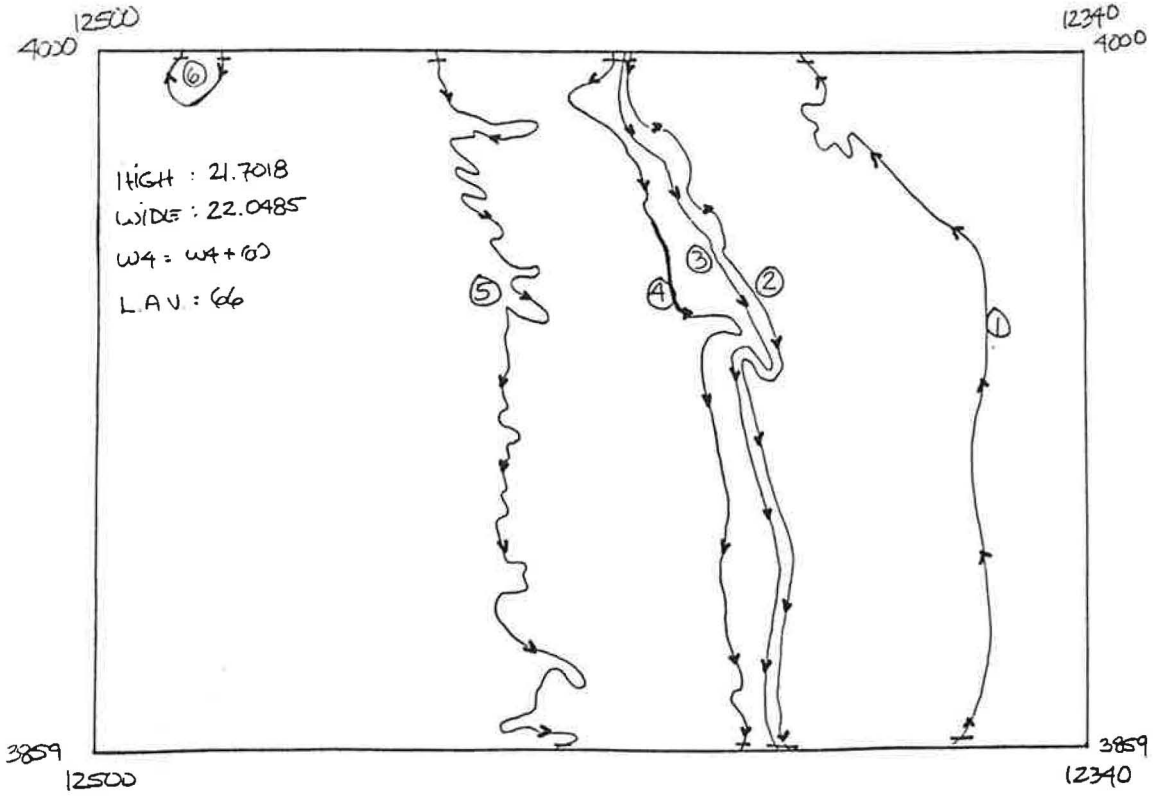

Figure A-1f.--Sketch indicating the preliminary assignment of segment values prior to execution of program DIGITIZER from 38°59' N to 40°00' N latitude.

