

FINAL REPORT:

Aerial Photography of the GCES-II
Test Flows and Interim Flows.

Part One:
Analysis of Test Flows

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ABSTRACT

A program of repeated aerial photography was applied to monitor the geometry of 75 sandbars along the Colorado River in Glen and Grand Canyons during a series of test flows from Glen Canyon Dam in 1990-1991. Aerial photography was continued during the interim flow period that followed the test flows. The dam has caused environmental changes downstream and the test flows were designed to help evaluate alternative modes of dam operation. Aerial photographs were taken during 16 flights that bracketed 15 test flows and two biannual periods of the interim flow period. Planimetric maps and area calculations for 64 sandbars are presented in this report. Area of erosion and area of deposition were defined as the reworked area and the difference between eroded and deposited area was defined as the net area change. Multiple regression techniques were applied to mean area calculations and to several geographic, hydrologic and temporal predictor variables. The results indicate that single variable models using hydrologic predictors are significantly correlated to two responses of change in sandbar area during the test flows. However, the models are not the same for the reworked area and net area responses. The models indicate that sandbars respond quickly to changes in sediment transport capacity but that the net result of a test flow was a function of rapid changes in discharge. This result suggests that high flows result in deposition of sand along the channel margins unless rapid discharge changes accompany the high flow. Aerial photography and inexpensive two dimensional analysis were successful in monitoring changes in sand storage as measured from the surface area of sandbars. The resulting database is valuable for additional statistical analysis including long term sampling requirements as well as for site specific details of geomorphic change to specific dam operations. More analysis is needed to determine sample size and sample interval for long-term monitoring investigations.

INTRODUCTION

Environmental Setting - Problem The Colorado River in Grand Canyon National Park and Glen Canyon National Recreation Area is regulated by Glen Canyon Dam. The dam, completed in 1964, generates hydroelectric power to meet instantaneous electrical demand in the western United States integrated electric grid. The optimal pattern of water release for electrical production is characterized by rapid fluctuation from minimum discharge of about 3,000 cubic feet per second (cfs) to maximum discharge of approximately 28,000 cfs. The maximum power plant discharge is approximately 31,200 cfs and discharge can be adjusted from minimum to maximum within one hour. Consequently, normal operations result in a daily 'tide' of cold clear water released from Glen Canyon Dam to meet midday peak electrical demand. This mode of operation has resulted in environmental impacts downstream in Glen and Grand Canyons. An environmental impact statement (EIS) on the operations of Glen Canyon Dam (GCD) was ordered by the Secretary of Interior in 1990.

Sand deposits along the margins of the river channel are important in many respects. Perhaps most important is that deposits of sand are a resource limited by local supplies downstream of the efficient sediment trap -- Lake Powell. Prior to dam closure sand deposits were continuously eroded and replenished by the river. But, removal of the annual spring high flows (mean annual peak 70,000 cfs) by GCD means that there is no longer a mechanism to replenish sands at elevations above maximum powerplant discharge. Sand deposits are the substrate for a rich and diverse, but very compact, strip of riparian habitat in a harsh desert environment. Sandbars also have characteristic geomorphic features that result in biologically productive back waters where endangered fish and other fauna may feed on warm water aquatic plants, insects and other nutrients. Also important is the use of sandbars for camping activities by

the thousands of white water rafting enthusiasts and back packers that visit the Colorado River in Grand Canyon each year.

Project Background One component of the GCD-EIS investigations was a suite of possible dam operation scenarios called test flows that began in June 1990 and ended in July 1991. Twenty individual test flows were designed with typical duration of 11 days (some were longer). Each test flow was followed by three days of constant low discharge at 5,000 cfs to facilitate evaluation of the downstream effects. Terrestrial surveying of sandbars during the three day evaluation intervals was limited to about 30 sites (Beus and Avery, 1991). The US Bureau of Reclamation (USBR) Glen Canyon Environmental Studies (GCES) Program Manager and Park Resource Managers felt that the test flows provided an unique opportunity and a larger sample size would afford analysis of more variables through robust statistical tests.

Aerial photography provides an efficient method of increasing the sample size given the short evaluation periods between test flows. A pilot aerial photography program was established in September 1990 under the direction of GCES with the support of USBR helicopters and Grand Canyon National Park staff and facilities. The program was fully implemented in November 1990 and 75 sandbars were photographed out of a population of approximately 500. Overlapping stereo photographs of each of the sampled sandbars were obtained during each of the evaluation periods between test flows.

A significant technical limitation was encountered as analysis of the photographs progressed. Occasional image motion due to a combination of low light conditions, the moving photo platform and slow shutter speeds was more common than preliminary tests indicated. In many of the photographs the magnitude of image motion was greater than three-dimensional

mapping techniques could tolerate. The difficulty of navigating and providing a stable photography platform at low altitude in a deep canyon (well below the rim in the Grand Canyon) became apparent. This ultimately prohibited three-dimensional analysis of the photographs. Three dimensional aerial photogrammetry is possible under conditions such as those encountered by choosing a wide angle lens (Dr. Sherman Wu, USGS Astrogeology Division, Flagstaff; pers. comm.).

A two-dimensional analysis technique was tried that was less influenced by image motion problems. This technique was applied on a trial basis to 10 sites which yielded positive results (Cluer, 1991). Results from the 10 sites analyzed for the test flows confirmed the utility of the photogrammetric approach in monitoring changes in sediment storage over a widely distributed sampling area during a short period of time. This, coupled with the relatively inexpensive analytical procedures (approximately \$50 per measurement per site) prompted continuing the aerial photography program during the interim flow period which followed the test flows. The goal was to monitor changes in sand storage until a record of decision was reached by the Secretary of Interior, or until a long-term monitoring program was implemented.

The overall objective of the interim flow monitoring proposal was "to determine if the interim flow prescription achieved the resource protection objective" [of stabilizing channel margin sand deposits]. The specific objective of this investigation was to fully develop the aerial photography analysis technique and the database from the test flow program in order to evaluate subsequent changes in sandbar areas measured during the interim flow period. Quarterly flights were proposed to obtain photographs following the seasonally adjusted low, medium and high volume release seasons in the interim flow period. At that time it was anticipated that evaluation periods would be provided as they were during the test flow program following each of the

seasonal adjustments in dam operations. After the proposal was accepted and funded it was decided that minimum water releases would be increased from 5,000 to 8,000 cfs and there would be only two evaluation periods per year when water level would be held constant at 8,000 cfs for three days. The consequences of these changes were to reduce the number of measurements per year and to change the reference elevation between the test flows and the interim flows. These consequences are discussed later.

The tasks and objectives of this investigation were modified due to the above sequence of events which occurred after the investigation was initiated. The interim flow objective stated above "to determine....resource protection...." can not be adequately evaluated because a three-year analysis schedule resulted in completion of only those sites that were in the analytical process during the final contract year with the USGS Astrogeology Division. Therefore, the interim flow sample consists of 11 sandbars for one period and 8 sandbars for two periods -- a small sample size. Fortunately other interim flow monitoring proposals had the same objective and more successful data collection programs (Kaplinski et al, 1994; and Cluer and Dexter, 1994). The objective to fully develop and analyze the test flow photography database remained attainable.

Despite the problems encountered during analysis and collection of interim flow photographs, the aerial photo database presented in this report represents the largest and most widely distributed sample of any investigation involving repeated measurement of sand deposits along the Colorado River. While the two week time step between measurements has been shown to be inadequate to capture the full dynamic range of sandbar areas downstream of GCD (Cluer, 1991), it is nonetheless the shortest time-step available for a large sample size, and is considerably shorter than the typical annual measurements obtained in prior investigations.

