NOAA Technical Memorandum NMFS

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ATLAS OF AIRBORNE SEA SURFACE TEMPERATURE OBSERVATIONS IN NEARSHORE CALIFORNIA WATERS, 1980-1983.

Paul N. Sund

NOAA-TM-NMFS-SWFC-43

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary
National Oceanic and Atmospheric Administration
John V. Byrne, Administrator
National Marine Fisheries Service
William G. Gordon, Assistant Administrator for Fisheries

Atlas of airborne sea surface temperature observations in nearshore California waters, 1980-1983. With a note pertaining to El Niño of 1982-83

by
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Pacific Environmental Group
Southwest Fisheries Center
National Marine Fisheries Service

In the course of monthly aerial surveys of the distribution of marine mammals and birds, remotely sensed observations of sea surface temperature (S.S.T.) were made along the California coast between Pt. Conception and the Oregon border. The close spacing and high frequency of these observations make them unique.[1)] In addition, the survey series runs prior to and during the beginning of the recent and extensive El Niño event. In recognition of these factors, attendees at the 1982 EPOC (Eastern Pacific Oceanic Conference) requested that an atlas of the survey data be prepared in a timely manner so that the oceanographic community might be made aware of the data and have access to them. The involvement of the P.E.G. (Pacific Environmental Group) was motivated by possibilities of using wind observations recorded with the temperature data to define the offshore structure of the wind field on a scale smaller than was possible heretofore. This is of interest because the wind affects upwelling and surface convergence patterns. Observational precision unfortunately was found to be inadequate for that purpose.

ACKNOWLEDGMENTS:

The surveys were funded by a contract to the University of California Santa Cruz (UCSC) by the Marine Minerals Management Service. Tom Dohl and his survey and analysis group collected the data and supplied a copy of their data tape. Craig Nelson and Douglas McLain adapted plotting routines that generated the individual charts. Ken Raymond and Roy Allen drafted the final charts. Craig Nelson, Gunter Seckel and Tom Dohl reviewed the manuscript. The assistance of all the above is gratefully acknowledged.

THE DATA:

There were two series of aerial surveys: high altitude surveys (100-series) flown at approximately 1000 ft ASL (above sea level), and low altitude surveys (200-series) flown at about 200 ft ASL. Each series had one flight per month; the high altitude surveys starting in March 1980 (number 101), and the low altitude surveys starting in February 1980 (number 201). The surveys concluded in February 1983. The transect lines are illustrated in Figure 1. Not all lines were flown in any single survey. The aircraft followed east-west oriented transect lines, which were selected from the 92-line series in an attempt to systematically and uniformly cover the entire study area. The choice of lines flown on any one survey was sufficient to achieve a coverage of 66% of the total number of lines.

Data collection procedures for the surveys are covered in Dohl, et al. (1983). Temperature readings were obtained from a Barnes PRT-5 precision airborne radiometer either visually from an analog meter or from a strip-chart recording. Locations of the readings were noted by reference to a repeater of a GNS-500 VLF precision navigation system. The temperature and ancillary position data were subsequently transferred to computer tape, a copy of which was sent to the author. These data were processed in conjunction with plotting and mapping routines developed at P.E.G. The resulting monthly charts were hand contoured.

The surveys were designed to investigate distribution patterns of birds and mammals, and were not concerned primarily with precise measurement of environmental factors such as temperature. Some attention was given to "calibration" of temperature observations, but this effort was secondary to the principal survey objectives. Radiometer data were not collected on all survey flights due to various operational factors. The series of charts in this atlas provides the available time sequence of data. A limitation of unknown magnitude regarding the inter-chart comparability of charts prepared from data sensed at different altitudes and over different temperature scales may be present due to the influence of the amount of atmosphere through which the sensor viewed the sea surface.

Attempts were made by the UCSC Survey group early in the survey series to compare radiometer readings with temperatures obtained from moored data buoys in the area. They found this to be impractical. The flight lines selected did not always include a buoy location. Fog and other weather conditions at times made

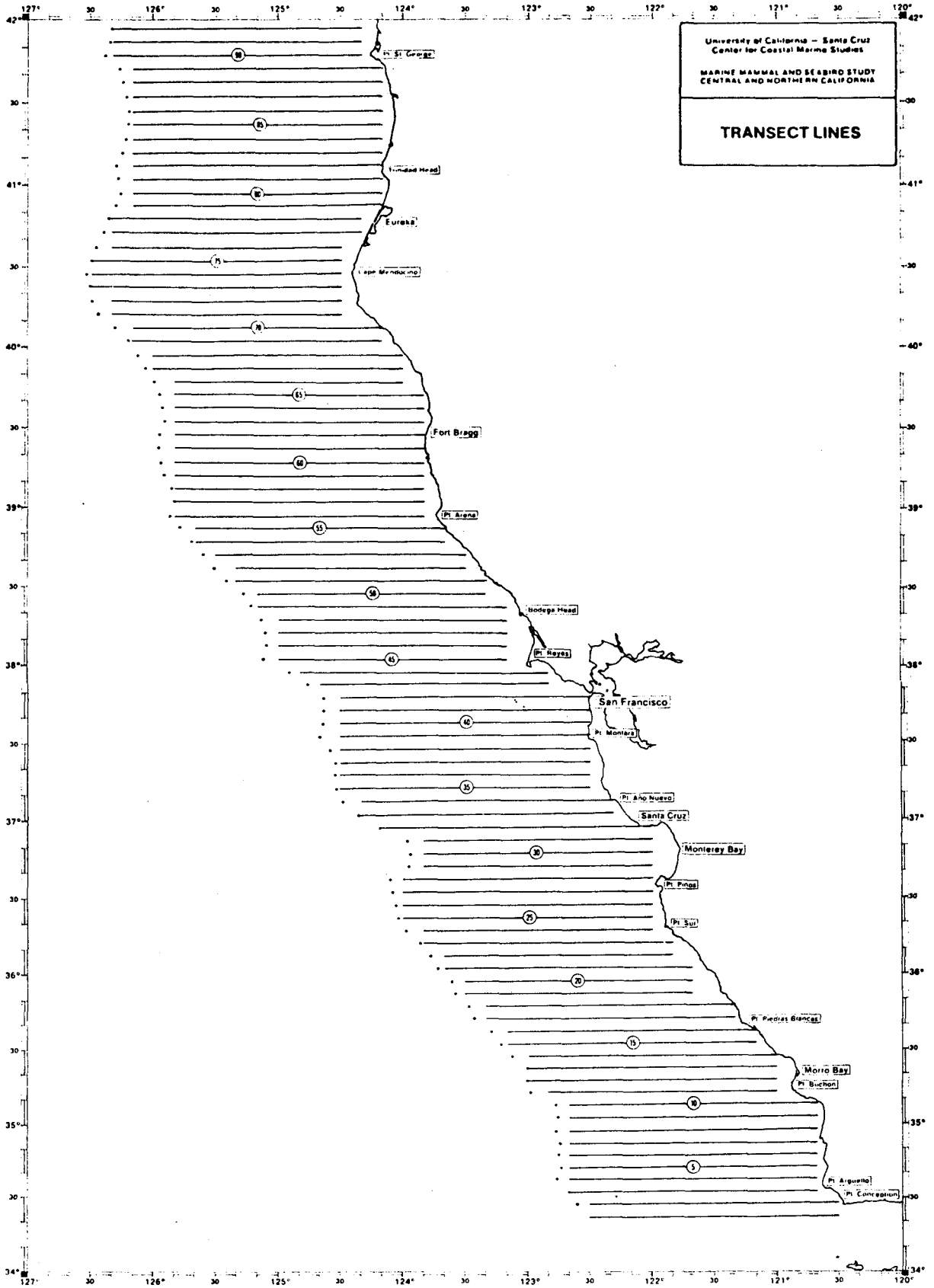


Figure 1. Aerial survey transect lines. From Dohl, et al., 1983.

overflights of the buoys impossible. Questions arose as to the comparability of buoy "surface temperature" readings due to varying depths (one to four meters) at which "surface temperature" sensors were placed. Therefore, they decided to abandon this approach.

The data used to generate the plots are "raw" and no corrections have been applied. Accuracy of the data is not known for a number of reasons: 1) The instrument drift of the PRT-5 is not known. 2) Some data were discarded by the survey group due to wide variance from recent (e.g. "yesterday's") values, often due to PRT-5 internal battery malfunction. 3) The visual temperature read-out of the PRT-5 is a multiple-range scale. There were some differences between data recorded from the two scales of the radiometer. The "low" scale range is from -20^{o} to $15^{o}C$; the "medium" scale is from 10^{o} to $45^{o}C$. When readings were below $10^{o}C$, the low scale was used. The medium scale is most reliable and usually was the one in use (Ken Briggs, UCSC, personal communication), but at times of low temperature conditions it was necessary to shift to the low scale. After January, 1982, data were taken from a digital readout of millivolts, then converted to temperatures. This was considered more reliable than the analog meter on the original unit, which was subject to vibration and oscillation due to aircraft motion.

In-flight comparisons of radiometer readings of an on-board reference were made with readings of a "true thermometer". The difference (PRT minus "true thermometer") ranged from -4.5^{o} to $4.1^{o}C$. For 305 comparisons the mean difference was $1.2^{o}C$; standard deviation and variance were $1.0^{o}C$. For the convenience of readers who may wish to use or interpret the data or charts, the temperature comparison data are listed in Annex 1.

As is apparent from Table 1, a complete monthly sequence of charts is not available, primarily due to weather and operational limitations. In addition, data were too sparse in some months and in some areas to make contouring possible. All monthly surveys with data sufficient to be useful are represented in charts of contoured SST's. More than one chart for a month is available in a number of cases. These are included because some readers may wish to compare features of thermal distribution over shorter times or read from the radiometer at different read-out scales or taken from different altitudes. Contours were drawn by hand and some subjectivity was exercised to smooth the lines. Discrepancies occurred

TABLE 1.
Aerial temperature survey trip numbers and dates. Temp 1 and Temp 2 designate radiometer range scale: Temp 1 is low range; Temp 2 is medium range. Trip numbers in 100 series were flown at 1000 feet, 200 at 200 feet. Plus sign indicates that a contoured chart of SST is included in the atlas.

YEAR	MONTH	DATES	TRIP NO.	TEMP 1	TEMP 2	TRIP NO.	TEMP 1	TEMP 2
1980	Feb/Mar	25-1				201		
	Mar	10-14	101					
		24-28				202	+	+
	Apr	7-11	102		+			
		21-25				203	+	+
	May	13-16	103	+	+			
		26-30				204	+	+
	June	9-13	104	+	+			
		23-24				205	+	+
		26-28						
	July	7-11	105	+	+			
		21-25				206	+	+
	Aug	11-12	106	+	+			
		25-28				207	+	+
	Sep	17-21	107					
		23-27				208	+	+
	Oct	6-10,13	108		+			
		20-24				209	+	+
	Nov	11-14	109		+			
		17-21				210	+	+
	Dec	1,2,4,5	110					
		15-18				211	+	+
1981	Jan	5-9	111					
		19,21-24				212		
	Feb	9-12	112					
		23-27				213		
	Mar	9-13	113					
		22-24,28				214		
	Apr	6-10	114	+	+			
		20,21,23,24				215	+	+
	May	11-15	115	+	+			
		25-29				216	+	+
	Jun	8-12	116		+			
		22-26				217	+	+
	Jul	6-10,15	117	+	+			
		20,24				218	+	+
	Aug	10-12	118		+			
		18-20						
		24-28				219	+	+
	Sep	7-10	119		+			
		17,18						
		21-25				220	+	+

TABLE 1, continued

YEAR	MONTH	DATES	TRIP NO.	TEMP 1	TEMP 2	TRIP NO.	TEMP 1	TEMP 2
	Oct	5-9,13 19-20	120		+			
						221		+
	Nov	2-6	121		+			
						222		+
	Dec	1-4 (+ Nov 30)	122		+			
						223		+
1982	Jan	4-7	123		+			
	Feb	8-12 22-26	124		+			
						225		+
	Mar	8-12 22-26	125		+			
						226		+
	Apr	5-9 19-23	126		+			
						227		+
	May	10-14 24-28	127		+			
						228		+
	Jun	7-11 21-25	128		+			
						229		+
	Jul	12-16,20 19-23	129		+			
						230		+
	Aug	9-13 23-26	130		+			
						231		+
	Sep	13-17 20-24	131		+			
						232		+
	Oct	4-8 18-22	132		+			
						233		+
	Nov	8-12 15-19	133		+			
						234		+
	Dec(Nov)	29-3 13-17	134		+			
						235		+
1983	Jan	17-21 24-25 27-29	135		+			
						236		+
	Feb	14-18	136		+			

at times due to data being collected on flights separated by one or more days. In such cases the contouring shows a break or discontinuity. Temparature values are not printed at the observation points because their spacing is too close for legibility.

INTER-YEAR COMPARISONS AMONG SELECTED MONTHS WITH RESPECT TO THE 1982 EL NIÑO EVENT.

Because of wide-spread interest in the warm water event (El Niño) of 1982-83, a brief inter-year comparison is presented for a portion of the data in this series for the months including the usual period of maximum seasonal warming, (August-September-October). The nine pertinent monthly charts from the atlas series are repeated in this section with shading of selected contours to emphasize the temperature changes. These are reduced for convenience here; the full-size charts in the atlas series may be referenced for details. Stippled areas indicate temperatures $14^{o}C$ or less and hatched areas indicate $16^{o}C$ or higher.

The usual situation:

During the three month period of August to October, the overall pattern of isotherms within the surveyed area is meridional. This is "usual" for the season (Sund, 1982) and there are two basic regimes present: (1) A meridional inshore coastal strip, influenced by cool upwelled waters which is separated by a thermal gradient from (2) warmer oceanic offshore waters. Inter-year variability can be expected in the degree of upwelling. The offshore extent of cool coastal waters--i.e., the width of the coastal cool water area--is due to its spreading offshore. Conversely, the shoreward movement of offshore waters is due to onshore winds and/or lack of upwelling and related processes and advection, or due to the intensity of seasonal warming.

For the area between San Francisco Bay ($38^{o}N$) and Trinidad Head ($41^{o}N$), peak warming of the offshore water occurs in September with highest SST's appearing closest to the coast. The greatest SST gradients exist at that time off cold upwelling centers such as Cape Mendocino. The nearshore SST's are approximately $13^{o}C$ and the highest offshore values are over $18^{o}C$. By October the upwelling processes are relaxed and winter storms begin to disrupt the established structure. The isotherms offshore begin to return to more southern latitudes and re-align zonally. Overall, the structure along the coast becomes less organized.

Comparison by month for the years 1980, 1981, 1982:

August: (Figures 2, 3, 4)

*Warm water intrusions from offshore (16-19^{o}C) appeared on the north and south sides of cold upwelled water off Cape Mendocino in 1981 and 1982 . Temperatures for these areas in 1980 were 11 to 12^{o}C.

*Upwelling in 1980 in the vicinity of Cape Mendocino evidently was stronger than in 1981 and 1982 because: 1) the plume at the surface in 1980 was less than 10^{o}C, whereas it was over 12^{o}C (up to 15) in the latter two years; OR 2) warmer waters overall were present in the two latter years and thus warmer waters were upwelled in those years.

*A cool (12 - 14^{o}C) coastal strip extended from Cape Mendocino (40^{o}N) south to Point Reyes (38^{o}N) in all years. The gradient to warmer offshore temperatures was greatest in 1982.

*An upwelling plume was present off Pt. Sur (36.5^{o}N). Again the strongest gradient was in 1982

*The warm offshore intrusion off Pt. Buchon (35^{o}N) was closer to the coast in 1980 and 1982 and warmest in 1981.

September: (Figures 5, 6, 7)

*In 1981 and 1982 (sparse data in 1980) at the Pt. Arena to Cape Mendocino region, warm oceanic water had moved closer to shore and the temperature gradients between the oceanic and upwelled waters were more intense.

*Intrusions of warm waters into Monterey Bay are evident in both 1980 and 1981. Temperatures were higher in 1981; Ano Nuevo area values were up to seven degress higher in 1982.

October: (Figures 8, 9, 10)

* Between Cape Mendocino and Pt. Arena in 1980 waters were up to 5^{o}C cooler than in 1981 and 1982. At the upwelling center off Cape Mendocino SST's were 10 ^{o}C in 1980, 13^{o}C in 1981 and 15^{o}C in 1982.

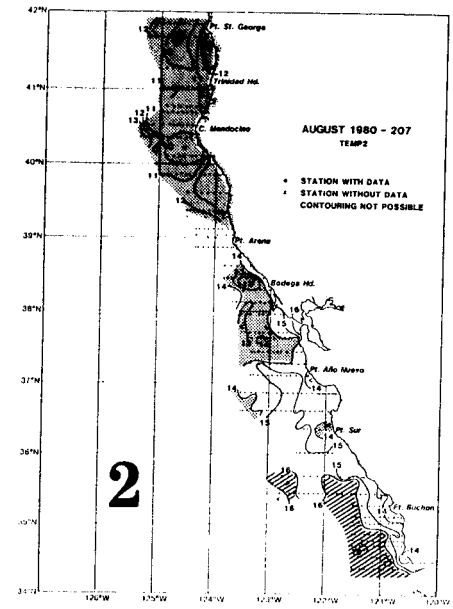
*The warm oceanic intrusion north and south of the upwelling plume off Cape Mendocino was about 4^{o}C warmer in 1981 and 1982 than in 1980. Also, the onshore-to-offshore thermal gradient was stronger in the latter two years.

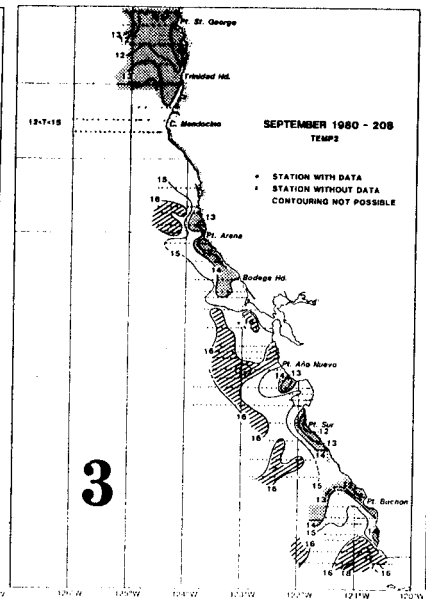
*In the southern half of the area surveyed, the inter-year pattern was less variable than in the north. Low SST's indicative of upwelling appeared in all years near Pt. Sur and a cool coastal patch was present between Point Conception and Point Buchon. The SST values varied only by one or two degrees between years in that area.

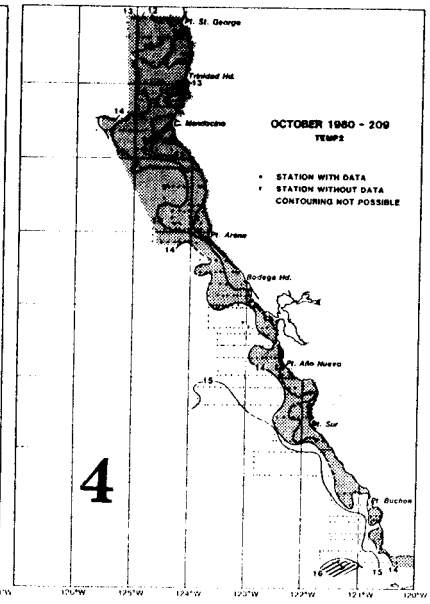
SUMMARY

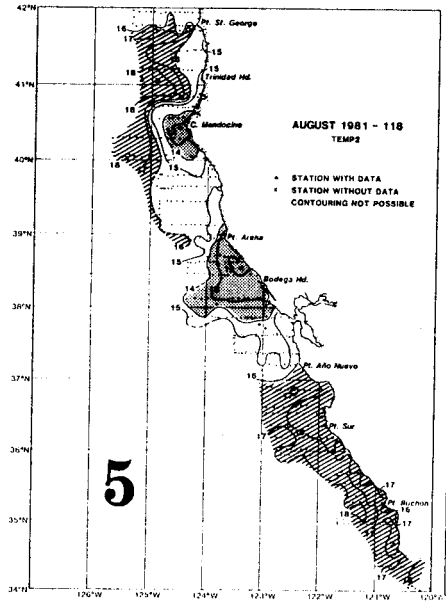
It is evident that the coastal waters surveyed generally were warmer in 1981 and 1982 than in 1980. Upwelling occurred in all three years but warmer SST's were observed in the later years. It is likely that the surface layer was deeper than usual in 1981 and 1982, so that cooler strata did not reach the surface. In-situ warming cannot be discounted as a likely factor, however.

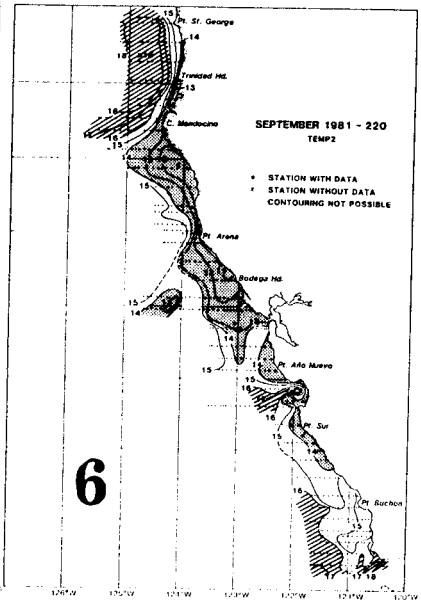
The series of charts offers to interested investigators the opportunity to compare sea surface thermal structure and features on a monthly interval as well as among the three years covered by the surveys.

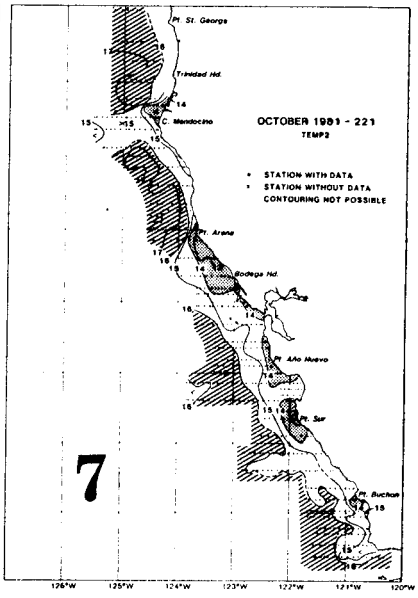

AUGUST 1980 - 207
TEMP2
* STATION WITH DATA
x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
2

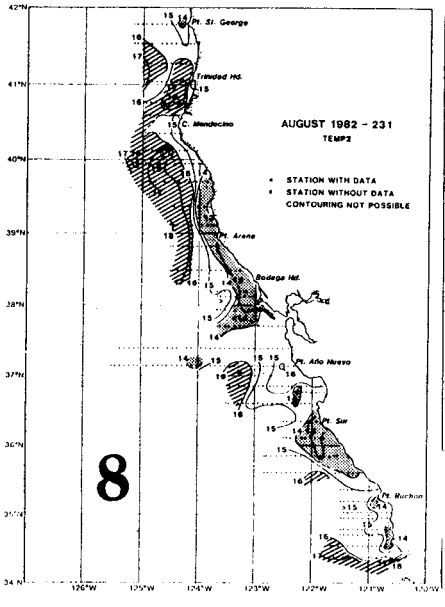

SEPTEMBER 1980 - 208
TEMP2
* STATION WITH DATA
x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
3


OCTOBER 1980 - 209
TEMP2
* STATION WITH DATA
x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
4


AUGUST 1981 - 118
TEMP2
* STATION WITH DATA
x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
5


SEPTEMBER 1981 - 220
TEMP2
* STATION WITH DATA
x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
6


OCTOBER 1981 - 221
TEMP2
* STATION WITH DATA
x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
7


AUGUST 1982 - 231
TEMP2
* STATION WITH DATA
x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
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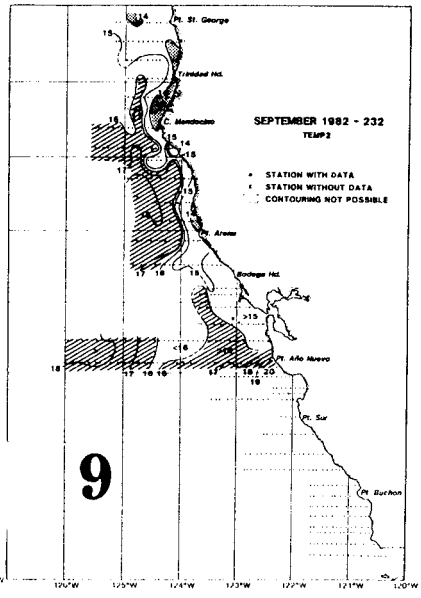
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
8


SEPTEMBER 1982 - 232
TEMP2
* STATION WITH DATA
x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
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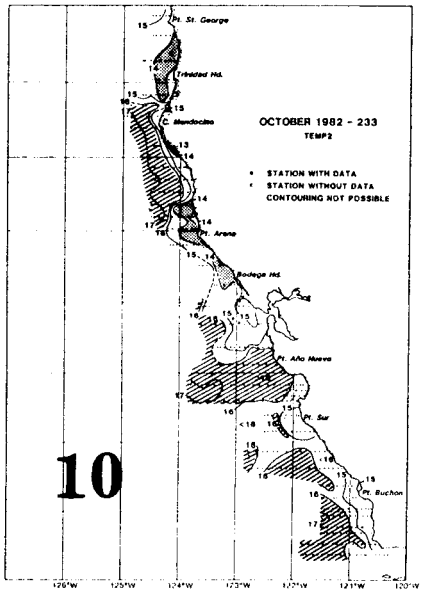
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
9


OCTOBER 1982 - 233
TEMP2
* STATION WITH DATA
x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
10

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Dohl, T.P., R.C. Guess, M. Duman, and R. Helm

1983. Cetaceans of Central and Northern California, 1980 - 1983: Status, abundance, and distribution. Prepared for Minerals Management Service, U.S. Department of the Interior. Contract No. AA551-CT9--3. Date of Submission: Aug. 1983.

Sund, P.N.

1982. Distribution of albacore and surface temperatures off California. Coastal Oceanography and Climatology News. Nov. 1982.

FOOTNOTES

[1] Previous airborne radiometer surveys in the California coastal region have been described in :

Squire, James L.
1971 Measurments of sea surface temperature on the eastern Pacific continental shelf using infrared radiometry. U.S. Coast Guard Ocean. Rept. 47 (CG373-47), August 1963 - July 1968, 229 p.

Squire, James L.
1978 Sea surface temperature distribution off San Diego, California, using an airborne infrared radiometer NOAA Tech. Rept. NMFS SSRF 720, 30pp.

The data may be requested by contacting the Pacific Outer Continental Shelf Office, Marine Minerals Management Service, 1340 W. 6th St., Los Angeles, California 90017. Ask for the Data Base Tape containing environmental data, which is on UNIX Version #7, tar tape, at 1600 BPI.

Annex 1. PRT radiometer reading minus "true thermometer" reading for survey flights 215 to 236.

Trip	Date	Time	Location		PRT-True Thermometer
			Dg Mn	Dg Mn	
215	05/11/81	1240	34 27	121 37'	1.0
	05/12/81	1342	- -		.7
		1431	41 47	125 20	1.0
		1520	41 43	124 40	.6
		1624	41 07	125 10	-1.2?
	05/13/81	1158	40 20	125 00	1.2
		1300	40 03	125 10	.9
		1421	39 33	124 50	.3
		1527	38 54	124 20	1.0
	05/14/81	1055	37 52	123 40	1.0
		1401	36 56	123 19	.4
	05/15/81	1015	36 05	122 20	1.0
		1148	35 38	122 40	1.2
		1309	35 14	121 30	1.0
		1427	34 54	121 10	1.2
216	05/25/81	1212	34 22	121 40	1.0
		1327	34 47	121 30	1.5
		1431	35 02	121 40	1.5
		1537	35 22	121 30	.1
	05/26/81	0925	35 37	121 34	1.7
		1046	36 07	121 51	1.8
		1155	36 37	122 22	1.4
		1638	36 50	121 50	.9
	05/27/81	0850	37 22	123 20	1.3
		0958	37 42	123 40	1.5
		1105	38 07	123 40	1.2
		1244	38 22	123 50	1.2
		1410	38 52	125 00	1.2
		1508	39 07	124 20	1.3
	05/28/81	0957	39 22	124 30	1.7
		1057	39 52	125 00	1.5
		1213	40 32	125 30	1.1
		1315	40 52	125 00	1.4
		1500	41 17	125 00	1.5
		1611	41 47	125 10	1.4
	05/29/81	1133	37 42	123 40	1.6
116	06/08/81	1505	40 58	125 10	1.4
		1643	41 52	125 21	2.1
	06/09/81	1016	40 27	124 24	1.9
		1038	40 20	125 00	1.4
		1235	39 34	125 30	.9
		1507	38 50	124 10	1.9
		1557	38 38	124 00	1.4
	06/10/81	0954	38 10	124 10	1.9

		1334	37 02	123 42	1.7
	06/11/81	1218	35 58	122 40	1.5
		1449	35 33	121 08	1.0
	06/12/81	0949	35 23	120 54	1.6
		1126	34 58	121 09	1.4
		1240	34 33	121 10	1.5
217	06/22/81	1151	35 02	120 38	1.3
		1229	35 12	121 40	.9
		1458	34 42	121 30	1.0
		1610	34 32	121 30	1.2
	06/23/81	0953	35 37	122 30	1.4
		1118	36 07	122 40	1.1
	06/24/81	0907	37 07	123 30	1.2
		1013	37 22	123 20	1.2
	06/25/81	1009	39 52	125 00	.8
		1143	40 22	125 30	1.3
		1611	41 97	125 00	1.3
		1103	38 37	124 00	1.0
117	07/07/81	1048	35 52	122 40	1.4
		1428	36 31	122 59	.9
		1107	37 58	124 11	3.0?
		1430	37 28	123 20	1.5
	07/09/81	1001	38 47	124 40	1.8
		1113	39 16	124 20	1.9
		1425	40 04	125 00	1.3
	07/10/81	1221	40 59	125 20	1.4
		1415	40 32	125 30	1.6
	07/15/81	1415	35 16	122 30	1.5
218	07/20/81	1127	34 23	121 40	1.0
		1240	34 44	121 30	1.8
		1341	34 59	121 30	1.5
		1436	35 12	121 30	1.7
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		1345	36 41	123 30	2.0
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		1303	38 09	123 40	1.8
		1404	38 31	124 00	1.6
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	07/23/81	1040	40 26	125 00	1.3
		1131	40 44	125 00	1.7
		1234	41 08	125 00	1.5
		1350	41 42	125 10	1.5
		1643	39 24	124 30	1.1
	07/24/81	1147	40 05	125 00	1.2
		1255	39 34	124 30	1.3
118	08/11/81	1241	36 12	122 50	-1.2
	08/12/81	1021	37 23	123 30	1.7

	08/18/81	1459	38 42	124 00	3.5
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	08/20/81	1154	41 34	125 11	1.4
		1310	41 11	125 10	1.8
219	08/24/81	1159	41 52	125 10	1.2
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		1414	40 47	125 00	1.8
		1516	40 52	125 30	1.5
	08/25/81	1033	40 07	125 20	1.9
		1141	39 37	124 30	1.6
		1230	39 17	124 30	1.4
		1340	39 02	125 00	1.2
		1452	38 37	124 00	1.3
	08/26/81	0950	38 12	123 40	1.5
		1048	37 57	123 40	1.8
		1204	37 27	123 20	1.5
		1307	37 12	123 20	1.4
	08/27/81	0843	36 42	122 10	1.8
		1000	36 52	123 50	1.0
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		1414	35 22	121 40	1.4
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		1153	34 42	121 30	0.4
		1257	34 57	121 40	1.5
119	09/07/81	1059	34 23	119 55	1.5
		1544	35 11	121 50	1.0
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		1401	35 47	122 30	1.3
	09/17/81	0954	37 57	123 50	1.5
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	10/07/81	1052	37 17	122 25	2.2
		1205	37 32	123 30	2.2
		1447	38 13	124 00	1.9
	10/08/81	1124	38 57	123 44	2.1
		1534	40 26	125 00	1.9
	10/09/81	1043	40 42	125 50	2.3
	10/13/81	1150	36 41	123 00	2.3
		1529	35 53	121 28	2.4
221	10/19/81	1447	35 22	120 52	1.5
	10/20/81	1105	39 37	122 50	1.0
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	10/23/81	1440	41 17	125 00	1.7

121	11/04/81	1517	38 47	124 40	2.1
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		1252	40 02	125 20	2.0
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		1600	35 18	121 40	1.9
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	12/04/81	1042	41 52	125 40	3.4
223	12/07/81	1030	34 36	120 44	2.5
		1227	35 02	120 52	2.2
		1316	35 22	121 39	2.2
	12/08/81	1024	35 52	121 27	2.2
	12/09/81	0916	37 27	123 20	2.7
123	01/07/82	1505	40 17	125 00	1.3
224	01/18/82	1317	34 50	122 10	1.0
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124	02/12/81	1155	41 52	124 12	2.3
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		1357	35 38	121 08	0.6
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		1129	34 47	121 40	-0.9
		1239	35 02	121 30	-1.0
		1353	35 36	121 07	-0.8
	02/09/82	1116	36 12	122 20	-1.3
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	04/07/82	1035	39 22	124 20	1.4
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229	06/22/82	1219	36 07	122 11	0.9
		1335	36 37	123 04	4.0 PRT
		1417	36 52	123 38	3.2 Flaky

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134	12/01/82	1235	40 02	124 40	-0.1