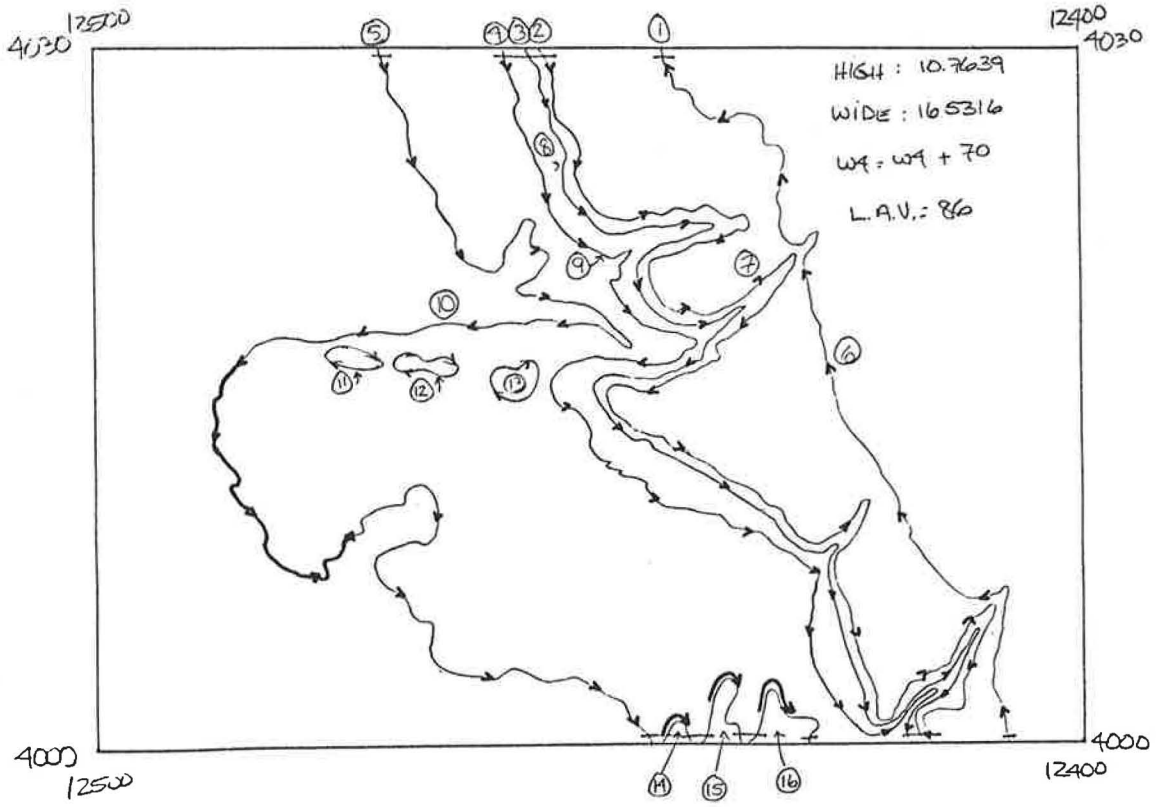

Figure A-1g.--Sketch indicating the preliminary assignment of segment values prior to execution of program DIGITIZER from 40°00' N to 40°30' N latitude.

intersection points through execution of program GENERATE/BOUNDARY.

STAGE 2

Stage 2 of the operation consisted of three steps which are shown in Fig. 1. Work flow language (WFL) jobs were employed to expedite the use of RACE programs necessary for producing surface area calculations and plots. Command and Edit (CANDE) schedule files were utilized to merge binary lines files.

The output file from program DIGITIZER is used as the input file to program INVERSE/MAP to prepare for surface area calculations and plot production. This program takes the digitized values, recorded as x-y coordinates, and converts them to latitudes and longitudes based on the chart projection (Mercator or Polyconic). INVERSE/MAP requires a parameter file which specifies the geographic boundaries of the section digitized. The computer calculated "High" and "Wide" values from the output of program DIGITIZER must be used in this parameter file. An example of the output from program DIGITIZER for the first chart section in the Monterey INPFC statistical area is found in Fig. A-2.

The output file from program INVERSE/MAP is then input into program MAKE/BINE/LINES, which transforms an EBCDIC coded (character) file into a binary coded file. Once this is completed, the output from program MAKE/BINE/LINES can be routed directly into program MAP for plotting. However, in order for line segments from adjacent chart sections to be joined, adjustments to the numerical values assigned to each boundary intersection point and line segment (binary word 4 of a binary lines file) must be made. This step is accomplished via program NEW/MATH. Proper addition of constants will assure no duplication of line segment values between sections. The constant added to each chart section depends upon the last assigned value (LAV) of the previous chart

overlay parameter file
PARAM/A

```
PROGRAM DIGITIZER
OUTPUT DIGITIZED (X,Y) POINTS FILE 1...
      CHAR1/1E660/3648103720.

DIGITIZE THE BOTTOM, RIGHT CORNER
XR=699.6   YR=6.3
DIGITIZE THE TOP, LEFT CORNER
XT=-2.6   YT=278.3
CALCULATED WIDE, HIGH    WIDE=27.5444238439   HIGH=10.9571710591
ANGLE OF CHART VS. DIGITIZER=    0.00900490239 24
DO YOU WANT TO DIGITIZE A LINE?  Y OR N=
Y
DIGITIZE YOUR LINE.  WHEN DONE, RELEASE BUTTON,
MOVE CURSOR AT LEAST 1/2 AN INCH BELOW & LEFT
OF YOUR ORIGIN (-1/2, -1/2) AND PRESS THE
CURSOR BUTTON ONCE
END OF SEGMENT      1
       1=POINTS READ
       0=DUPLICATE POINTS REMOVED
       1=POINTS WRITTEN - THIS SEGMENT
       1=TOTAL POINTS WRITTEN
DO YOU WANT TO DIGITIZE A LINE?  Y OR N=
Y
DIGITIZE YOUR LINE.  WHEN DONE, RELEASE BUTTON,
MOVE CURSOR AT LEAST 1/2 AN INCH BELOW & LEFT
OF YOUR ORIGIN (-1/2, -1/2) AND PRESS THE
CURSOR BUTTON ONCE
END OF SEGMENT      2
       1=POINTS READ
       0=DUPLICATE POINTS REMOVED
       1=POINTS WRITTEN - THIS SEGMENT
       2=TOTAL POINTS WRITTEN
DO YOU WANT TO DIGITIZE A LINE?  Y OR N=
Y
DIGITIZE YOUR LINE.  WHEN DONE, RELEASE BUTTON,
MOVE CURSOR AT LEAST 1/2 AN INCH BELOW & LEFT
OF YOUR ORIGIN (-1/2, -1/2) AND PRESS THE
CURSOR BUTTON ONCE
END OF SEGMENT      3
       1=POINTS READ
       0=DUPLICATE POINTS REMOVED
       1=POINTS WRITTEN - THIS SEGMENT
       3=TOTAL POINTS WRITTEN
DO YOU WANT TO DIGITIZE A LINE?  Y OR N=
Y
DIGITIZE YOUR LINE.  WHEN DONE, RELEASE BUTTON,
MOVE CURSOR AT LEAST 1/2 AN INCH BELOW & LEFT
OF YOUR ORIGIN (-1/2, -1/2) AND PRESS THE
CURSOR BUTTON ONCE
END OF SEGMENT      4
       1=POINTS READ
       0=DUPLICATE POINTS REMOVED
       1=POINTS WRITTEN - THIS SEGMENT
       4=TOTAL POINTS WRITTEN
DO YOU WANT TO DIGITIZE A LINE?  Y OR N=
Y
DIGITIZE YOUR LINE.  WHEN DONE, RELEASE BUTTON,
MOVE CURSOR AT LEAST 1/2 AN INCH BELOW & LEFT
OF YOUR ORIGIN (-1/2, -1/2) AND PRESS THE
```