The goals of this investigation are to:

- (1) fully develop the two dimensional analytical techniques for repeated aerial photographs,
- (2) obtain measurements and calculate areas from all usable photographs from the test flow program,
- (3) perform statistical analysis on the sample averaged sandbar measurements for 15 of the test flows in an effort to determine which physical parameters are most closely correlated to changes in sandbar size, and
- (4) disseminate the resulting database so other investigators can use it.

Goals 1,2 and 3 are achieved in Part One of this report and goal 4 is achieved in Part Two (APPENDIX) which consists of area calculations and maps. A disk in DOS text format is included in Part Two that contains the table of area calculations.

METHODS

Image Processing and Measurements

Test Flows Photographs Photographs were taken with a hand held 70x70 mm Rollie metric camera from a helicopter flown approximately 1200 feet above the river surface. On average, six images were required to provide complete coverage of each sandbar. To obtain a composite image the original photographic negatives were visually aligned under magnification in order to match the water edge at the front of sandbars and immobile rocks at the back and edges of sandbars. The aligned overlapping images were fixed onto a stable transparency base to create a full-coverage composite image for each evaluation period. Outlines of sand deposits were then digitized along the water edge and between visible rocks well above the influence of the river, thus defining the area as a perimeter file. A technique was developed to process the digital perimeter files on a video monitor with a computer program that counted the number of pixels

filling the perimeter. Scaling factors were applied from surveyed references on each sandbar and areas within the perimeters were calculated.

To compare subsequent perimeters and develop universal scales for perimeters measured during different flights, additional corrections were made to rectify angular variations. One composite image was chosen as the geometric control image. All other perimeters were manually adjusted on the video monitor to align the common rock points to those on the geometric control image. With the common points aligned, the differences in surface area between preceding or succeeding perimeters were visually discernible and measurable, and consequently, the geomorphic result of the subject test flow. Individual perimeters were assigned unique colors and layers in a rudimentary GIS fashion. This provided the ability to further distinguish between areas of erosion and areas of deposition between test flows.

Interim Flows Photographs GCES contracted with an aerial photography company to fly the entire river corridor from GCD to the backwaters of Lake Mead and to obtain 9x9 inch color images at 1:4,800 scale during biannual evaluation periods. Copies of photographs covering the 75 study sites were obtained for the October 1992 and May 1993 evaluation periods. The analysis procedure outlined above was applied to the interim flow photographs except that composite images were not necessary.

One important factor when interpreting any photography from river environments is the water level at the time of the photograph. The project was fortunate that water levels were controlled by dam discharge, thus minimizing this influence. However, drainage of water stored in the banks can take several hours after river stage is dropped from a high level (Werrell et al 1993). Photo missions were designed to maximize drainage times and provide consistent water levels in each epoch. Visual inspection identified photographs that captured water levels differing

from the normal 5,000 cfs stage were removed from the data base. Unfortunately, changing the minimum discharge from 5,000 to 8,000 cfs at the beginning of the interim flow period made comparisons of test flow and interim flow sandbar areas difficult.

Statistical Analysis - Test Flows

Sandbar area measurements taken at each evaluation interval included: area of deposition, area of erosion and gross area. Two response variables were developed from the area measurements: (1) the net change in area as a percent of the original area, and (2) the reworked area expressed as the sum of eroded and deposited areas (as a percentage of the original area). The areas measured were averaged, resulting in 15 means for each of 64 sandbars sampled.

Eleven predictor variables were analyzed that included date, time span between measurements, duration of test flow and a variety of hydrologic variables. The hydrologic variables of the test flows considered in this investigation included; maximum discharge, minimum discharge, discharge range, whether or not a test flow included fluctuations in discharge, the total number of fluctuations in a test flow, the time between fluctuations and if fluctuations included a double peak (resulting from peak electricity demands that occur midday and again in early evening). If double peaks did occur, the maximum range in discharge of the larger peak was a predictor variable (Figure 1). Also included as a predictor variable was an empirically derived estimate of sediment transport which is a power function of water discharge based on a long-term record of stream gage data (Cluer and Vernieu, 1991; and USBR, 1994). The response and predictor variables of the summary database are presented in table 1.

RESULTS and DISCUSSION

Pearson correlation coefficients of the response and predictor variables indicated that few of the predictors were correlated with the net change in area or the reworked area due to the test flows. Stepwise multiple regression analyses (forward, backward, stepwise and adjusted R^2 techniques) at $\alpha = 0.05$ produced single parameter models for both the net area and the reworked area responses. The optimal models were:

$$\text{Percent Net Area} = 101.64 - 0.000245 (Q_{\text{DOUBLE PEAK}})$$

and,

$$\text{Percent Reworked Area} = 4.94 + 0.0252(\sqrt{\text{TONS}})$$

where $Q_{\text{DOUBLE PEAK}}$ is the maximum range in peak discharge for flow fluctuations that included a double peak (see Figure 1) and TONS is the transport capacity of the test flow in metric tons (1000 kg or 2200 pounds) of sediment.

The net area and reworked area models have R^2 values of 0.64 and 0.63, respectively (figures 2 and 3), and the parameters are significantly correlated at $\alpha = 0.05$ (p-values $\ll 0.001$). Standard diagnostic procedures (residual plots, normal probability plots, variance inflation factor, and Cook's Distance test) revealed no gross violations of the assumptions of linear regression (figures 4 and 5). The parameter TONS was transformed using the square root function following inspection of a scatter plot. The transformation resulted in slight improvement in R^2 values from 0.62 to 0.63.

Because the data were collected at incremental times, and are therefore time series data, time series autocorrelated errors were anticipated. The Durbin-Watson test for autocorrelation (Neter et al, 1985) was used as a diagnostic test. This resulted in d values of 1.64 and 1.98 for

the response variables percent net area and percent reworked area, respectively. Values for d outside the range 1.08-1.36 (for $n = 15$ at $\alpha = 0.01$) suggest significant serial correlation, indicating that time series analysis is appropriate. The testing of serial correlation was further investigated with time series plots of the model residuals (figure 6). Three weakly developed cycles of sand bar area were noted in the time series plot. Investigation of time series analysis was pursued because discharge varied in a broad seasonal pattern during the test flows and it was hypothesized that sandbar size would also show seasonality.

Iterative autocorrelation of percent net area was performed at time shifts (14-days) of 2-7 until the best fits were found at time shifts of 5 or 6. Classical decomposition was also performed on percent net area, giving similar results. Although the cyclic models were somewhat successful in predicting temporal oscillations, there was a tendency for the models to under predict the cyclic peak magnitude in sand bar area as well as a temporal lag problem that developed beyond one cycle. The temporal lag problem resulted in prediction series out of phase with the response series. Lag in this data set is due to the temporal irregularity of the time series -- the cycles have different wavelengths. Therefore it was concluded that the selected parameters may be serially correlated with a relationship more complex than autocorrelation can describe. More complex time series analysis is possible but would require breaking the series into individual cycles or synthetically deriving a new sample from the time series which is characterized by only 15 time-steps. This analysis is recommended for future investigation because it offers the possibility of predicting the response of sandbars to dam operations that were not tested directly.

Using two years of daily measurements of sandbar area from 20 sites, Cluer and Dexter (1994) showed that sandbar area is significantly autocorrelated with seasonal cycles of three, six and nine months. The cycle periods correspond to the quarterly adjustments in water volumes

released from GCD. Daily time step measurements made that analysis possible, whereas it is not possible with the aerial photo database because of the small number of observations in a temporal sense.

The area reworked and the net resulting area of specific test flows are not predicted by the same hydrologic parameter. This is interesting for several reasons that deserve discussion. Perhaps most important is that the transport capacity of a flow proved to be a relatively good predictor of reworked sandbar area, explaining 63% of the variability in those measurements. The relationship between transport capacity and reworked area is positive which shows that high discharges resulted in reworking large areas. Therefore, transport capacity may be used in predicting how sediment might be 1) exchanged within sand storage sites, and 2) exchanged between bank storage and channel storage for different types of discharges. The latter is essentially the efficiency of eddy deposition where the storage site is not already in a filled state.