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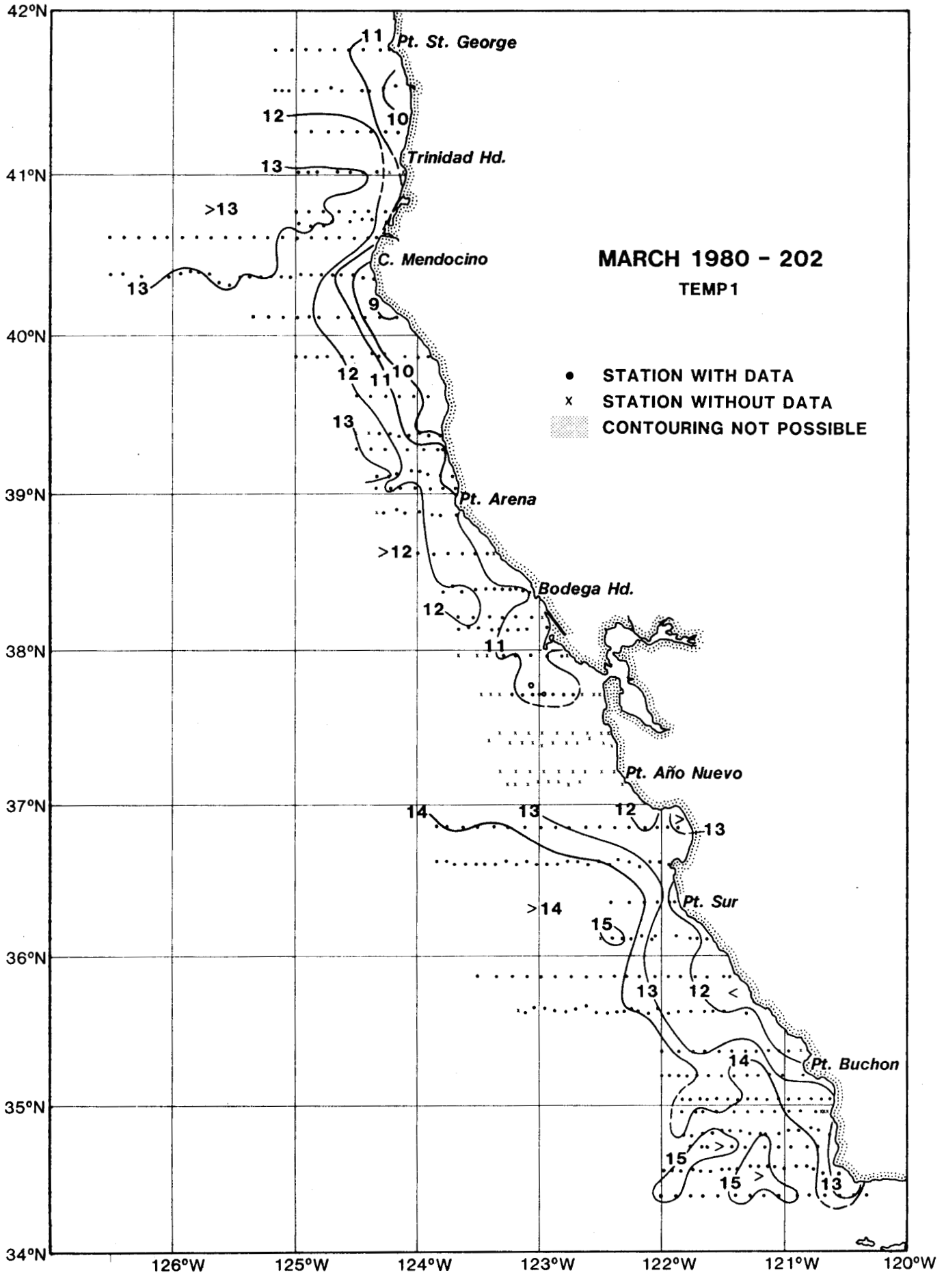
Footnote: Question marks and comments were recorded on the original tabulation.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Pt. Sur
Pt. Buchon
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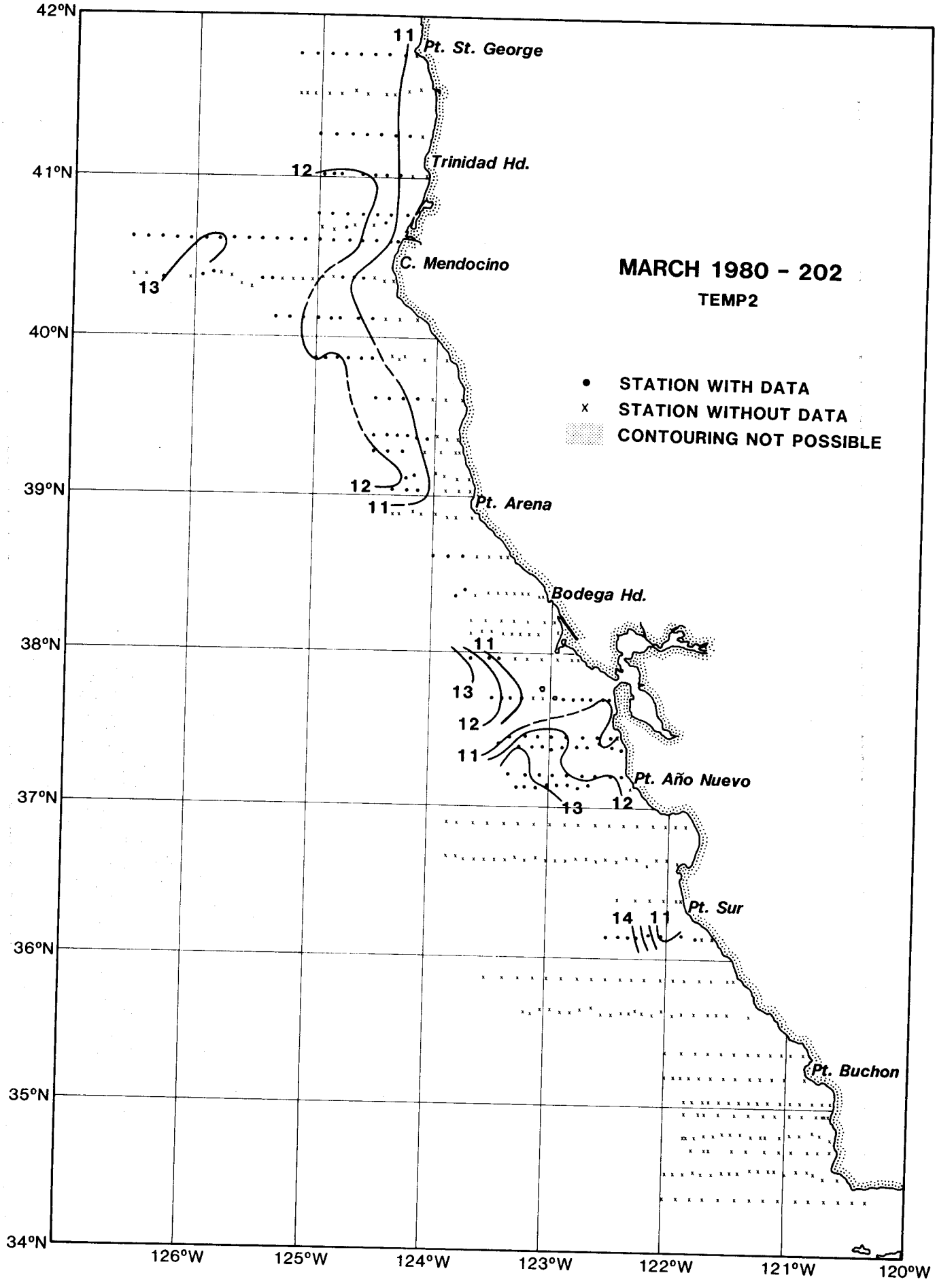
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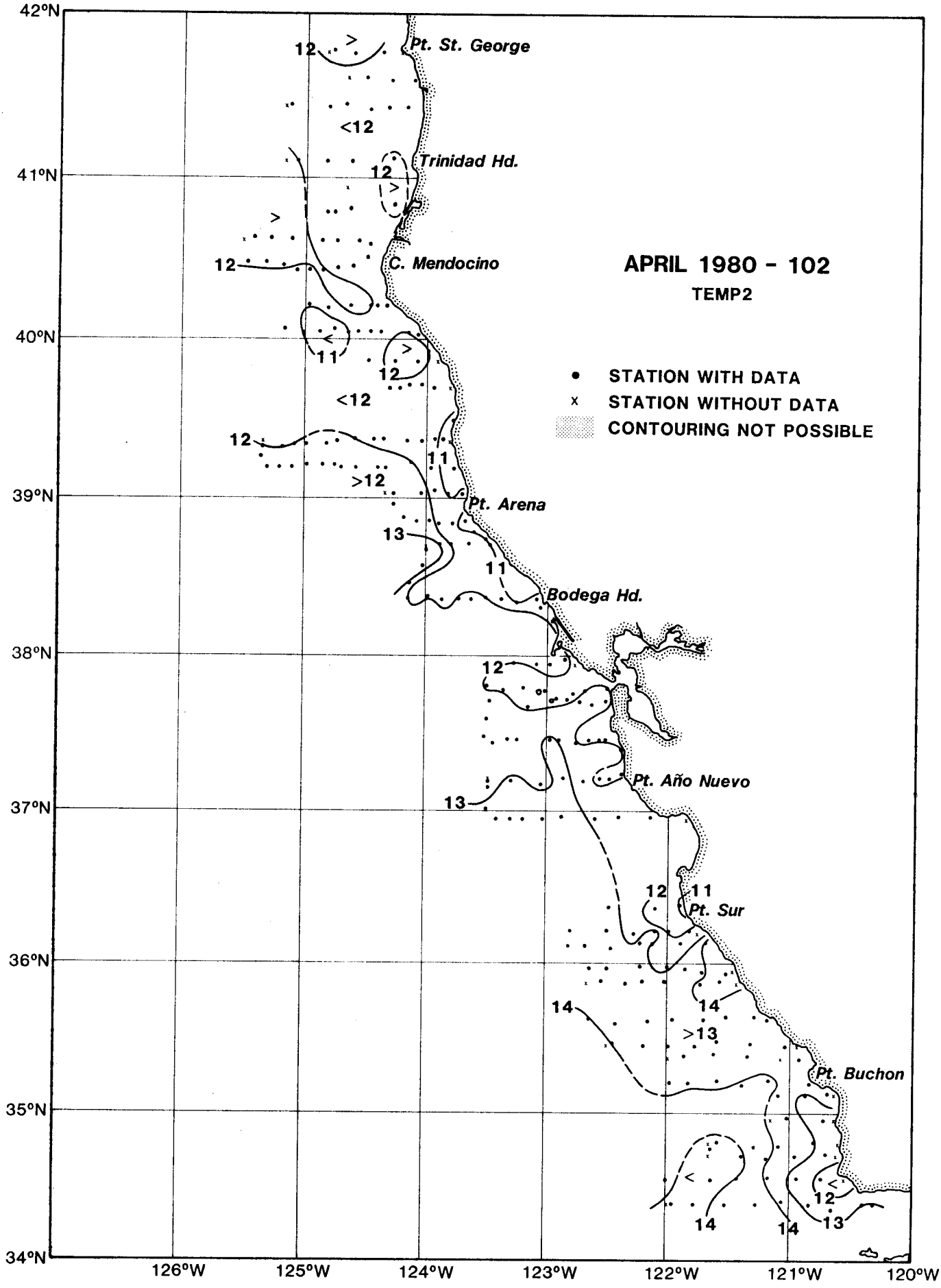
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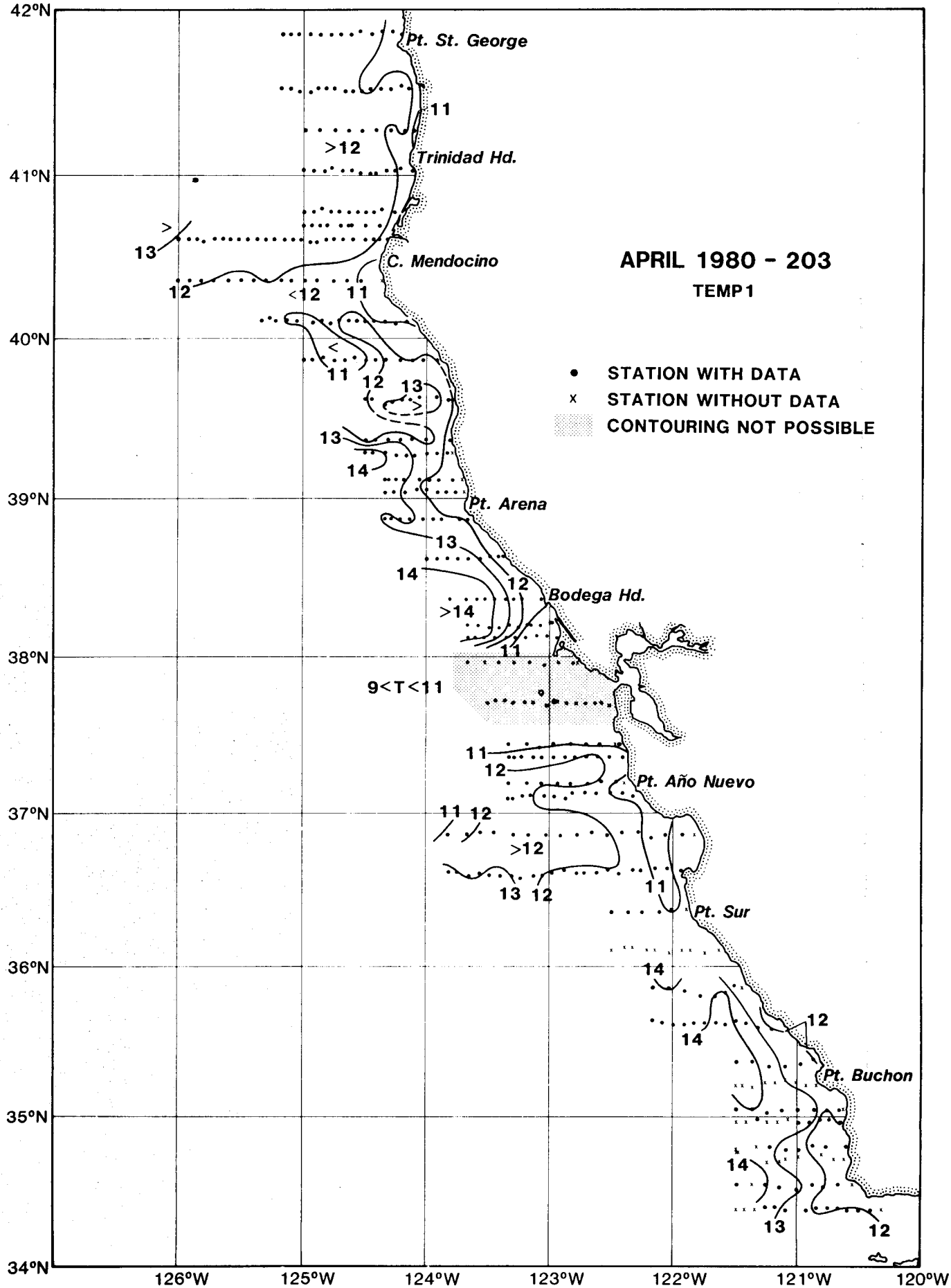
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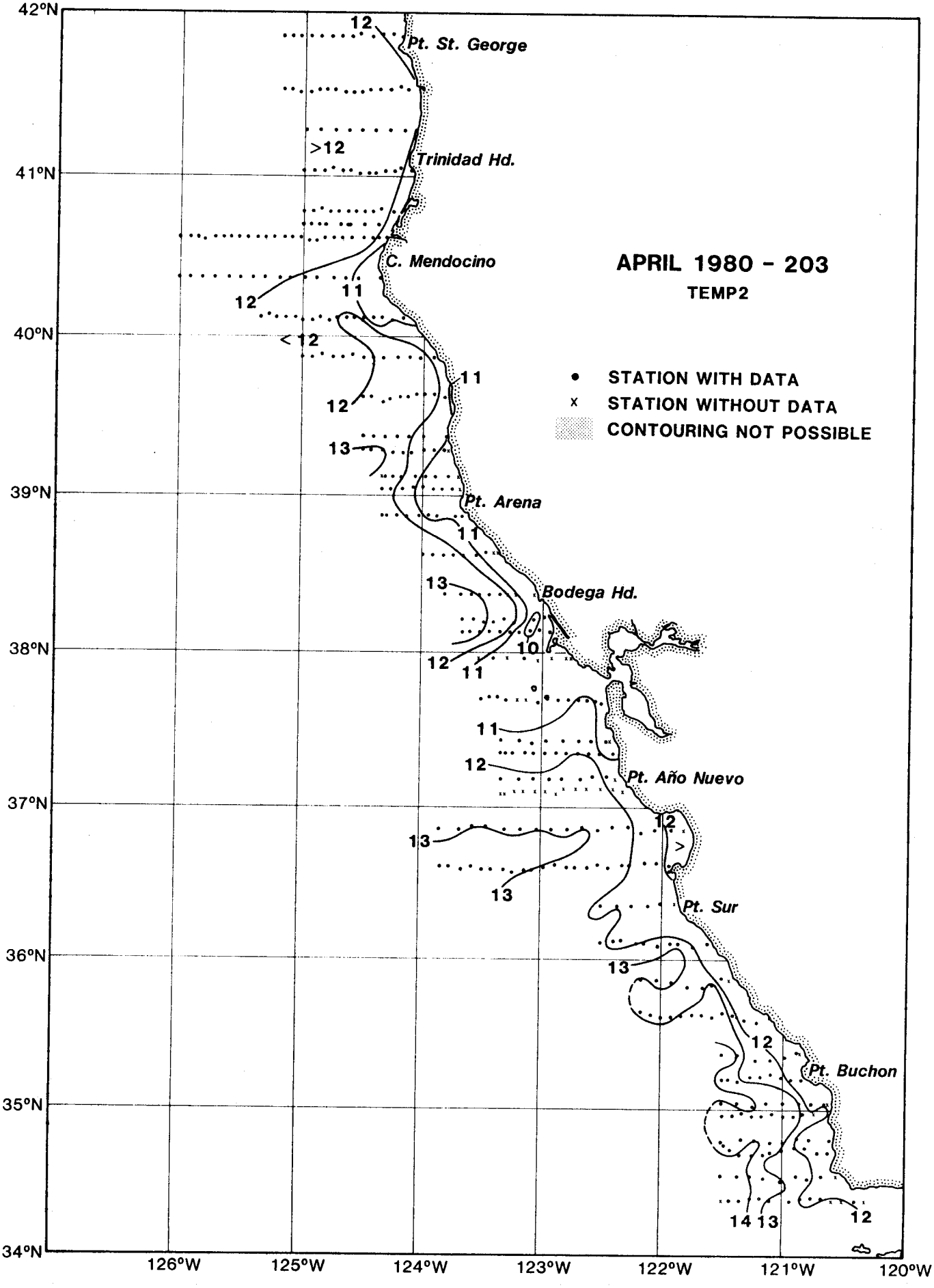
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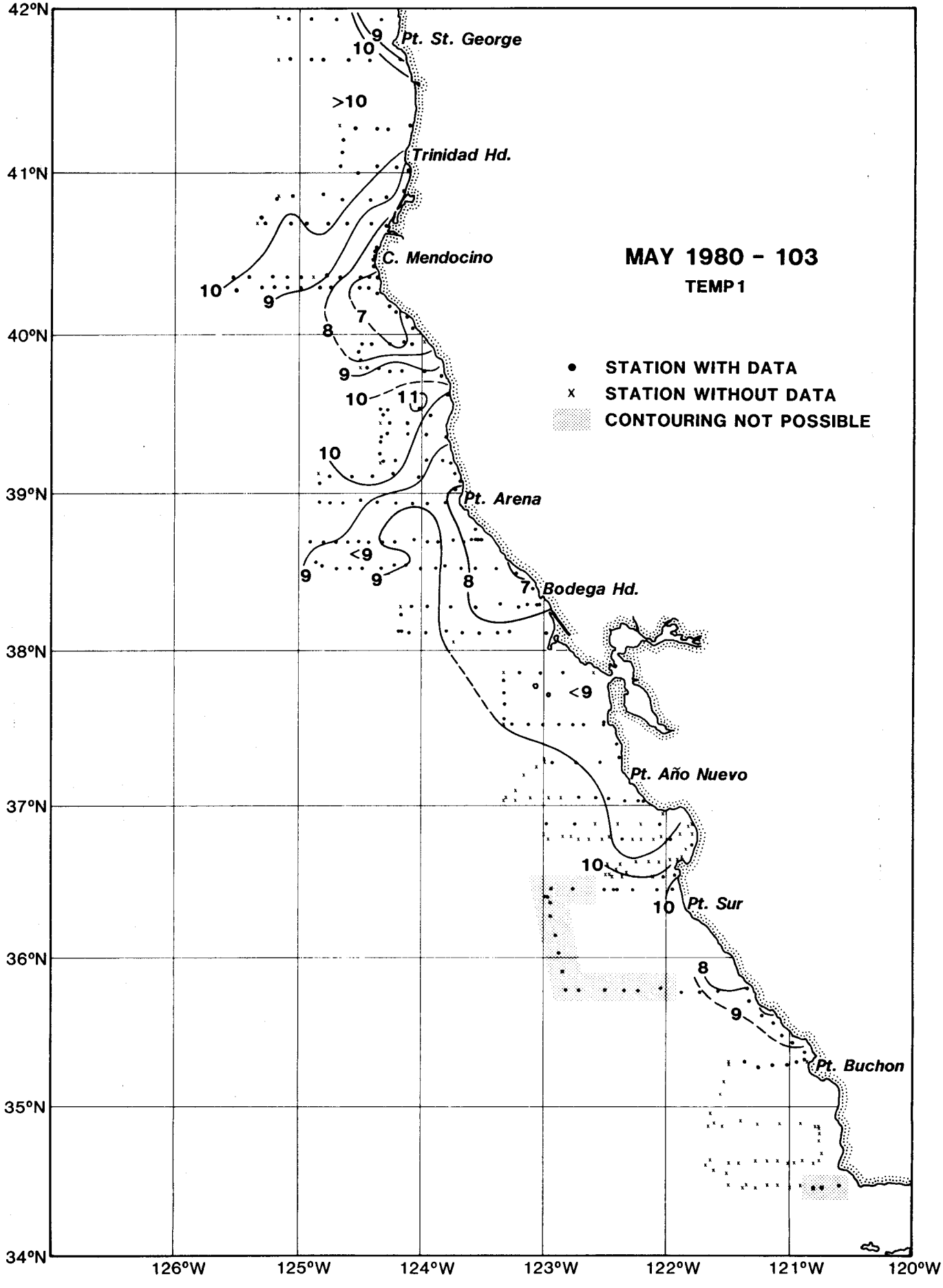
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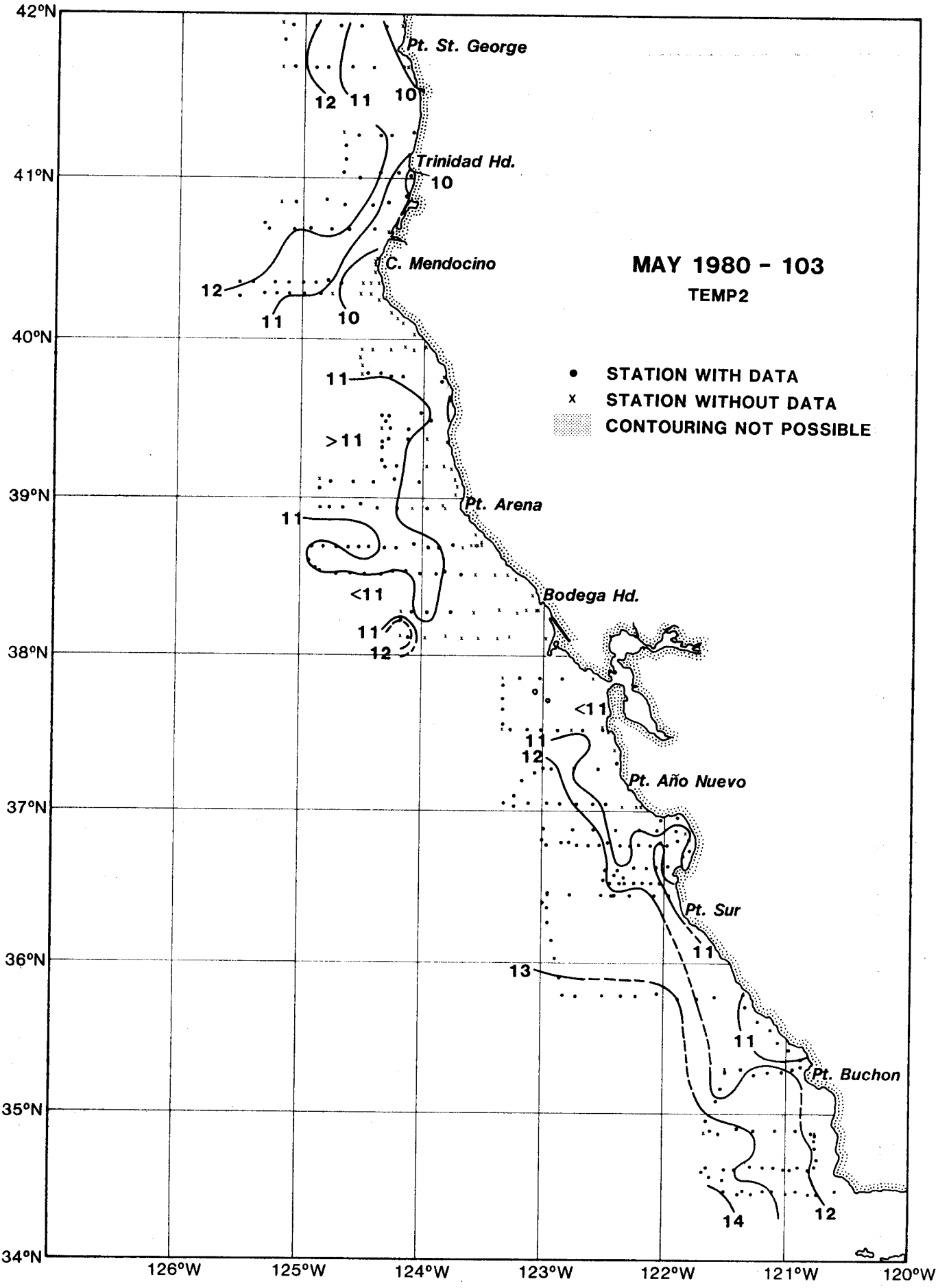
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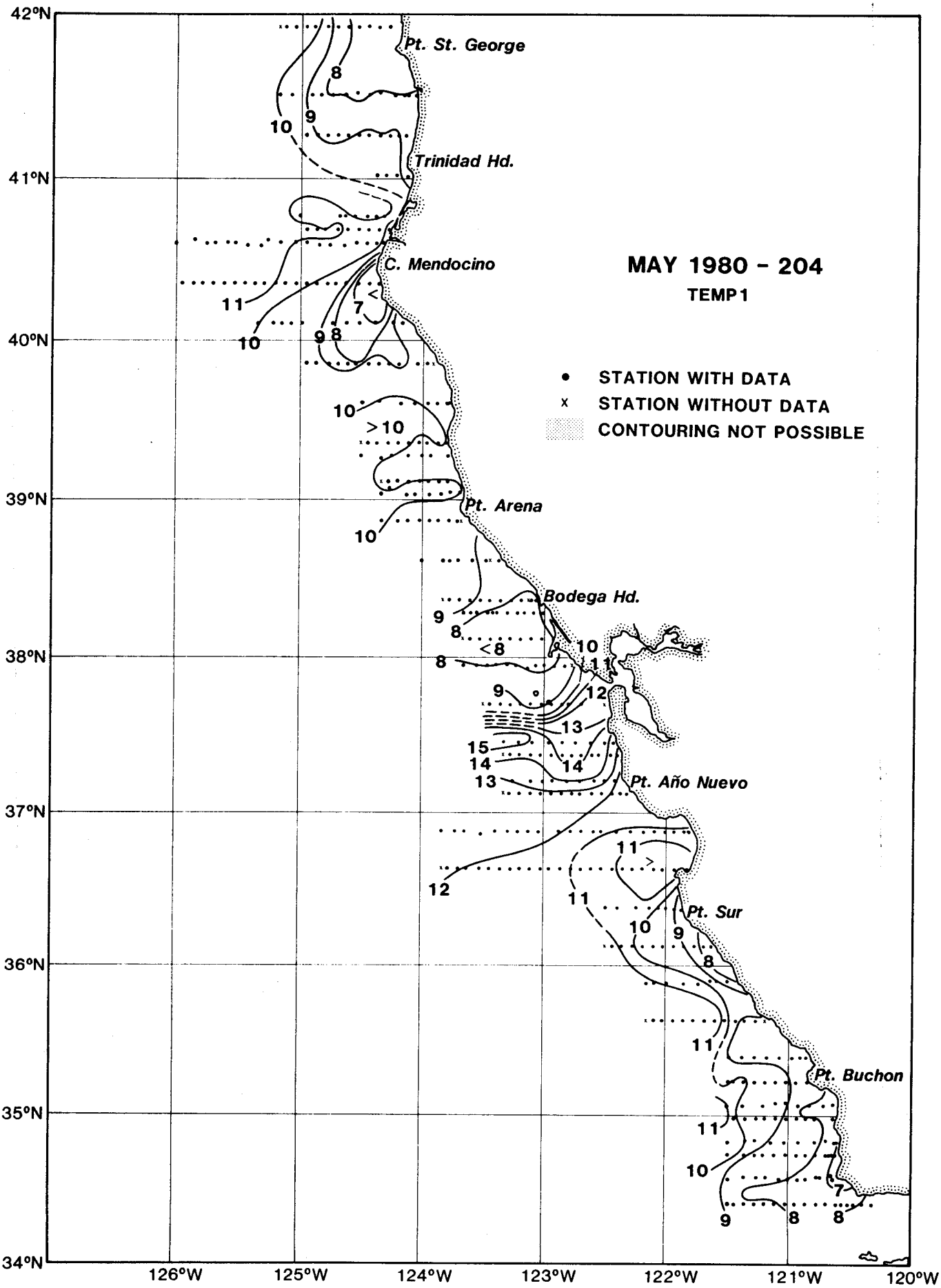
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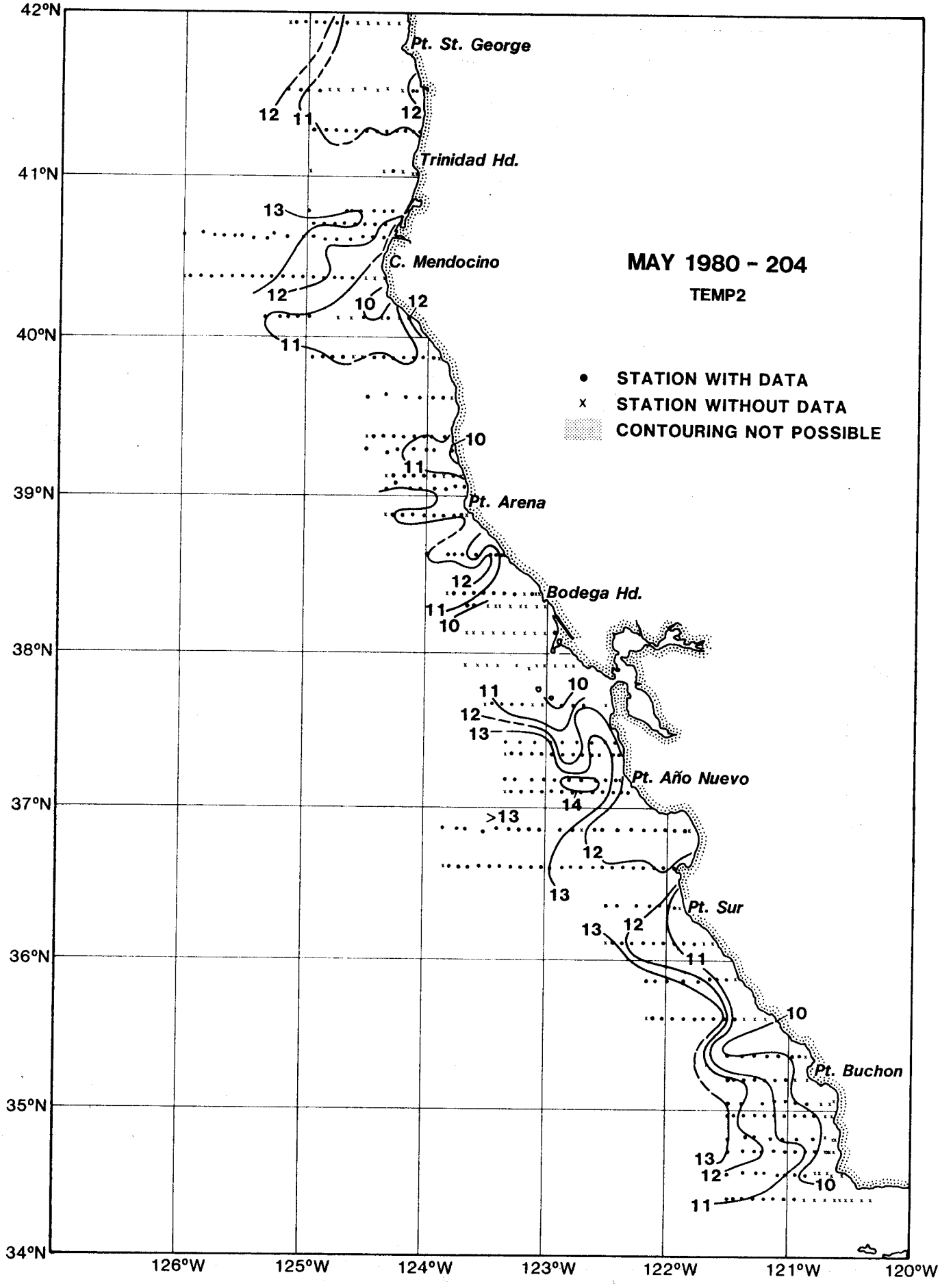
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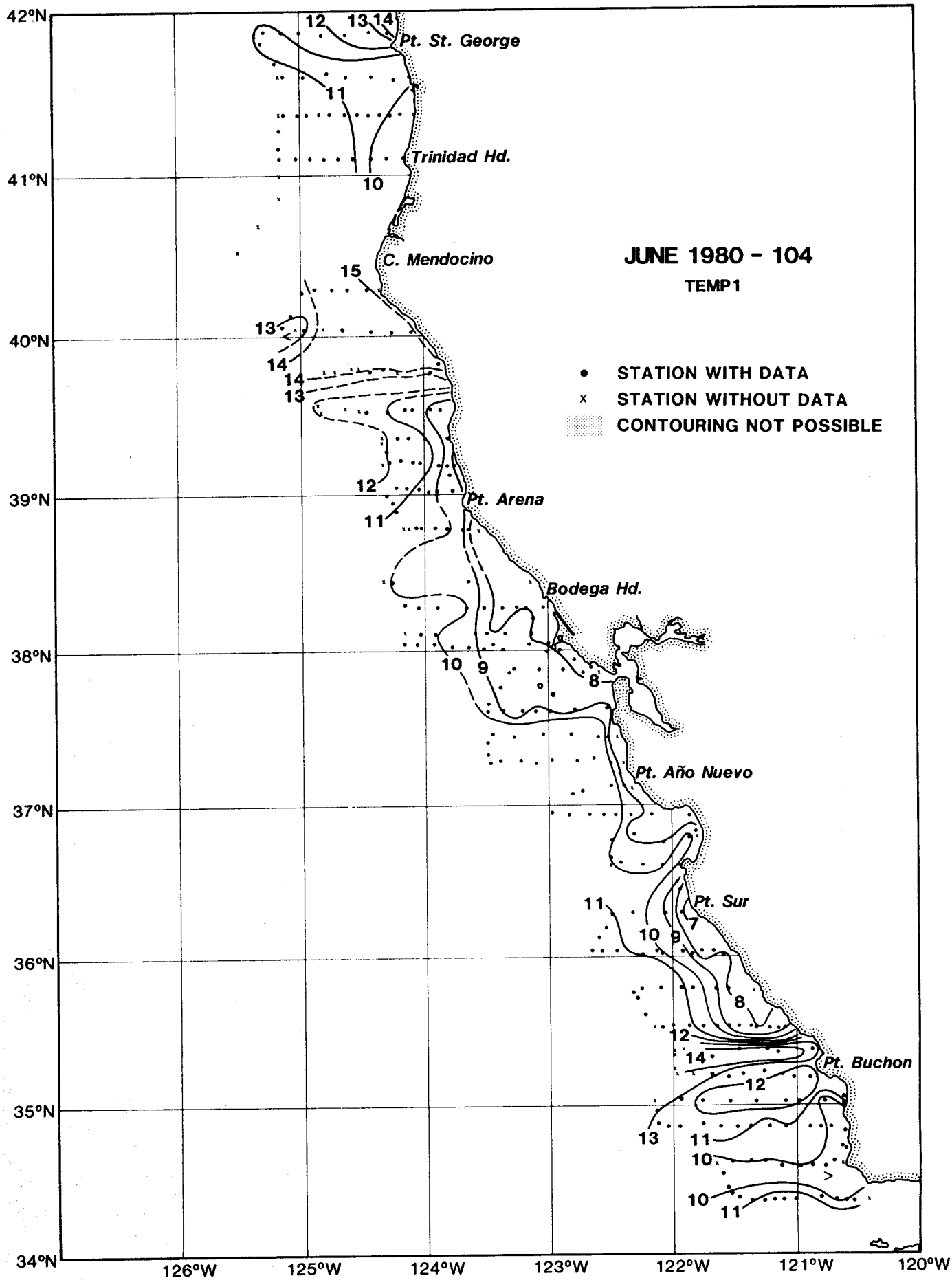
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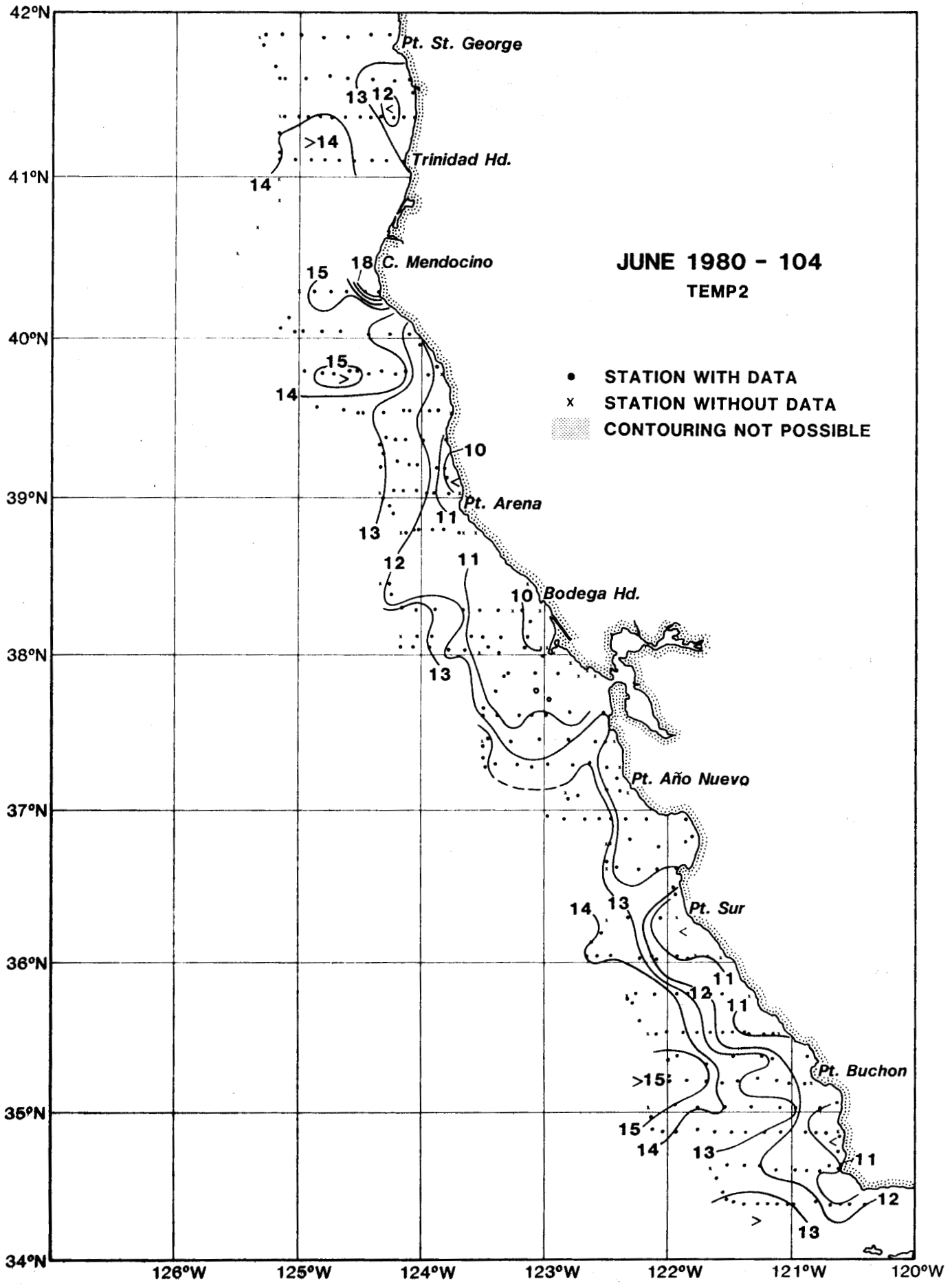
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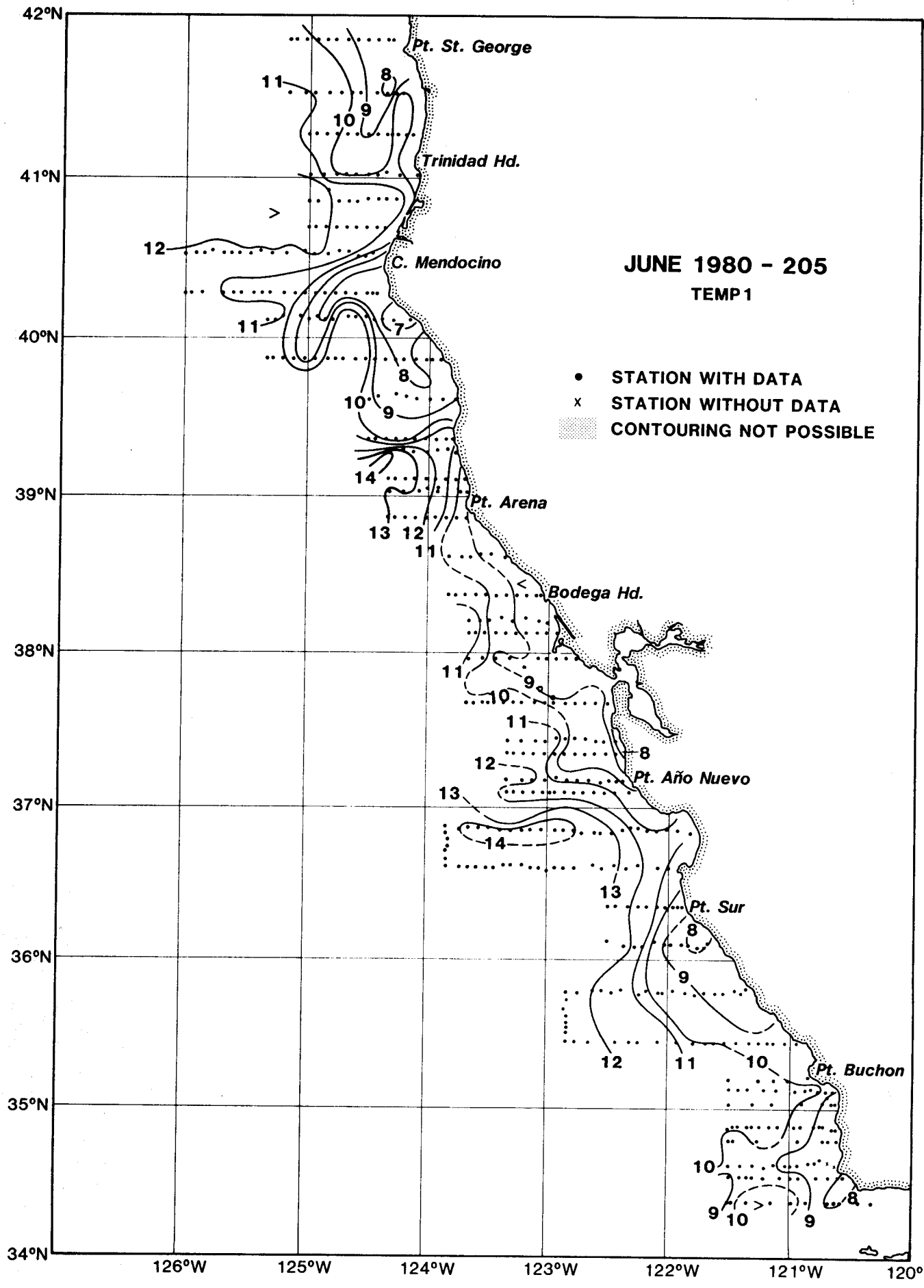
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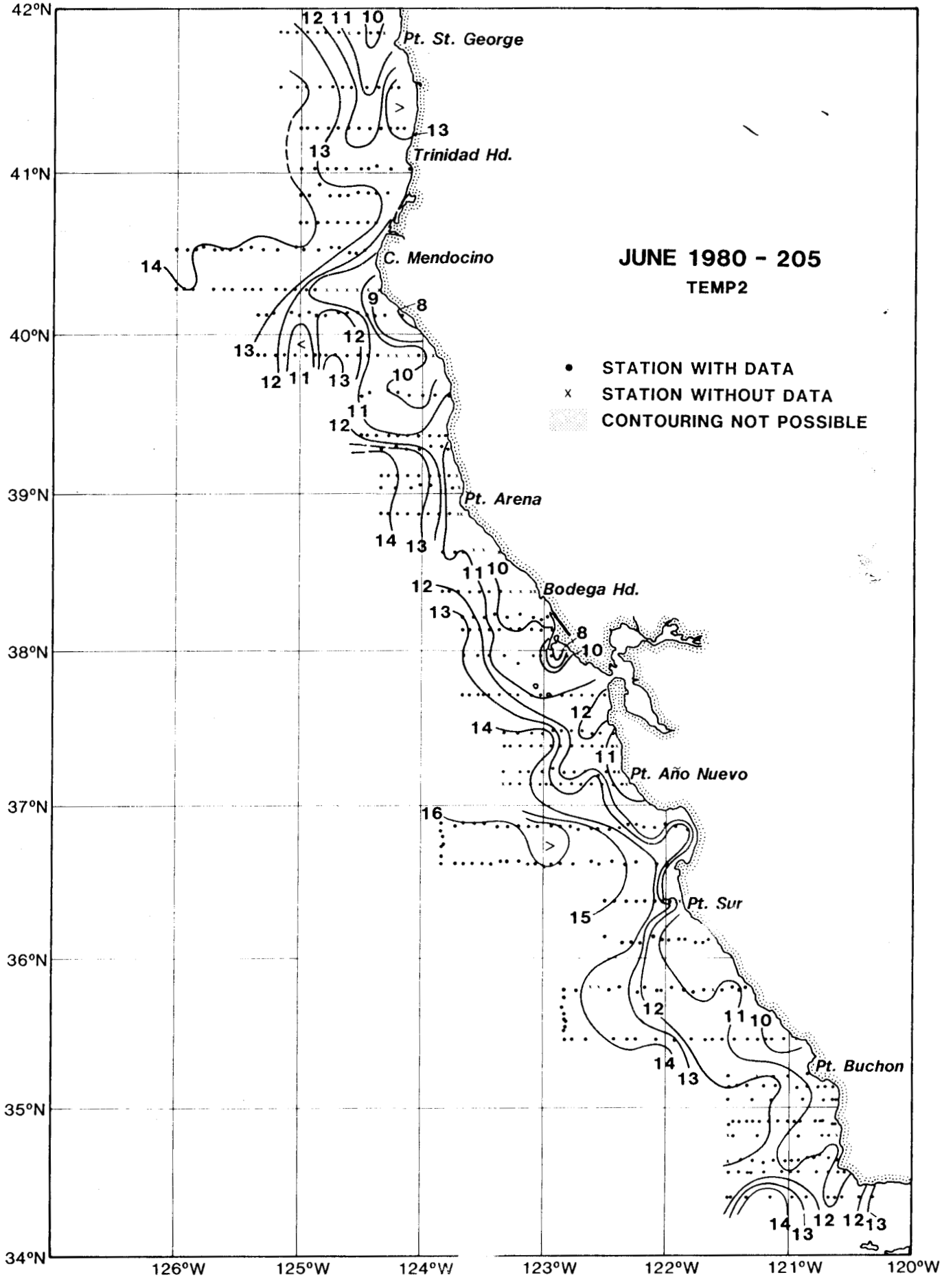
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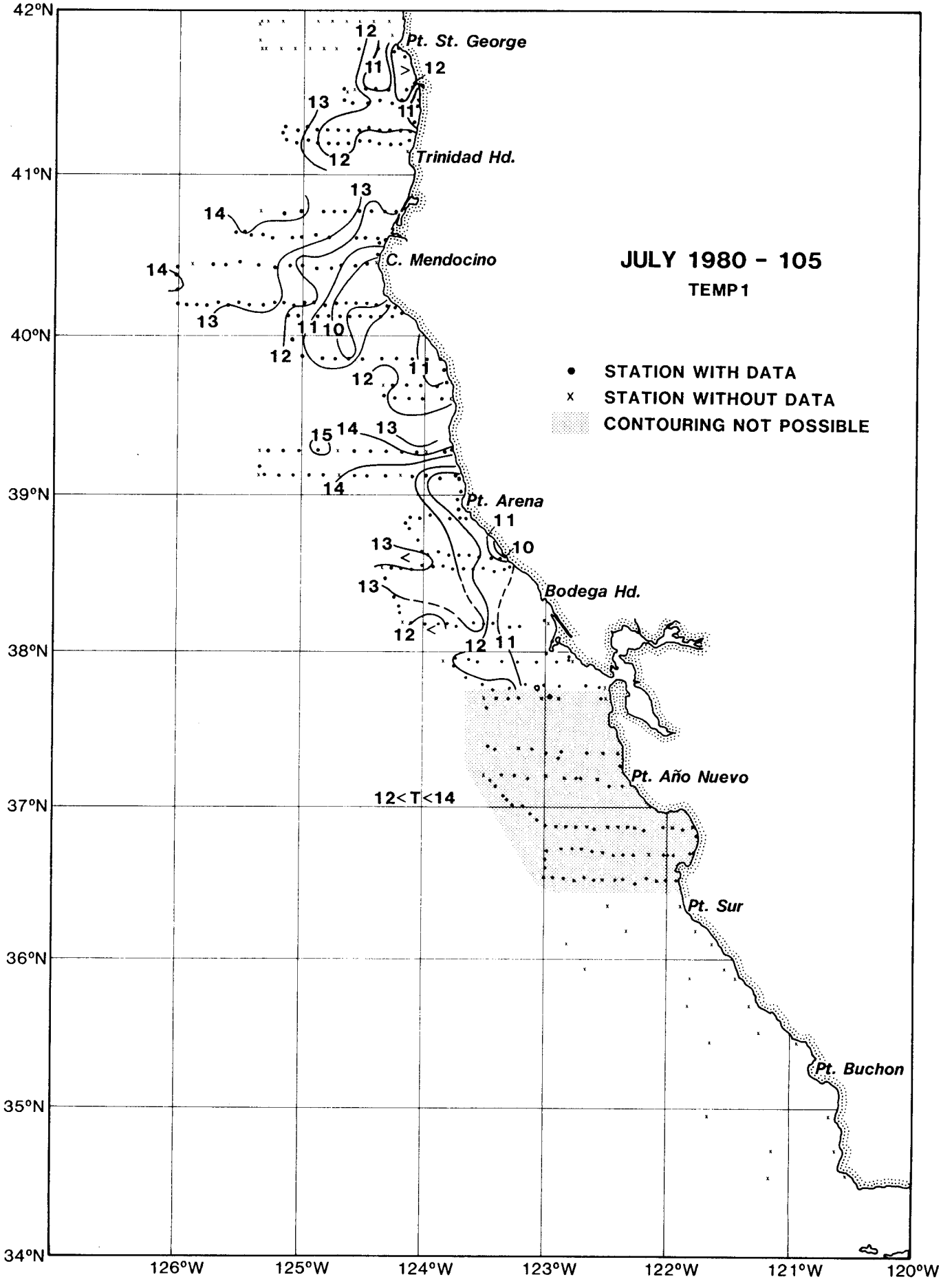
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Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
JULY 1980 - 105
TEMP1
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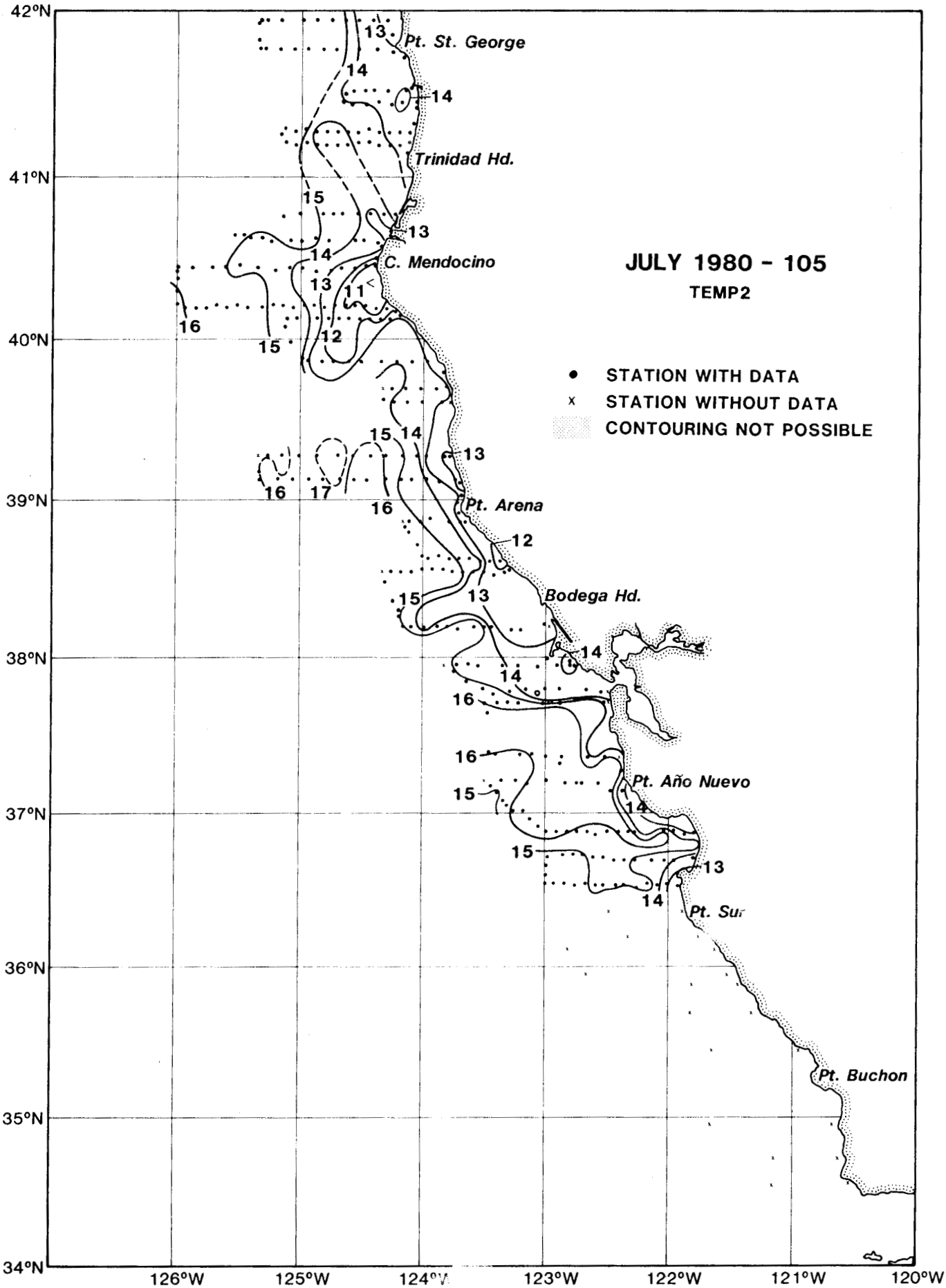
JULY 1980 - 105
TEMP2
• STATION WITH DATA
x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
41°N
40°N
39°N
38°N
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35°N
34°N
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124°W
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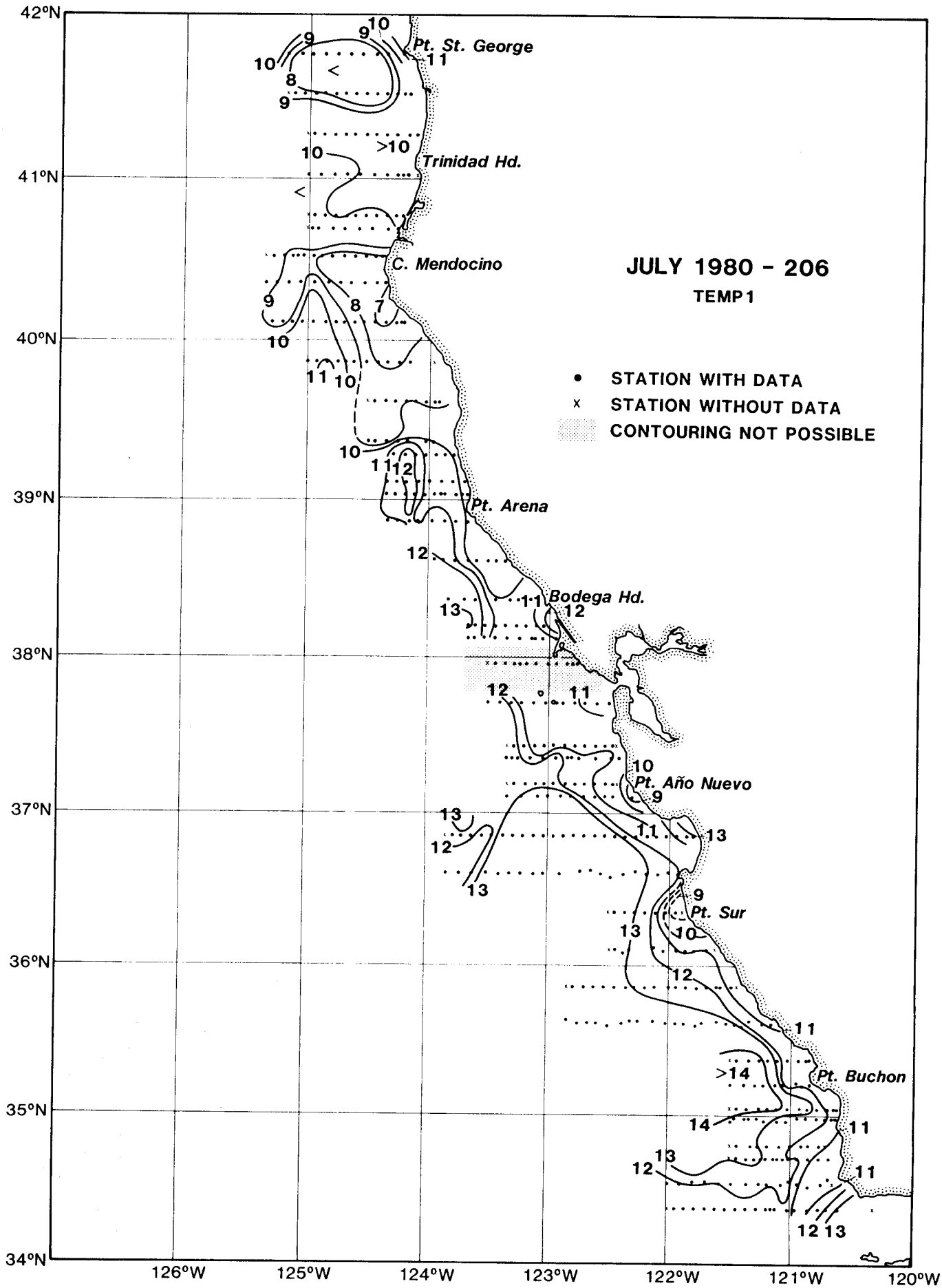
121°W
120°W