new math adds constant 0
∴ segment values are 1-16

Figure A-2.--Output from program DIGITIZER displaying the computer calculated HIGH and WIDE values for the first digitizing session.

```
CURSOR BUTTON ONCE
END OF SEGMENT      5
       1=POINTS READ
       0=DUPLICATE POINTS REMOVED
       1=POINTS WRITTEN - THIS SEGMENT
       5=TOTAL POINTS WRITTEN
DO YOU WANT TO DIGITIZE A LINE?  Y OR N=
Y
DIGITIZE YOUR LINE.  WHEN DONE, RELEASE BUTTON,
MOVE CURSOR AT LEAST 1/2 AN INCH BELOW & LEFT
OF YOUR ORIGIN (-1/2, -1/2) AND PRESS THE
CURSOR BUTTON ONCE
END OF SEGMENT      6
     188=POINTS READ
       2=DUPLICATE POINTS REMOVED
     186=POINTS WRITTEN - THIS SEGMENT
     191=TOTAL POINTS WRITTEN
DO YOU WANT TO DIGITIZE A LINE?  Y OR N=
Y
DIGITIZE YOUR LINE.  WHEN DONE, RELEASE BUTTON,
MOVE CURSOR AT LEAST 1/2 AN INCH BELOW & LEFT
OF YOUR ORIGIN (-1/2, -1/2) AND PRESS THE
CURSOR BUTTON ONCE
END OF SEGMENT      7
     433=POINTS READ
      21=DUPLICATE POINTS REMOVED
     412=POINTS WRITTEN - THIS SEGMENT
     603=TOTAL POINTS WRITTEN
DO YOU WANT TO DIGITIZE A LINE?  Y OR N=
Y
DIGITIZE YOUR LINE.  WHEN DONE, RELEASE BUTTON,
MOVE CURSOR AT LEAST 1/2 AN INCH BELOW & LEFT
OF YOUR ORIGIN (-1/2, -1/2) AND PRESS THE
CURSOR BUTTON ONCE
END OF SEGMENT      8
     435=POINTS READ
      34=DUPLICATE POINTS REMOVED
     401=POINTS WRITTEN - THIS SEGMENT
   1,004=TOTAL POINTS WRITTEN
DO YOU WANT TO DIGITIZE A LINE?  Y OR N=
Y
DIGITIZE YOUR LINE.  WHEN DONE, RELEASE BUTTON,
MOVE CURSOR AT LEAST 1/2 AN INCH BELOW & LEFT
OF YOUR ORIGIN (-1/2, -1/2) AND PRESS THE
CURSOR BUTTON ONCE
END OF SEGMENT      9
     407=POINTS READ
      11=DUPLICATE POINTS REMOVED
     396=POINTS WRITTEN - THIS SEGMENT
   1,400=TOTAL POINTS WRITTEN
DO YOU WANT TO DIGITIZE A LINE?  Y OR N=
Y
DIGITIZE YOUR LINE.  WHEN DONE, RELEASE BUTTON,
MOVE CURSOR AT LEAST 1/2 AN INCH BELOW & LEFT
OF YOUR ORIGIN (-1/2, -1/2) AND PRESS THE
CURSOR BUTTON ONCE
END OF SEGMENT     10
     538=POINTS READ
      21=DUPLICATE POINTS REMOVED
     517=POINTS WRITTEN - THIS SEGMENT
```