The reworked area is a useful measure of how much sand was transported in the sandbar environment for specific flow tests, but the net area describes the deposit size that resulted. Net area was not significantly correlated to transport capacity (at $\alpha = 0.05$). Instead, a variable that estimates the maximum range in peak discharge for a double peaked flow fluctuation was found to be the significant predictor, explaining 64% of the variability in measurements of percent net area. Percent net area was negatively correlated with the predictor -- double peak discharge. The greater the magnitude of discharge range during test flows with double peaked fluctuations, the smaller the resulting net area. The model for net area suggests that rapid changes in discharge, as indicated by large $Q_{\text{DOUBLE PEAK}}$ values, cause erosion of sandbars. The models for sand deposit reworking and net size suggest that large discharges rework large areas of sand deposits but if discharge changes rapidly the net result may be erosion and reduction of sand storage.

This result highlights the importance of documenting and understanding the temporal adjustments in sand storage in addition to the more traditional spatial emphasis used in monitoring investigations. Transport capacity for a test flow is estimated by a power function of water discharge. It is based on an estimate of the volume of water released weighted by the duration and magnitude of maximum discharge. Consequently, this estimate is a summary of the hydrograph for the duration of a test flow and represents at least a two week period of time. The discharge range of a double peaked flow fluctuation is an estimate of the maximum short term variability (a few hours) in discharge for a flow test. The discharge range of double peaked flow fluctuations is similar to ramping rate and further statistical analyses should include the ramping rate variable. This could lead to identifying ramping rate thresholds as defined by erosion of sand deposits.

CONCLUSIONS

The net resulting sandbar area was significantly correlated to a short term hydraulic variable rather than a variable that describes the overall hydrology of a test flow. This suggests that short term processes play an important role in adjustments to sediment storage, as measured by sandbar size, to different patterns of discharge from GCD. Findings from studies using daily and shorter temporal measurements of sandbar size (Cluer and Dexter, 1994) and volume (Cluer et al., 1993) supports this conclusion. The results of this investigation indicate that high flows result in deposition of sand along the channel margins unless rapid changes in discharge occur.

The aerial photo database resulting from the GCD-EIS test flow program is a valuable database because it documented the natural variability in sediment storage as sandbars adjusted to a suite of alternative dam operations. Site specific area calculations and perimeter maps are

presented in Part Two of this report. Additional analysis of this database using advanced statistical regression, ANOVA and time series tests is recommended in order to determine the optimal sample size and sampling time interval. Answers to the sampling questions will be important to future long term monitoring activities on the Colorado River in Grand Canyon as well as other regulated rivers.

Monitoring Implications Following analysis of photographs from 10 sites during the test flow program, it was recommended (Cluer, 1991) that a large sample size be used for subsequent monitoring in the interim flow period. This was because sandbars responded so dynamically to the test flows (Beus and Avery, 1991) that sample trend or central tendency were difficult to determine due to the variability. Monitoring sandbars at daily and shorter intervals revealed even greater size variability in shorter time increments (Cluer, 1991; Cluer and Dexter, 1994). It was found that a high percentage of sandbars undergo deposition and rapid erosion in cycles, and the cycles are repeated.

Improperly monitoring cyclic processes can lead to significantly biased interpretations of changes in sand storage along the channel margins (Cluer, 1995). The bias is most severe for repeat measurements made at time intervals much greater than the erosion/deposition cycle, which was found to vary between a few weeks and a year or more for 20 sites studied (Cluer and Dexter, 1994). As in many other sampling situations, the ergodic hypothesis (temporal and spatial scales are interchanged) has been employed in sandbar monitoring. In this situation where size variability is greatest in the short-term there is potentially an optimal trade-off between time span and sample size. Large sample sizes can partially offset the temporal variability problem in monitoring programs if the goal is estimation of total sand storage (the population trend), not site

specific or even reach scale changes in sand storage. However, the necessary sample size is unknown and little work has been done on this subject.

In an environment where sand is a limited resource, a monitoring program for changes in sand storage needs to address the effects of cyclic processes and of sampling at time intervals longer than the cycle period. To disregard cyclic processes is to bias the measurements and to inconsistently filter the minimum and maximum measurements from the data set. These measurements are the estimates of variability. Any measurements obtained without estimates of the variability in those measurements can not be interpreted with any level of confidence. This accuracy of measurement is necessary in a monitoring program in order to discriminate between short-term cyclic processes and long-term trends in sediment storage.

ACKNOWLEDGMENTS

This investigation was conducted with the cooperation of the USBR Glen Canyon Environmental Studies office and the USGS Astrogeology Division, both in Flagstaff, Arizona. Dr. Sherman Wu and Lori Frick and Annie Howington of his staff at the Astrogeology Division deserve credit for perfecting the two-dimensional analysis techniques, making what was an imperfect database ultimately useful and valuable. The report was prepared with the assistance of the National Park Service - Water Resources Division. Draft versions of this report were thoughtfully reviewed by Rick Inglis and Bill Jackson. Their helpful comments and suggestions were gratefully incorporated.

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Table 1. Data used in regression analysis.

PREDICTORS									
DATE	Julian Date	Transport Capacity	Change in Transport	Q max	Q min	Q range	Dbl Peak	Q dblpk	
10/14/90	0	4000	-28000	13000	3000	10000	0	0	
10/30/90	14	3000	-1000	8000	8000	0	0	0	
11/11/90	28	4000	1000	17500	1500	16000	1	7000	
12/17/90	64	18000	14000	23000	1500	21500	1	9500	
12/30/90	78	6000	-12000	10000	10000	0	0	0	
01/12/91	92	17000	11000	20000	8000	12000	0	1200	
01/26/91	106	11000	-6000	23000	1500	21500	1	7000	
02/09/91	120	6000	-5000	15000	5000	10000	0	500	
04/20/91	192	51000	45000	25000	1500	23500	1	6500	
05/04/91	206	5000	-46000	18000	3000	15000	1	10000	
05/19/91	220	33000	28000	27000	2500	24500	0	0	
06/02/91	234	15000	-18000	15000	15000	0	0	0	
06/30/91	262	61000	46000	30800	3500	27300	1	2500	
07/14/91	276	45000	-16000	27000	8000	19000	0	0	
07/27/91	290	34000	-11000	27000	8000	19000	0	0	
PREDICTORS cont.					RESPONSES				
Number Maj Flucs	Total Num Fluc	Fluc Time in hours	Duration Days	NET AREA	PERCENT NET	REWORKED AREA	PERCENT REWORKED		
11	11	24	11	-22.96	99.98	8491.70	8.91		
0	0	264	11	545.61	100.66	4484.45	5.41		
11	22	12	11	-1342.37	98.99	8550.79	6.40		
32	64	12	32	-4124.50	97.24	12863.16	8.61		
0	0	264	11	856.41	100.46	10097.58	5.38		
11	11	24	11	2314.07	101.60	10024.63	6.95		
11	22	12	11	705.05	100.37	15721.73	8.27		
11	11	24	11	-117.77	99.94	13268.44	6.94		
66	132	12	69	-3471.86	98.15	19551.16	10.42		
10	20	12	11	-2477.16	98.52	10692.91	6.38		
11	11	24	11	1720.42	101.09	15864.25	10.01		
0	0	264	11	946.89	100.51	17095.17	9.27		
25	50	12	25	626.47	100.36	19029.37	11.08		
11	11	24	11	371.48	100.30	14749.47	12.07		
11	11	24	11	1041.31	100.59	12706.71	7.16		