JULY 1980 - 206
TEMP1
• STATION WITH DATA
x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
41°N
40°N
39°N
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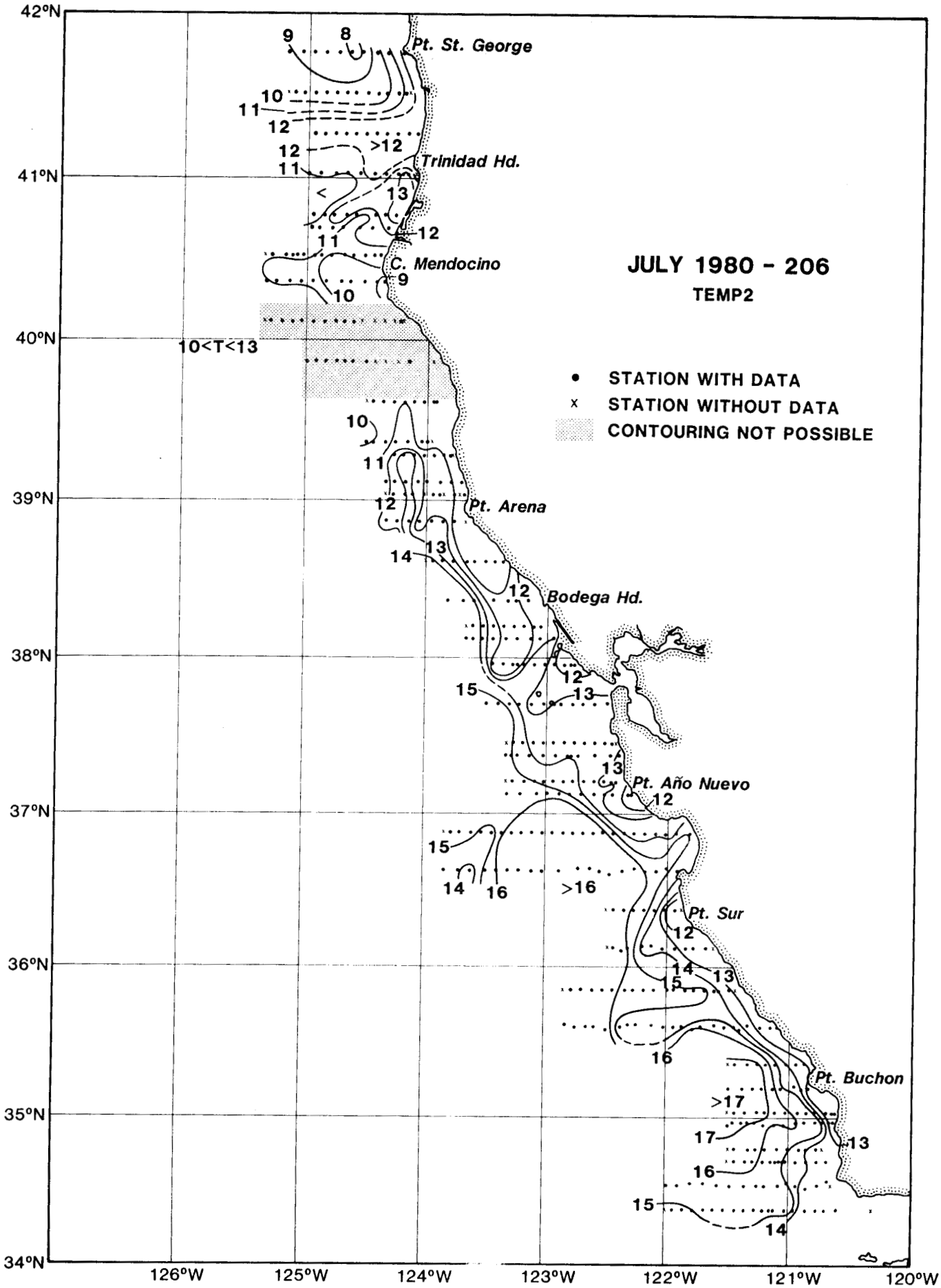
JULY 1980 - 206
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x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
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Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
41°N
40°N
39°N
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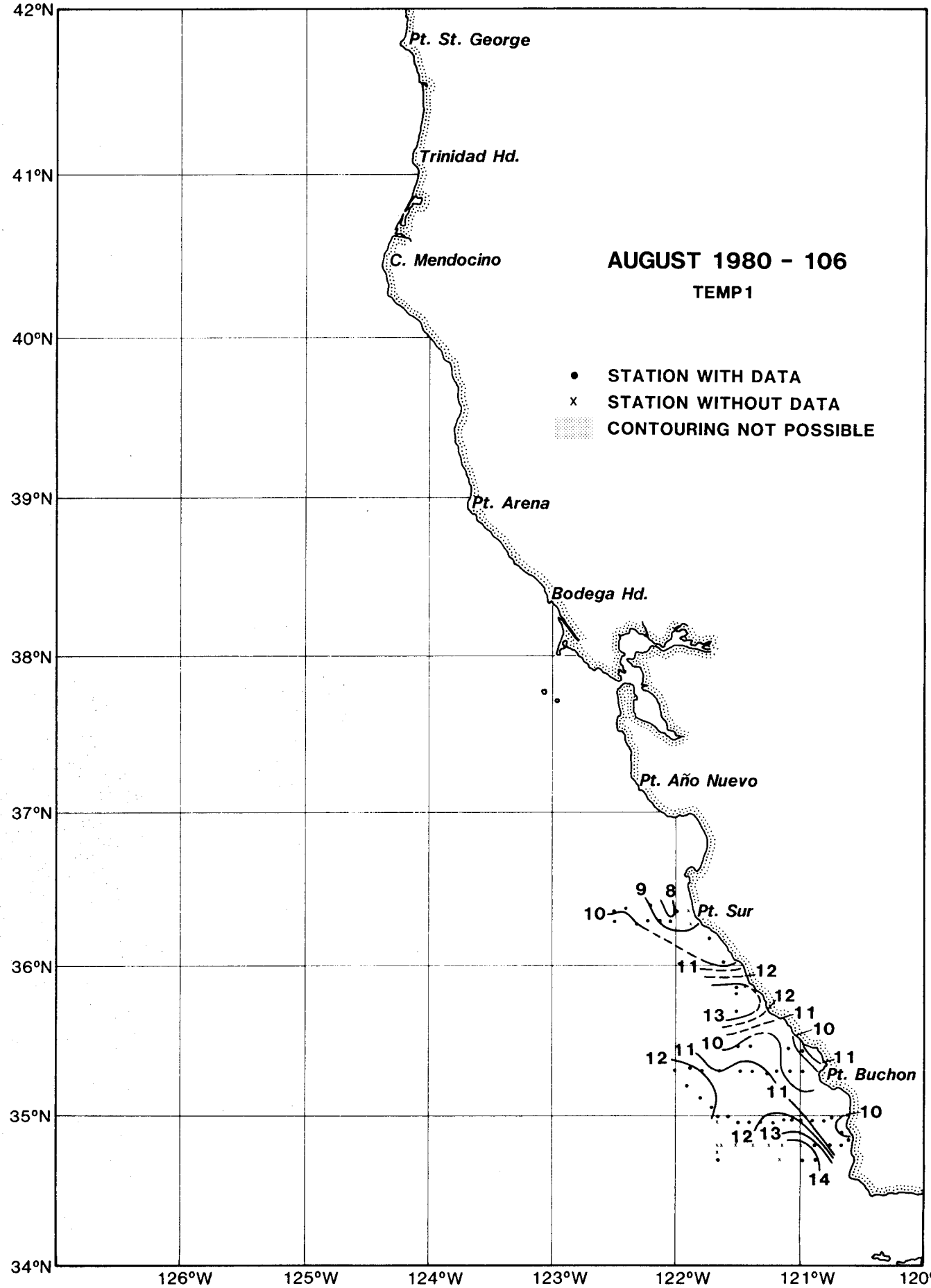
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125°W
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123°W
122°W
121°W
120°W
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
AUGUST 1980 - 106
TEMP 1
• STATION WITH DATA
x STATION WITHOUT DATA
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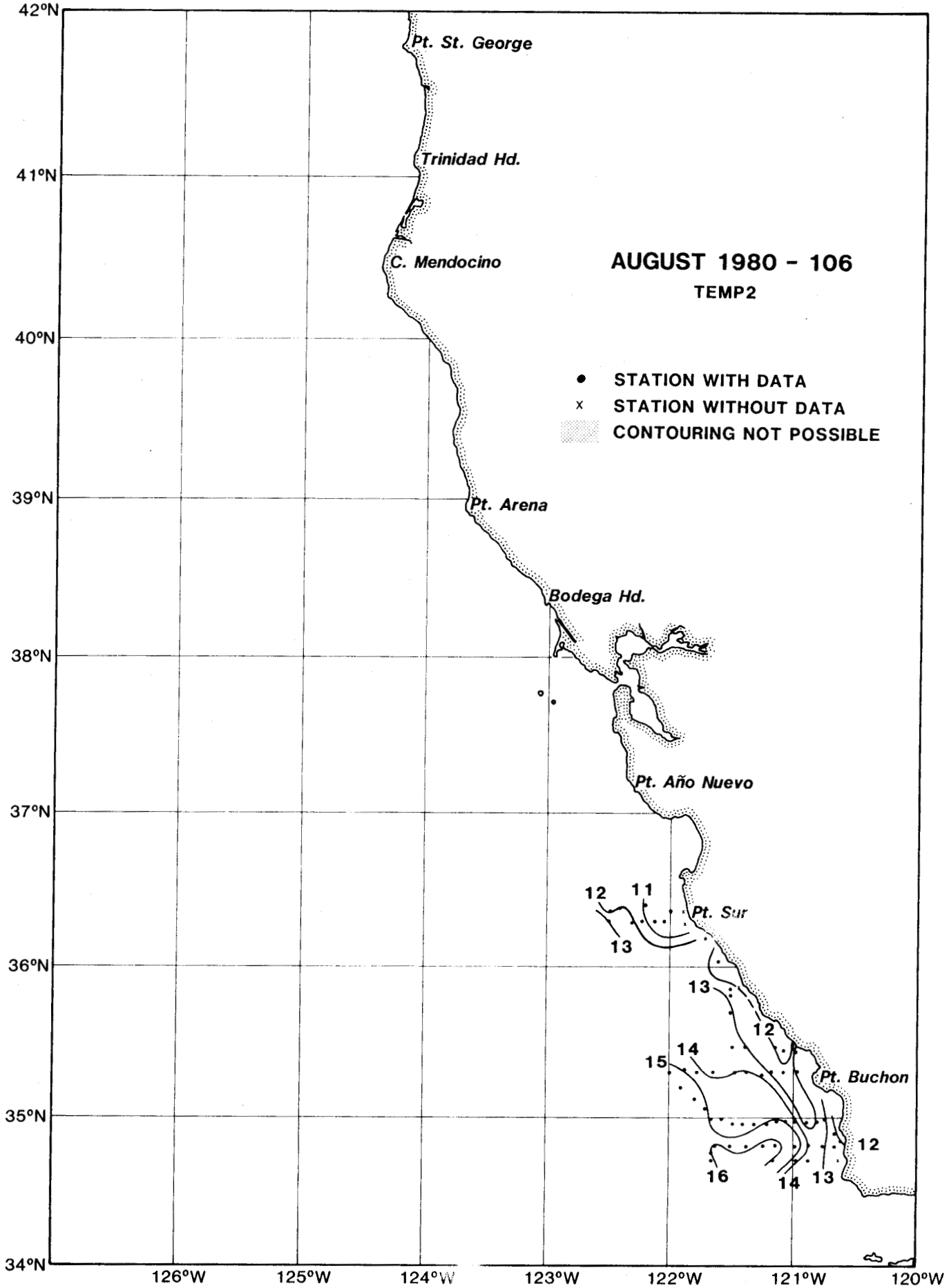
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125°W
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123°W
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121°W
120°W
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
AUGUST 1980 - 106
TEMP2
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STATION WITHOUT DATA
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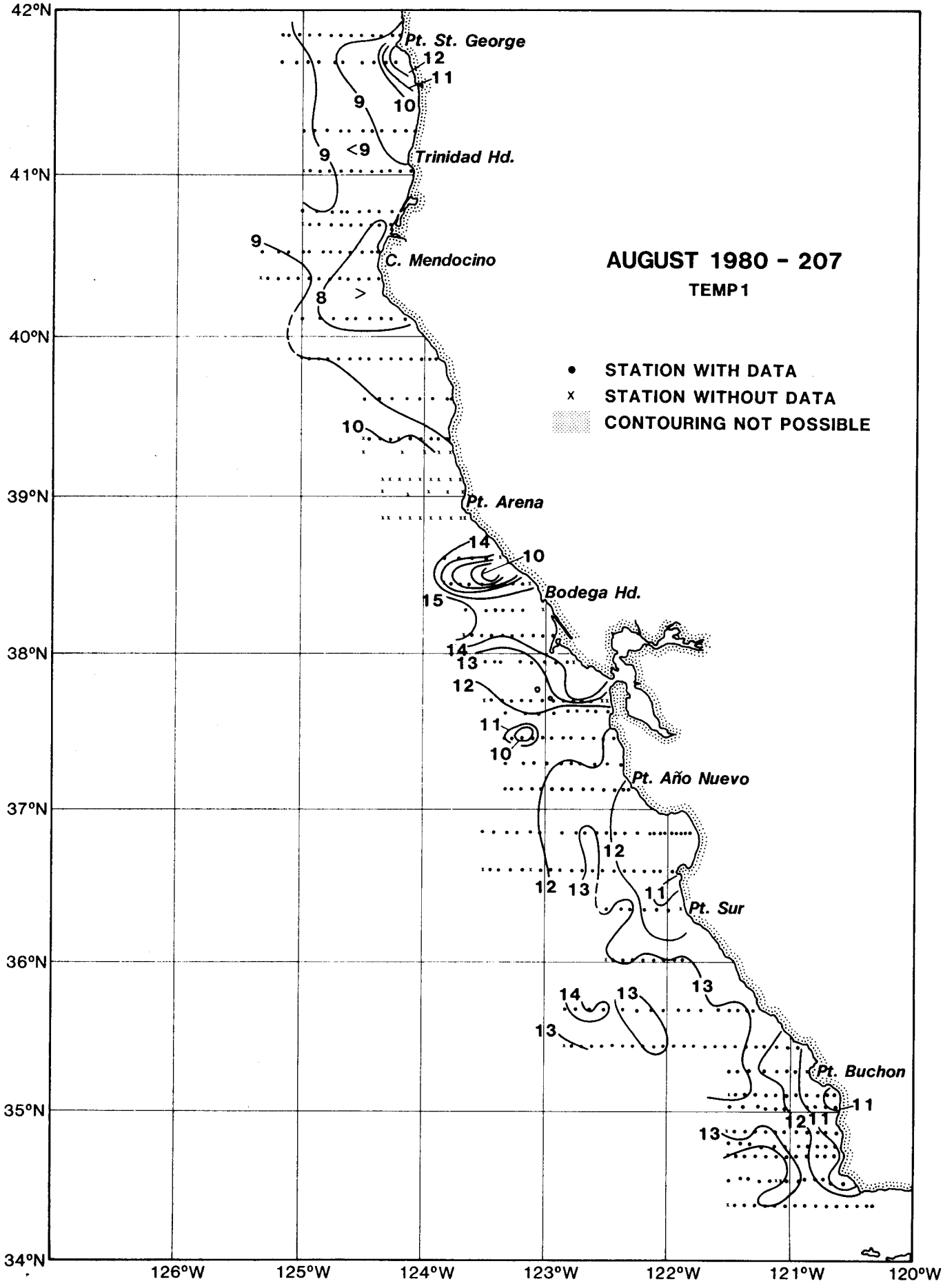
AUGUST 1980 - 207
TEMP1
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Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
41°N
40°N
39°N
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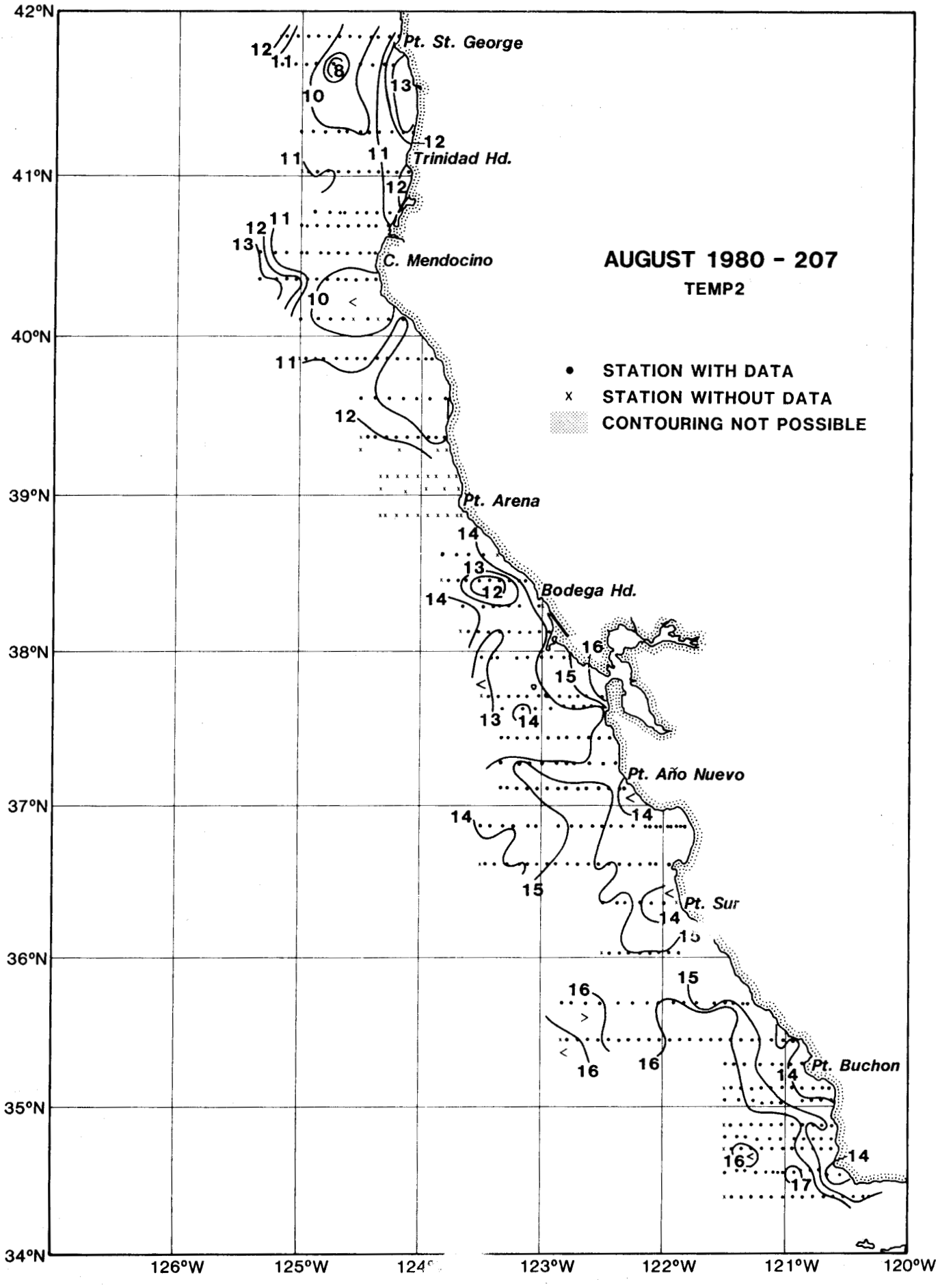
AUGUST 1980 - 207
TEMP2
• STATION WITH DATA
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Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
41°N
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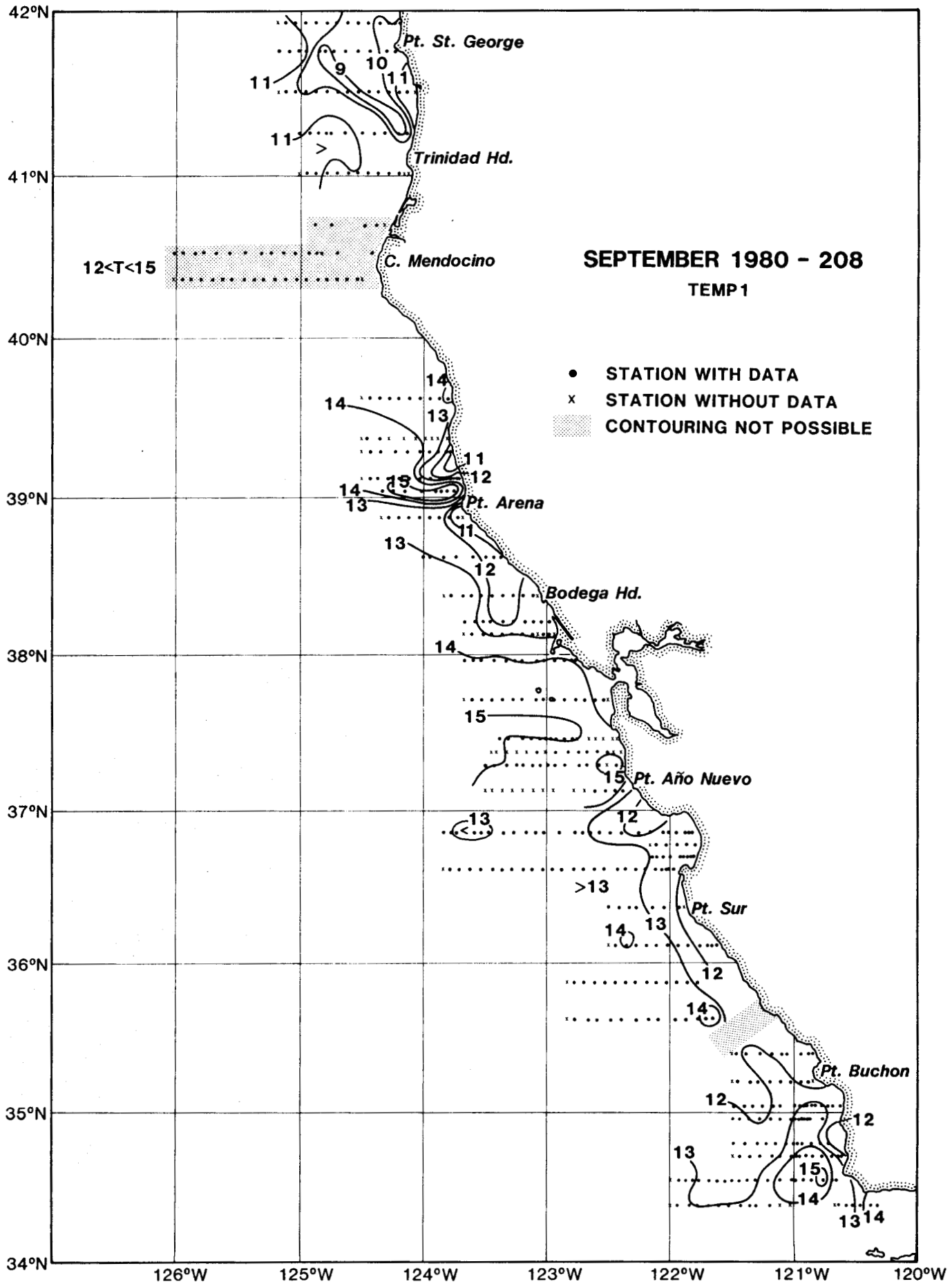
SEPTEMBER 1980 - 208
TEMP1
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x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
12<T<15
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
41°N
40°N
39°N
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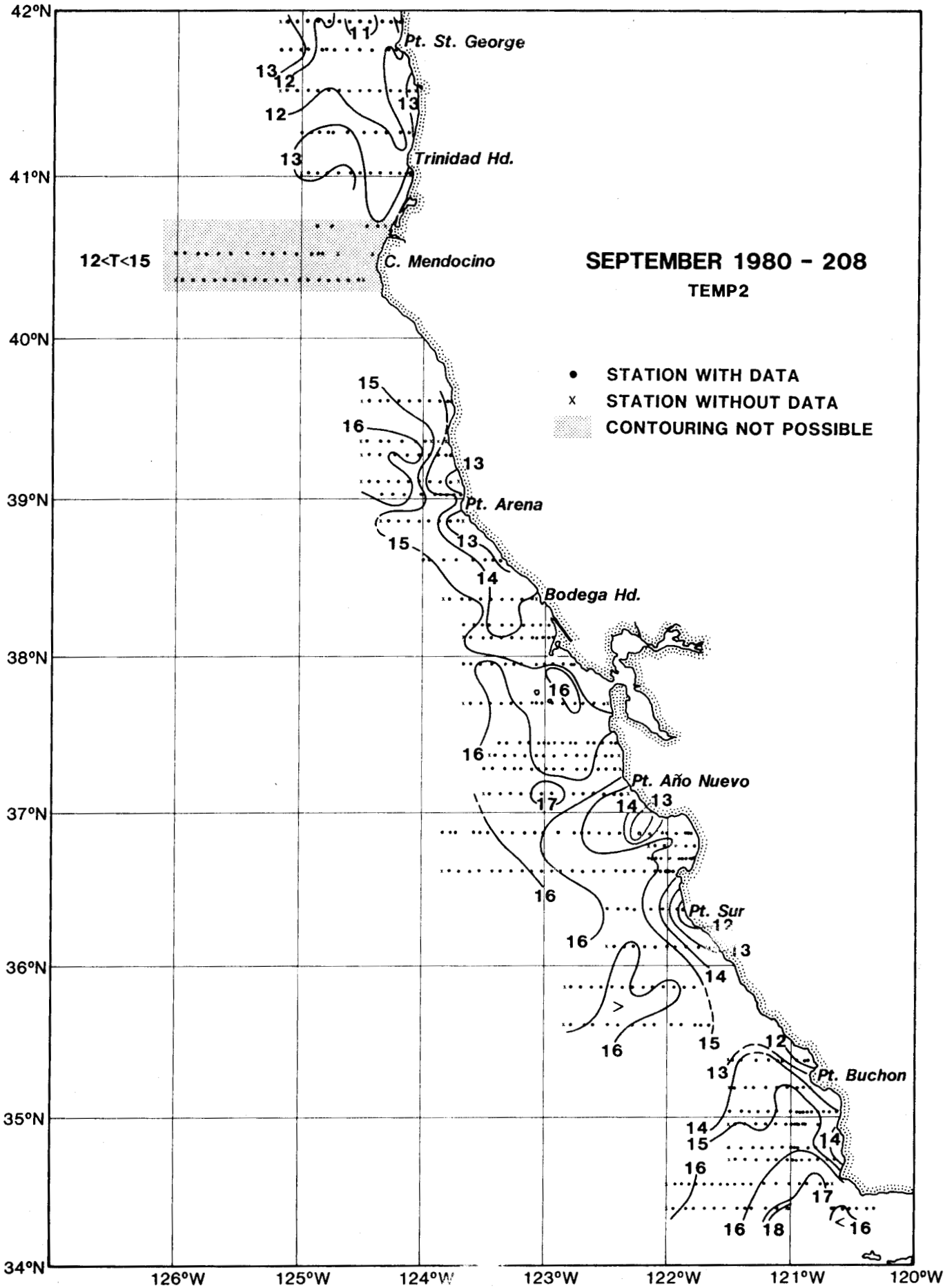
SEPTEMBER 1980 - 208
TEMP2
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Pt. Sur
Pt. Buchon
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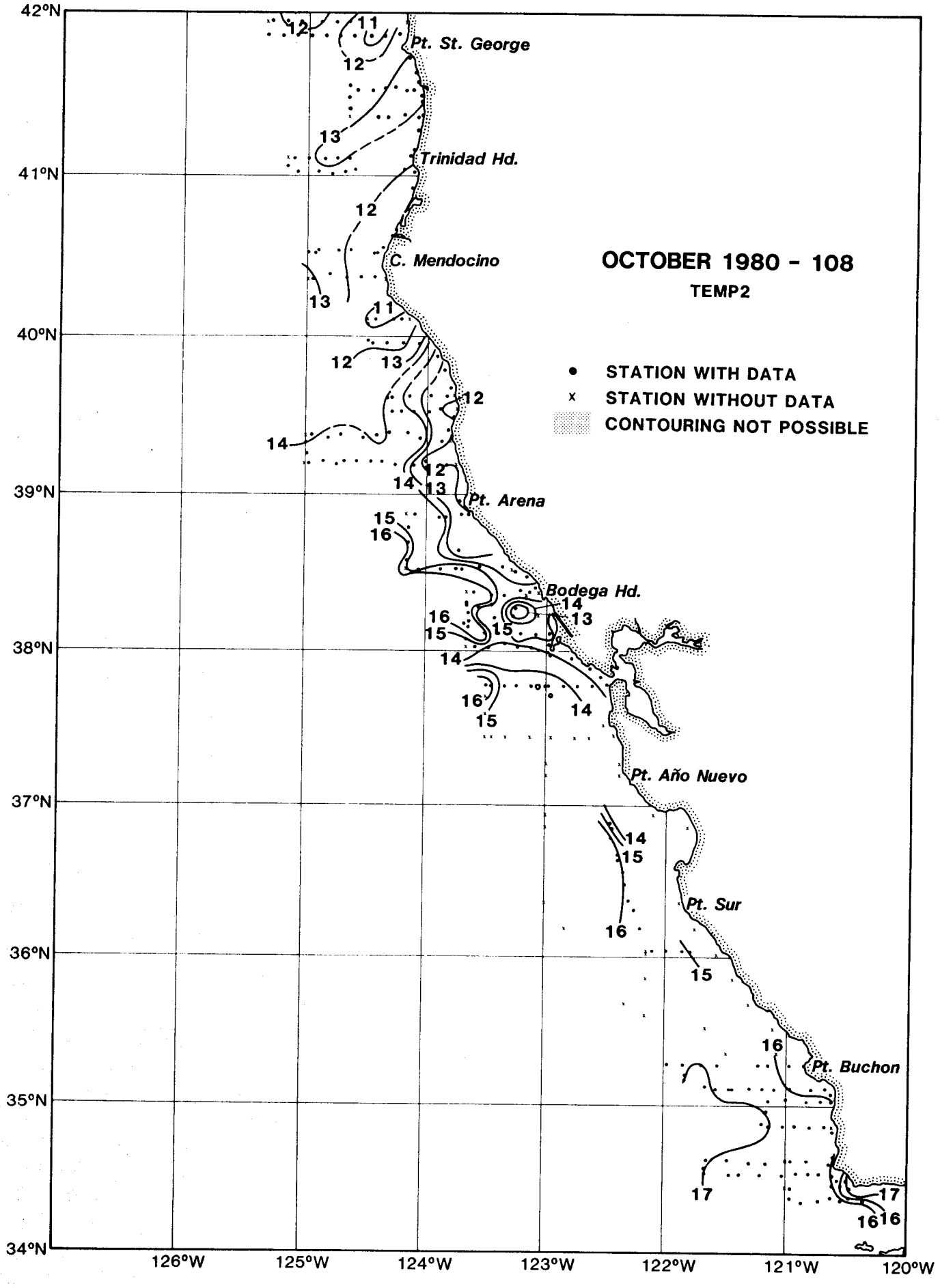
OCTOBER 1980 - 108
TEMP2
• STATION WITH DATA
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C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
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40°N
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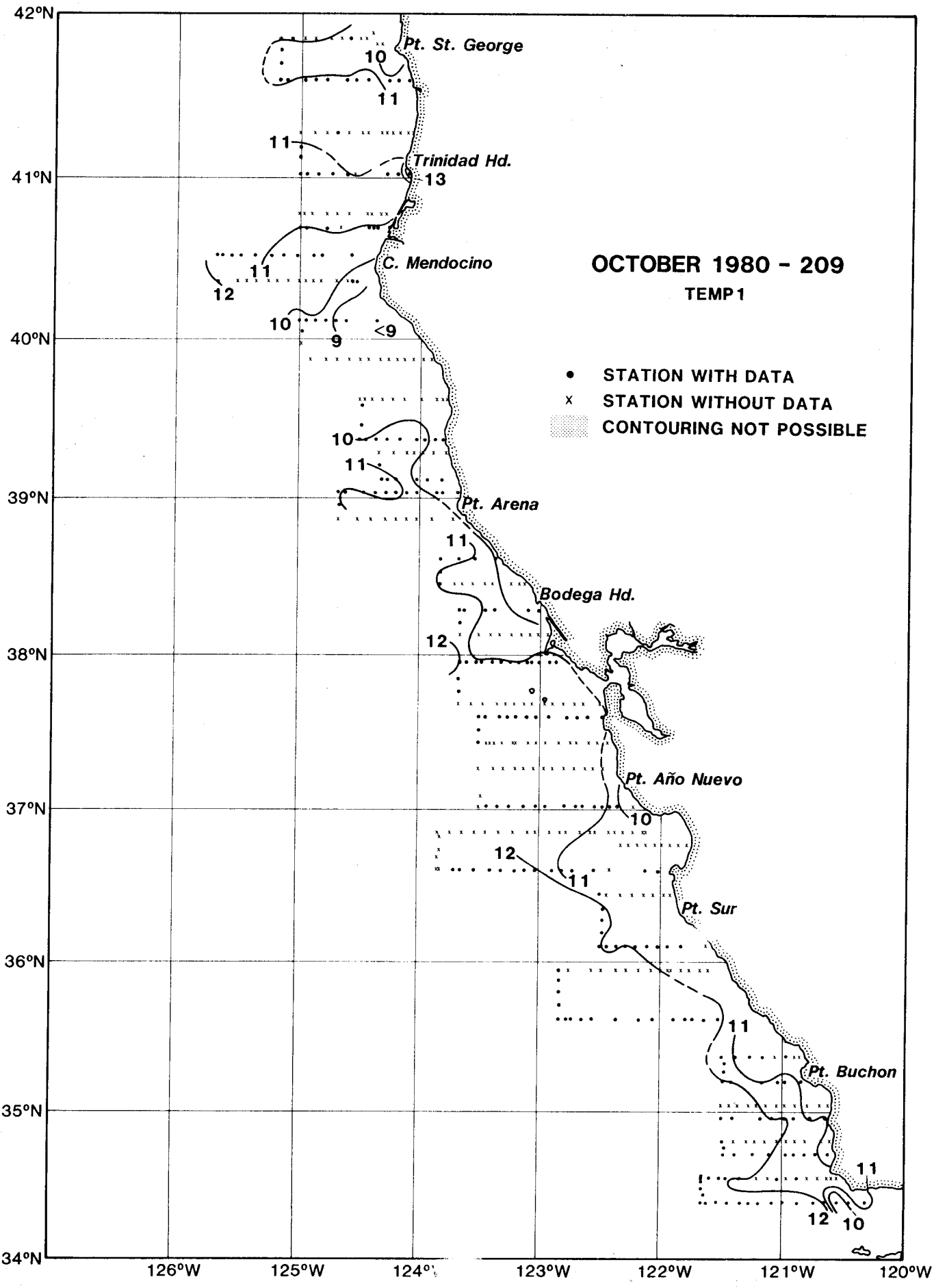
OCTOBER 1980 - 209
TEMP1
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Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
41°N
40°N
39°N
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35°N
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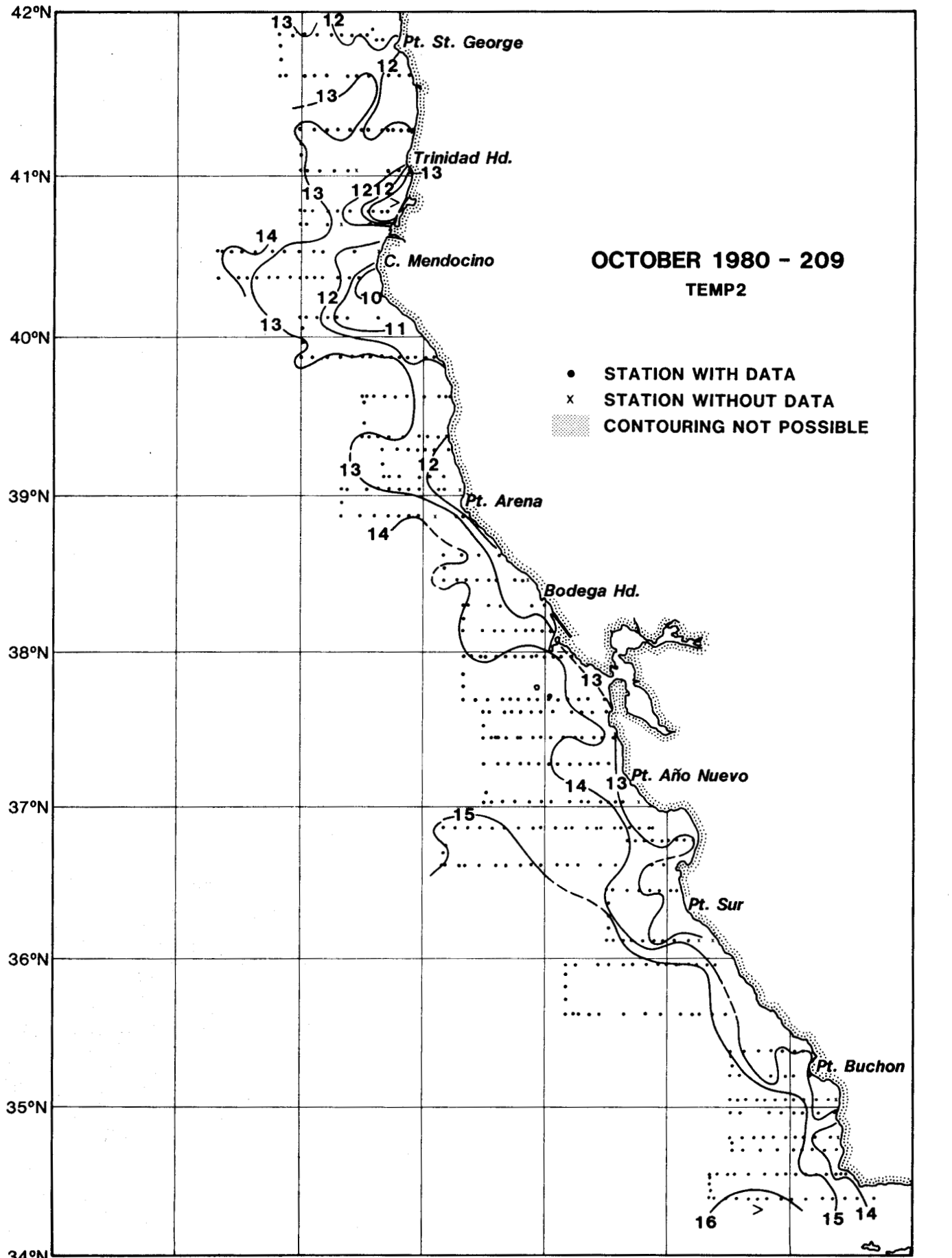
121°W
120°W