Figure A-2.--Continued

```
   1,917=TOTAL POINTS WRITTEN
DO YOU WANT TO DIGITIZE A LINE?  Y OR N=
Y
DIGITIZE YOUR LINE.  WHEN DONE, RELEASE BUTTON,
MOVE CURSOR AT LEAST 1/2 AN INCH BELOW & LEFT
OF YOUR ORIGIN (-1/2, -1/2) AND PRESS THE
CURSOR BUTTON ONCE.
END OF SEGMENT    11
      54=POINTS READ
       2=DUPLICATE POINTS REMOVED
      52=POINTS WRITTEN - THIS SEGMENT
   1,969=TOTAL POINTS WRITTEN
DO YOU WANT TO DIGITIZE A LINE?  Y OR N=
Y
DIGITIZE YOUR LINE.  WHEN DONE, RELEASE BUTTON,
MOVE CURSOR AT LEAST 1/2 AN INCH BELOW & LEFT
OF YOUR ORIGIN (-1/2, -1/2) AND PRESS THE
CURSOR BUTTON ONCE.
END OF SEGMENT    12
      73=POINTS READ
       5=DUPLICATE POINTS REMOVED
      68=POINTS WRITTEN - THIS SEGMENT
   2,037=TOTAL POINTS WRITTEN
DO YOU WANT TO DIGITIZE A LINE?  Y OR N=
Y
DIGITIZE YOUR LINE.  WHEN DONE, RELEASE BUTTON,
MOVE CURSOR AT LEAST 1/2 AN INCH BELOW & LEFT
OF YOUR ORIGIN (-1/2, -1/2) AND PRESS THE
CURSOR BUTTON ONCE.
END OF SEGMENT    13
      52=POINTS READ
       0=DUPLICATE POINTS REMOVED
      52=POINTS WRITTEN - THIS SEGMENT
   2,089=TOTAL POINTS WRITTEN
DO YOU WANT TO DIGITIZE A LINE?  Y OR N=
Y
DIGITIZE YOUR LINE.  WHEN DONE, RELEASE BUTTON,
MOVE CURSOR AT LEAST 1/2 AN INCH BELOW & LEFT
OF YOUR ORIGIN (-1/2, -1/2) AND PRESS THE
CURSOR BUTTON ONCE.
END OF SEGMENT    14
      96=POINTS READ
       8=DUPLICATE POINTS REMOVED
      88=POINTS WRITTEN - THIS SEGMENT
   2,177=TOTAL POINTS WRITTEN
DO YOU WANT TO DIGITIZE A LINE?  Y OR N=
Y
DIGITIZE YOUR LINE.  WHEN DONE, RELEASE BUTTON,
MOVE CURSOR AT LEAST 1/2 AN INCH BELOW & LEFT
OF YOUR ORIGIN (-1/2, -1/2) AND PRESS THE
CURSOR BUTTON ONCE.
END OF SEGMENT    15
     102=POINTS READ
       3=DUPLICATE POINTS REMOVED
      99=POINTS WRITTEN - THIS SEGMENT
   2,276=TOTAL POINTS WRITTEN
DO YOU WANT TO DIGITIZE A LINE?  Y OR N=
Y
DIGITIZE YOUR LINE.  WHEN DONE, RELEASE BUTTON,
MOVE CURSOR AT LEAST 1/2 AN INCH BELOW & LEFT
```

Figure A-2.--Continued

```
OF YOUR ORIGIN (-1/2, -1/2) AND PRESS THE
CURSOR BUTTON ONCE
END OF SEGMENT    16
      23=POINTS READ
       0=DUPLICATE POINTS REMOVED
      23=POINTS WRITTEN - THIS SEGMENT
   2,299=TOTAL POINTS WRITTEN
DO YOU WANT TO DIGITIZE A LINE?  Y OR N=
N
   2,299=POINTS ON FILE 1...
      (RACE00600)CHART/1868C/3648TC3720 ON RACE.
```

Figure A-2.--Continued

section. For example, by default the first chart section of the Monterey region (Fig. A-1a) has assigned segment values of 1-16. A constant of 20 was then added to the second Monterey chart section (Fig. A-1b), thereby yielding a range of segment values from 21 to 34 with the LAV being 34. The third chart section (Fig. A-1c) in the series had a constant of 36 added to each line segment value, thus creating a LAV of 40. This process was continued throughout the entire west coast survey region.

In some instances, pinnacles, seamounts, and/or depressions were overlooked when digitizing. The creation of plots to overlay nautical charts proved helpful in locating such omissions. The addition or deletion of new line segments corrected these errors. At this point, the file representing each chart section had a unique range of line segment values. These smaller files were then merged into a larger binary lines file for an entire INPFC area. CANDE "Schedule" file jobs (Fig. A-3) were utilized for inserting one file after another because WFL job files cannot execute "INSERT" commands. After creating a single strata lines file per INPFC statistical area containing all line segment values, program GENERATE/BOUNDARY was implemented. This program bridged the gap between boundary intersection points between adjacent chart sections thereby allowing all depth contours to be continuous within, as well as between, chart sections.