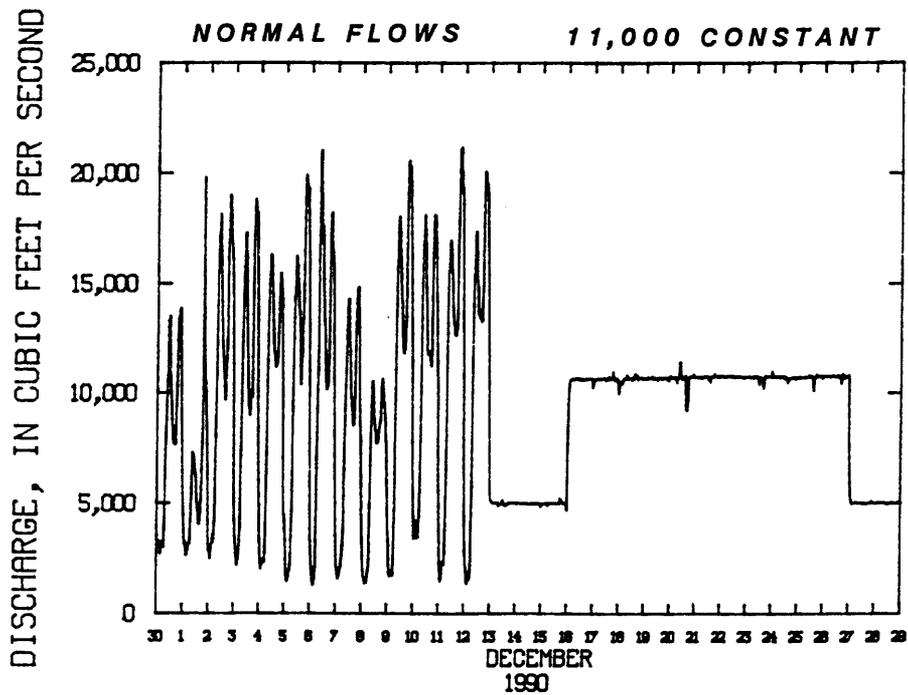


Figure 1. Example of discharge hydrograph from two test flows in December, 1990. Daily fluctuations during December 1 - 13 included double peak dam operations.

$Y = 100.64 - 2.45E-04X$
 R-Squared = 0.641
 --- 95.0% Confidence Bands --- 95.0% Prediction Bands

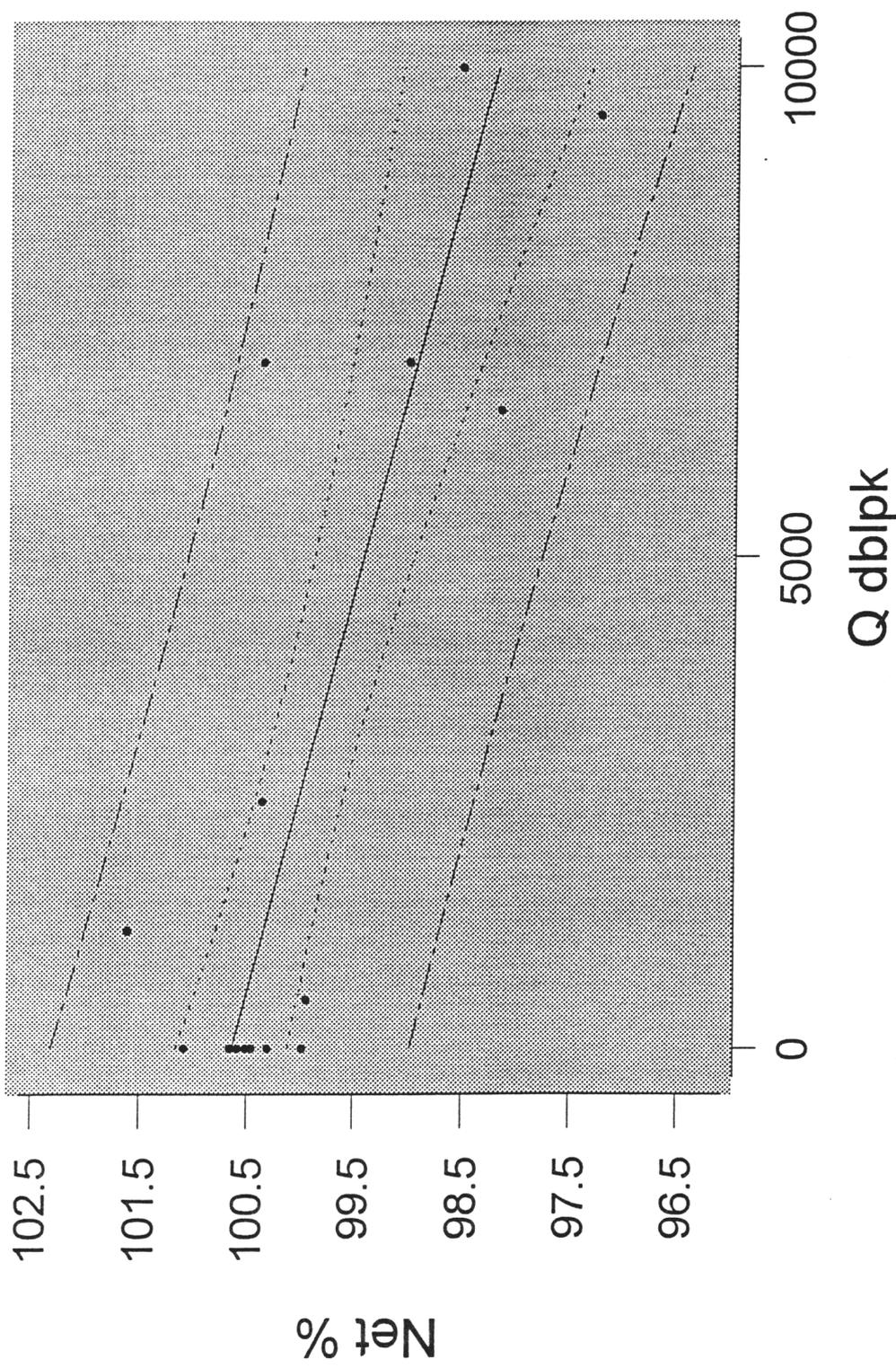


Figure 2. Fit of regression model for net area as a percentage of original area versus the discharge for double peaked flows.