OCTOBER 1980 - 209
TEMP2
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Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
41°N
40°N
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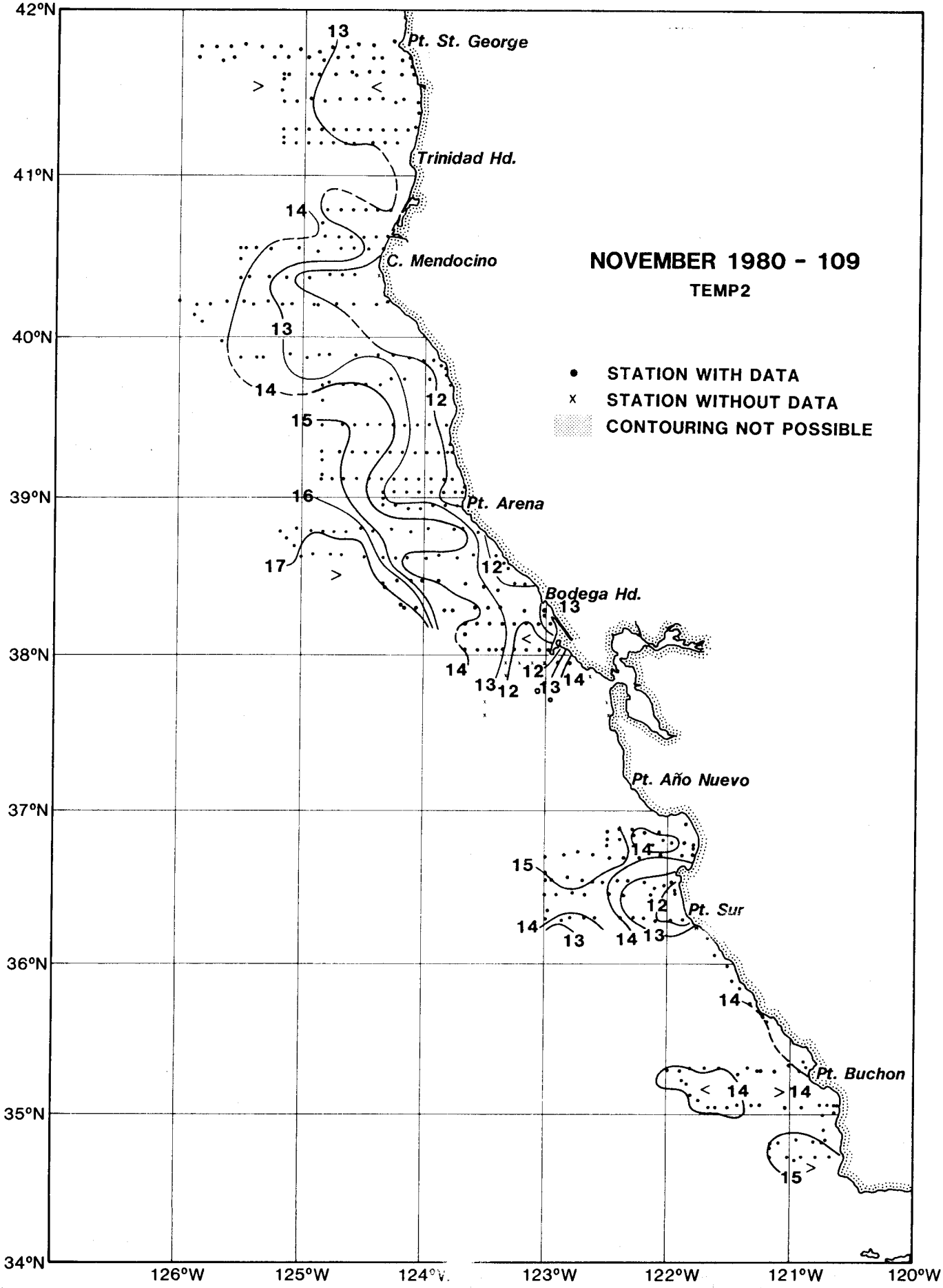
NOVEMBER 1980 - 109
TEMP2
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Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
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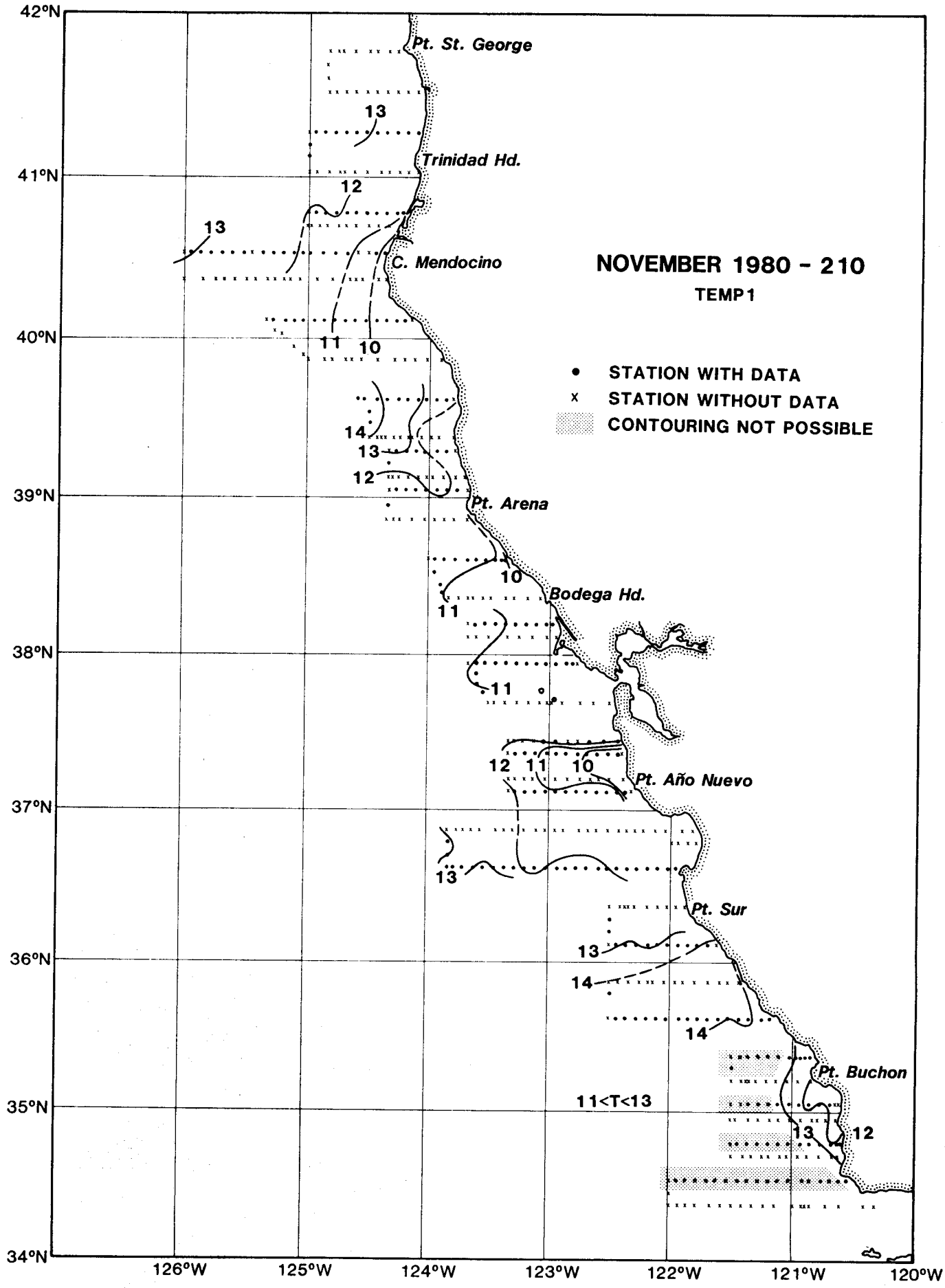
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123°W
122°W
121°W
120°W
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
NOVEMBER 1980 - 210
TEMP1
STATION WITH DATA
STATION WITHOUT DATA
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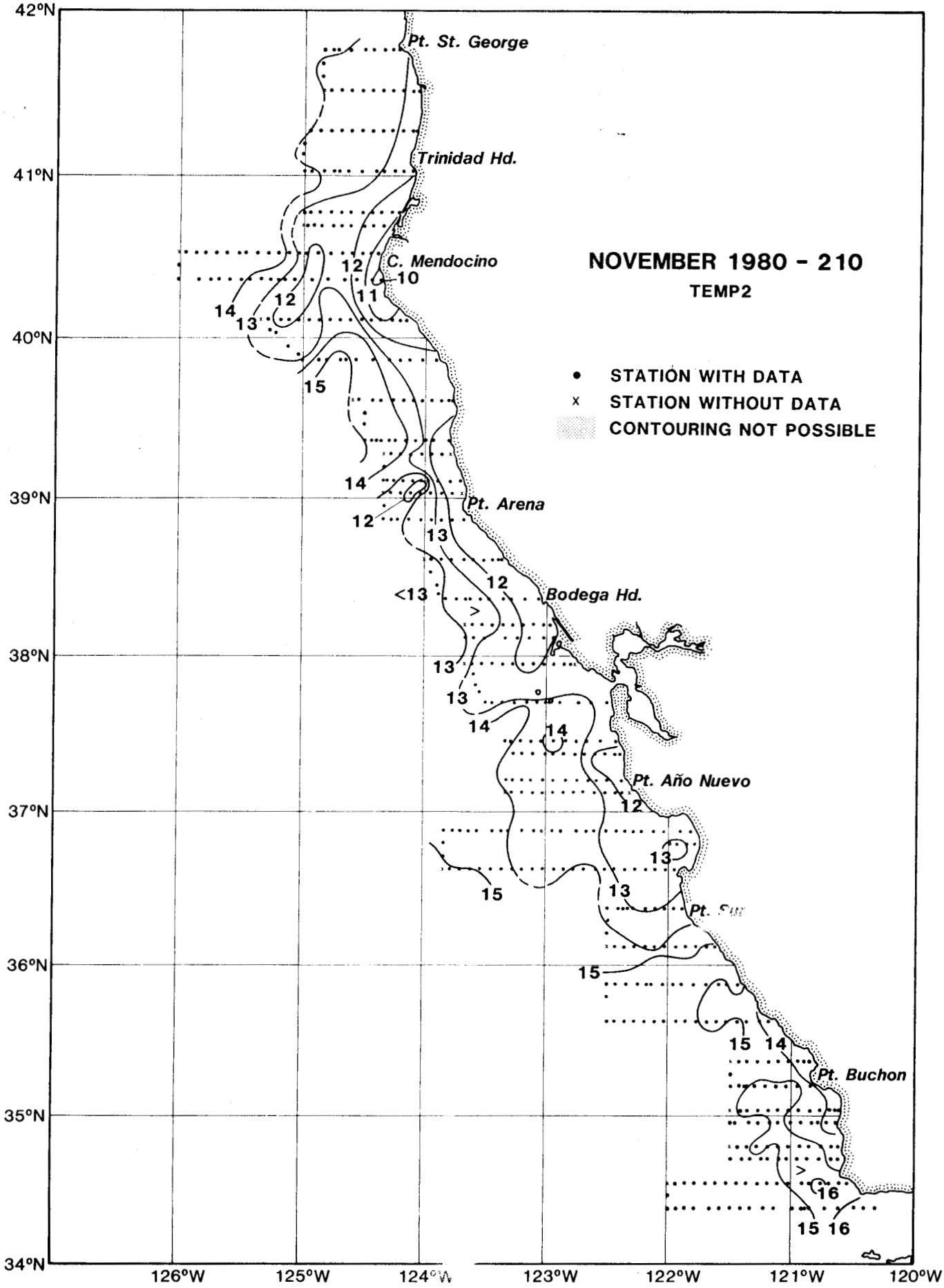
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TEMP2
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Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Buchon
42°N
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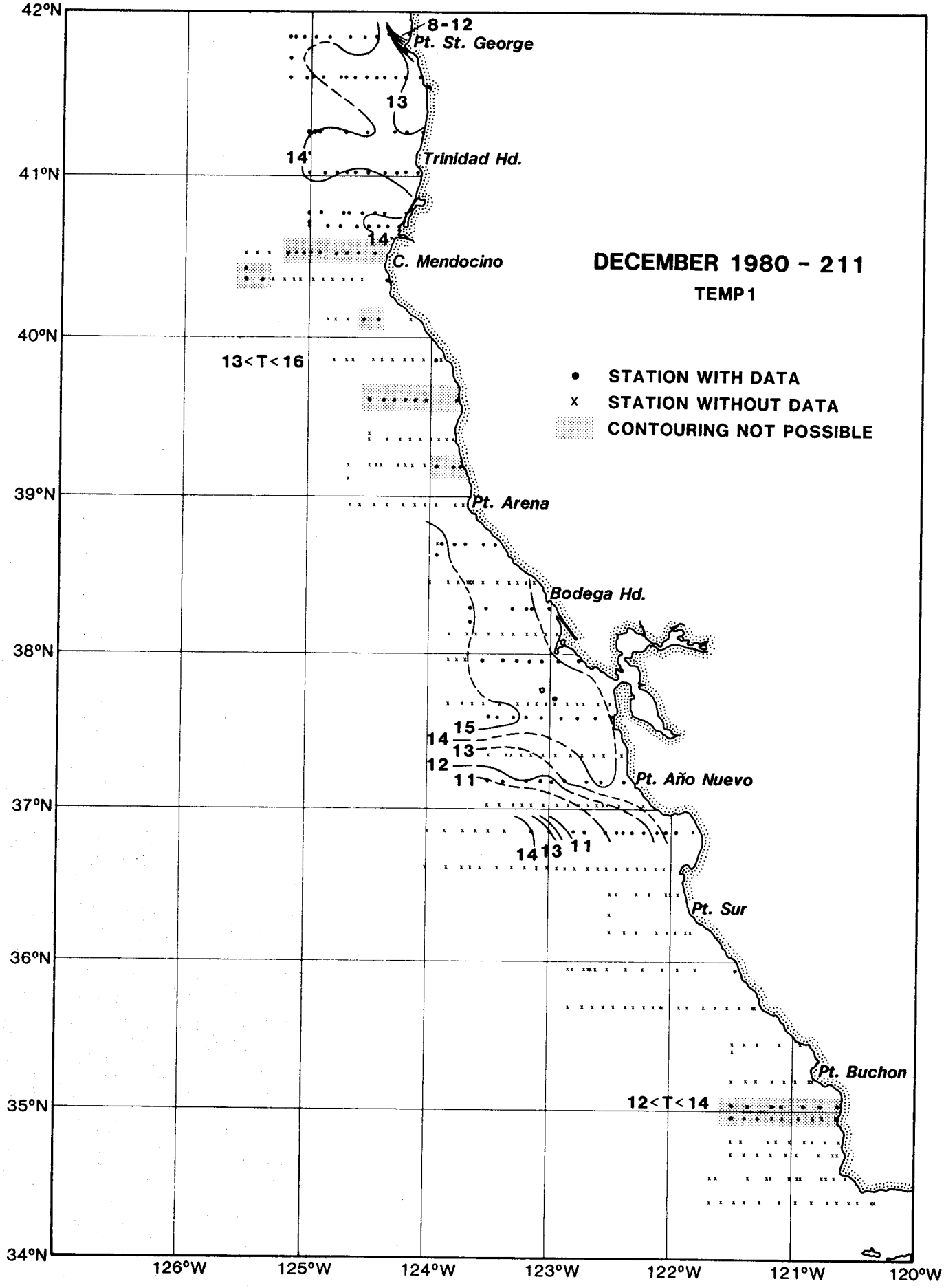
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124°W
123°W
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120°W
8-12
Pt. St. George
13
14
Trinidad Hd.
14
C. Mendocino
DECEMBER 1980 - 211
TEMP1
13<T<16
STATION WITH DATA
STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
Pt. Arena
Bodega Hd.
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Pt. Año Nuevo
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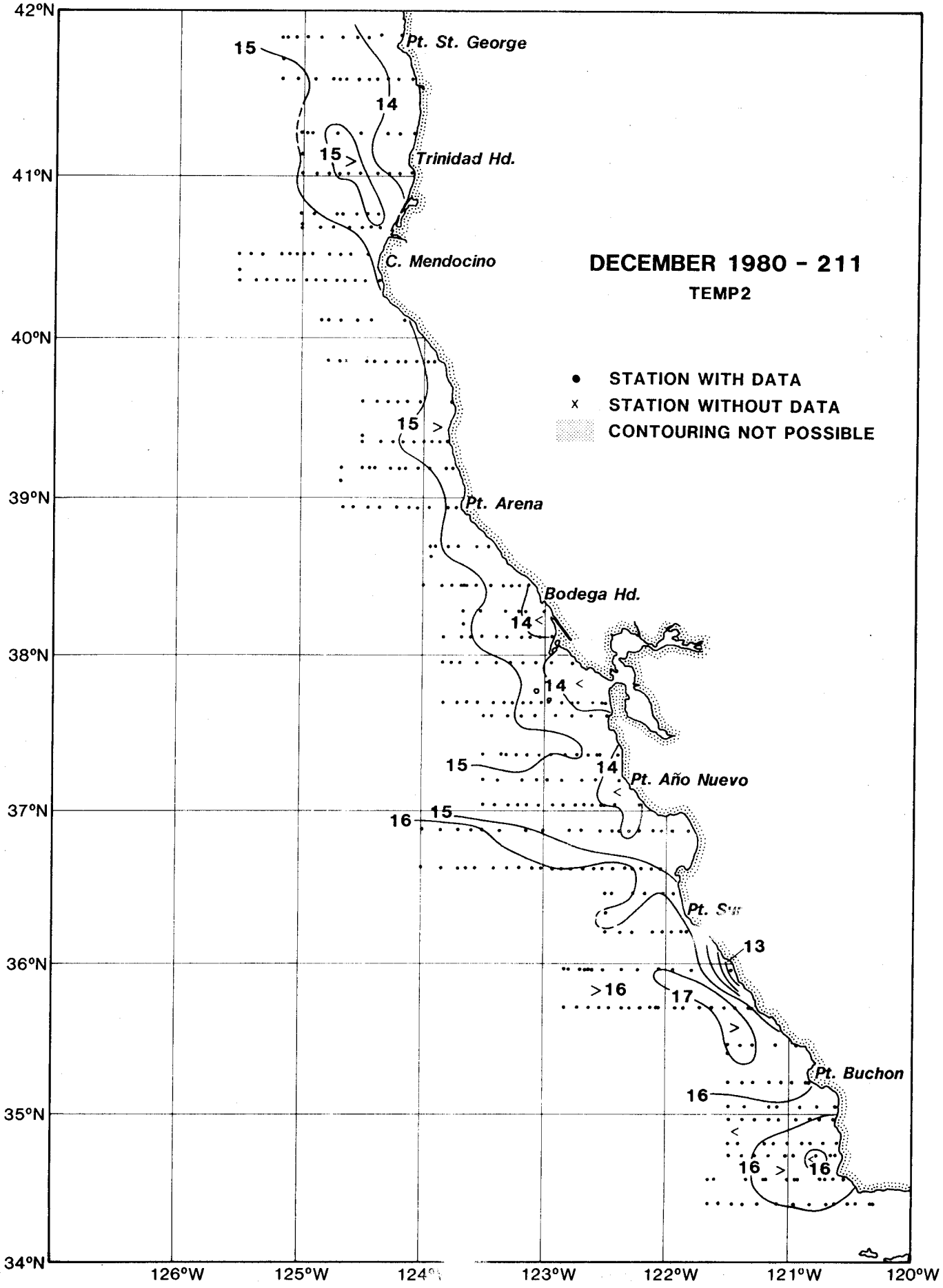
Pt. Sur
Pt. Buchon
12<T<14


DECEMBER 1980 - 211
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Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
41°N
40°N
39°N
38°N
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123°W
122°W
121°W
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14 <
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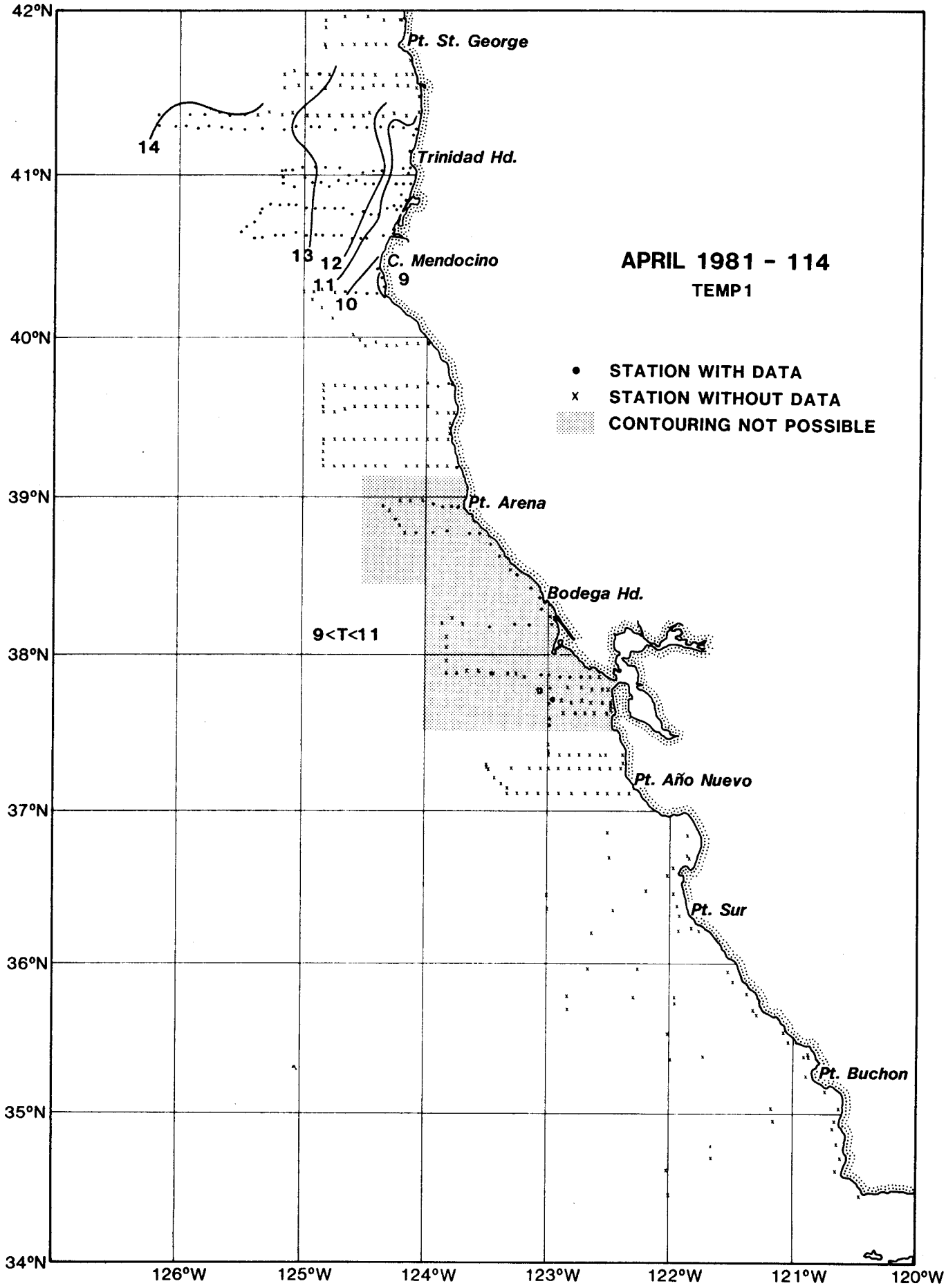
16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123°W
122°W
121°W
120°W
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
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10
9
APRIL 1981 - 114
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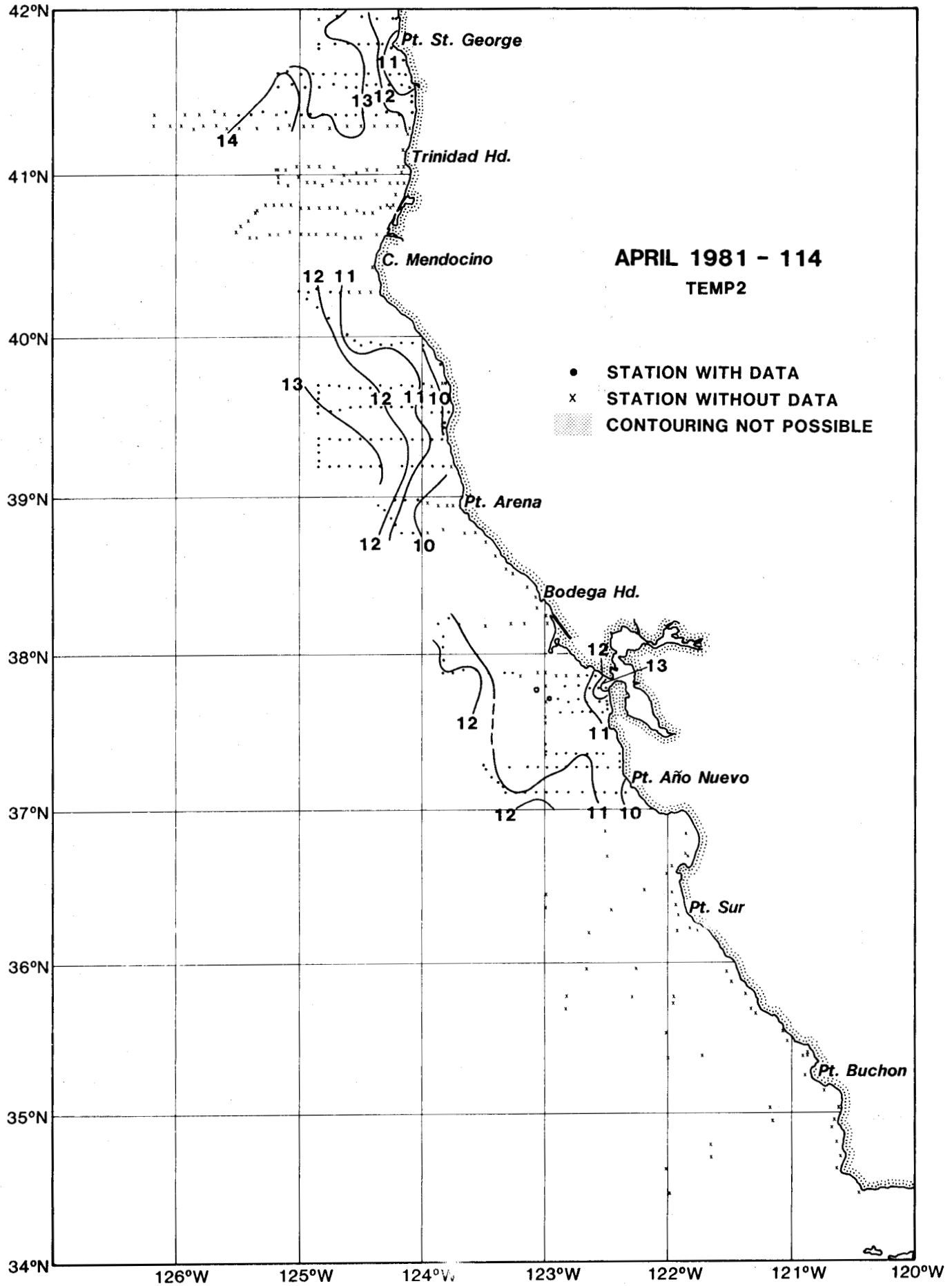
APRIL 1981 - 114
TEMP2
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x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
41°N
40°N
39°N
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34°N
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124°W
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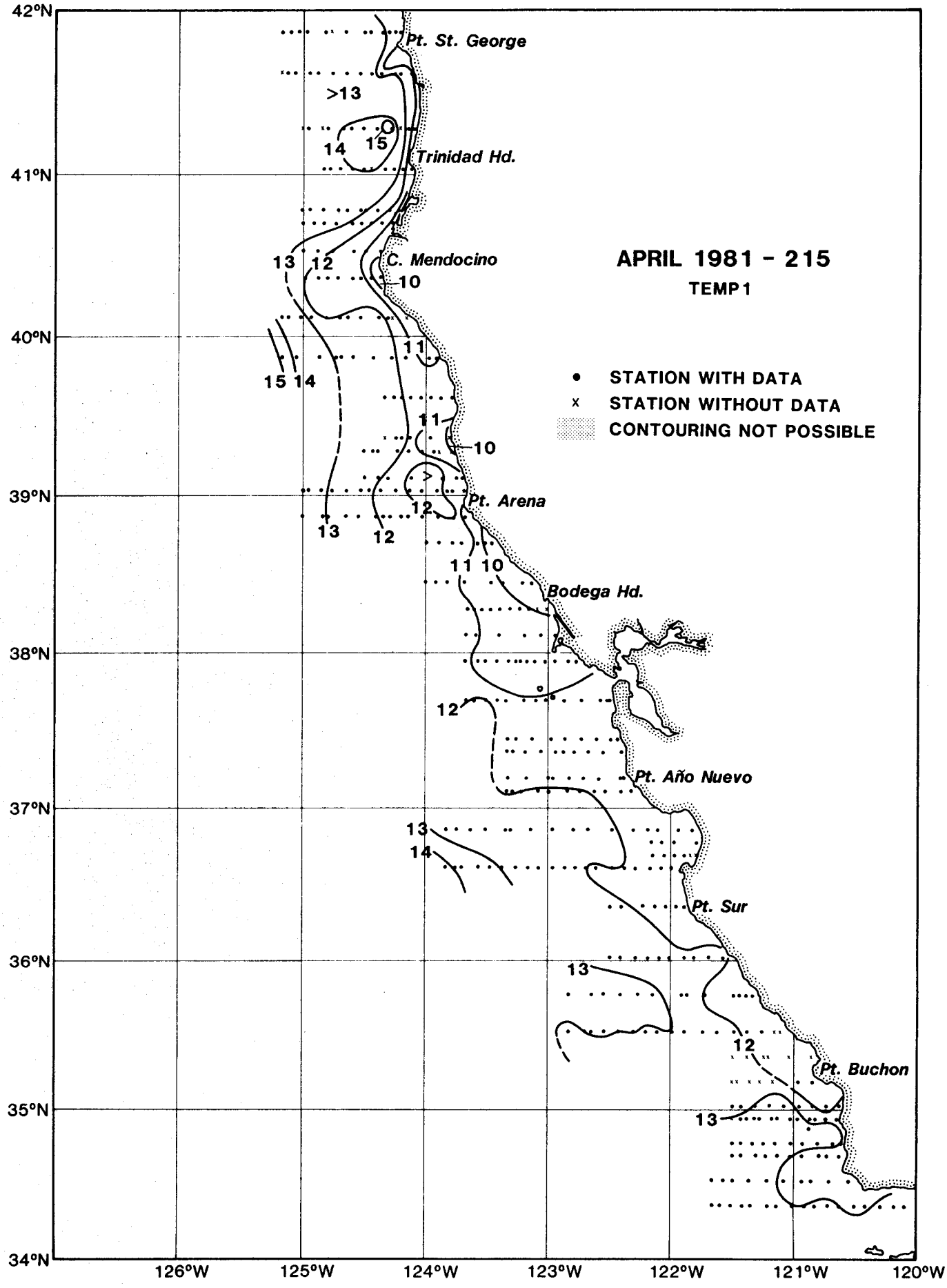
APRIL 1981 - 215
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Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
>13
14
15
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15 14
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11 10
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12
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42°N
41°N
40°N
39°N
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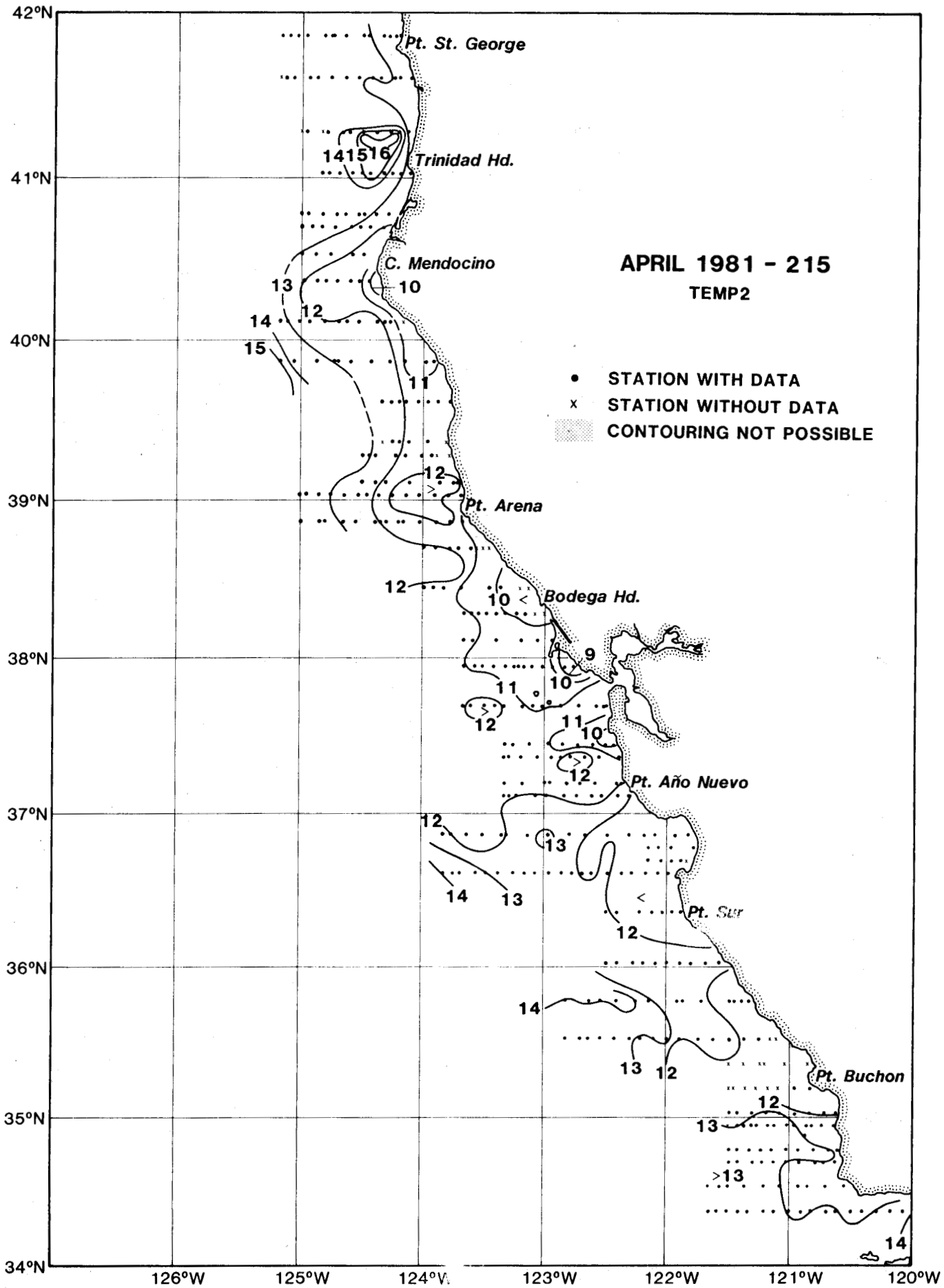
APRIL 1981 - 215
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Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
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40°N
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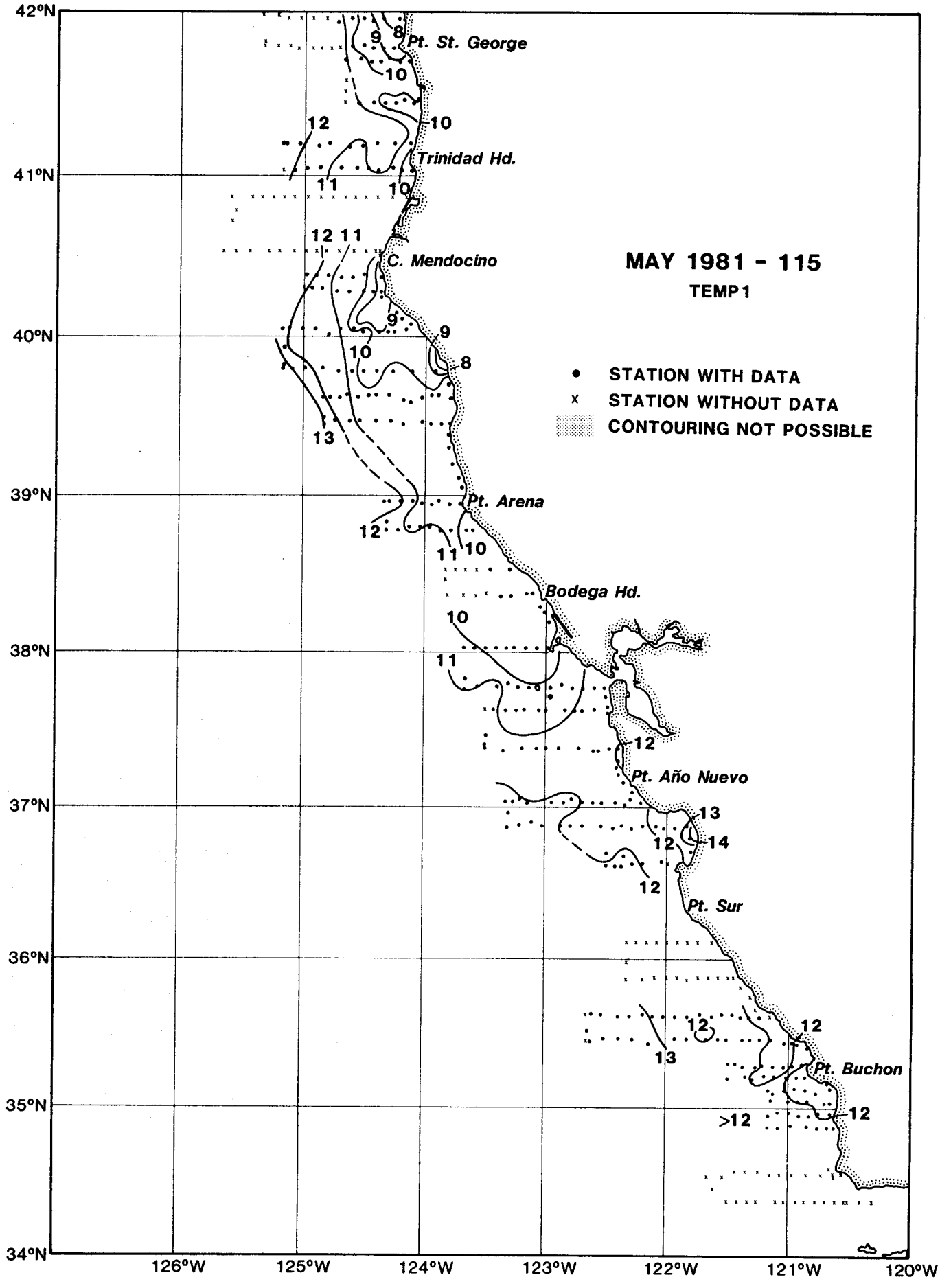
MAY 1981 - 115
TEMP 1
STATION WITH DATA
STATION WITHOUT DATA
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Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
41°N
40°N
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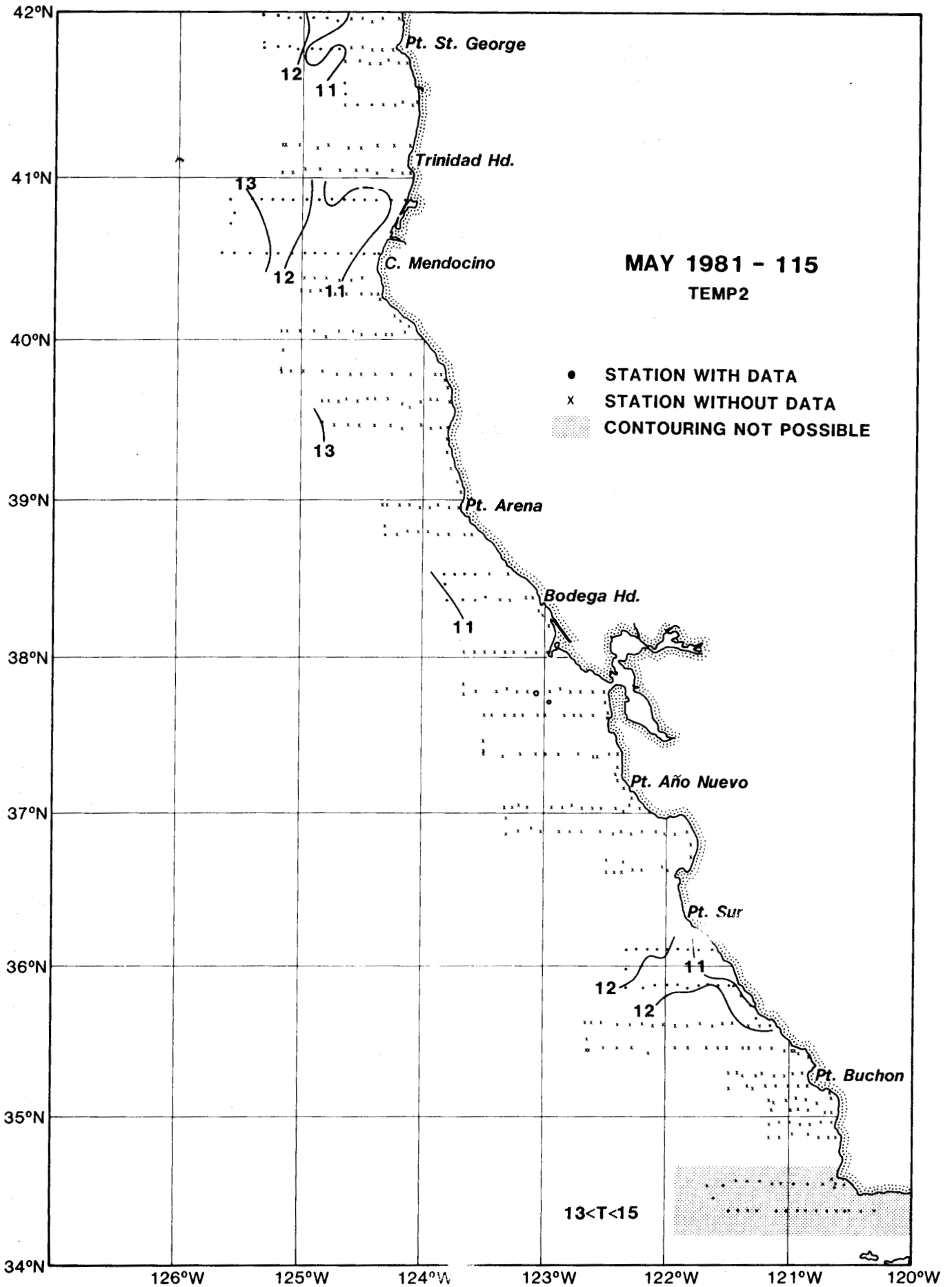
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121°W
120°W
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
MAY 1981 - 115
TEMP2
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STATION WITHOUT DATA
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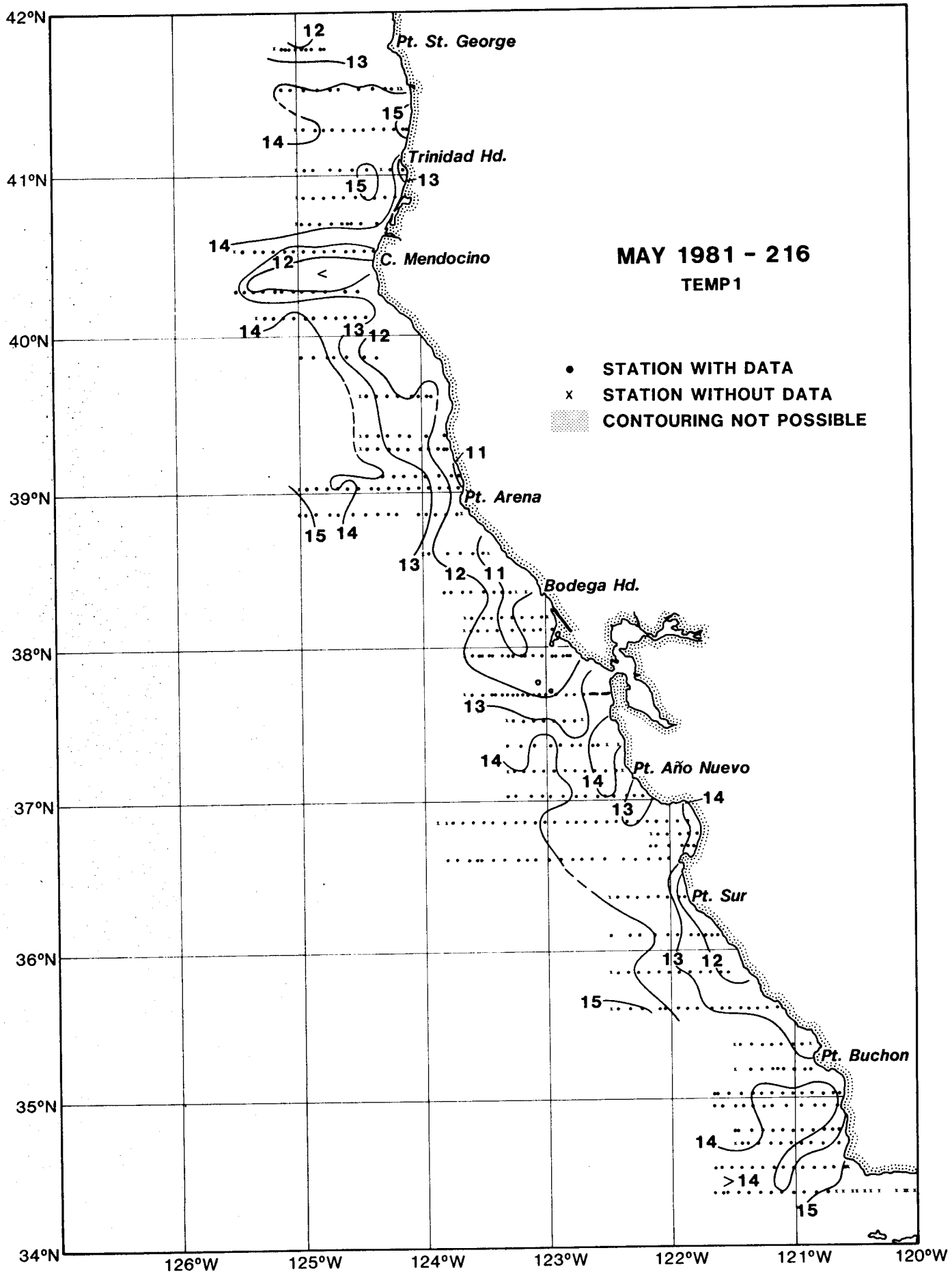
13