To calculate surface areas and produce plots of the strata, separate parameter files and separate executions of programs GENERATE/BOUNDARY were necessary. For plotting purposes, an "Open" parameter file was required. The "Open" parameter was specified to prevent individual depth contours from being joined together at northern and southern extremities. By leaving these isobaths open, the plotter pen remained in an "up" position at the end of each INPFC statistical area and depth contours were not retraced when plotted. The

```
JOB/MONTEREY/SCHEDULE/STRATA/LINES/STEP2 (03/26/85)

  100    REMOVE MONTEREY/INPFC/=
  200    GET BINARY/18680/3648T03720 AS MONTEREY/INPFC/3648T04030
  300    INSERT BINARY/18680/3720T03802 AT END
  400    INSERT BINARY/18680/3720T03802/ADDITION AT END
  500    INSERT BINARY/18640/3750T03802 AT END
  600    INSERT BINARY/18640/3802T03820 AT END
  700    INSERT BINARY/18640/3802T03820/ADDITION AT END
  800    INSERT BINARY/18640/3820T03859 AT END
  900    INSERT BINARY/18640/3820T03859/ADDITION AT END
 1000    INSERT BINARY/18620/3859T04000 AT END
 1100    INSERT BINARY/18620/4000T04030 AT END
 1200    SA
 1300    ?REPORT JOB/MONTEREY/SCHEDULE/STRATA/LINES/STEP2 IS FINISHED!!!!
 1400    START JOB/MONTEREY/STRATA/LINES/STEP3
```

Figure A-3.--CANDE schedule file for the Monterey statistical area of the International North Pacific Fisheries Commission utilized in creating the west coast strata lines files.

output binary lines file from program GENERATE/BOUNDARY was routed directly to program MAP for the production of plots. Figure A-4 displays the open parameter file for program GENERATE/BOUNDARY utilized in producing plots of the west coast strata.

A "Closed" parameter file was required for surface area calculations. Each depth stratum was composed of the area bounded by two depth contours (i.e., 30-100, 101-120 fm, etc.) which were joined together (closed) at northern and southern extremities of the survey region. There are four major strata which comprise the west coast depth strata and adjacent strata share a common isobath (i.e., the line segment values for the 100 fm contour are used in defining both the 30-100 and 101-120 fm strata. Figure A-5 presents the closed parameter file for program GENERATE/BOUNDARY utilized for strata surface area computation. The output binary lines file from program GENERATE/BOUNDARY became the input file for program STRATA/WINDOW. This program restricted a given strata boundary file to an area specified within a rectangle referred to as the "Window". The parameters required for program STRATA/WINDOW corresponded to latitudes and longitudes (Top, Bottom, Left, Right). Geographic boundaries, other than INPFC area boundaries, were defined by employing this program. The output binary lines file from program STRATA/WINDOW became the input binary lines file for program STRATA/AREA which computed strata surface areas. It should be noted that program STRATA/WINDOW operates on parameters specified by straight vertical and horizontal lines. Therefore, if the strata is bordered by nonvertical or nonhorizontal lines (e.g., U.S./Canadian border) program STRATA/WINDOW cannot be employed. Instead, the output binary lines file from program GENERATE/BOUNDARY should be routed directly to program STRATA/AREA for surface area computations. A curved line to be used as a border must be considered back in the digitizing step. The curve should be divided into straight portions

```
PARAM/GENERATE/ SHELF /4PLOT (03/26/85)

  100     %30 FM CONTOUR
  200     %
  300     OPEN
  400     BOUNDARY 1= 1,6,21,41,51,61,76,71,91,101,121,136,131,141,151,161,171
  500     BOUNDARY 1=191,211,236,231,251,279,261
  600     %
  700     %CONTINUATION OF 30 FM INTO CANADIAN H2O
  800     %
  900     OPEN
 1000     BOUNDARY 2=321,322,381,406,401
 1100     %100 FM CONTOUR
 1200     %
 1300     OPEN
 1400     BOUNDARY 3=2,-7,-22,37,-42,-52,-62,-77,72,-92,-102,-122,-137,132,
 1500     BOUNDARY 3=-142,-152,-162,-172,-192,-212,-237,232,-252,-280,262
 1600     %CONTINUATION OF 100 FM BEGINNING IN CANADIAN H2O
 1700     %THEN CROSSES INTO U.S. H2O THEN PROCEEDS NORTH INTO CANADIAN H2O
 1800     %
 1900     OPEN
 2000     BOUNDARY 4=-327,268,283,273,-323,-382,361,364,-407,402
 2100     %120 FM CONTOUR
 2200     %
 2300     OPEN
 2400     BOUNDARY 5=3,-8,-23,-38,-43,-53,-63,-78,73,-93,-103,-123,-138,133,
 2500     BOUNDARY 5=-143,-153,-163,-173,-193,-213,-238,233,-253,-281,263
 2600     %CONTINUATION OF 120 FM BEGINNING IN CANADIAN H2O
 2700     %THEN CROSSES INTO U.S. H2O THEN PROCEEDS NORTH INTO CANADIAN H2O
 2800     %
 2900     OPEN
 3000     BOUNDARY 6=-328,267,282,274,-324,-383,362,-365,-412,370,-411,
 3100     BOUNDARY 6=371,-408,403
 3200     %200 FM CONTOUR
 3300     %
 3400     OPEN
 3500     BOUNDARY 7=4,-9,-24,-39,-44,-54,-64,-79,74,-94,-104,-124,-139,134
 3600     BOUNDARY 7=-144,-154,-164,-183,-174,-194,-214,-239,234,-254,-284,275
 3700     %
 3800     %CONTINUATION OF 200 FM IN CANADIAN H2O
 3900     %
 4000     OPEN
 4100     BOUNDARY 7=-325,-384,363,-366,-414,369,-409,404
 4200     %
 4300     %500 FM CONTOUR
 4400     %
 4500     OPEN
 4600     BOUNDARY 8=5,-10,-25,-40,-45,-55,-65,-86,-66,-85,-84,-80,75,-95,-105,
 4700     BOUNDARY 8=-125,-140,135,-145,-155,-165,-175,-195,216,206,217,-215,
 4800     BOUNDARY 8=-240,235,-256,241,-255,-285,277
 4900     %
 5000     %CONTINUATION OF 500 FM IN CANADIAN H2O
 5100     %
 5200     OPEN
 5300     BOUNDARY 8=-326,368,-339,-367,-410,405
 5400     BOUNDARY 9= 12
 5500     BOUNDARY 10=13
 5600     BOUNDARY 11=14
 5700     BOUNDARY 12=15
```