$$Y = 4.94343 + 2.52E-02X$$

R-Squared = 0.632

----- 95.0% Confidence Bands ----- 95.0% Prediction Bands

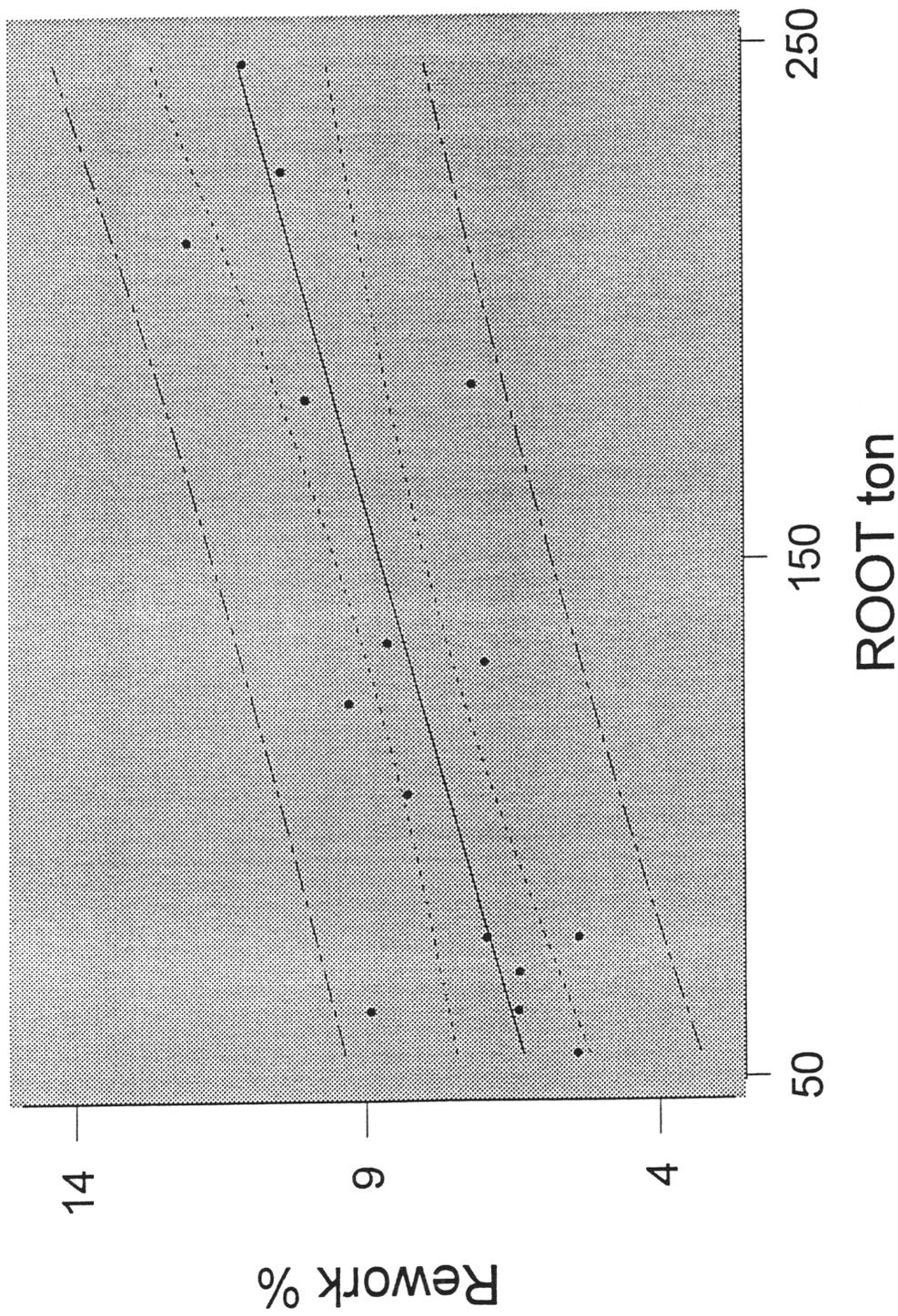
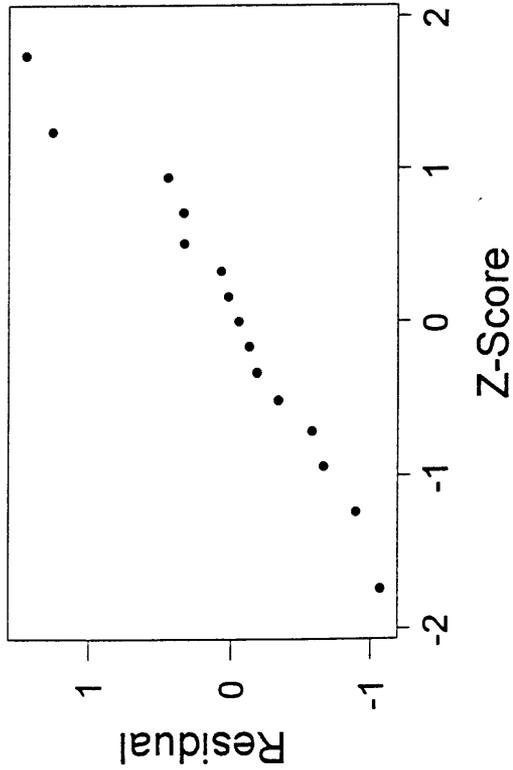
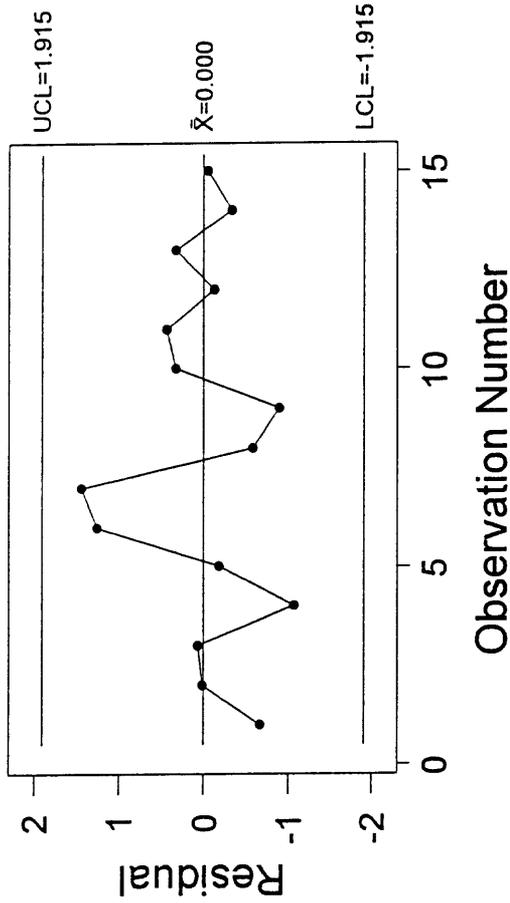


Figure 3. Fit of regression model for reworked area as a percentage of the original area versus transport capacity.