MAY 1981 - 216
TEMP1
• STATION WITH DATA
x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
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Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
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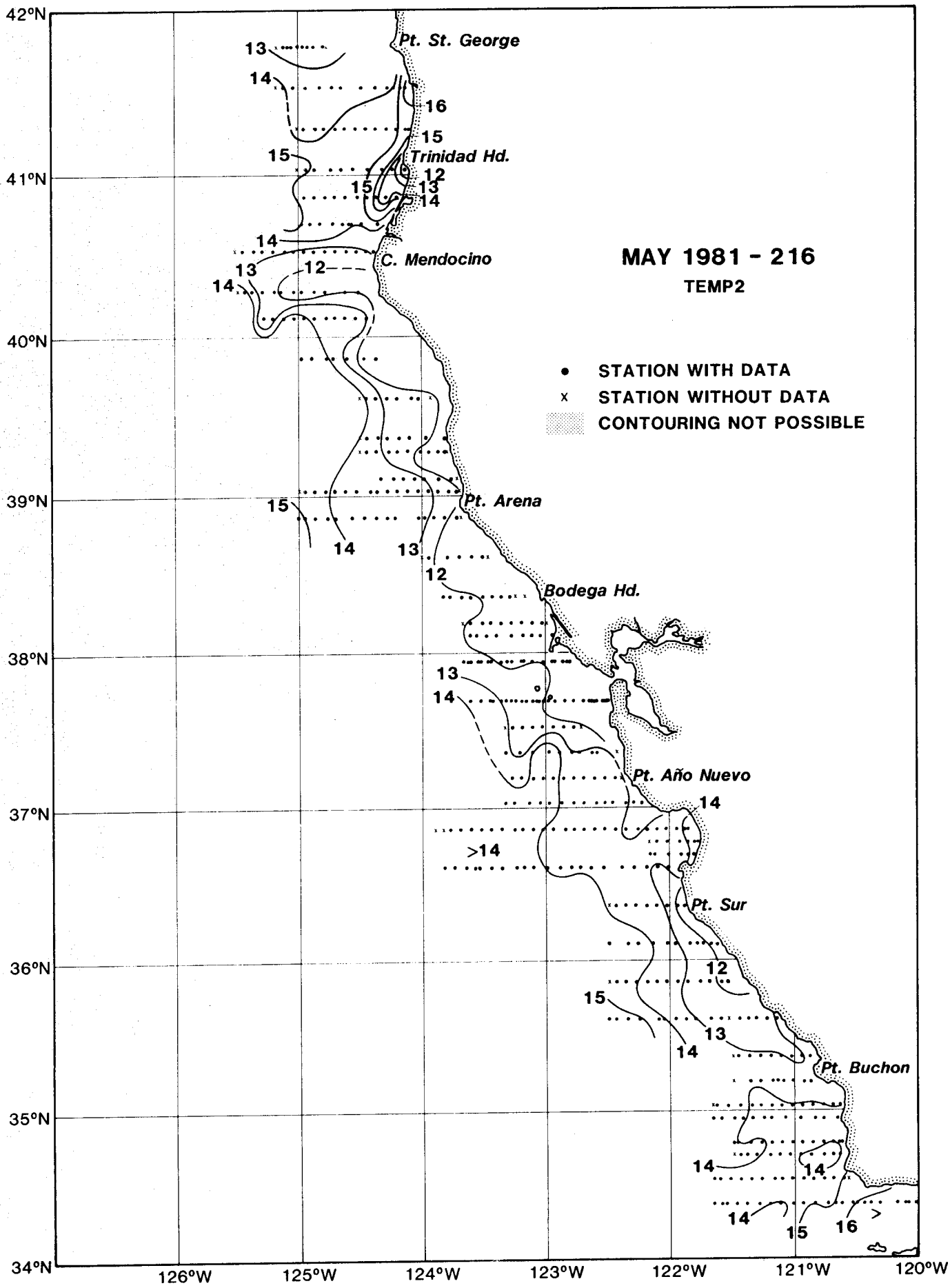
MAY 1981 - 216
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STATION WITH DATA
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C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
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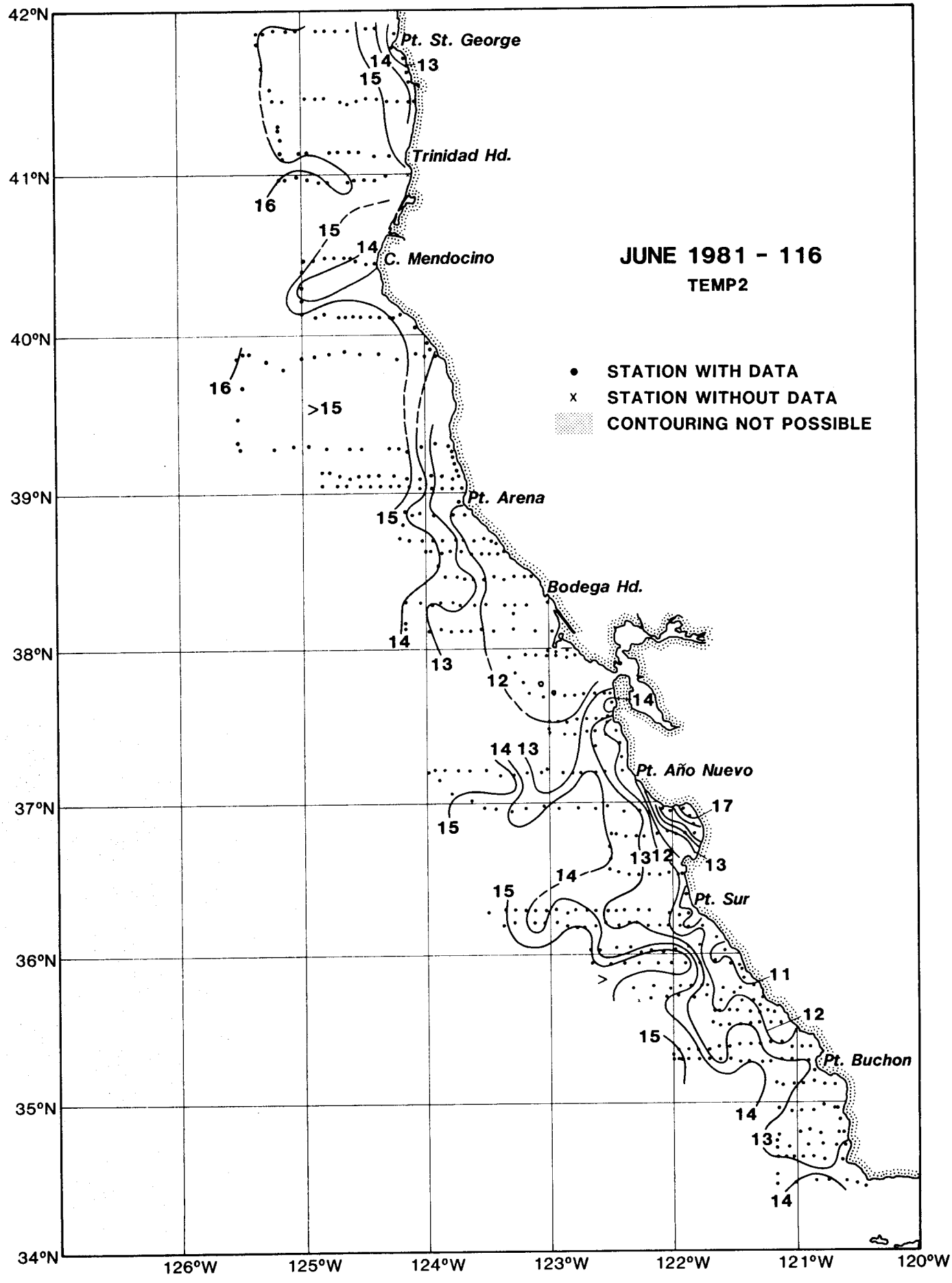
JUNE 1981 - 116
TEMP2
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STATION WITHOUT DATA
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Trinidad Hd.
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Pt. Arena
Bodega Hd.
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Pt. Sur
Pt. Buchon
42°N
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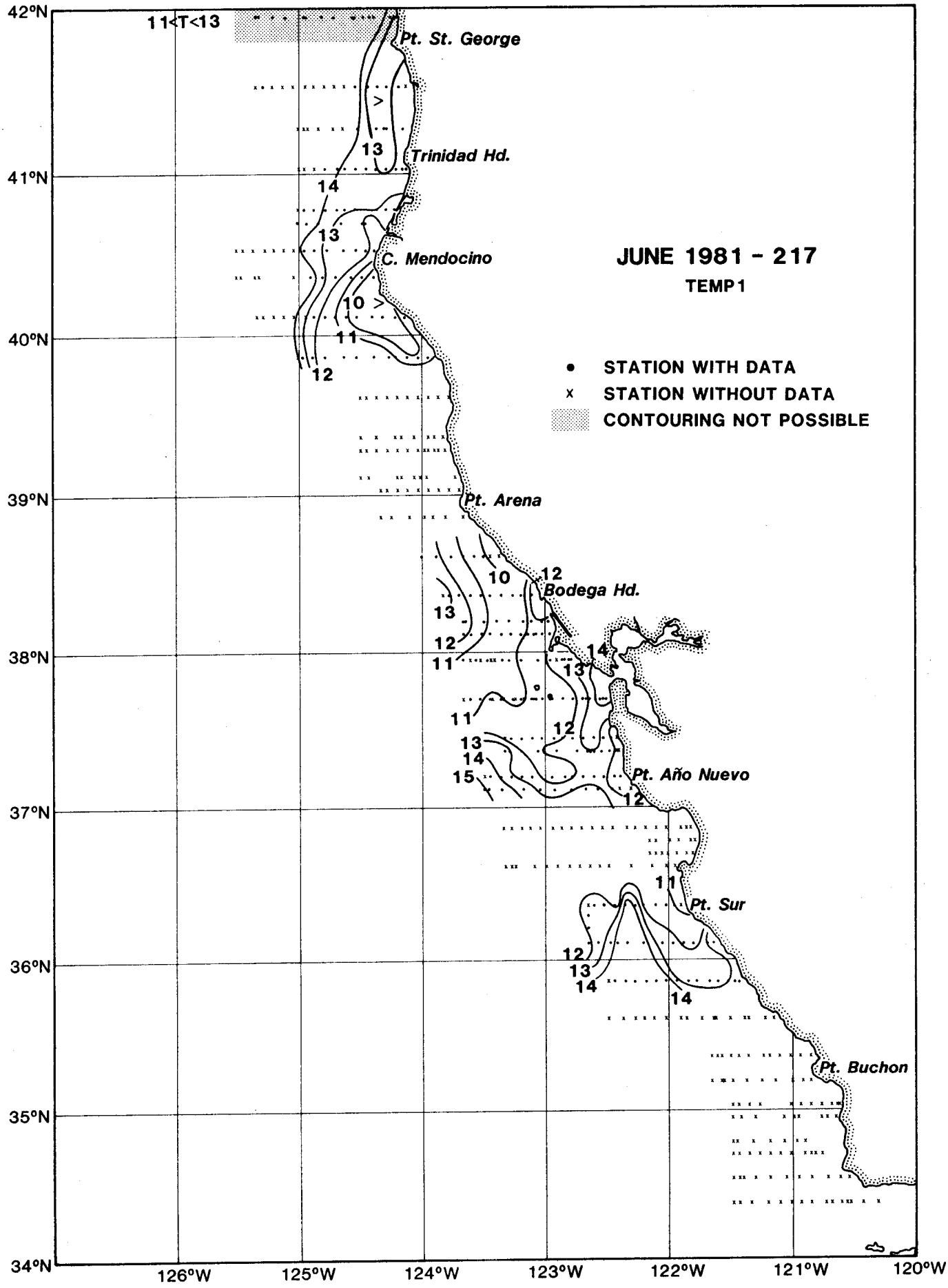
120°W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Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
JUNE 1981 - 217
TEMP1
STATION WITH DATA
STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
42°N
41°N
40°N
39°N
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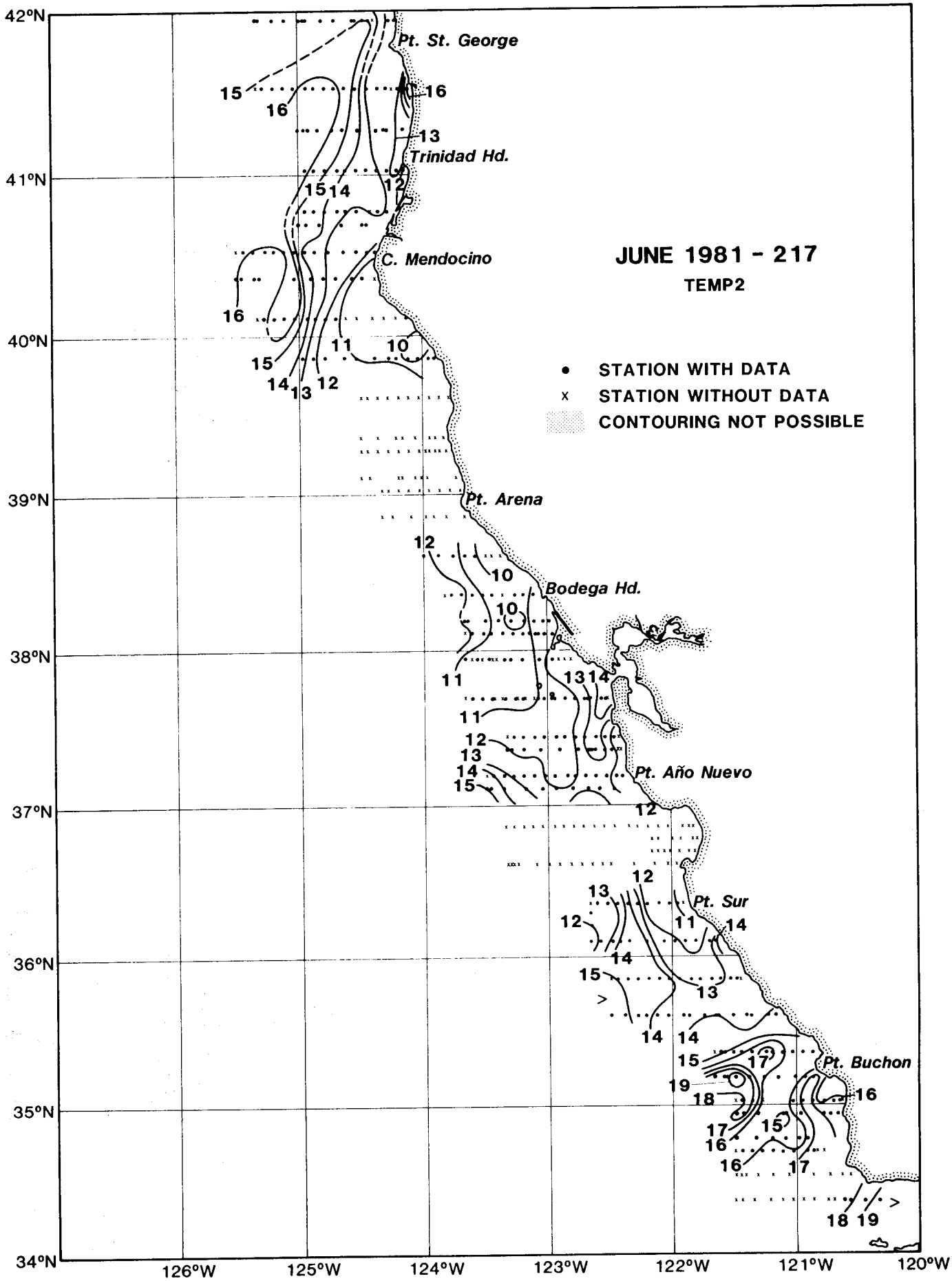
120°W


JUNE 1981 - 217
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Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
41°N
40°N
39°N
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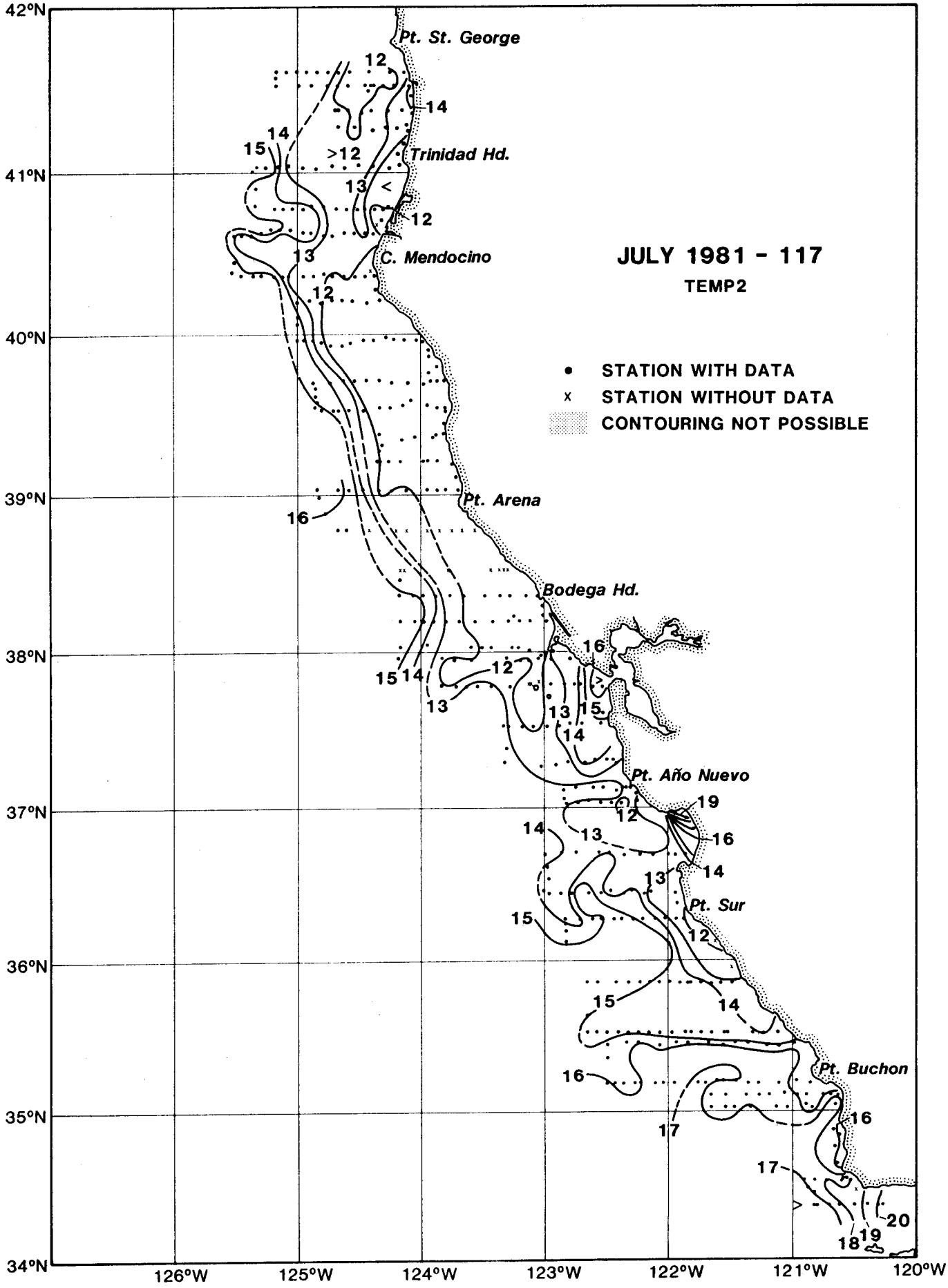
JULY 1981 - 117
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x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
41°N
40°N
39°N
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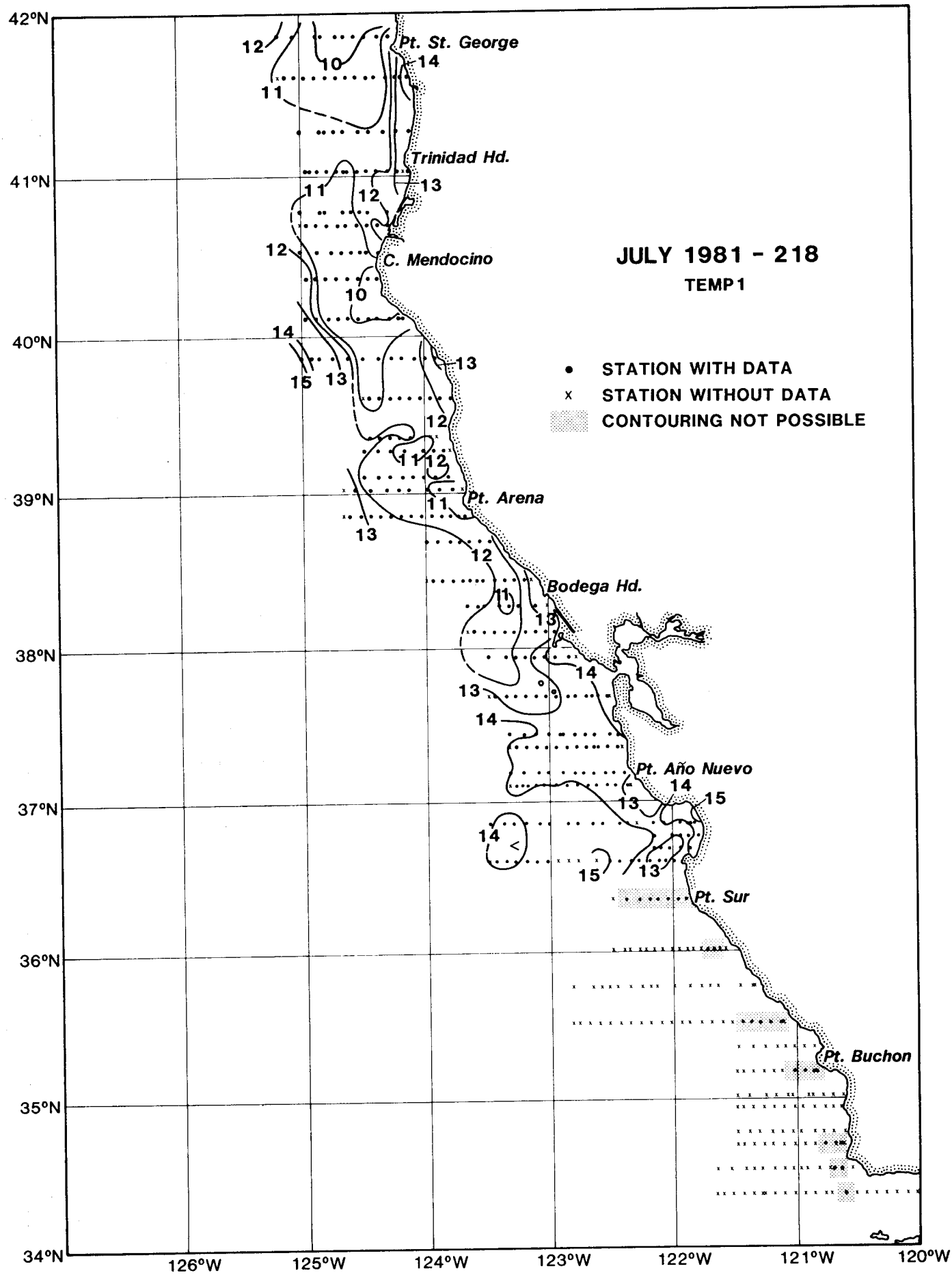
JULY 1981 - 218
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C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
41°N
40°N
39°N
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34°N
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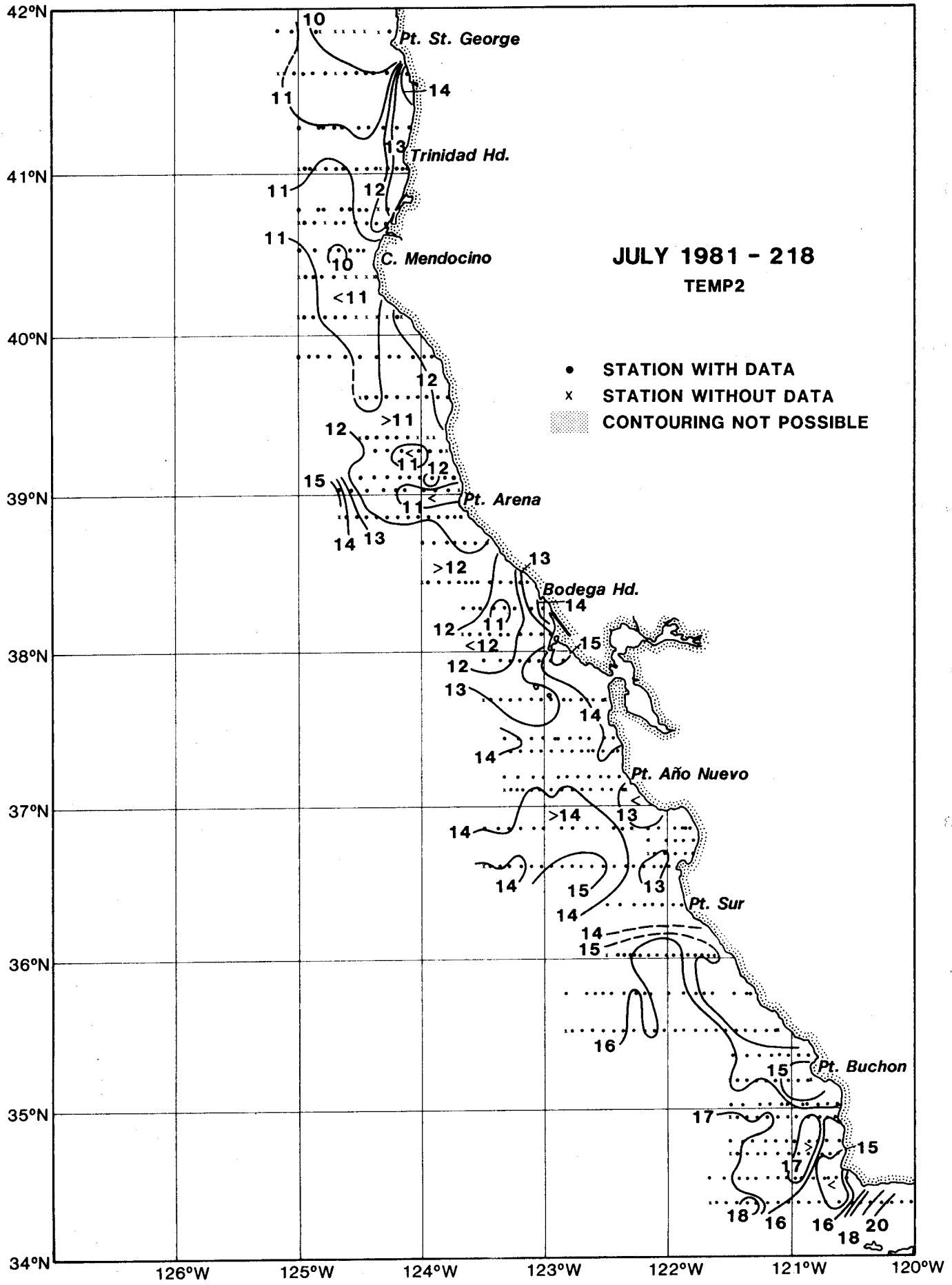
JULY 1981 - 218
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Bodega Hd.
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Pt. Sur
Pt. Buchon
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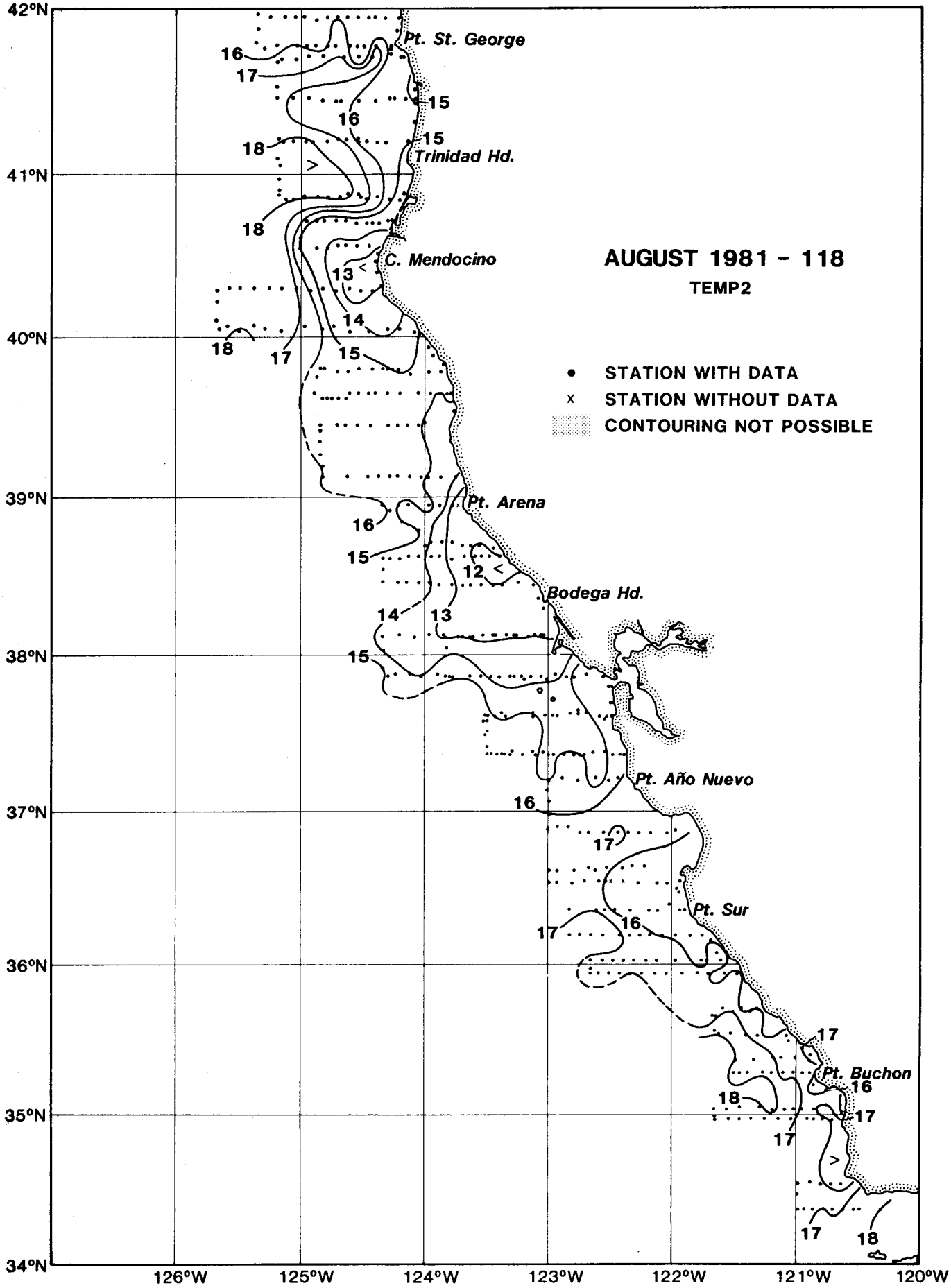
AUGUST 1981 - 118
TEMP2
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x STATION WITHOUT DATA
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Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
41°N
40°N
39°N
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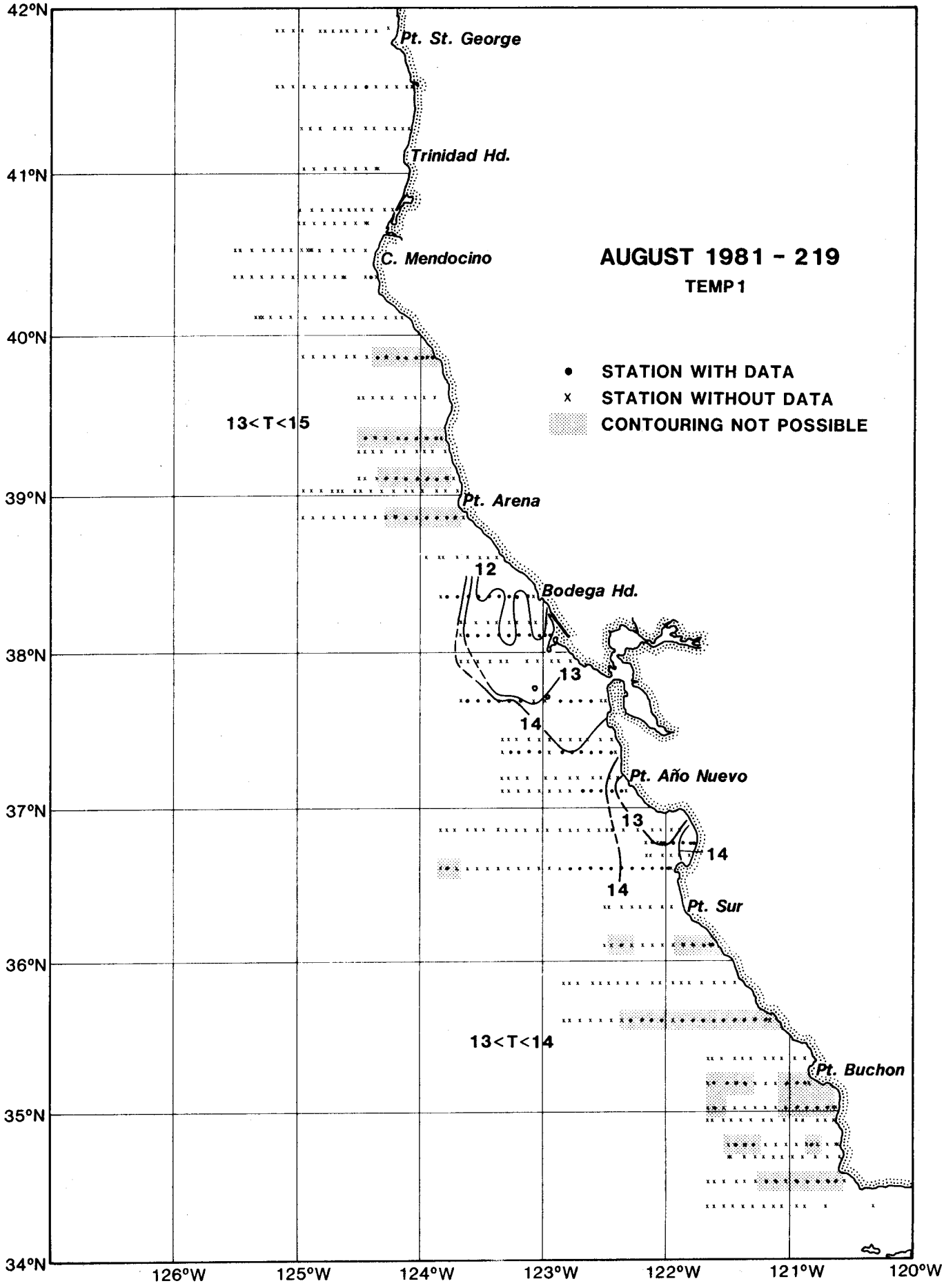
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125°W
124°W
123°W
122°W
121°W
120°W
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
AUGUST 1981 - 219
TEMP 1
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x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
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13<T<14
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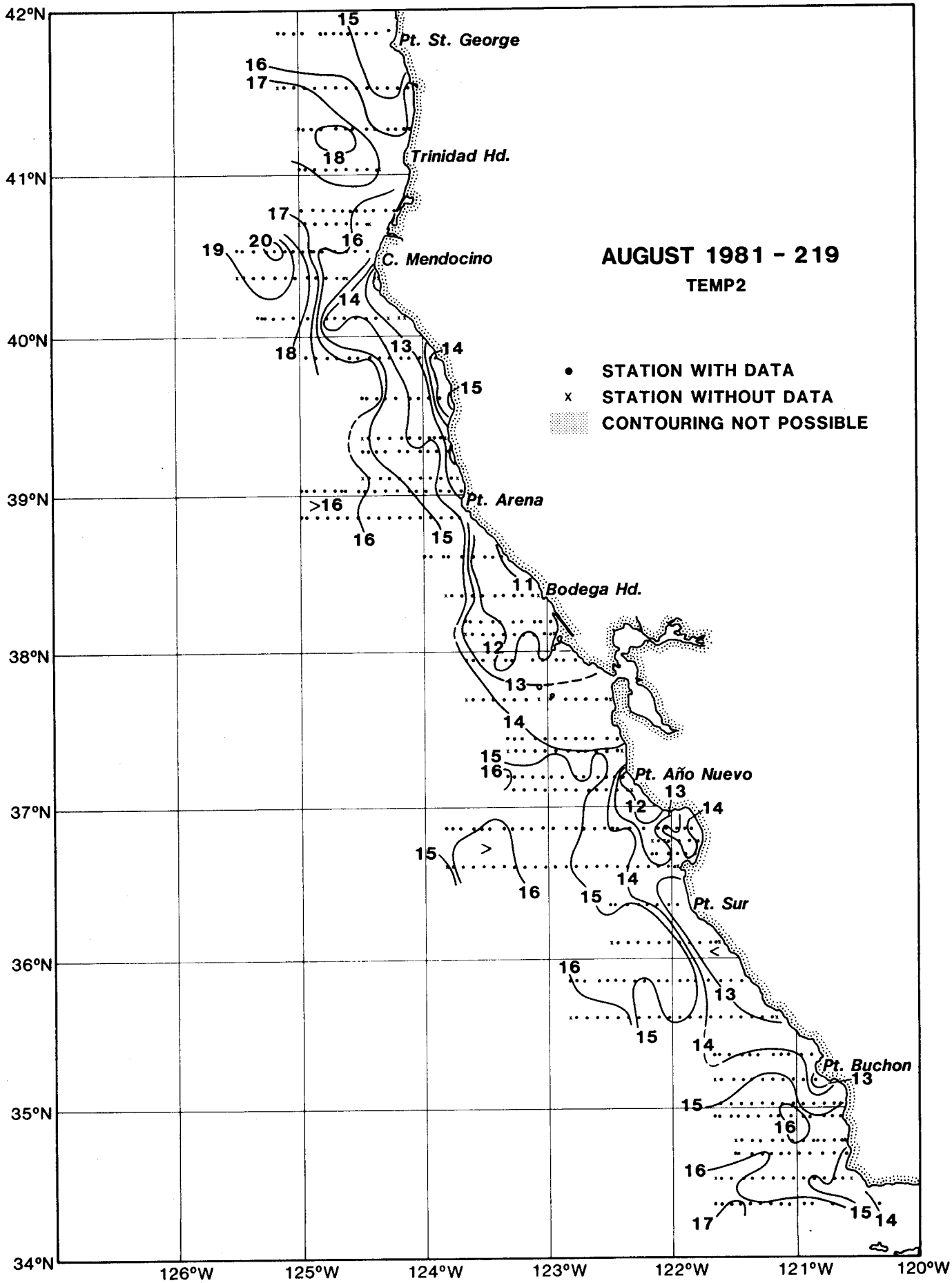
14
14