Figure A-4.--Parameter file utilized in contour reproduction for the west coast strata lines package.

```
 5800     BOUNDARY 13= 26
 5900     BOUNDARY 14= 27
 6000     BOUNDARY 15= 28
 6100     BOUNDARY 16= 29
 6200     BOUNDARY 17= 30
 6300     BOUNDARY 18= 31
 6400     BOUNDARY 19= 11
 6500     BOUNDARY 20= 33
 6600     BOUNDARY 21= 34
 6700     BOUNDARY 22=46
 6800     BOUNDARY 23=16
 6900     BOUNDARY 24=81
 7000     BOUNDARY 25=82
 7100     BOUNDARY 26=83
 7200     BOUNDARY 27=17
 7300     BOUNDARY 28=18
 7400     BOUNDARY 29=19
 7500     BOUNDARY 30=20
 7600     BOUNDARY 31=56
 7700     BOUNDARY 32=57
 7800     BOUNDARY 33=97
 7900     BOUNDARY 34=106
 8000     BOUNDARY 35=107
 8100     BOUNDARY 36=108
 8200     BOUNDARY 37=109
 8300     BOUNDARY 38=110
 8400     BOUNDARY 39=111
 8500     BOUNDARY 40=112
 8600     BOUNDARY 41=113
 8700     BOUNDARY 42=96
 8800     BOUNDARY 43=146
 8900     BOUNDARY 44=147
 9000     BOUNDARY 45=156
 9100     BOUNDARY 46=157
 9200     BOUNDARY 47=166
 9300     BOUNDARY 48=167
 9400     BOUNDARY 49=168
 9500     BOUNDARY 50=169
 9600     BOUNDARY 51=221
 9700     BOUNDARY 52=222
 9800     BOUNDARY 53=223
 9900     BOUNDARY 54=176
10000     BOUNDARY 55=177
10100     BOUNDARY 56=178
10200     BOUNDARY 57=179
10300     BOUNDARY 58=180
10400     BOUNDARY 59=181
10500     BOUNDARY 60=182
10600     BOUNDARY 61=184
10700     BOUNDARY 62=-170,185
10800     BOUNDARY 63=186
10900     BOUNDARY 64=187
11000     BOUNDARY 65=188
11100     BOUNDARY 66=189
11200     BOUNDARY 67=190
11300     BOUNDARY 68=196
11400     BOUNDARY 69=197
11500     BOUNDARY 70=198
11600     BOUNDARY 71=199
11700     BOUNDARY 72=200
```