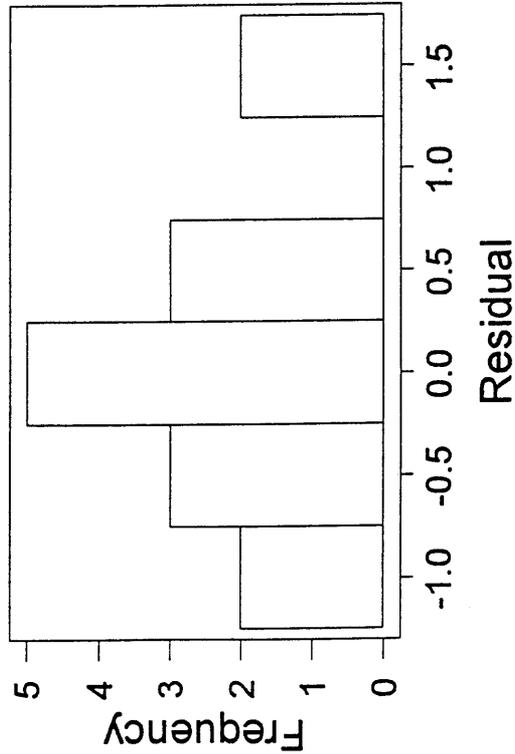
Normal Plot of Residuals



I Chart of Residuals



Histogram of Residuals



Residuals vs. Fits

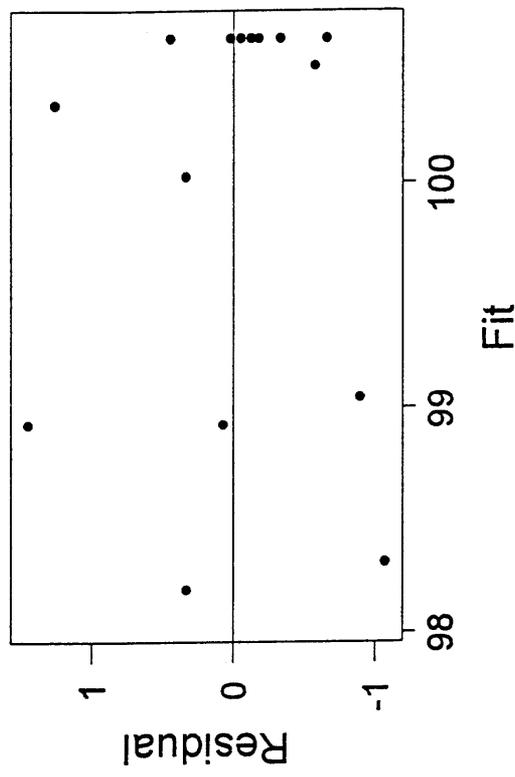
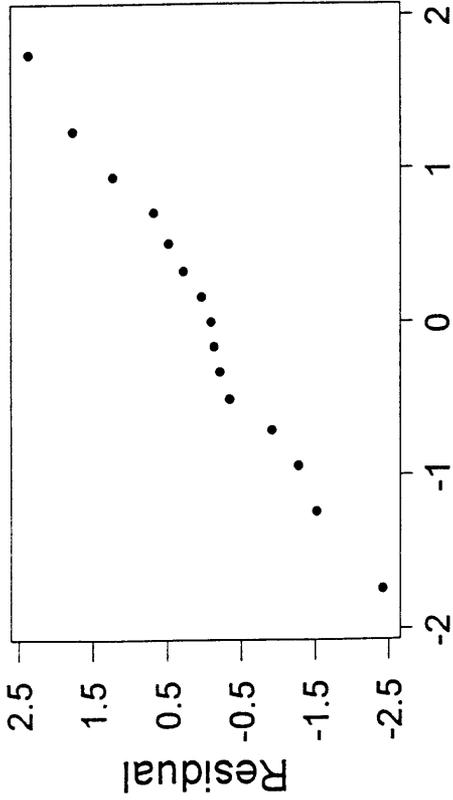
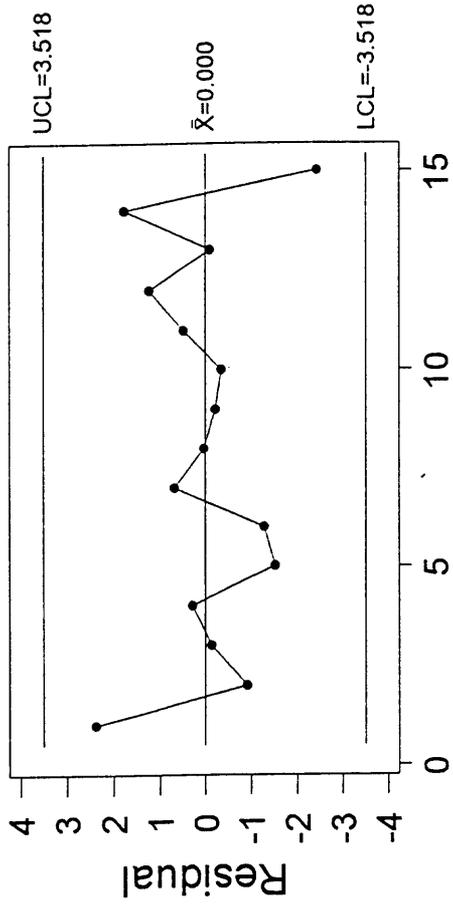


Figure 4. Diagnostic plots for the net area regression model.

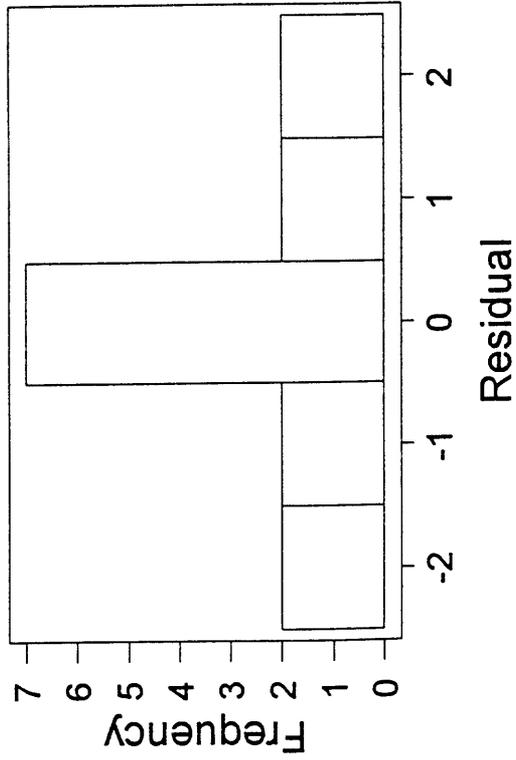
Normal Plot of Residuals



I Chart of Residuals



Histogram of Residuals



Residuals vs. Fits

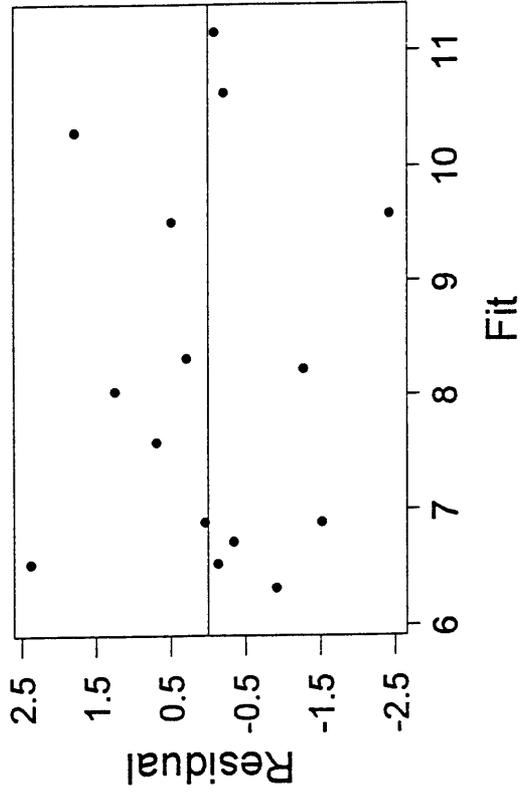


Figure 5. Diagnostic plots for the reworked area regression model.