AUGUST 1981 - 219
TEMP2
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Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
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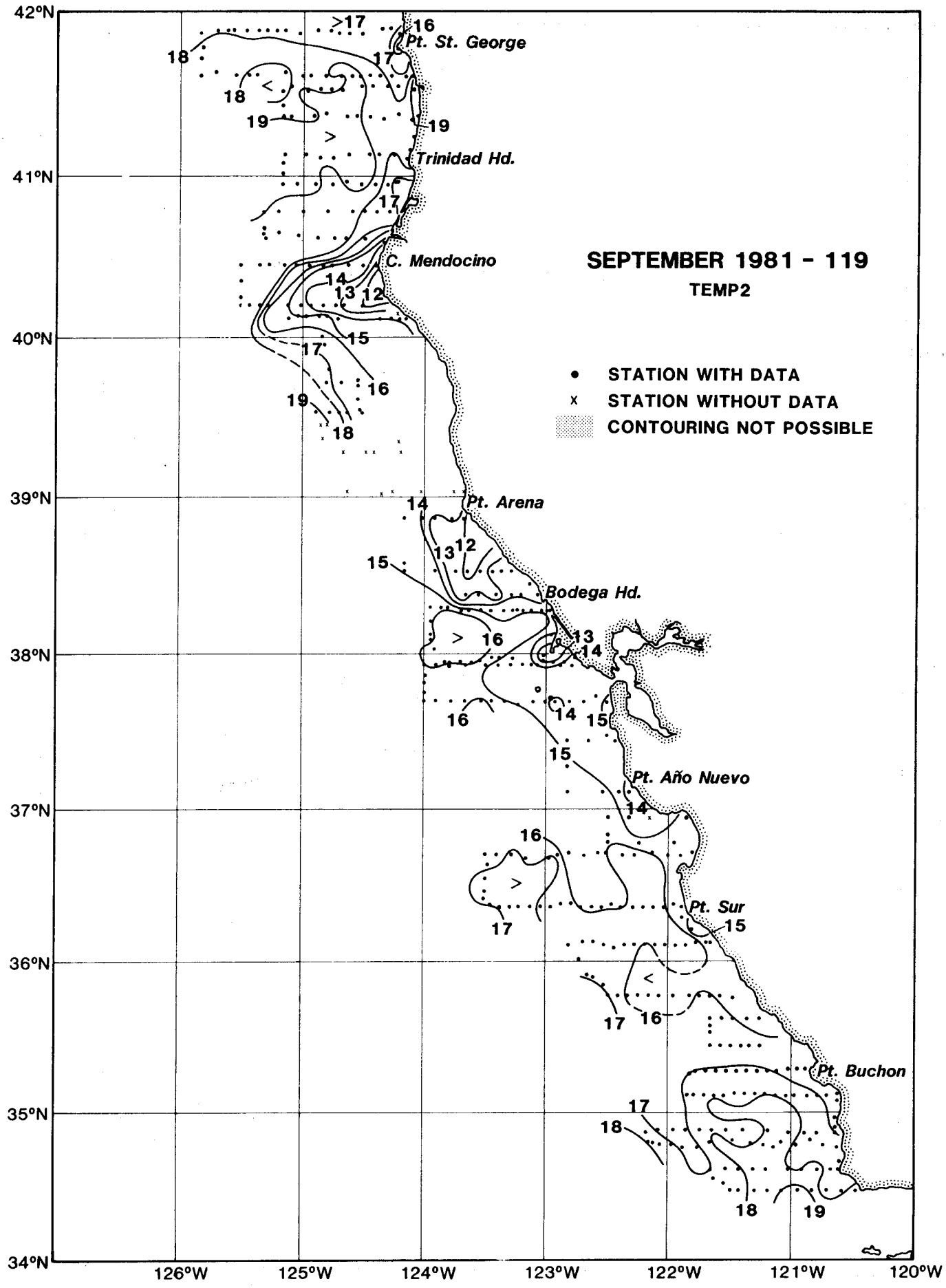
SEPTEMBER 1981 - 119
TEMP2
• STATION WITH DATA
x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
41°N
40°N
39°N
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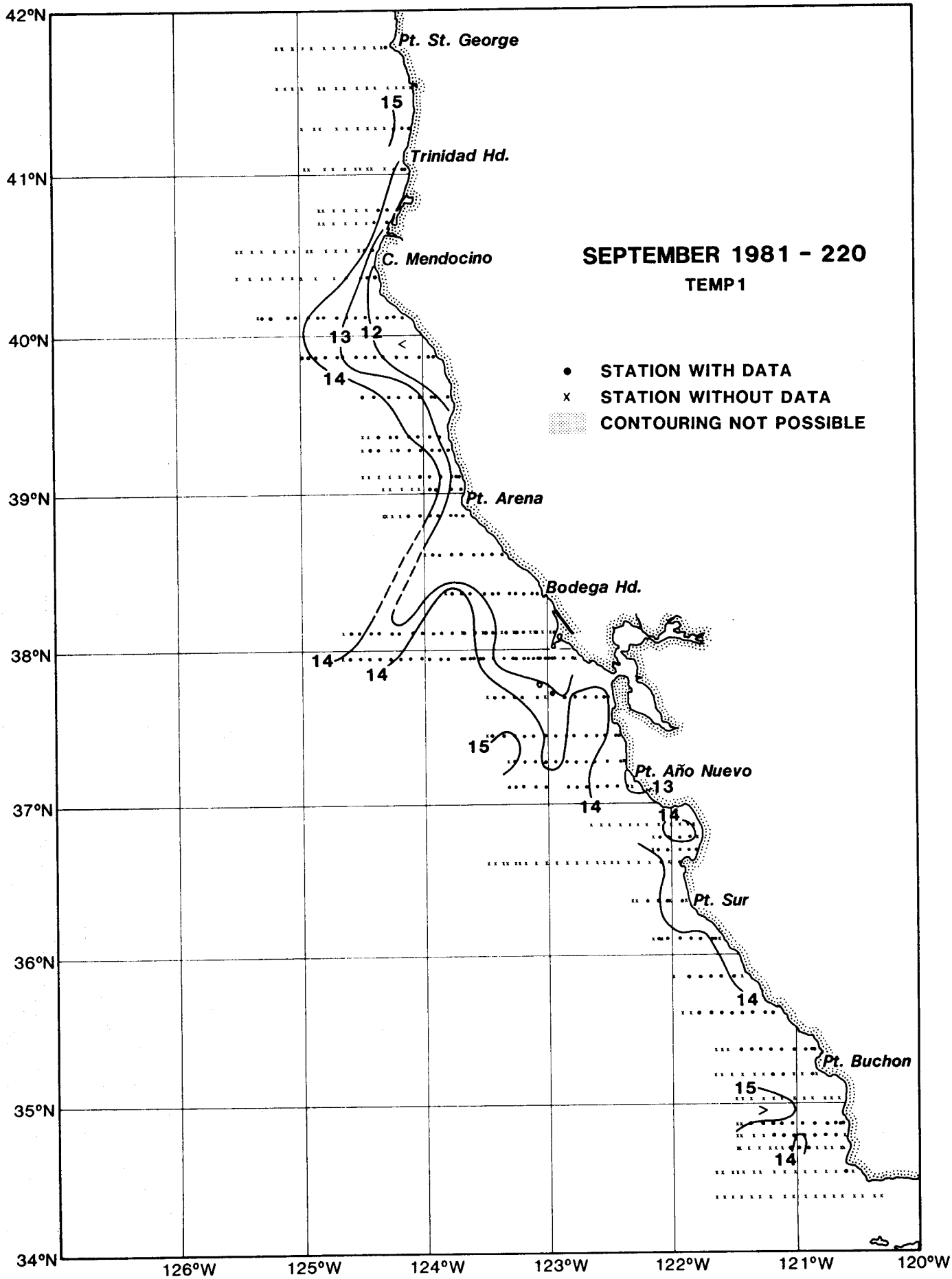
SEPTEMBER 1981 - 220
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STATION WITH DATA
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Bodega Hd.
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Pt. Sur
Pt. Buchon
42°N
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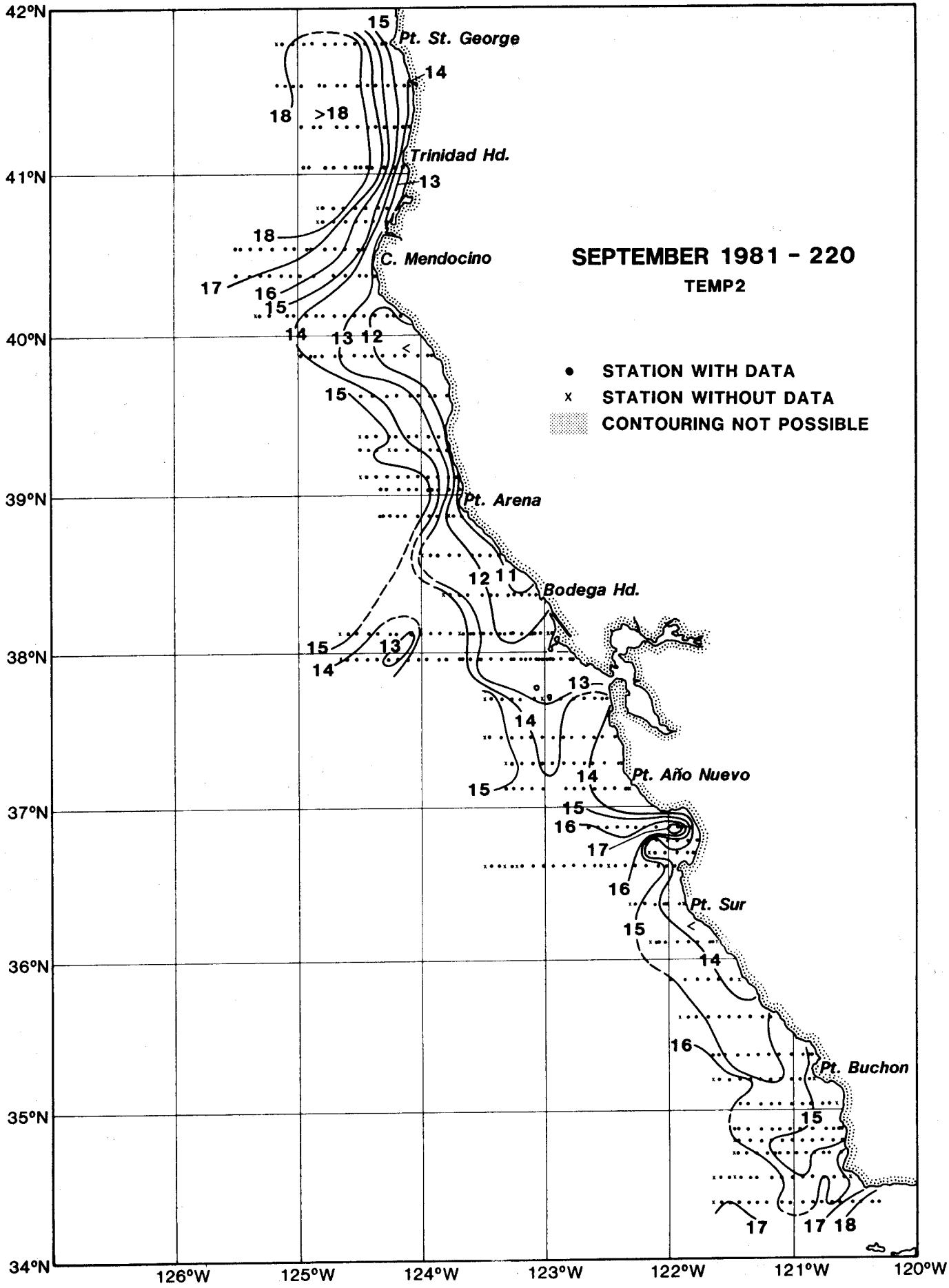
SEPTEMBER 1981 - 220
TEMP2
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Pt. St. George
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Bodega Hd.
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Pt. Buchon
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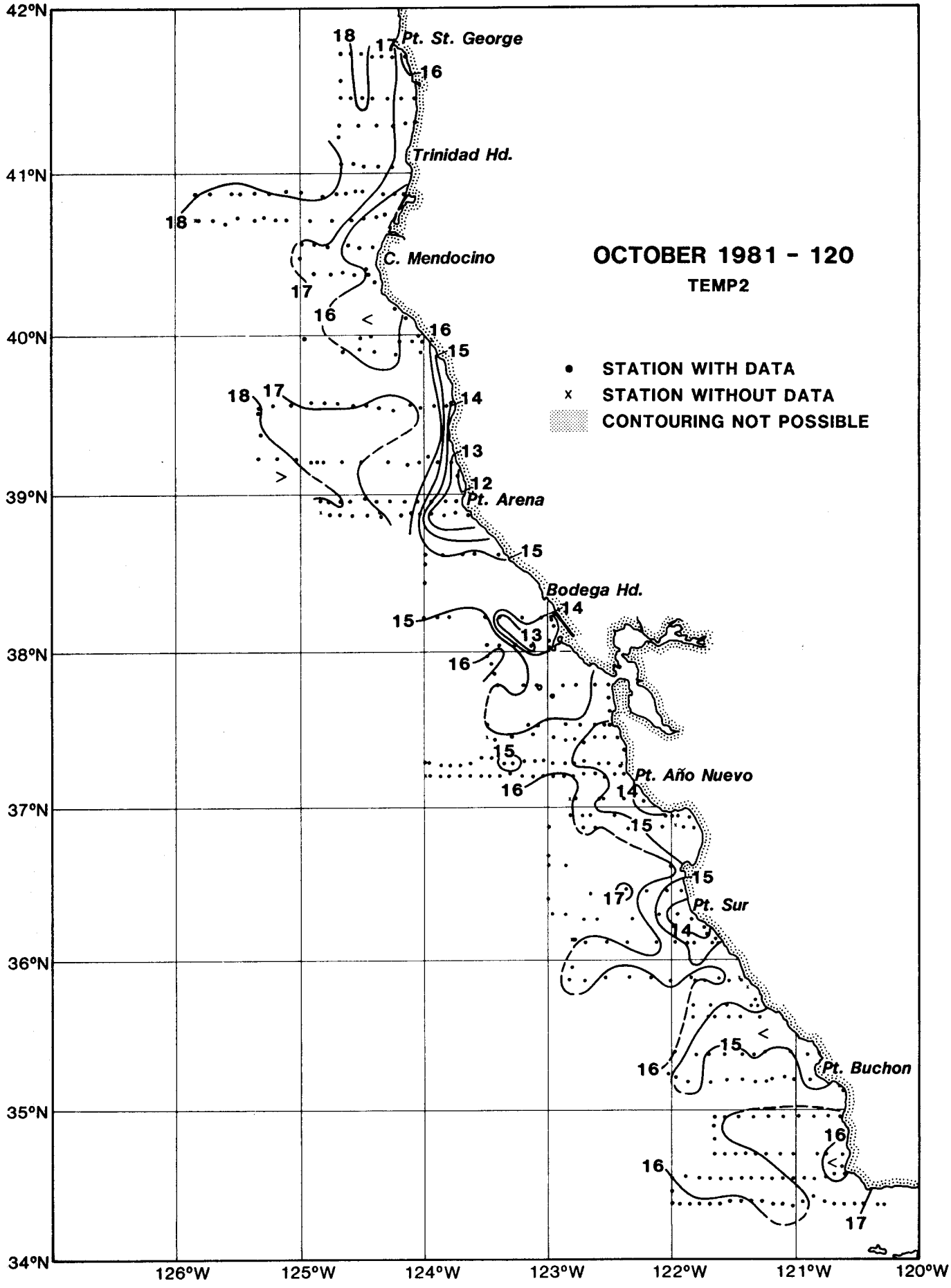
OCTOBER 1981 - 120
TEMP2
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x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
41°N
40°N
39°N
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34°N
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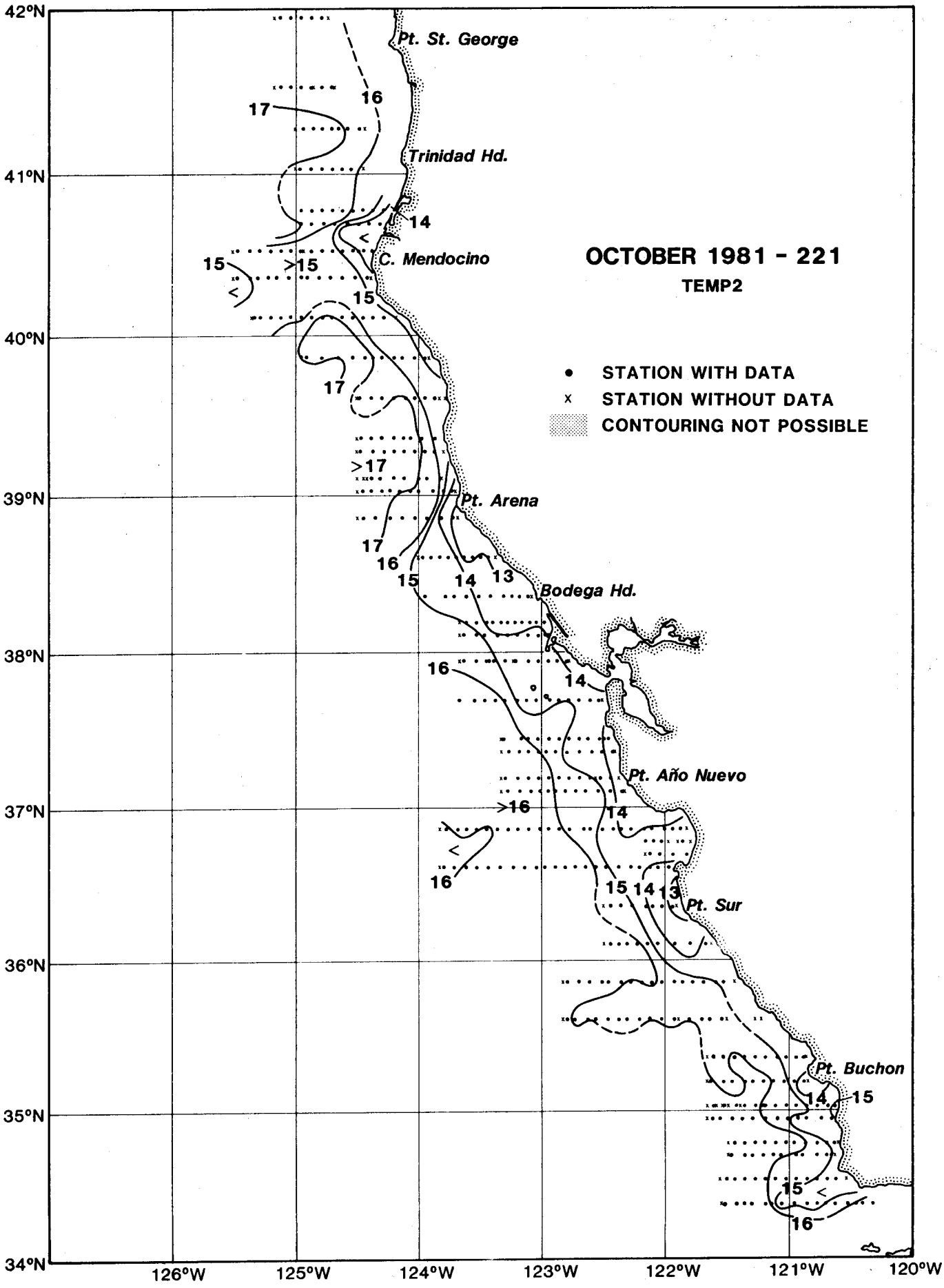
OCTOBER 1981 - 221
TEMP2
• STATION WITH DATA
x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
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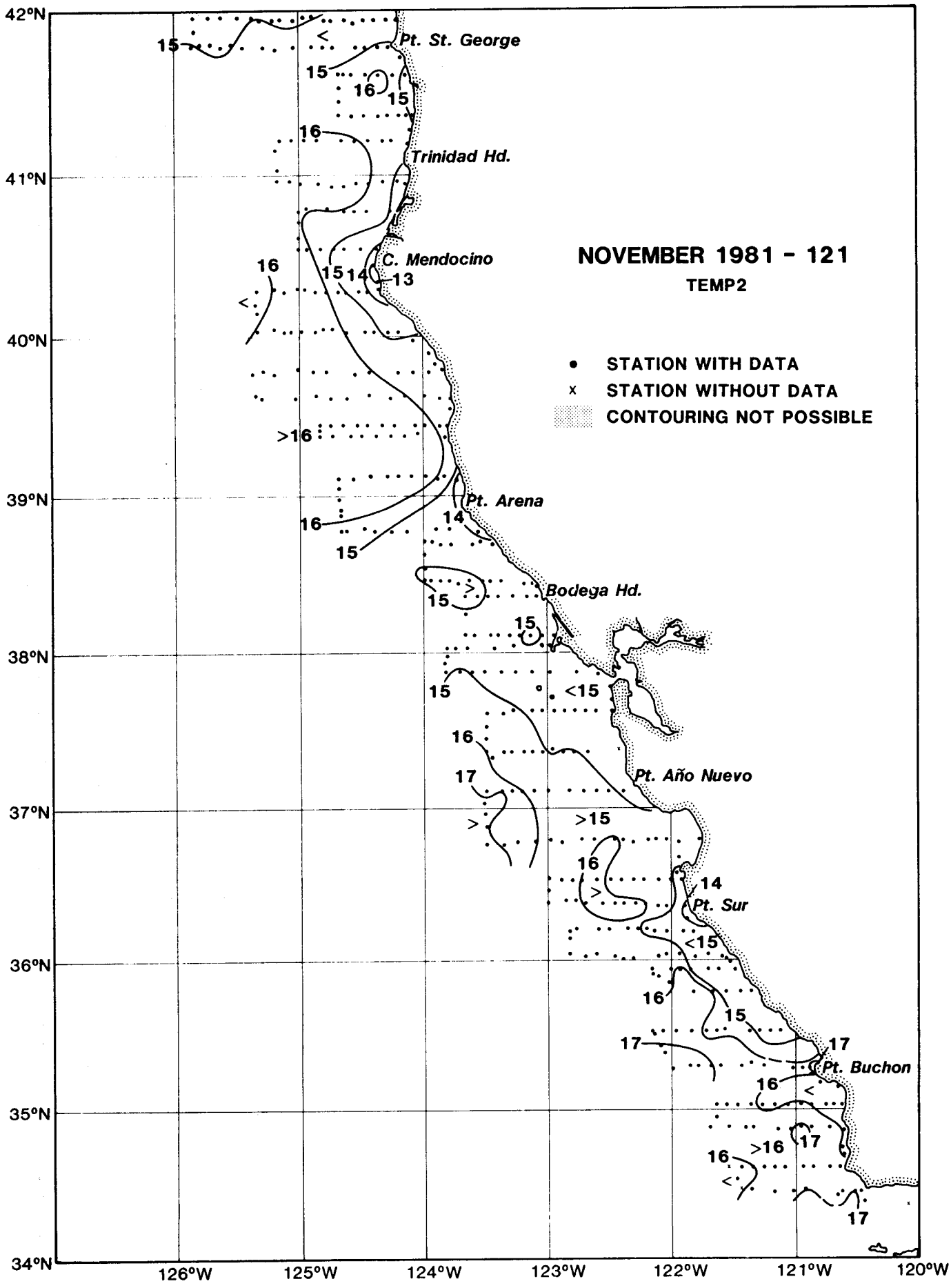
NOVEMBER 1981 - 121
TEMP2
• STATION WITH DATA
x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
41°N
40°N
39°N
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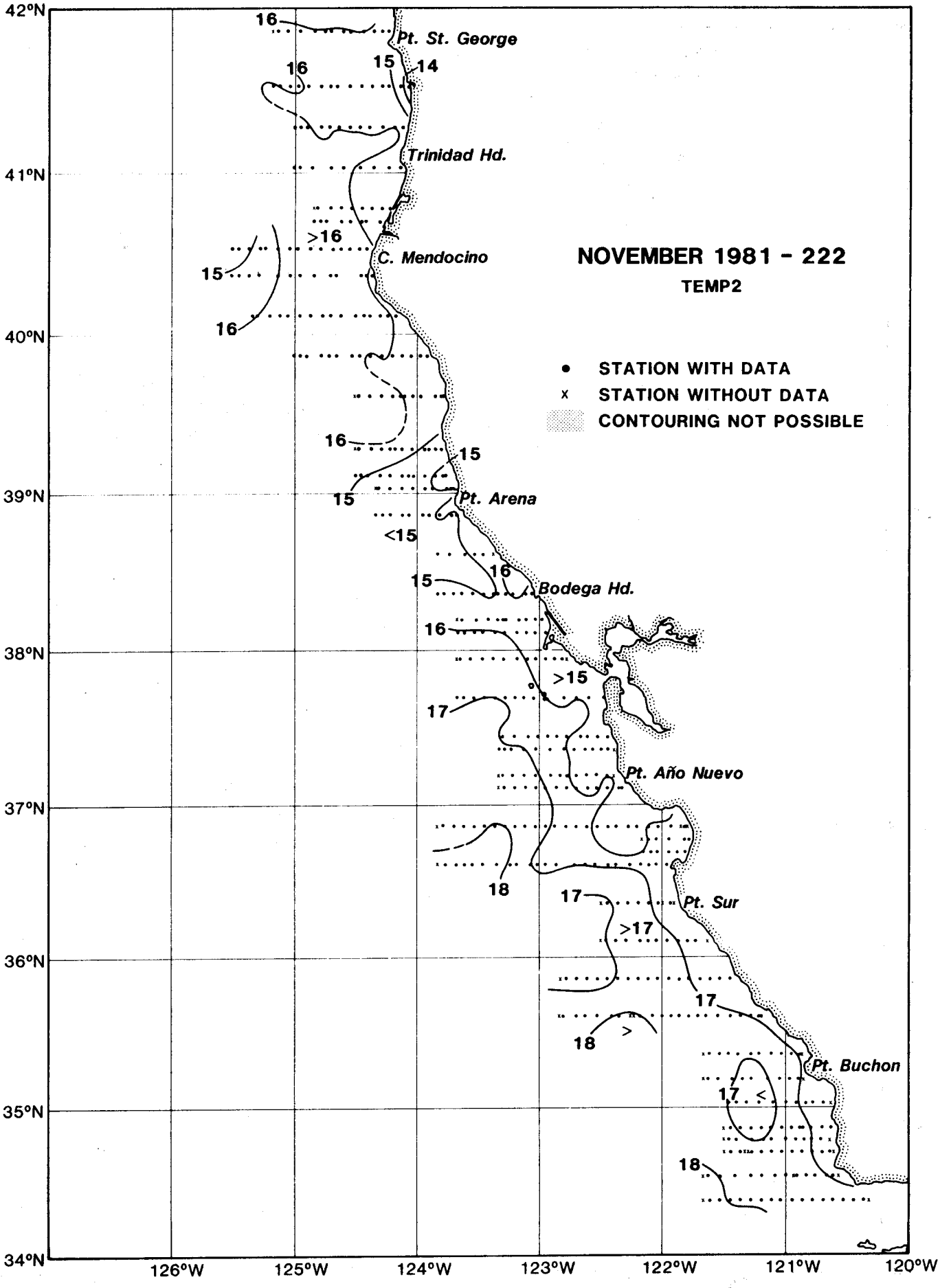
NOVEMBER 1981 - 222
TEMP2
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x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
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40°N
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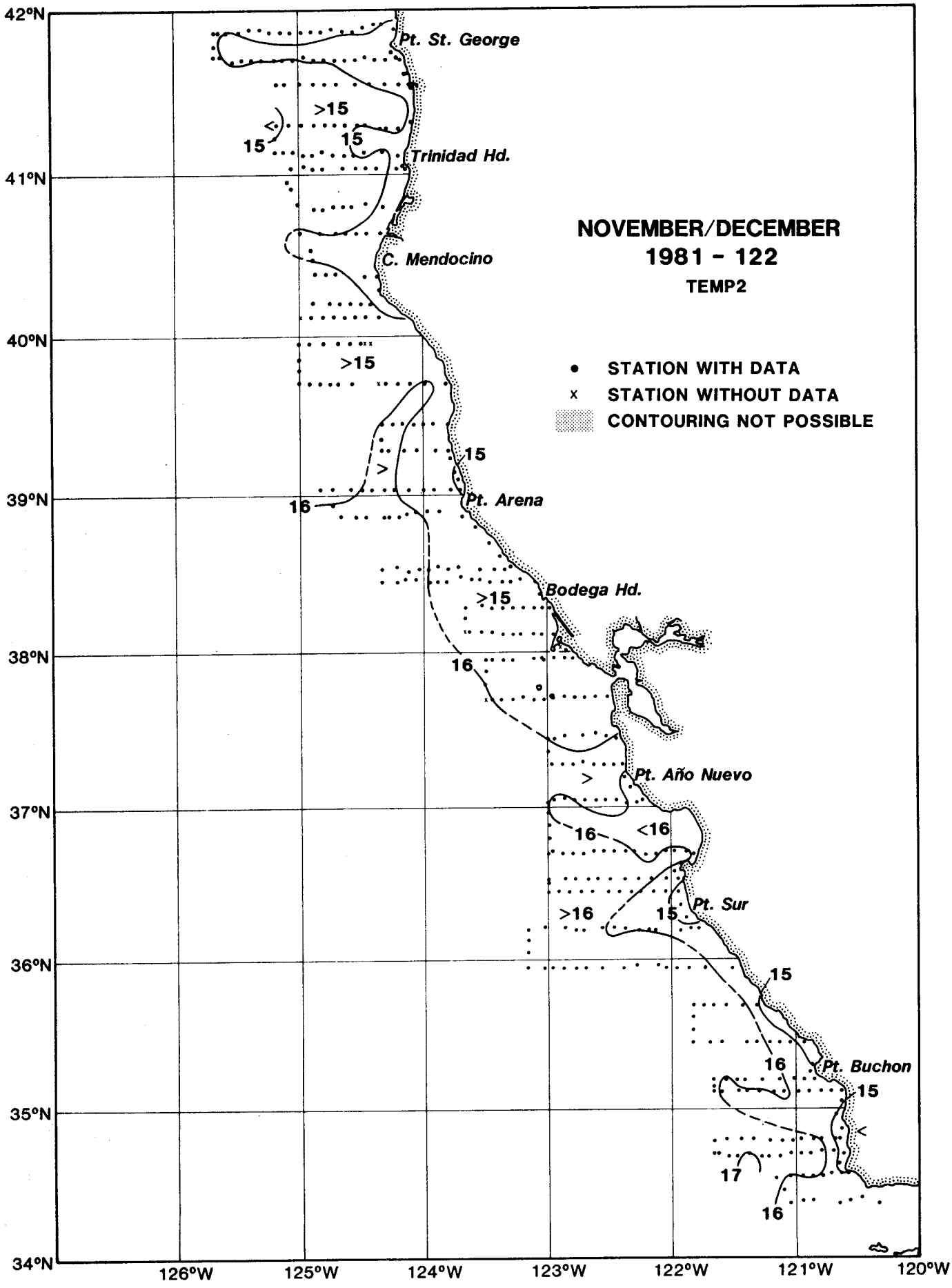
NOVEMBER/DECEMBER
1981 - 122
TEMP2
• STATION WITH DATA
x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
>15
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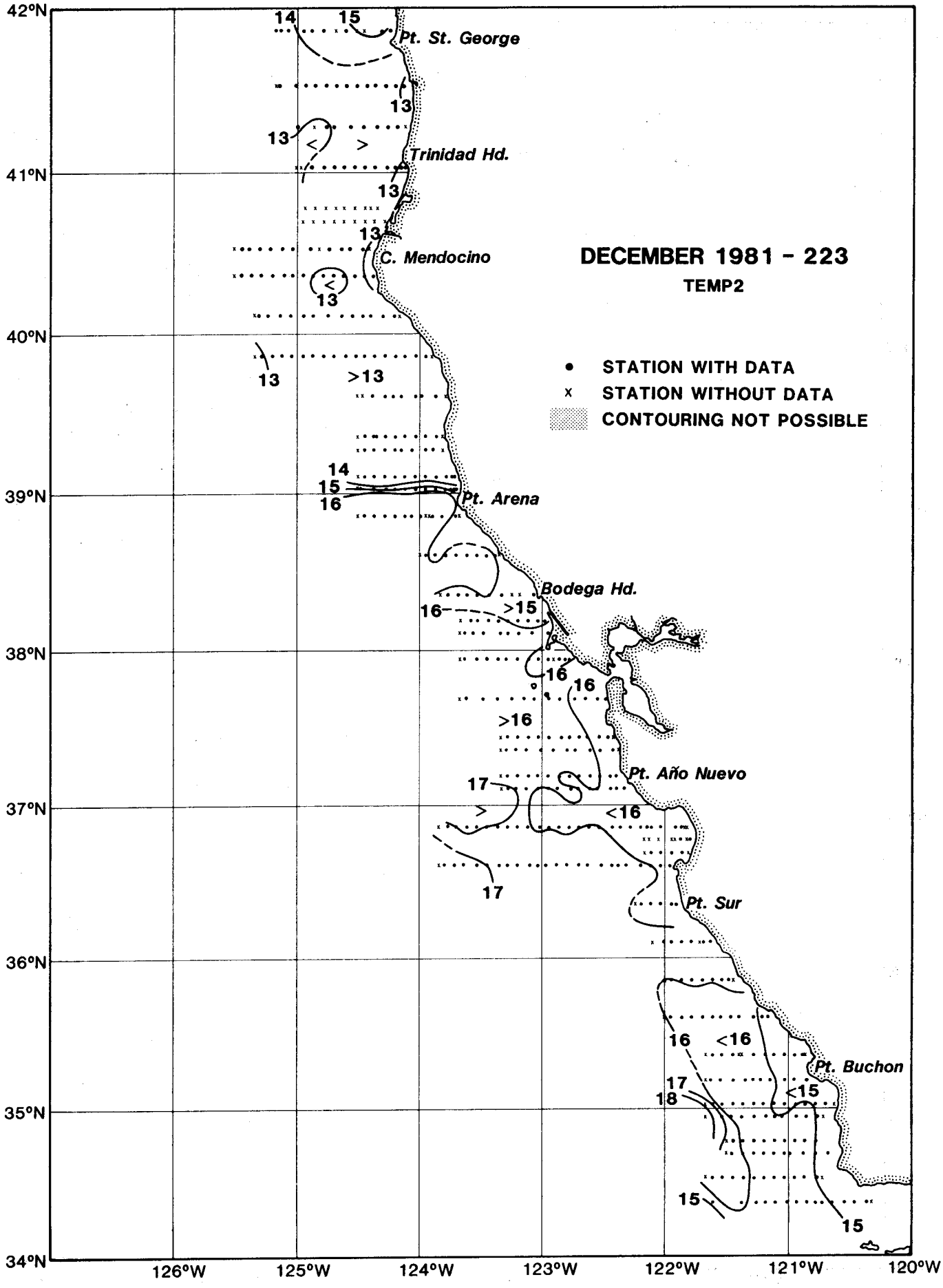
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122°W
121°W
120°W
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
DECEMBER 1981 - 223
TEMP2
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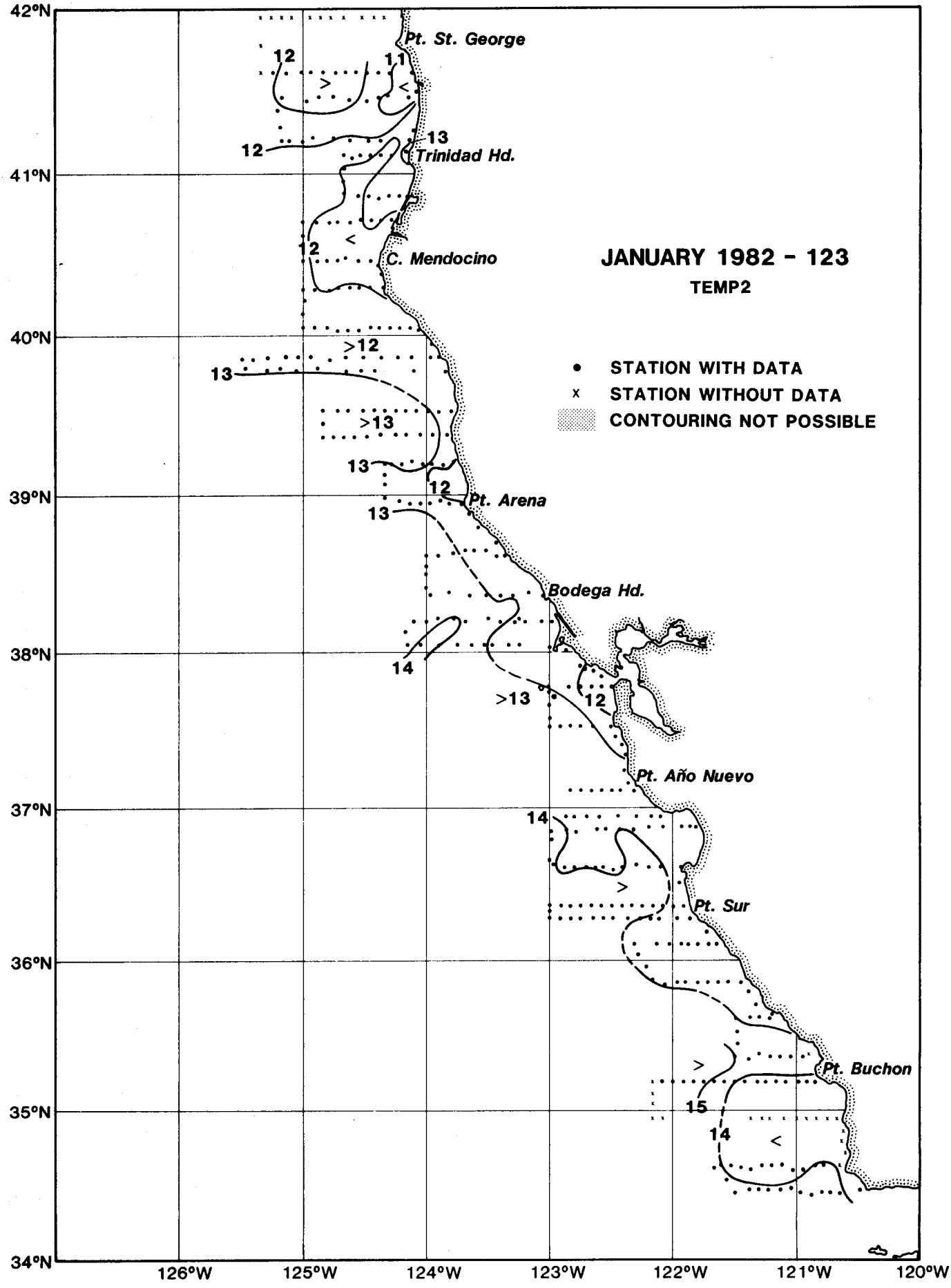
STATION WITHOUT DATA
CONTOURING NOT POSSIBLE