Figure A-4.--Continued

```
11800     BOUNDARY 73=201
11900     BOUNDARY 74=202
12000     BOUNDARY 75=203
12100     BOUNDARY 76=204
12200     BOUNDARY 77=205
12300     BOUNDARY 78=207
12400     BOUNDARY 79=208
12500     BOUNDARY 80=218
12600     BOUNDARY 81=245
12700     BOUNDARY 82=242
12800     BOUNDARY 83=243
12900     BOUNDARY 84=244
13000     BOUNDARY 85=286
13100     BOUNDARY 86=301
13200     BOUNDARY 87=302
13300     BOUNDARY 88=303
13400     BOUNDARY 89=288
13500     BOUNDARY 90=289
13600     BOUNDARY 91=290
13700     BOUNDARY 92=291
13800     BOUNDARY 93=292
13900     BOUNDARY 94=293
14000     BOUNDARY 95=294
14100     BOUNDARY 96=295
14200     BOUNDARY 97=296,333
14300     BOUNDARY 98=298
14400     BOUNDARY 99=299
14500     BOUNDARY 100=300
14600     BOUNDARY 101=287
14700     BOUNDARY 102=329
14800     BOUNDARY 103=330
14900     BOUNDARY 104=331
15000     BOUNDARY 105=332
15100     BOUNDARY 106=334
15200     BOUNDARY 107=335,392
15300     BOUNDARY 108=336,393
15400     BOUNDARY 109=337
15500     BOUNDARY 110=338
15600     BOUNDARY 111=340
15700     BOUNDARY 112=385
15800     BOUNDARY 113=386
15900     BOUNDARY 114=387
16000     BOUNDARY 115=388
16100     BOUNDARY 116=390
16200     BOUNDARY 117=391
16300     BOUNDARY 118=394
16400     BOUNDARY 119=395
16500     BOUNDARY 120=396
16600     BOUNDARY 121=397
```

Figure A-4.--Continued

```
PARAM/GENERATE/SHELF/4AREASIZE (03/08/85)

  100    %
  200     30-100 FM DEPTH STRATA (2 REGIONS)
  300    %
  400    BOUNDARY 1= 1,6,21,41,51,61,76,71,91,101,121,136,131,141,151,161,171
  500    BOUNDARY 1=191,211,236,231,251,279,261,
  600    BOUNDARY 1= 262,280,252,232,237,212,192,172,162,152,142,
  700    BOUNDARY 1= 132,137,122,102,92,72,77,62,52,42,-37,22,7,2
  800    BOUNDARY 2= 321,322,381,406,401,
  900    BOUNDARY 2= 402,407,-364,361,382,323,273,-283,268,327
 1000    %
 1100    %100-120 FM DEPTH STRATA (2 REGIONS)
 1200    %
 1300    BOUNDARY 3=2,-7,-22,37,-42,-52,-62,-77,72,-92,-102,-122,-137,132,
 1400    BOUNDARY 3=-142,-152,-162,-172,-192,-212,-237,232,-252,-280,262,
 1500    BOUNDARY 3= 263,281,253,233,238,213,193,173,163,153,143,133,138,123
 1600    BOUNDARY 3= 103,93,73,78,63,53,43,38,23,8,3
 1700    BOUNDARY 4=-327,268,283,273,-323,-382,361,364,-407,402,403,408,
 1800    BOUNDARY 4= -371,411,-370,412,365,362,383,324,274,-282,267,328
 1900    %
 2000     120-200FM DEPTH STRATA
 2100    %
 2200    BOUNDARY 5=3,-8,-23,-38,-43,-53,-63,-78,73,-93,-103,-123,-138,133,
 2300    BOUNDARY 5=-143,-153,-163,-173,-193,-213,-238,233,-253,-281,263,264,
 2400    BOUNDARY 5=-328,267,282,274,-324,-383,362,-365,-412,370,-411,371,-408,
 2500    BOUNDARY 5= 403,404,409,-369,414,366,363,384,325,275,284,254,234,239,
 2600    BOUNDARY 5= 214,194,174,183,164,154,144,134,139,124,104,94,74,79,64,54
 2700    BOUNDARY 5= 44,39,24,9,4
 2800    %
 2900     200-500FM DEPTH STRATA
 3000    %
 3100    BOUNDARY 6=4,-9,-24,-39,-44,-54,-64,-79,74,-94,-104,-124,-139,134
 3200    BOUNDARY 6=-144,-154,-164,-183,-174,-194,-214,-239,234,-254,-284,275
 3300    BOUNDARY 6=-325,-384,363,-366,-414,369,-409,404,
 3400    BOUNDARY 6= 405,410,367,339,-368,326,277,285,255,-241,256,235,240,215,
 3500    BOUNDARY 6= -217,-206,-216,195,175,165,155,145,135,140,125,105,95,
 3600    BOUNDARY 6= 75,80,84,85,66,86,65,55,45,40,25,10,5
 3700    BOUNDARY 7 = 12
 3800    BOUNDARY 8 =13
 3900    BOUNDARY 9=14
 4000    BOUNDARY 10=15
 4100    BOUNDARY 11= 26
 4200    BOUNDARY 12= 27
 4300    BOUNDARY 13= 28
 4400    BOUNDARY 14= 29
 4500    BOUNDARY 15= 30
 4600    BOUNDARY 16= 31
 4700    BOUNDARY 17= 11
 4800    BOUNDARY 18= 33
 4900    BOUNDARY 19= 34
 5000    BOUNDARY 20= 46
 5100    BOUNDARY 21= 16
 5200    BOUNDARY 22= 81
 5300    BOUNDARY 23= 82
 5400    BOUNDARY 24= 83
 5500    BOUNDARY 25= 17
 5600    BOUNDARY 26= 18
 5700    BOUNDARY 27= 19
```