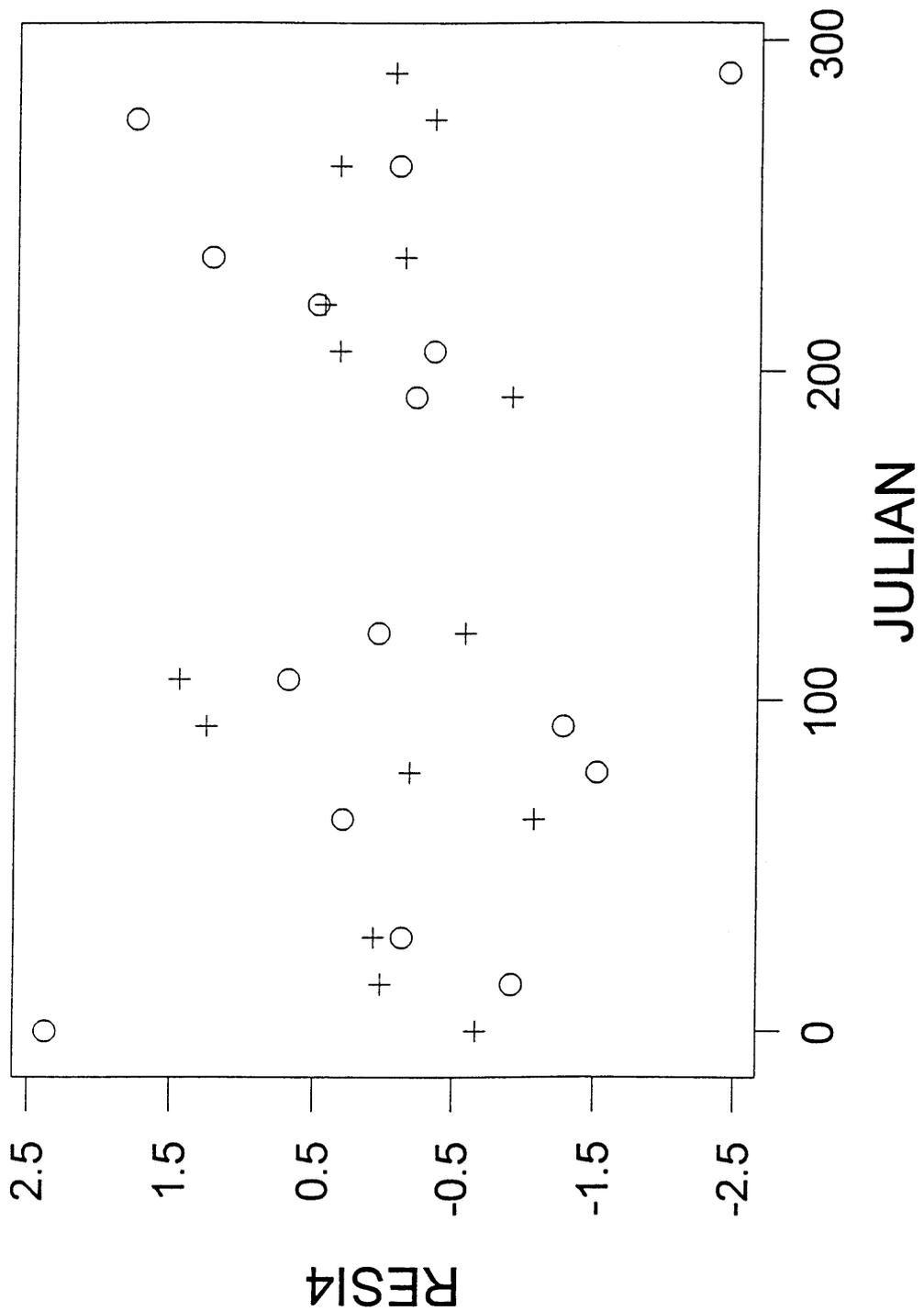


Figure 6. Time series plot of the model residuals indicating irregular cyclic pattern. Circles are for the reworked area residuals and the pluses are for the net area residuals.

Aerial Photography of the GCES-II
Test Flows and Interim Flows.

Part Two:
APPENDIX
Area Calculations and Perimeter Maps.

Brian L. Cluer

National Park Service
National Natural Resource Center
Water Resources Division

Fort Collins, CO

May 31, 1995

SITES:		33.0L				35.1R				37.5L				40.0L				43.1L - AMASAZI BRIDGE				
DATE	JULIAN	AREA	FILL	CUT	NET	AREA	FILL	CUT	NET	AREA	FILL	CUT	NET	AREA	FILL	CUT	NET	AREA	FILL	CUT	NET	
16-Sep-90	1																					
30-Sep-90	15	5616	115	-835	-720	1741	853	-7	848	2102	2671	853	-7	848	7214	1170	-278	4864	43	-6	37	
14-Oct-90	29	4814	1199	-186	1012	1770	34	-861	-827		2671	34	-861	-827	8072	1159	-699	4921	214	-1	214	
30-Oct-90	45	5604	279	-552	-273	2394	559	-17	542		1770	559	-17	542	8560	1159	-699	5188		-329	-329	
11-Nov-90	57	4940	187	-766	-579	2010	17	-325	-308		2671	17	-325	-308	7667	195	-1067	4864	78	-34	44	
17-Dec-90	93	5068	503	-382	121	2061	65	-16	49		1770	65	-16	49	8204	583	-128	4785	46	-20	26	
30-Dec-90	108	4869	208	-336	-128	1972	178	-296	-118		2394	178	-296	-118	7831	108	-352	4938	200		200	
12-Jan-91	132	4832	335	-562	-247	2243	357	-73	284		2061	357	-73	284	8204	583	-128	5169				
26-Jan-91	146	6768	2247	-240	2007	2331	118	-62	56		2394	118	-62	56	7866	285	-252	4864	78	-34	44	
9-Feb-91	202	4829	97	-1907	-1810	2150	139	-298	-159		2331	139	-298	-159	8204	583	-128	5169				
20-Apr-91	231	3916	19	-814	-795	423					2331				8204	583	-128	5169				
4-May-91	245	4364	600	-177	423						2331				8204	583	-128	5169				
19-May-91	287	4648	403	-176	228						2331				8204	583	-128	5169				
30-Jun-91	273										2331				8204	583	-128	5169				
14-Jul-91	287										2331				8204	583	-128	5169				
27-Jul-91	300										2331				8204	583	-128	5169				
11-Oct-92	740										2331				8204	583	-128	5169				
30-May-93	970										2331				8204	583	-128	5169				
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											2331				8204	583	-128	5169				
											2331				8204	583	-128	5169				

Map Key

Site name:

33.0L

Original profile

Date of original profile

10/15/90

General direction of river flow



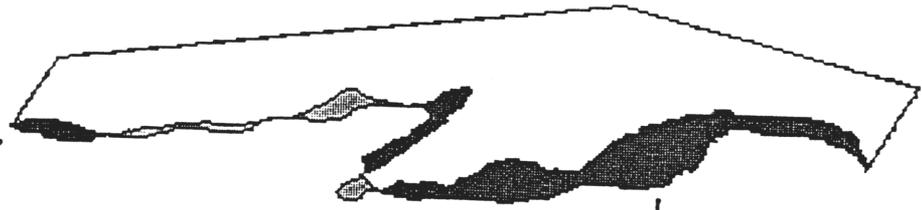
Subsequent profiles overlaid

10/15/90 - 10/30/90

Dates of overlaid maps

Light shading indicates deposited areas

Dark shading indicates eroded areas



River Mile Name	Deposit Type		
-10.2R	R		
-6.5R	UP		
-2.8L	R		
1.0R	S/R		
2.6L	R		
4.0L	S/R		
8.0L	S		
16.4L	S/R		
20.0L	M		
20.5R	UP/S		
21.8R	R		
29.1R	UP		
29.2L	S		
30.4R	R		
31.6R	S/R		
33.0L	S/R		
35.1R	R		
37.5L	R		
40.0L	R		
43.1L	UP		
44.6L	S/R		
47.1R	R		
50.0R	S/R		
51.2L	R		
55.5R	UP		
56.2R	S		
64.0L	R		
66.4L	R		
68.3R	S/R		
75.8R	R		
76.5L	UP		
81.2L	M		
83.9R	M		
87.1L	M		
91.1R	S/R		
93.3L	UP		
98.0R	UP		
103.9R	UP		
107.8L	S		
119.0R	R		
120.1R	R		
122.2R	R		
122.7L	R		
132.0R	S		
134.6L	S		
136.7L	S/R		
139.0R	UP		
145.5L	R		
153.6R	S		
157.7R	S		
166.5L	S		
168.0R	R		
171.2L	S/R		
172.3L	S/R		
182.4R	R		
182.8R	R		
183.9L	R		
194.1L	R		
201.5R	R		
202.0R	S/R		
211.6R	S		
212.9L	UP		
219.9R	M		
225.2R	UP		
sample size = 64	number of:	reattachments	24
		separations	11
		combinations	13
		upper pools	11
		margins	5
			64