JANUARY 1982 - 123
TEMP2
STATION WITH DATA
STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
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Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
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40°N
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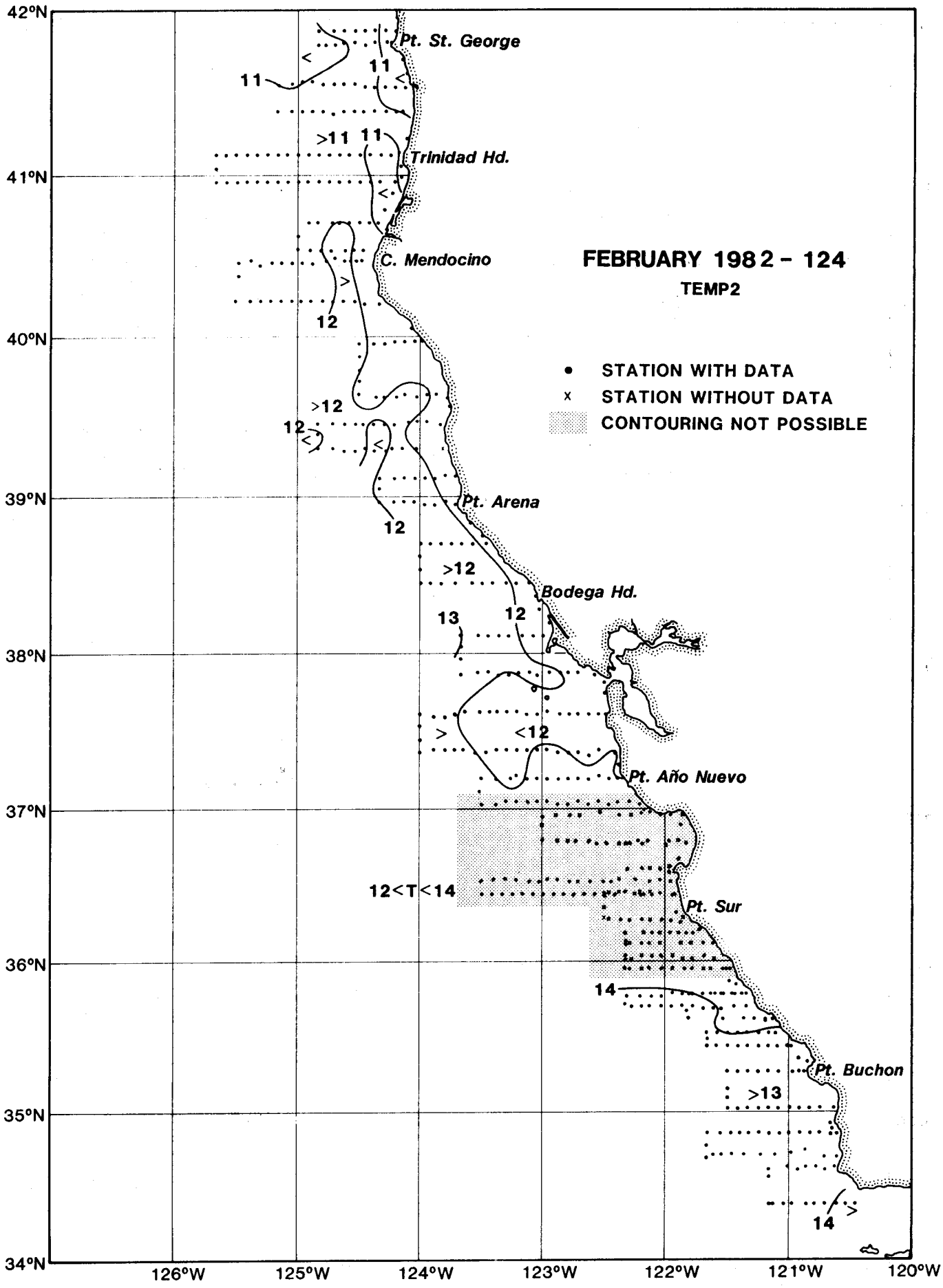
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123°W
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121°W
120°W
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
FEBRUARY 1982 - 124
TEMP2
STATION WITH DATA
STATION WITHOUT DATA
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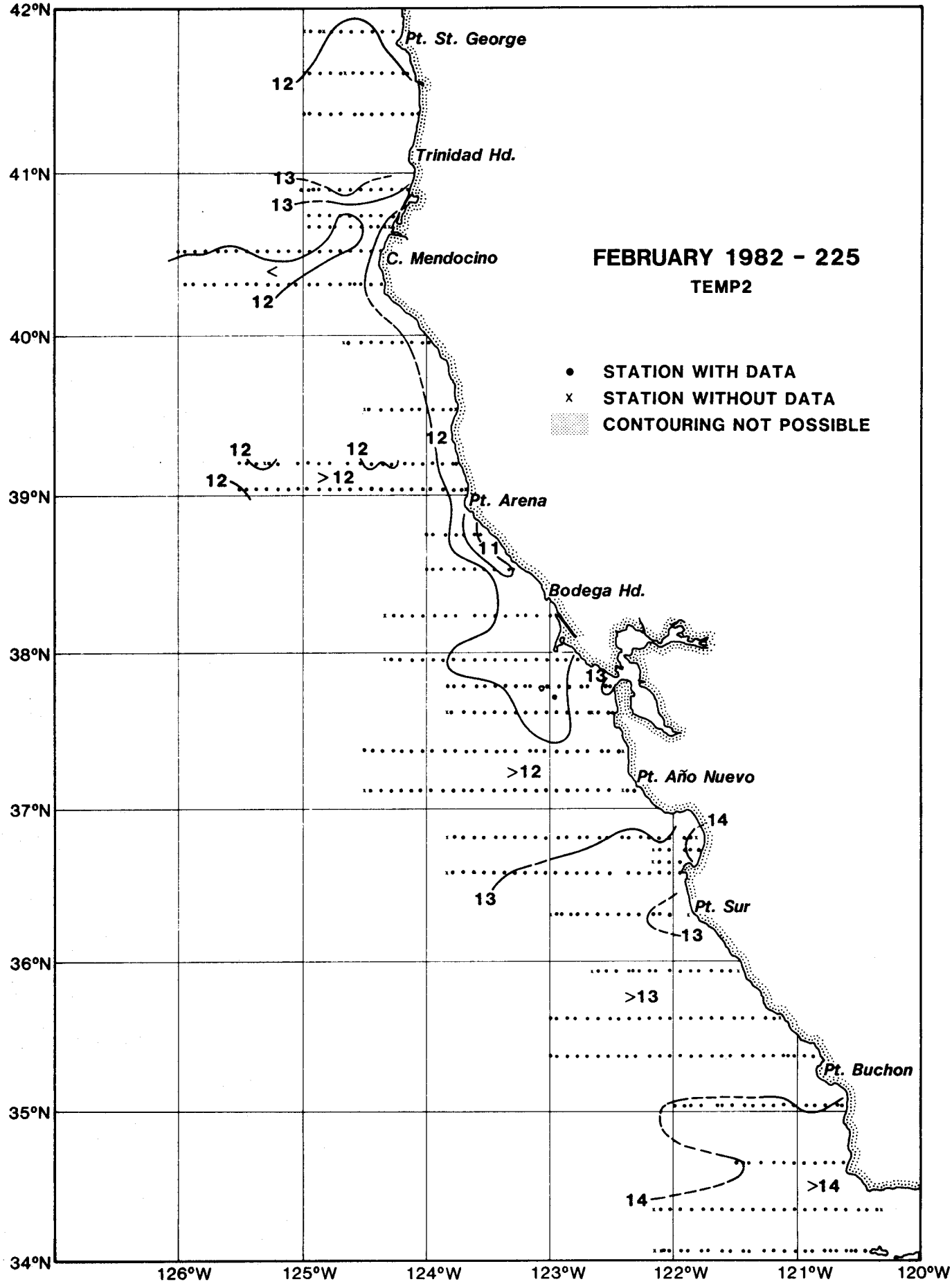
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123°W
122°W
121°W
120°W
Pt. St. George
Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
FEBRUARY 1982 - 225
TEMP2
STATION WITH DATA
STATION WITHOUT DATA
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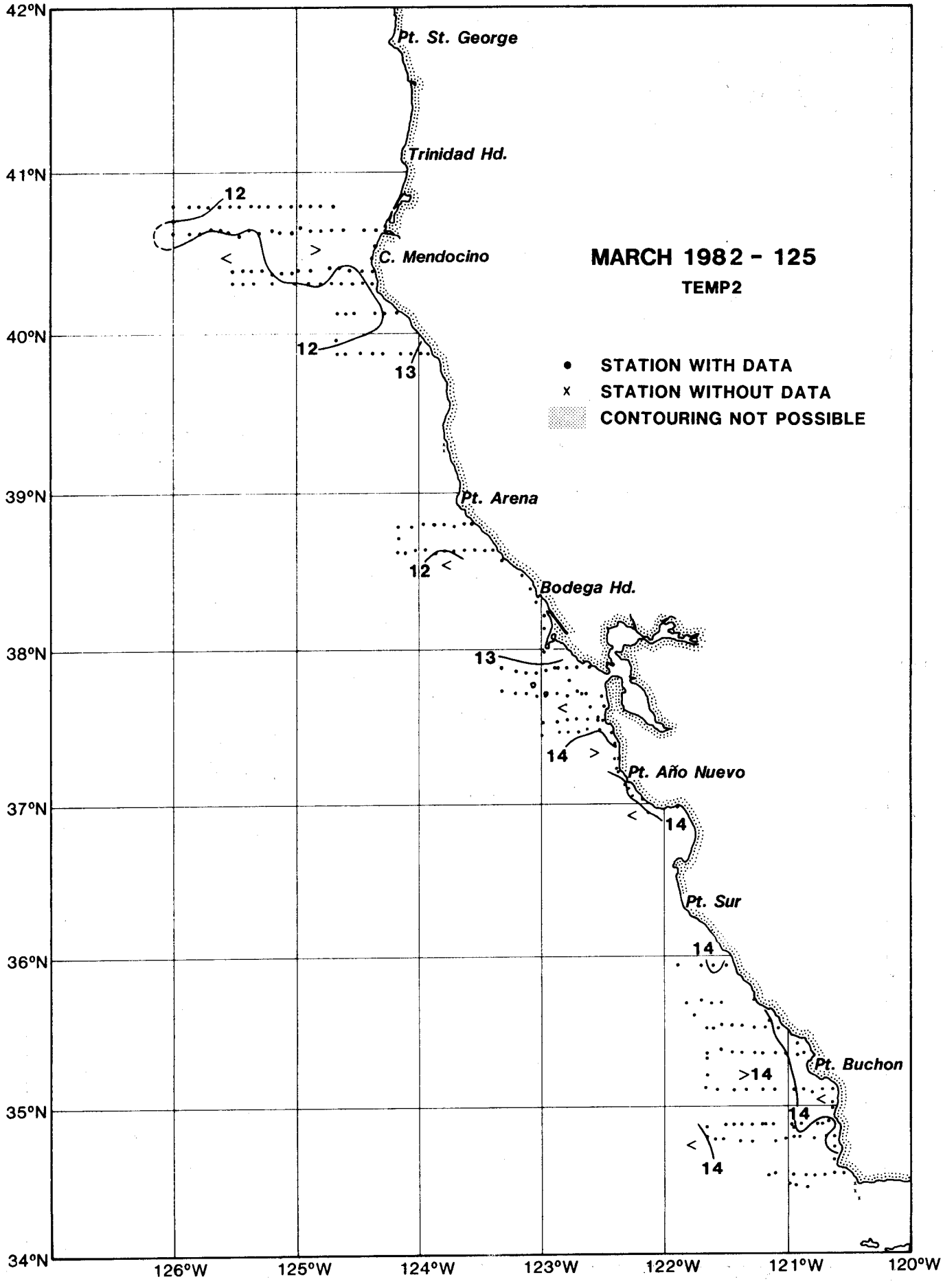
MARCH 1982 - 125
TEMP2
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x STATION WITHOUT DATA
CONTOURING NOT POSSIBLE
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C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
41°N
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37°N
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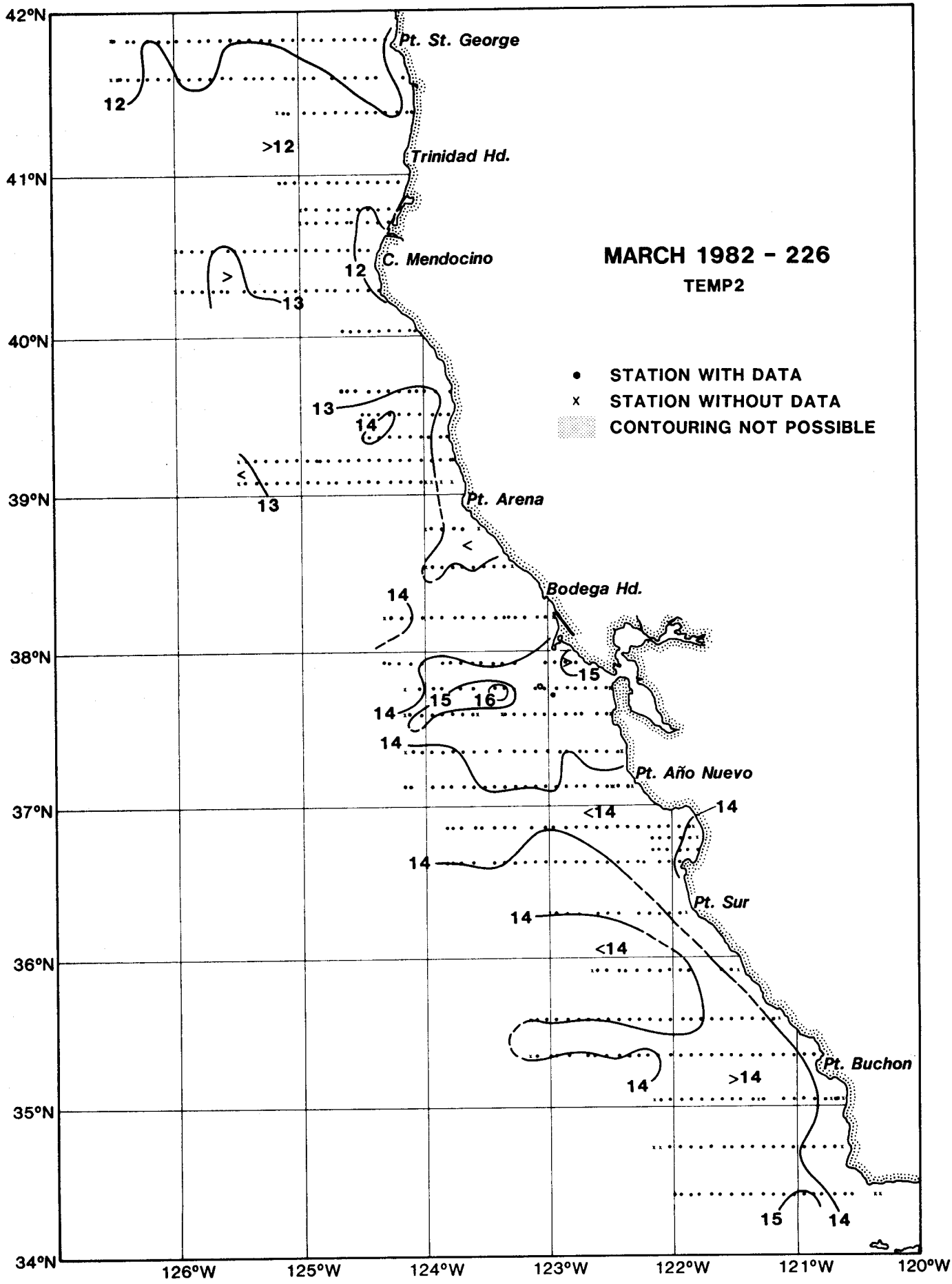
MARCH 1982 - 226
TEMP2
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Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
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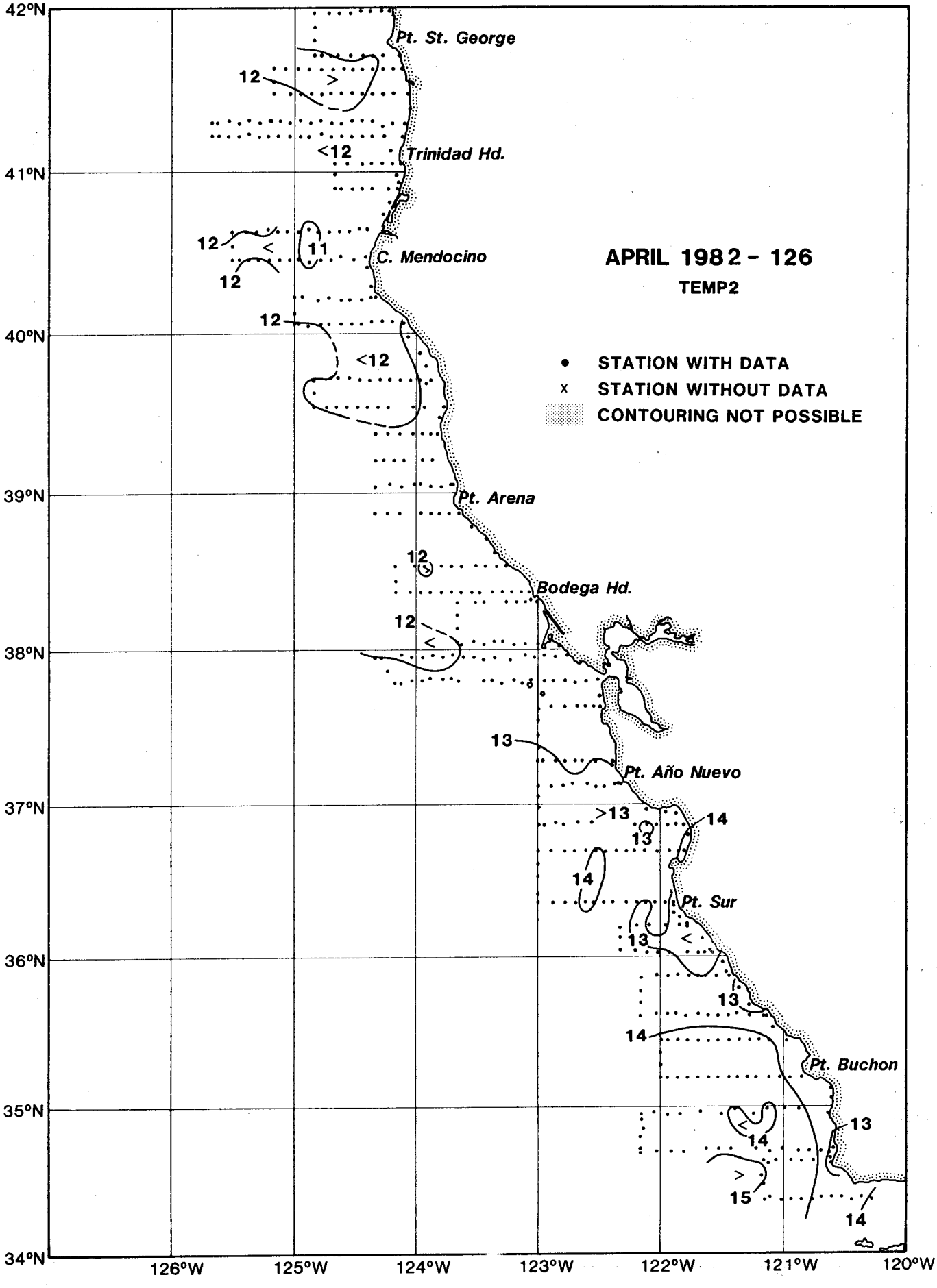
APRIL 1982 - 126
TEMP2
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x STATION WITHOUT DATA
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Trinidad Hd.
C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
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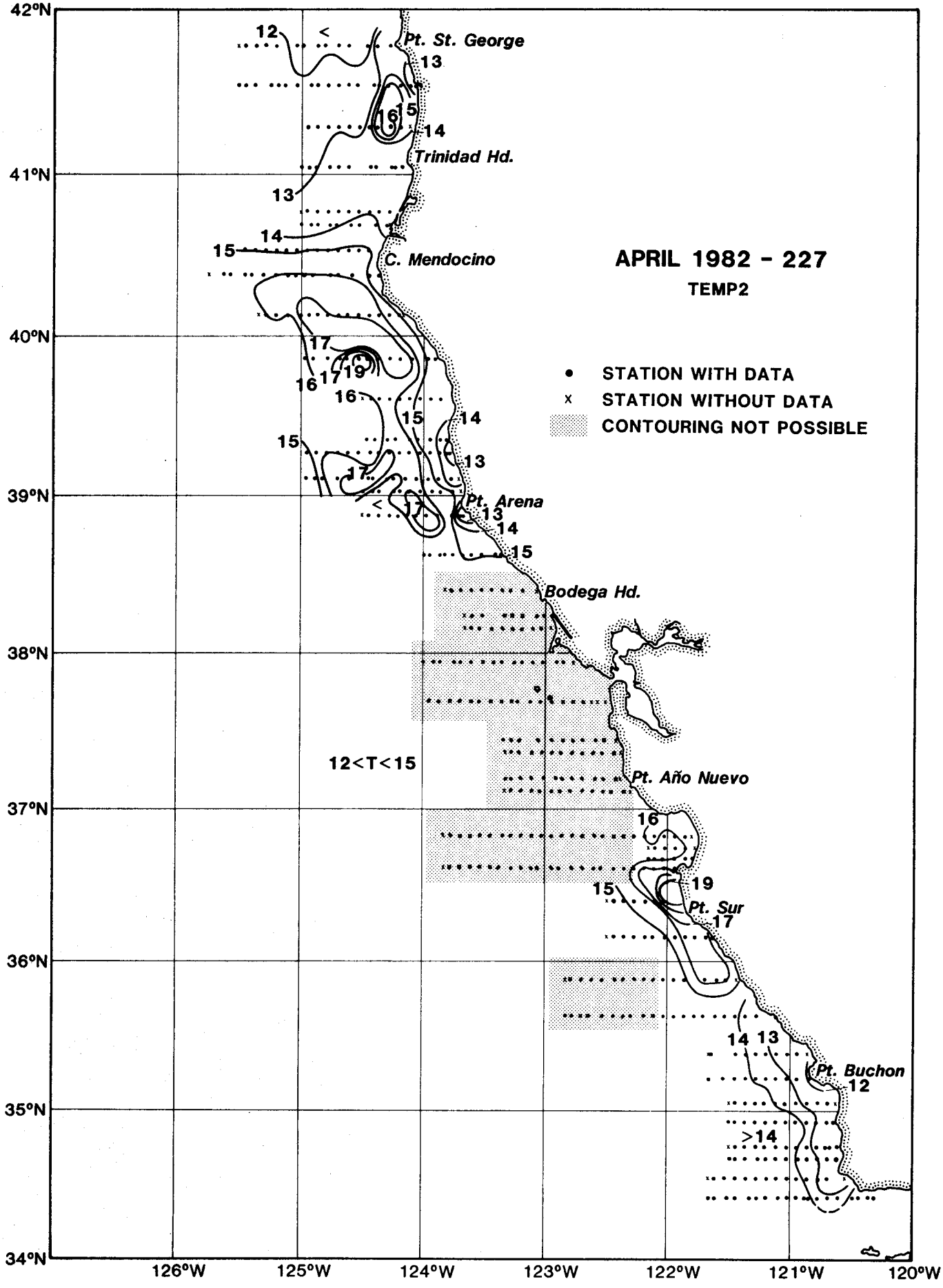
APRIL 1982 - 227
TEMP2
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CONTOURING NOT POSSIBLE
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Trinidad Hd.
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Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
42°N
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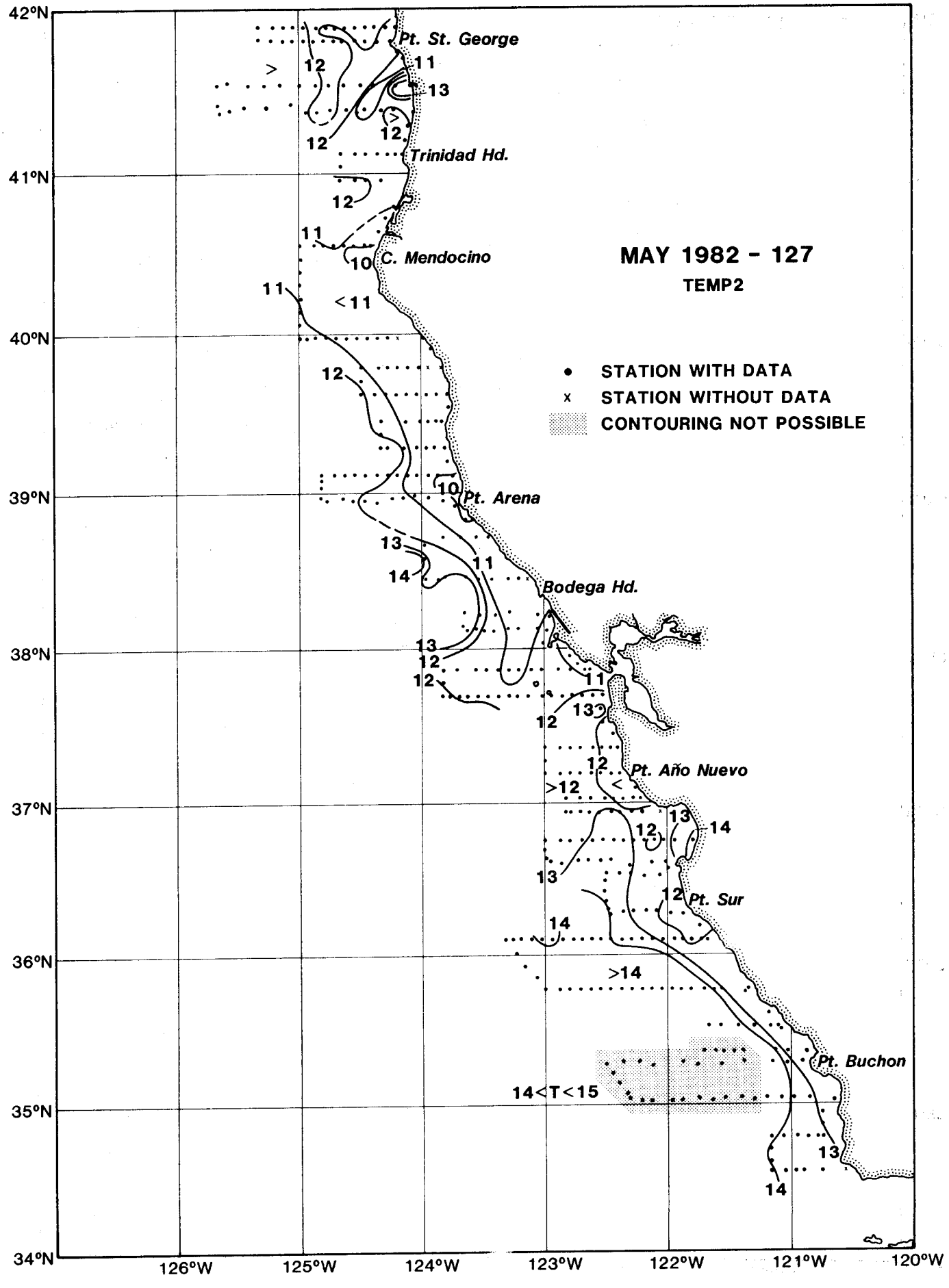