Figure A-5.--Parameter file utilized in strata area calculation for the west coast strata scheme.

```
 5800     BOUNDARY 28= 20
 5900     BOUNDARY 29 = 56
 6000     BOUNDARY 30= 57
 6100     BOUNDARY 31=97
 6200     BOUNDARY 32=106
 6300     BOUNDARY 33=107
 6400     BOUNDARY 34=108
 6500     BOUNDARY 35= 109
 6600     BOUNDARY 36= 110
 6700     BOUNDARY 37= 111
 6800     BOUNDARY 38= 112
 6900     BOUNDARY 39= 113
 7000     BOUNDARY 40=96
 7100     BOUNDARY 41=146
 7200     BOUNDARY 42=147
 7300     BOUNDARY 43=156
 7400     BOUNDARY 44=157
 7500     BOUNDARY 45=166
 7600     BOUNDARY 46=167
 7700     BOUNDARY 47=168
 7800     BOUNDARY 48=169
 7900     BOUNDARY 50=221
 8000     BOUNDARY 51=222
 8100     BOUNDARY 52=223
 8200     BOUNDARY 53=176
 8300     BOUNDARY 54=177
 8400     BOUNDARY 55=178
 8500     BOUNDARY 56=179
 8600     BOUNDARY 57=180
 8700     BOUNDARY 58=181
 8800     BOUNDARY 59=182
 8900     BOUNDARY 60=184
 9000     BOUNDARY 61=-170,185
 9100     BOUNDARY 62=186
 9200     BOUNDARY 63=187
 9300     BOUNDARY 64=188
 9400     BOUNDARY 65=189
 9500     BOUNDARY 66=190
 9600     BOUNDARY 67=196
 9700     BOUNDARY 68=197
 9800     BOUNDARY 69=198
 9900     BOUNDARY 70=199
10000     BOUNDARY 71=200
10100     BOUNDARY 72=201
10200     BOUNDARY 73=202
10300     BOUNDARY 74=203
10400     BOUNDARY 75=204
10500     BOUNDARY 76=205
10600     BOUNDARY 77=207
10700     BOUNDARY 78=208
10800     BOUNDARY 79=218
10900     BOUNDARY 80=245
11000     BOUNDARY 81=242
11100     BOUNDARY 82=243
11200     BOUNDARY 83=244
11300     BOUNDARY 84=286
11400     BOUNDARY 85=301
11500     BOUNDARY 86=302
11600     BOUNDARY 87=303
11700     BOUNDARY 88=288
```

Figure A-5.--Continued

```
11800     BOUNDARY  89=289
11900     BOUNDARY  90=290
12000     BOUNDARY  91=291
12100     BOUNDARY  92=292
12200     BOUNDARY  93=293
12300     BOUNDARY  94=294
12400     BOUNDARY  95=295
12500     BOUNDARY  96=296,333
12600     BOUNDARY  98=298
12700     BOUNDARY  99=299
12800     BOUNDARY  100=300
12900     BOUNDARY  101=287
13000     BOUNDARY  102=329
13100     BOUNDARY  103=330
13200     BOUNDARY  104=331
13300     BOUNDARY  105=332
13400     BOUNDARY  106=334
13500     BOUNDARY  107=335,392
13600     BOUNDARY  108=336,393
13700     BOUNDARY  109=337
13800     BOUNDARY  110=338
13900     BOUNDARY  111=340
14000     BOUNDARY  112=385
14100     BOUNDARY  113=386
14200     BOUNDARY  114=387
14300     BOUNDARY  115=388
14400     BOUNDARY  117=390
14500     BOUNDARY  118=391
14600     BOUNDARY  119=394
14700     BOUNDARY  120=395
14800     BOUNDARY  121=396
14900     BOUNDARY  122=397
```

Figure A-5.--Continued

using inflection points and each portion digitized as a separate line segment. These segments are then reflected in your boundary descriptions within the parameter file for program GENERATE/BOUNDARY.

STAGE 3

Following the calculation of the 4 major strata areas, the areas of pinnacles, seamounts and depressions were added or subtracted to give final strata areas. For example, boundaries 7-122 in Fig. A-5 refer to the pinnacles, seamounts, and depressions that exist within the latitudinal range (36°48'N-49°15'N lat.) of the west coast stratification scheme. Depending on the degree of detail desired, the surface areas of these irregularities can be added to or subtracted from the major stratum area totals which are given at the top of Table 1. Table 1 also lists each pinnacle, seamount, and depression by line segment number, its computer calculated surface area, depth, and gives the required arithmetic adjustments (if desired). Arithmetic adjustments are made by obtaining line segment numbers from Figs. 2-6 and then referring to Table 1 for the proper arithmetic action to be taken for each pinnacle, seamount, or depression.