MAY 1982 - 127
TEMP2
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STATION WITHOUT DATA
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C. Mendocino
Pt. Arena
Bodega Hd.
Pt. Año Nuevo
Pt. Sur
Pt. Buchon
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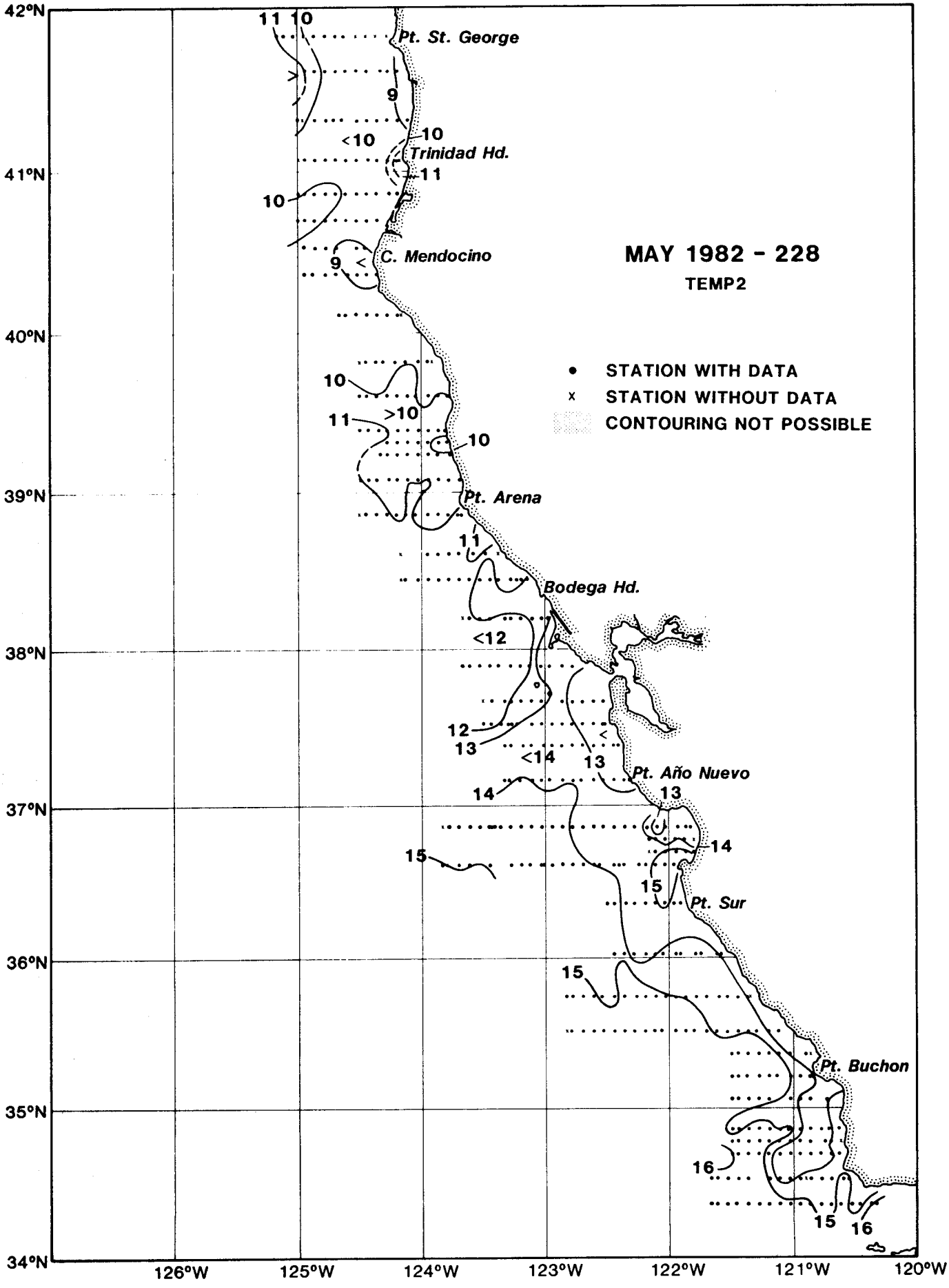
MAY 1982 - 228
TEMP2
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C. Mendocino
Pt. Arena
Bodega Hd.
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Pt. Sur
Pt. Buchon
42°N
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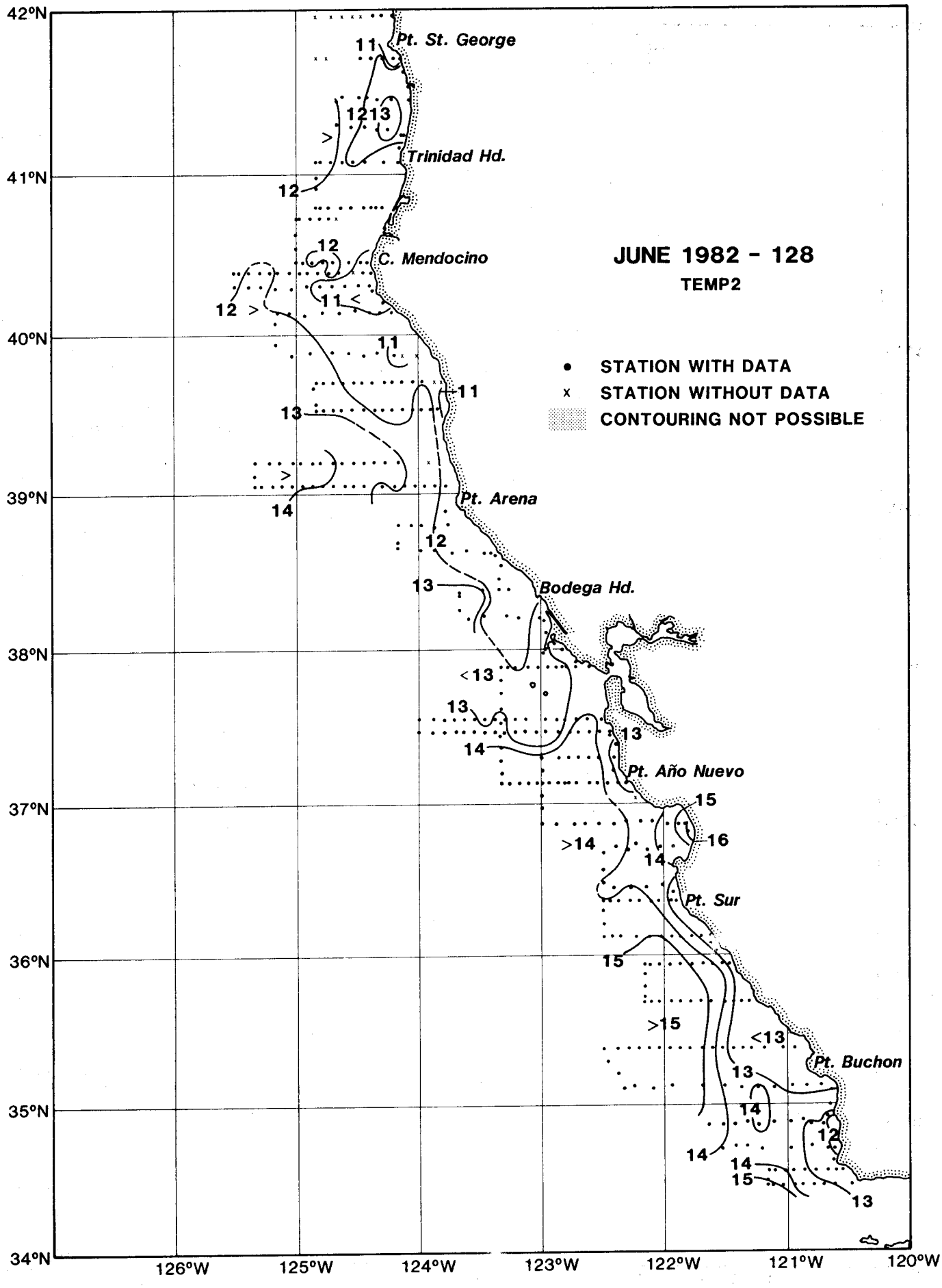
JUNE 1982 - 128
TEMP2
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Bodega Hd.
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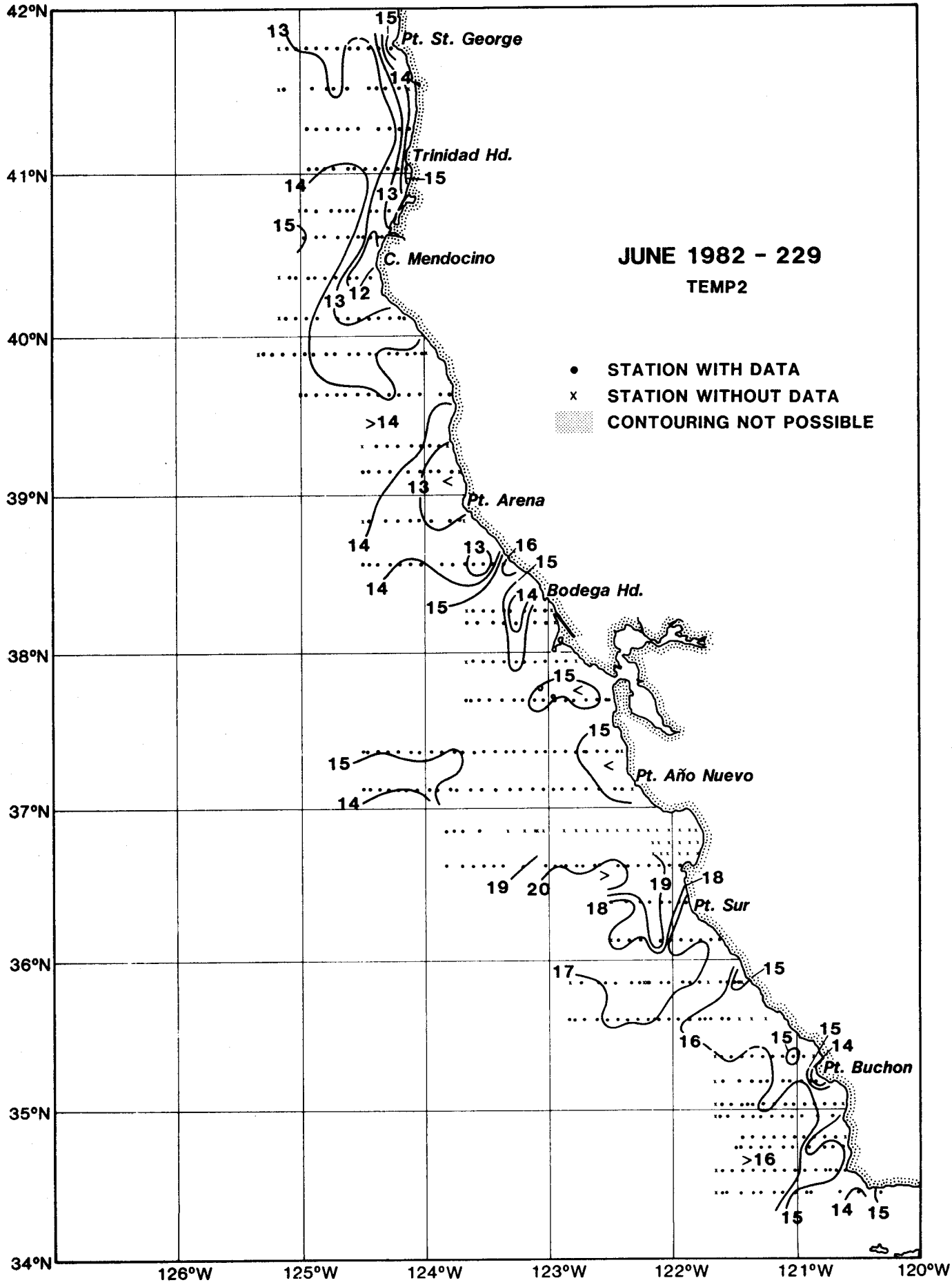
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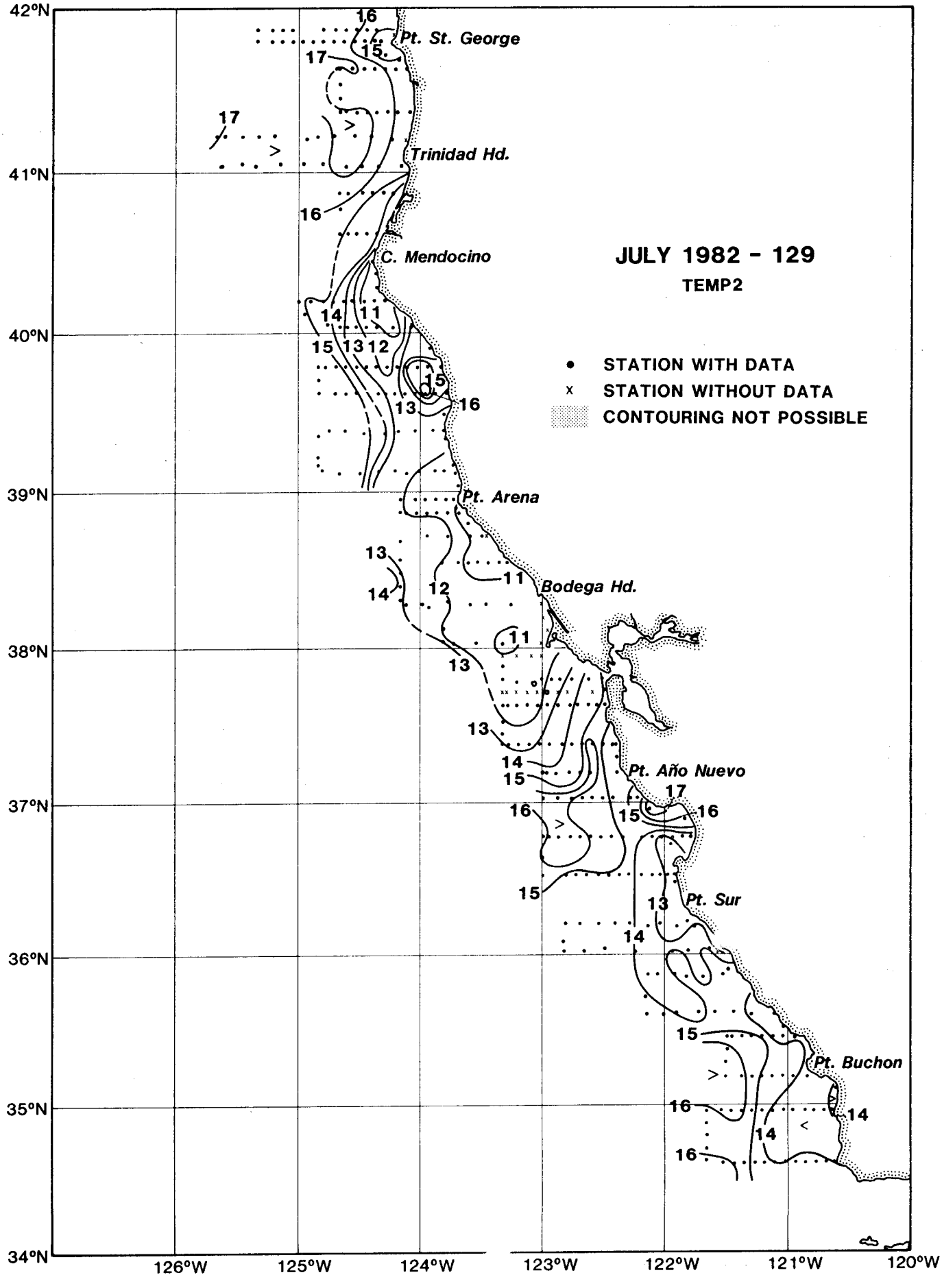
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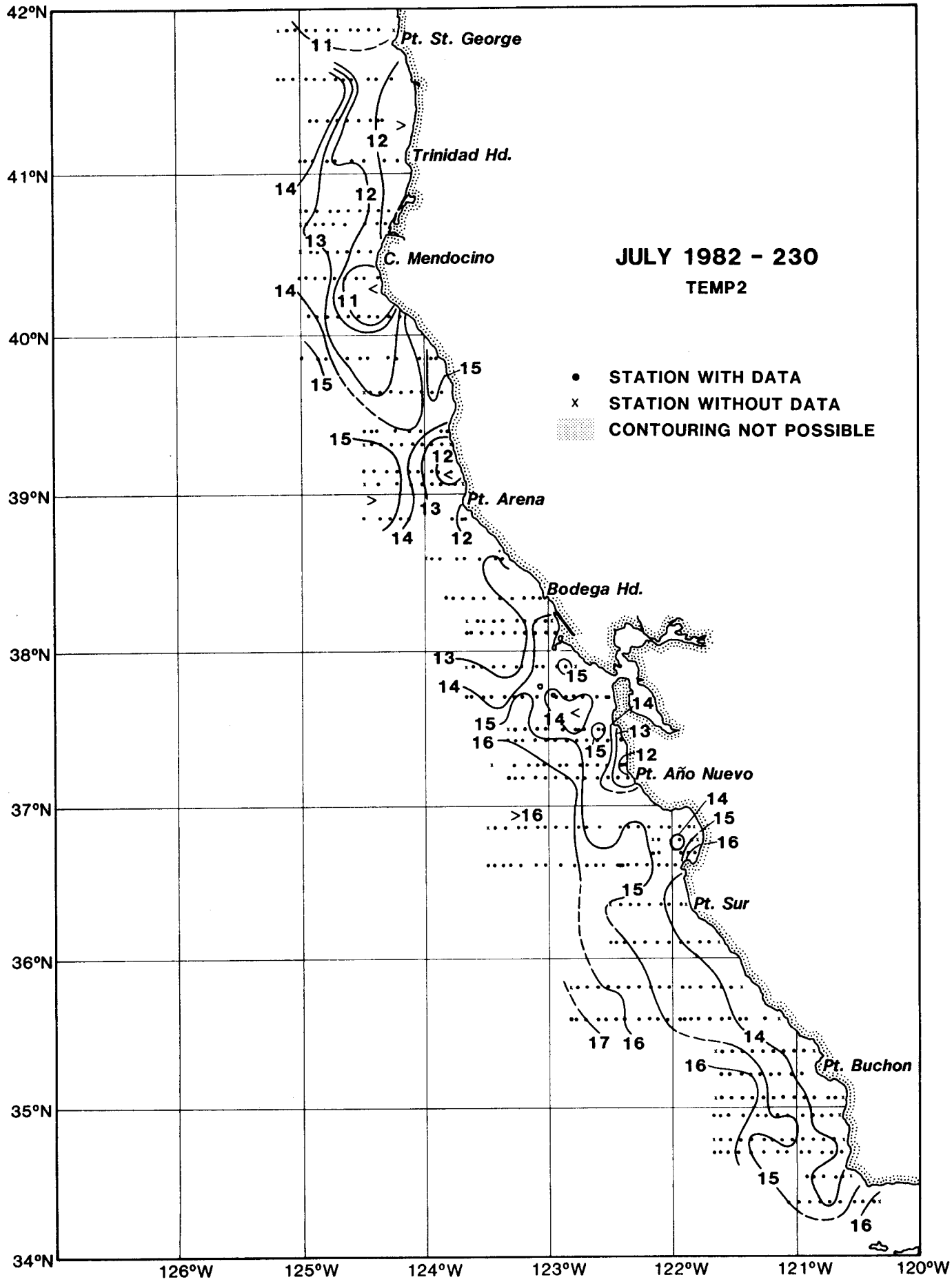
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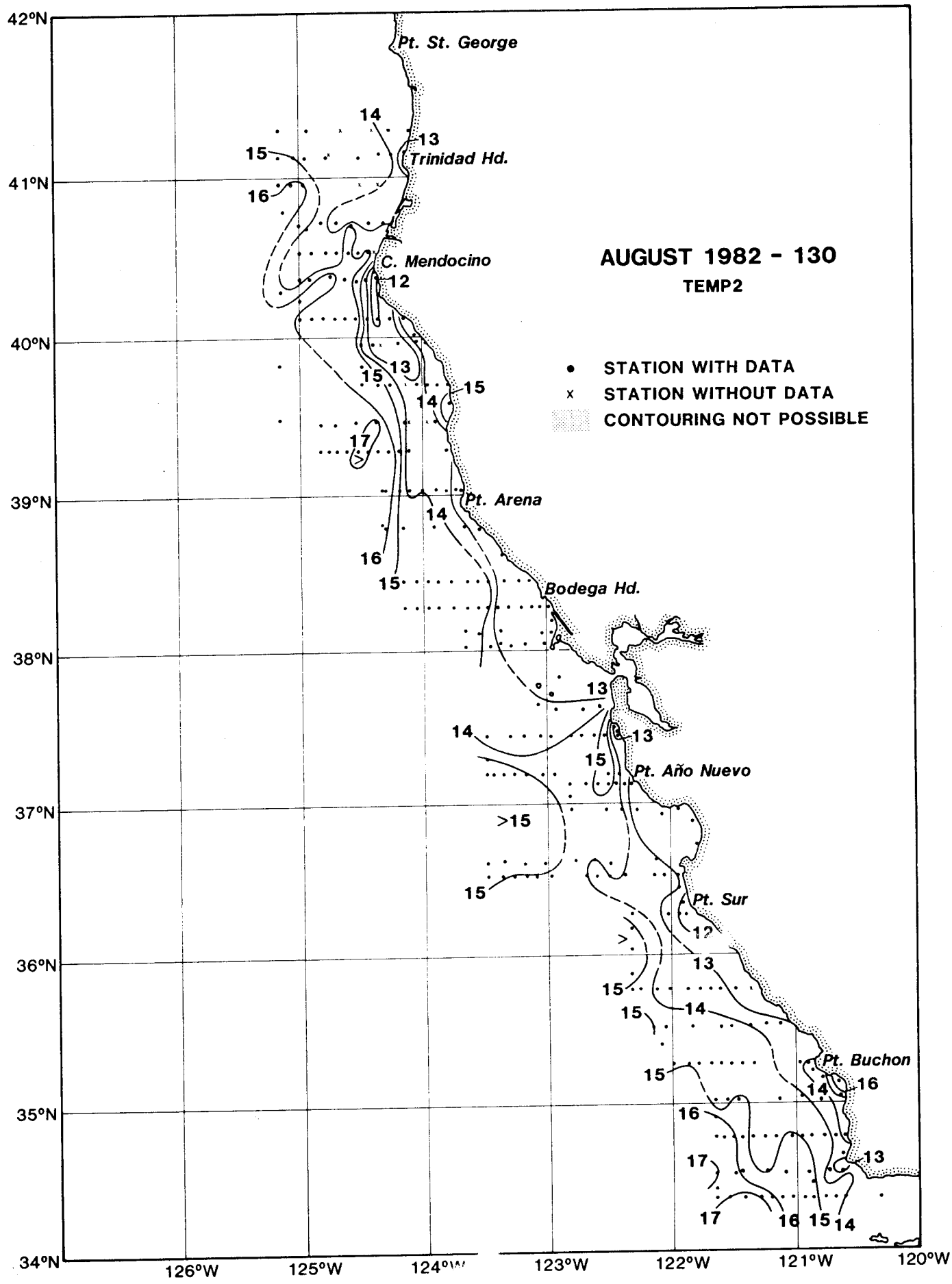
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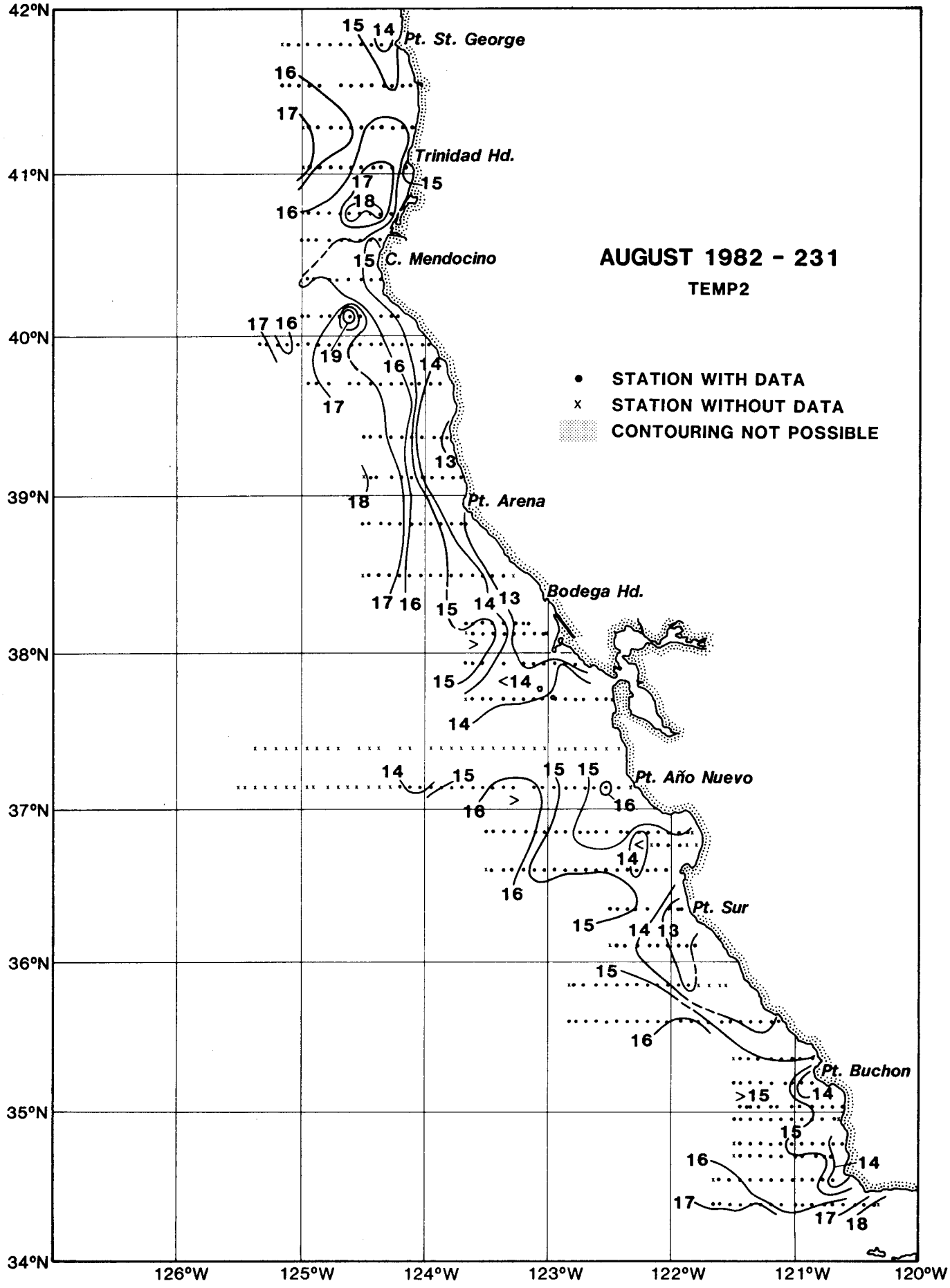
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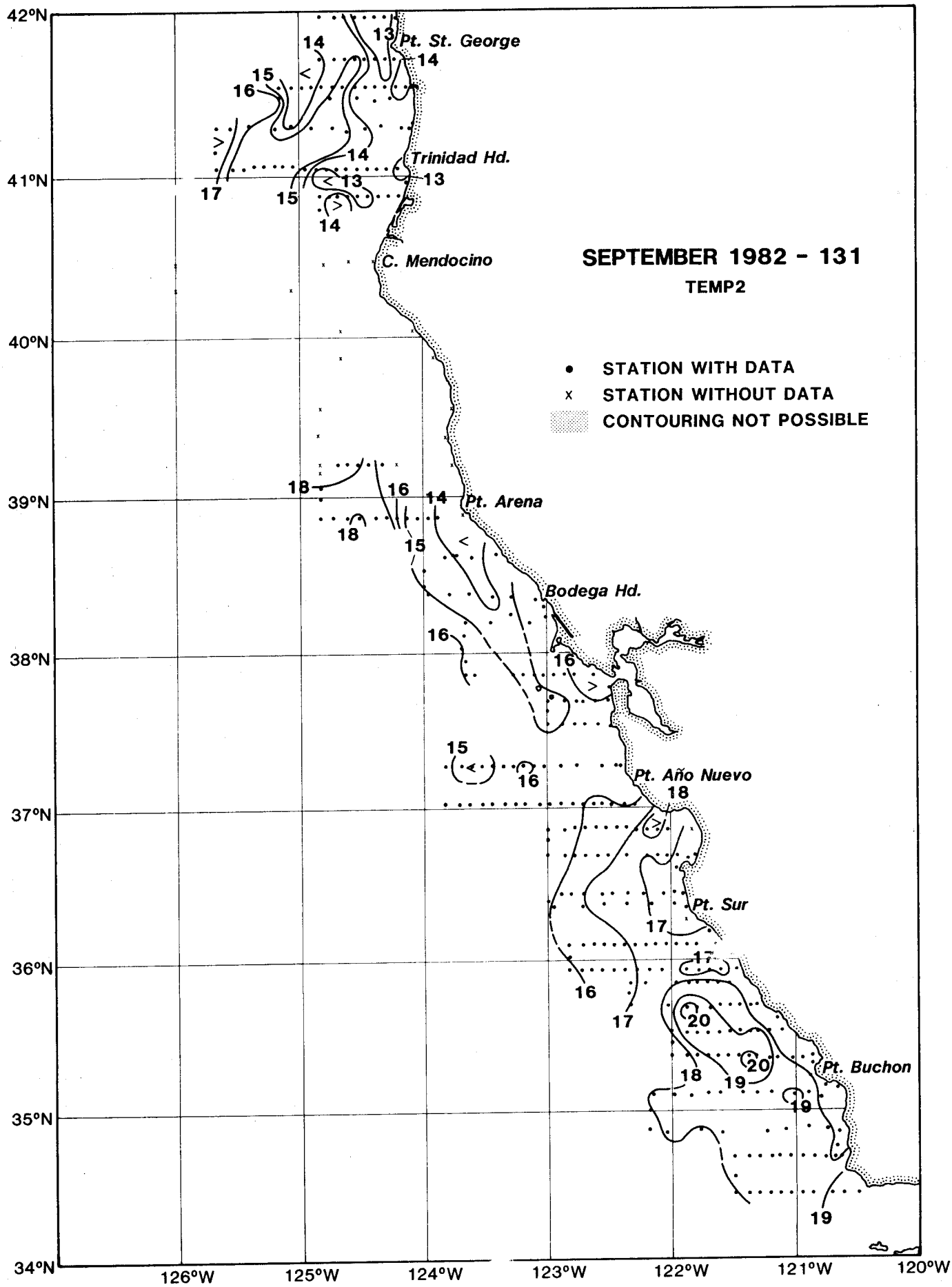
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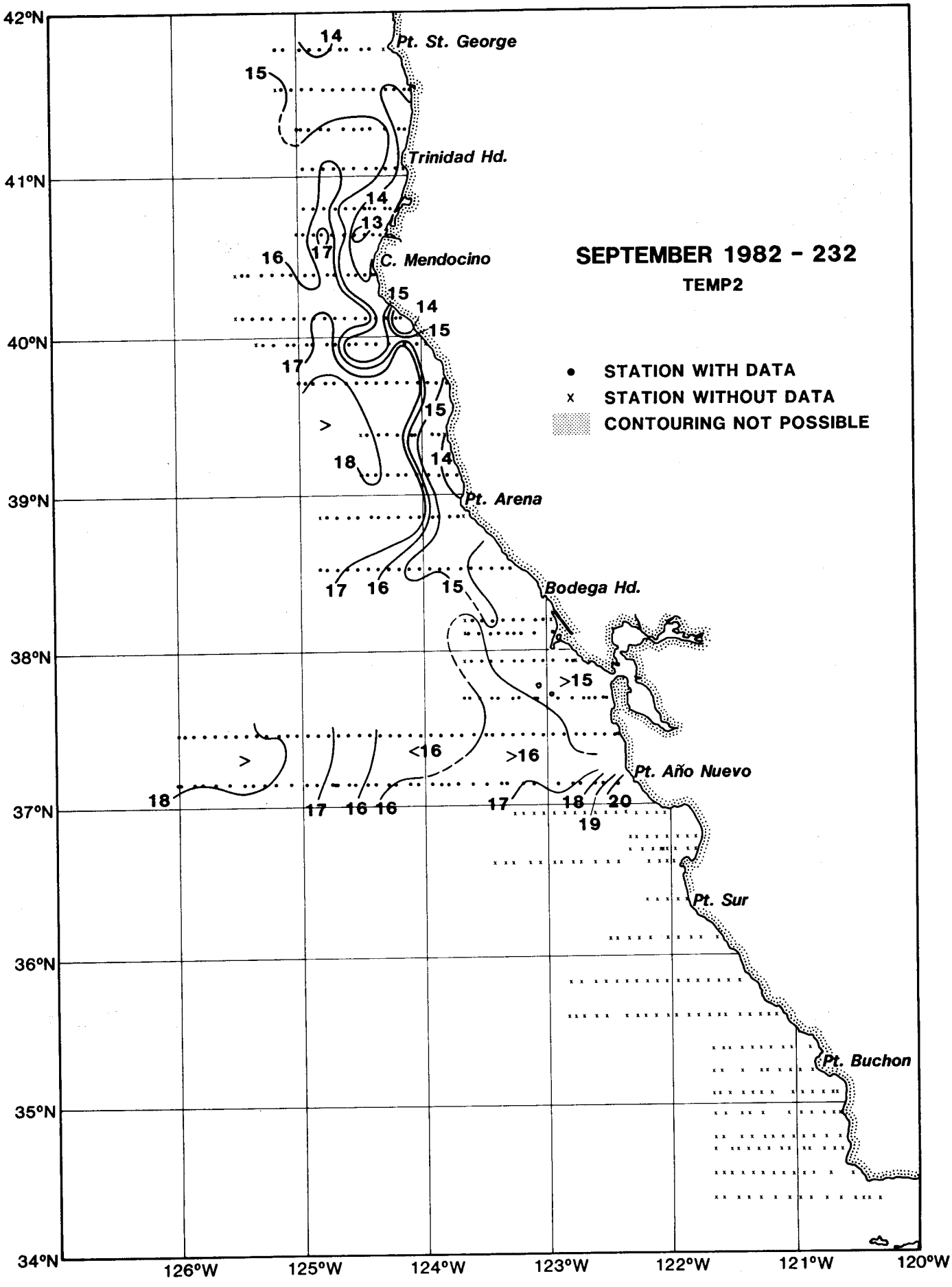
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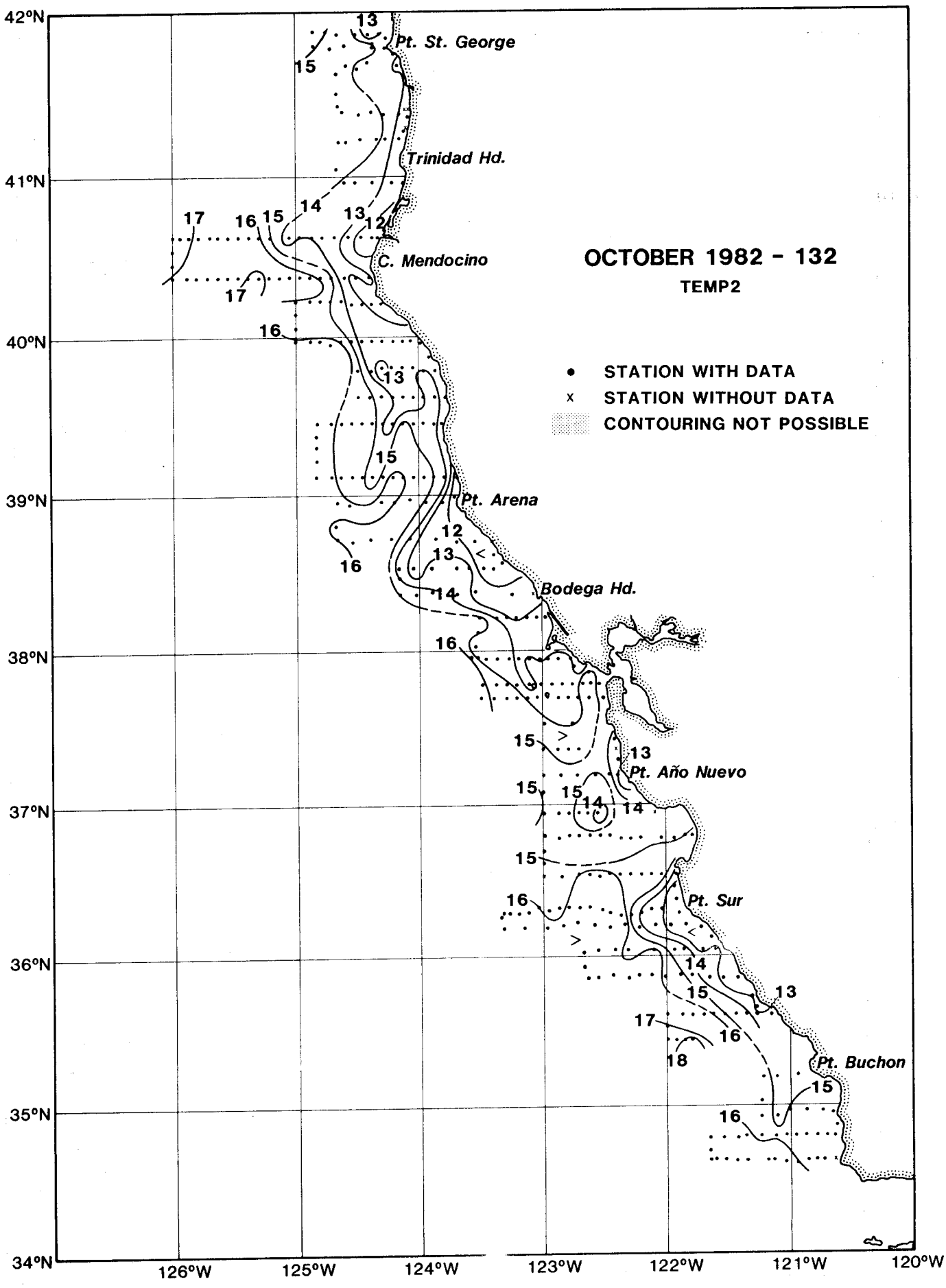
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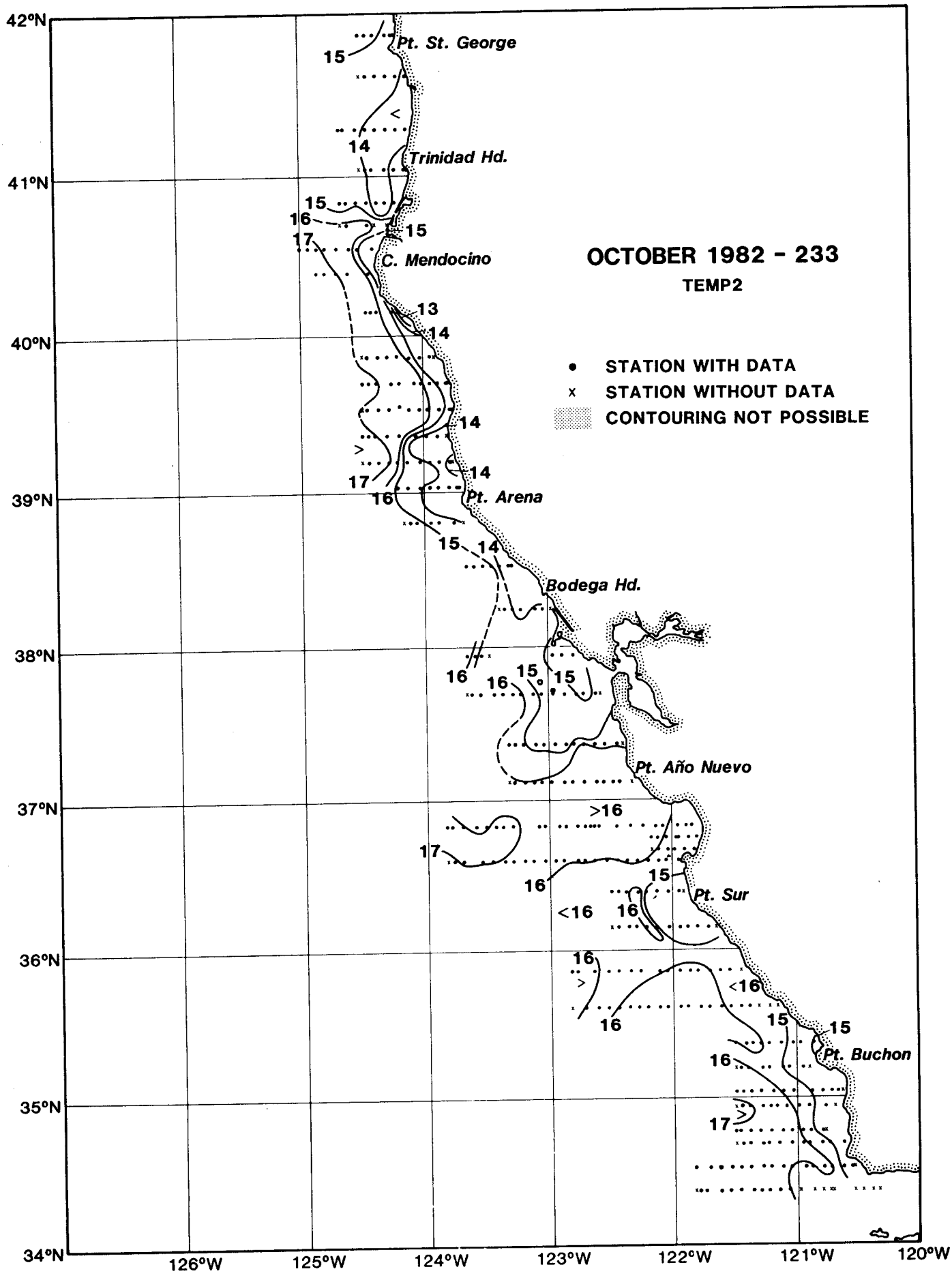
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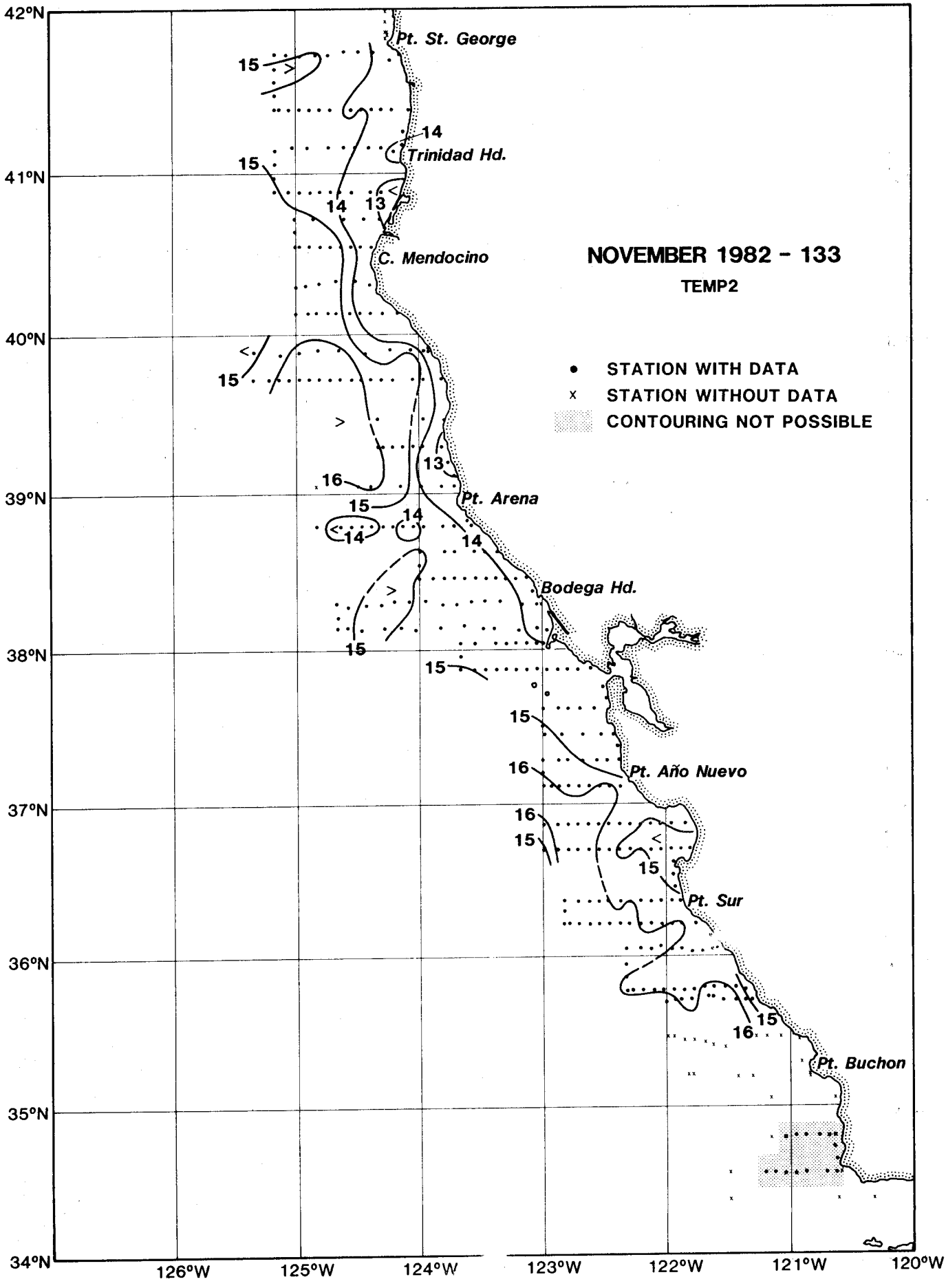
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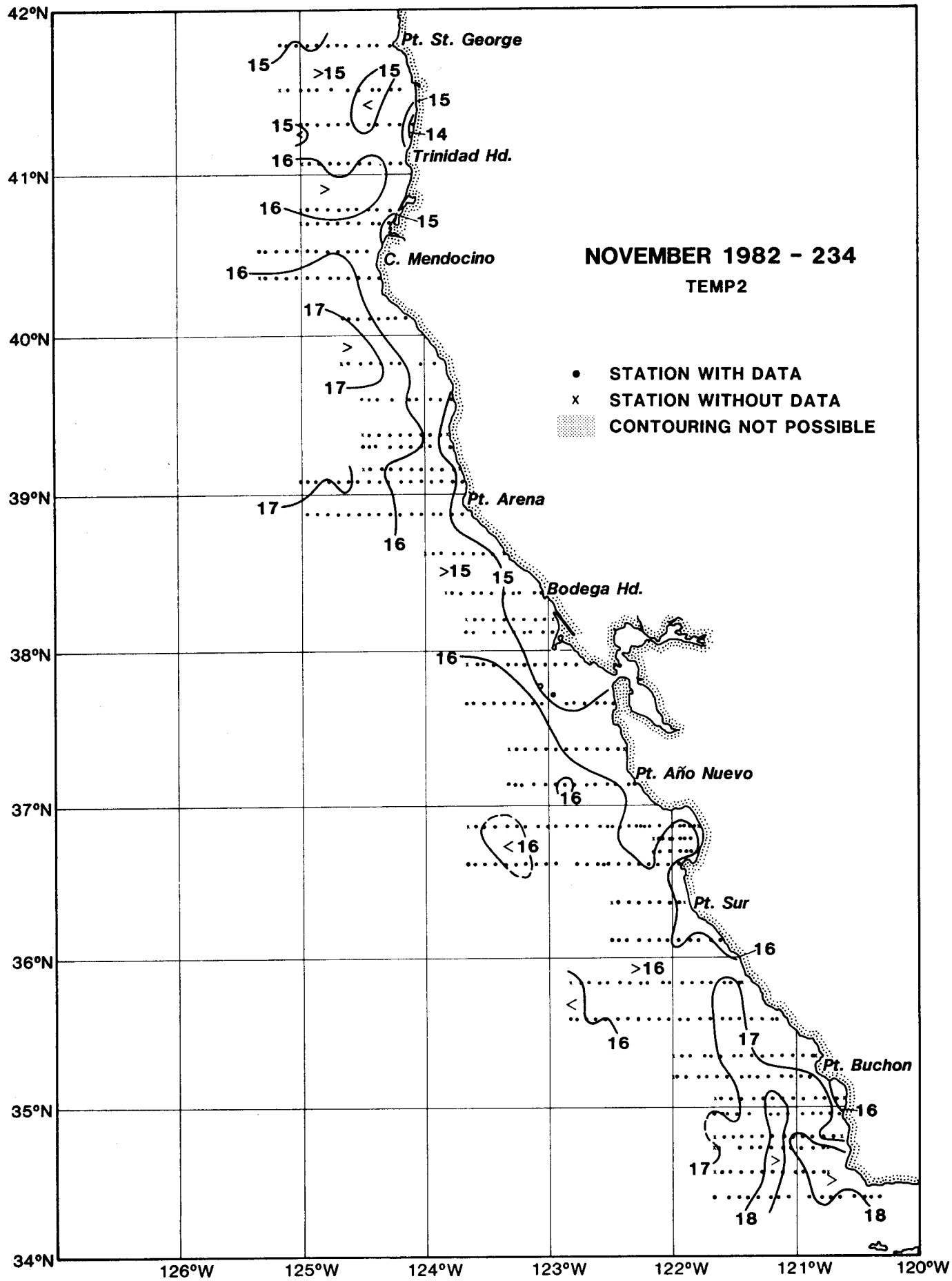
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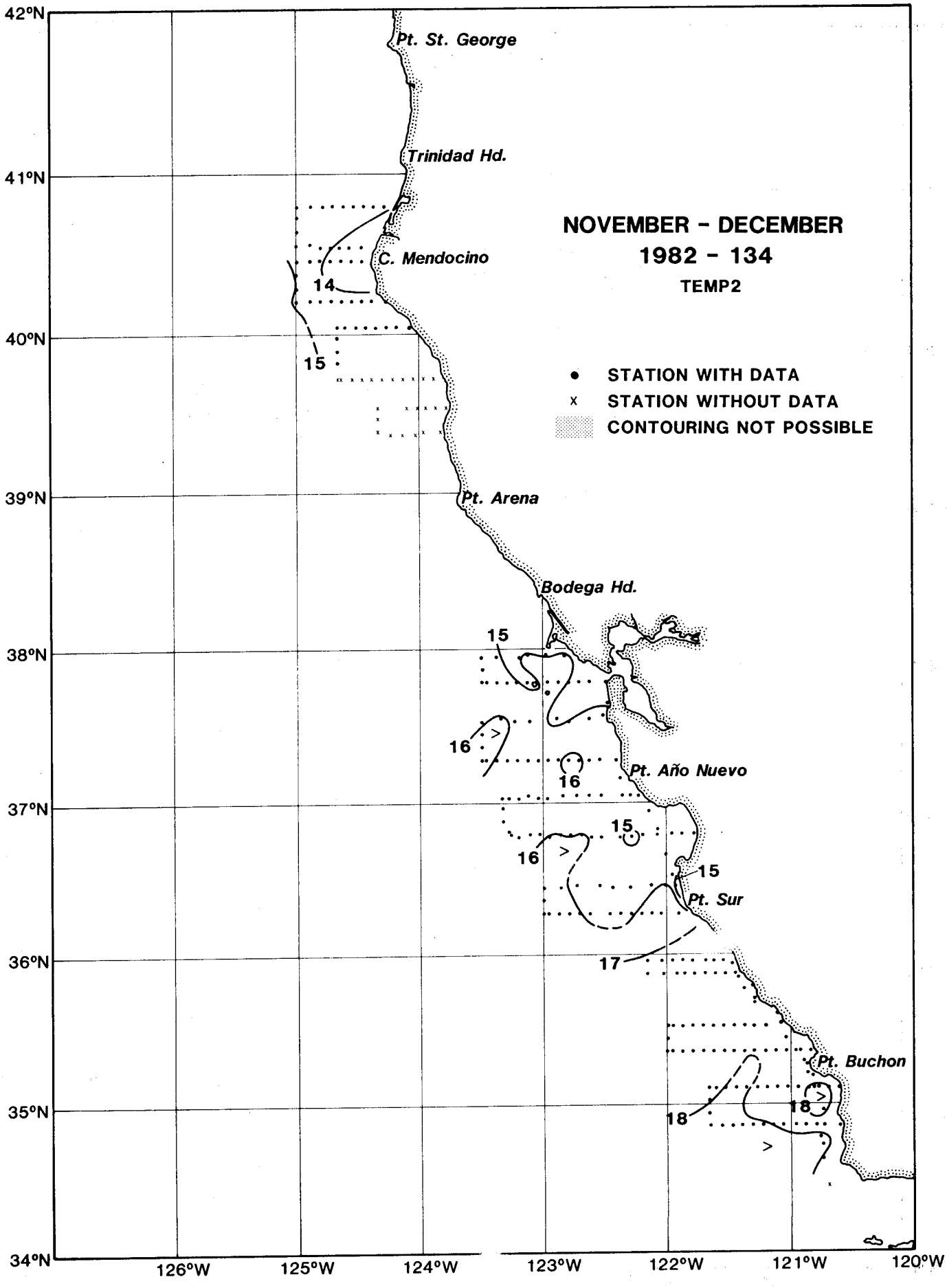
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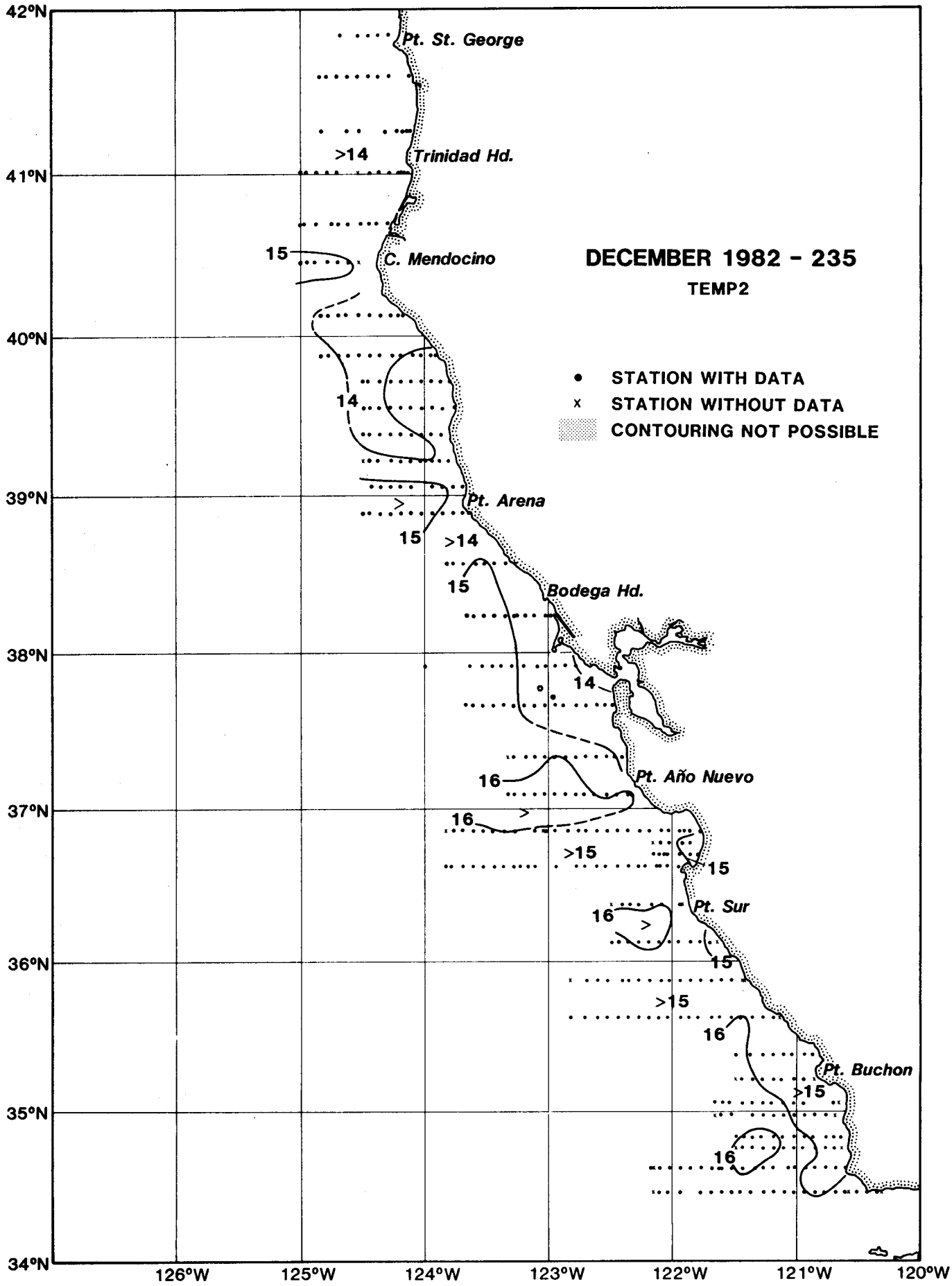
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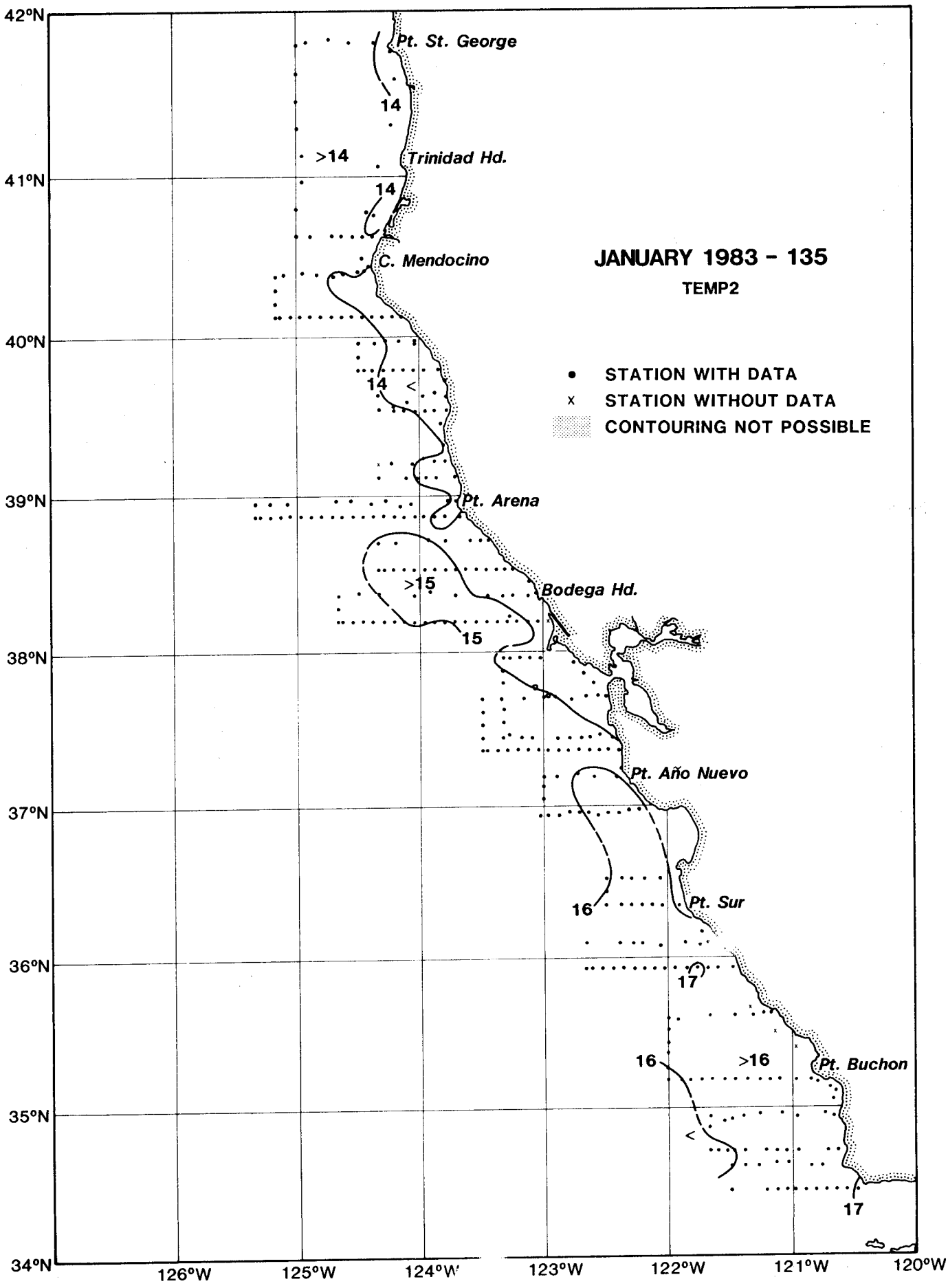
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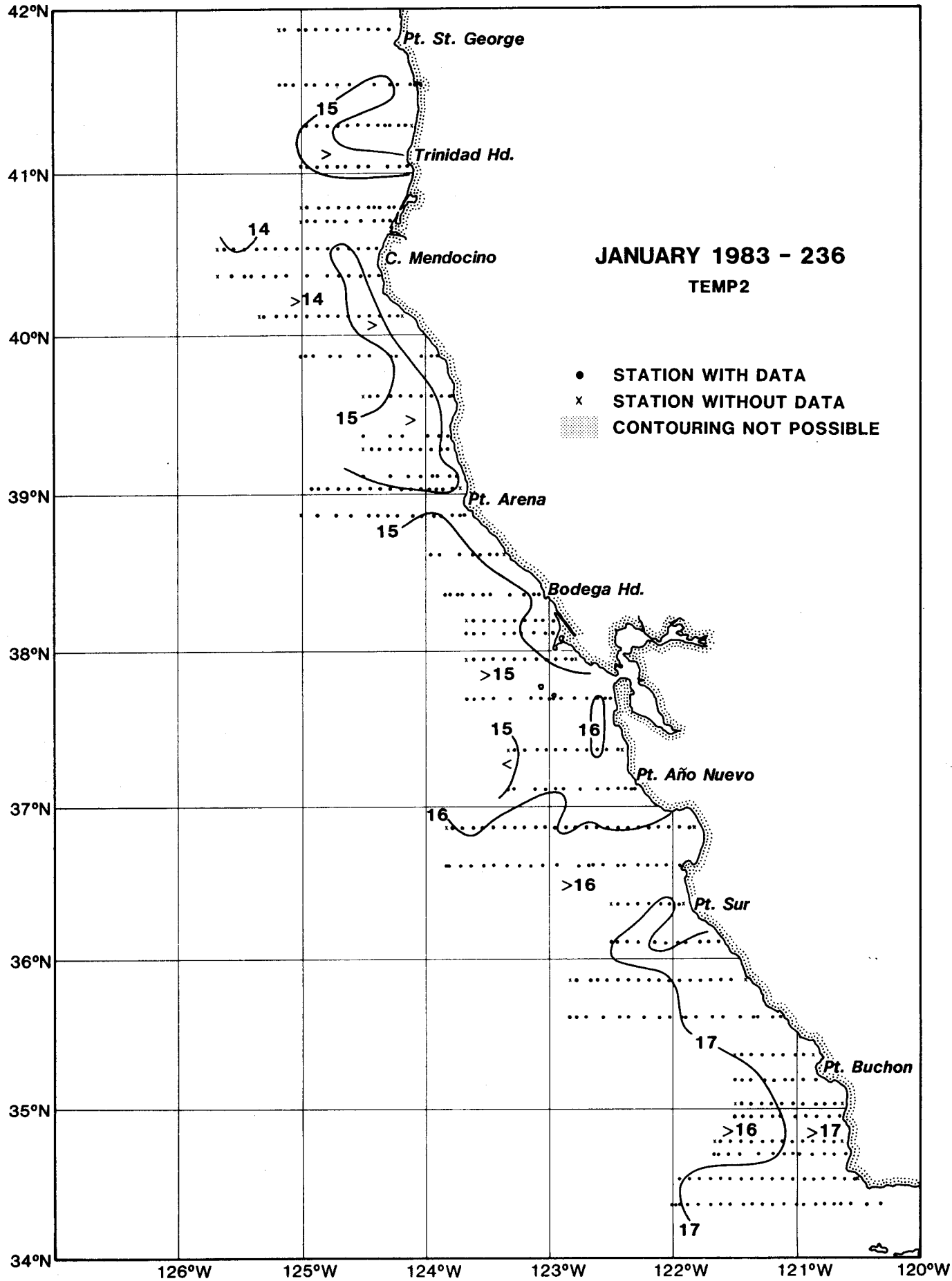
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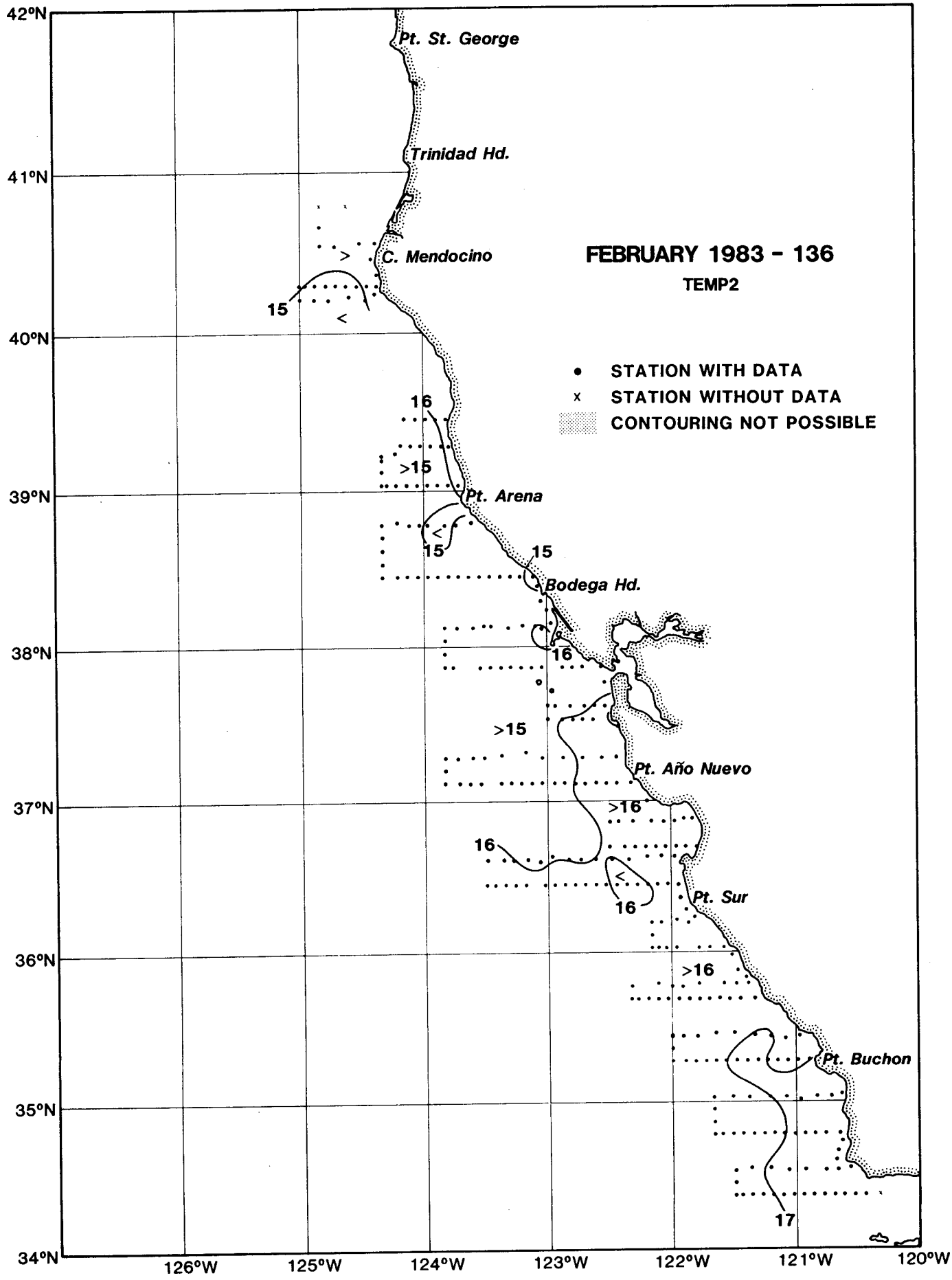
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FEBRUARY 1983 - 136
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