-10.2R

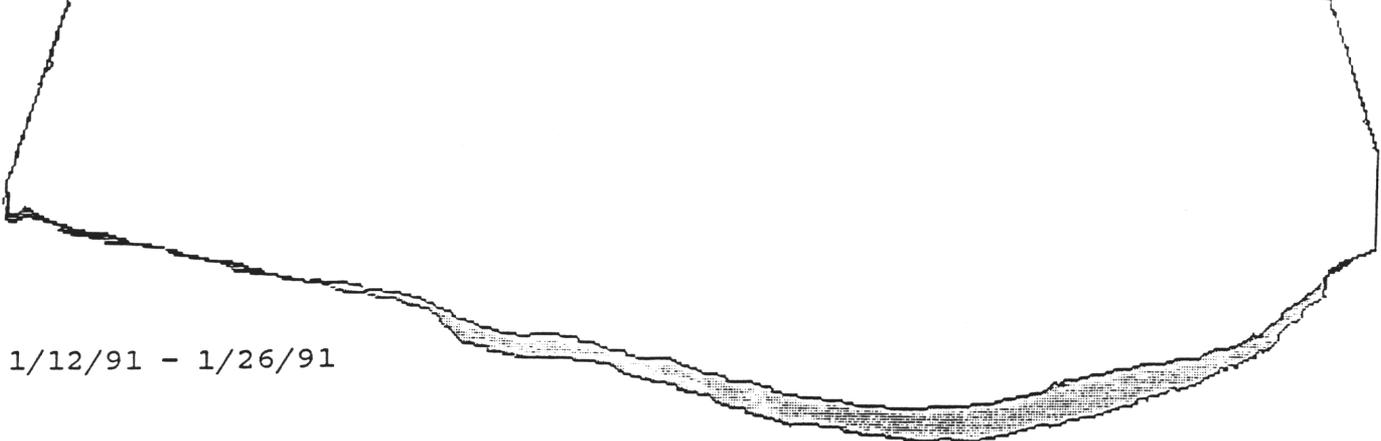
9/30/90



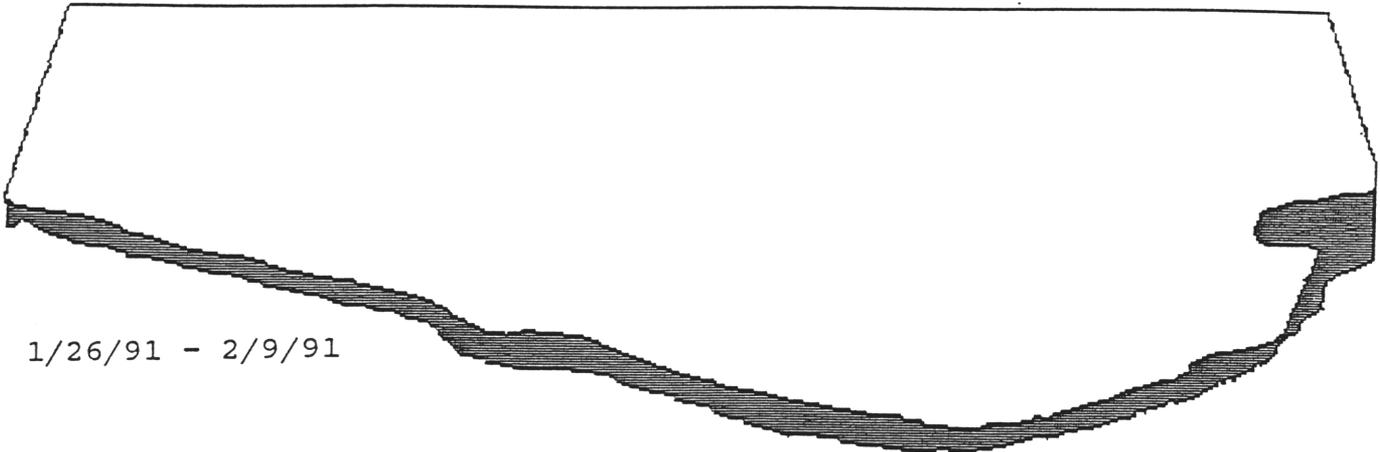
9/30/90 - 12/15/90

12/15/90 - 12/30/90

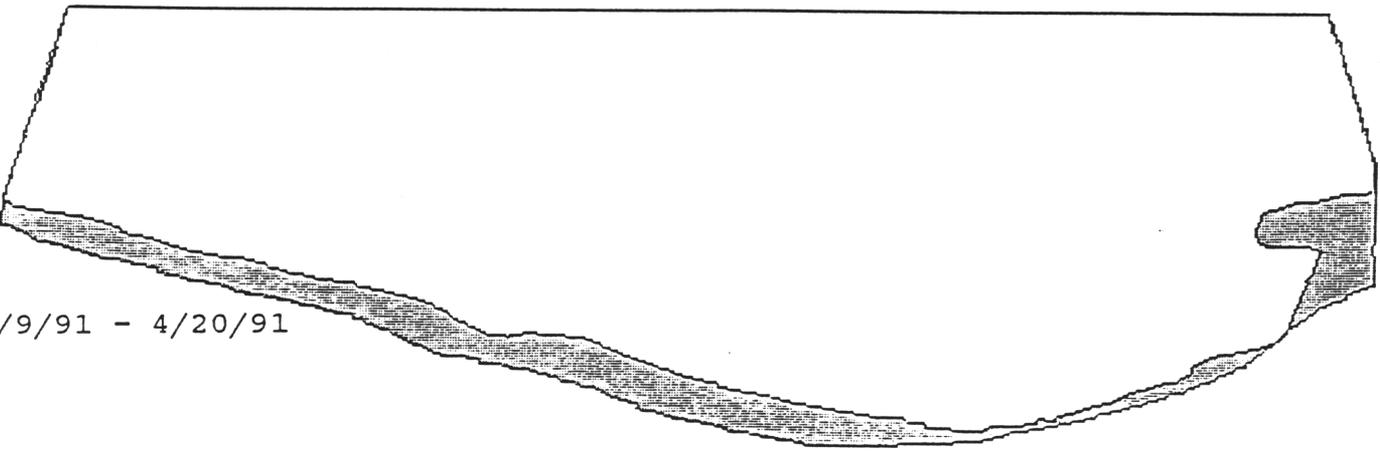
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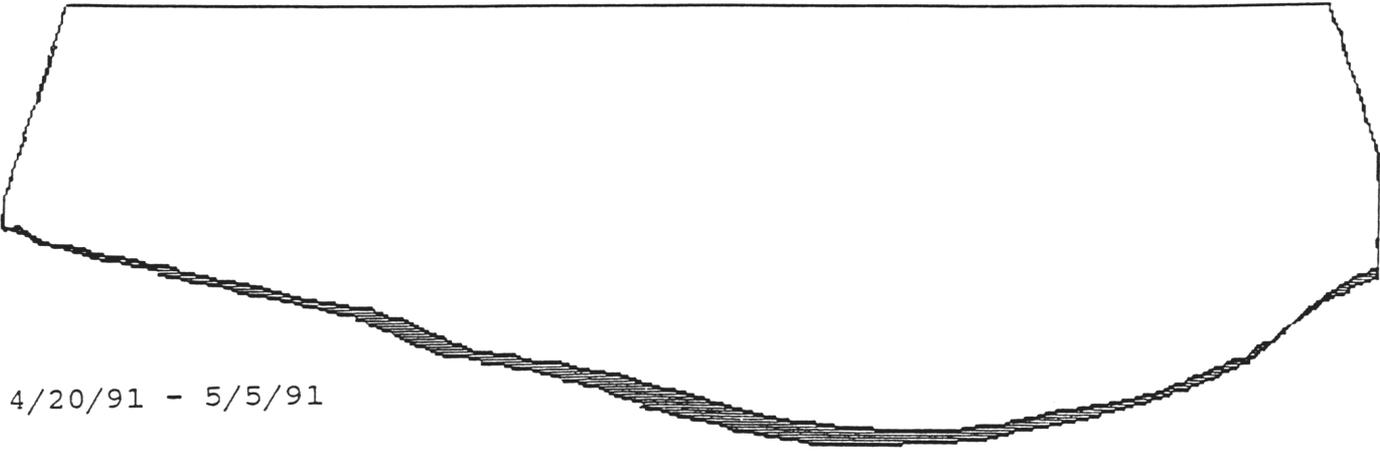
1/12/91 - 1/26/91



1/26/91 - 2/9/91



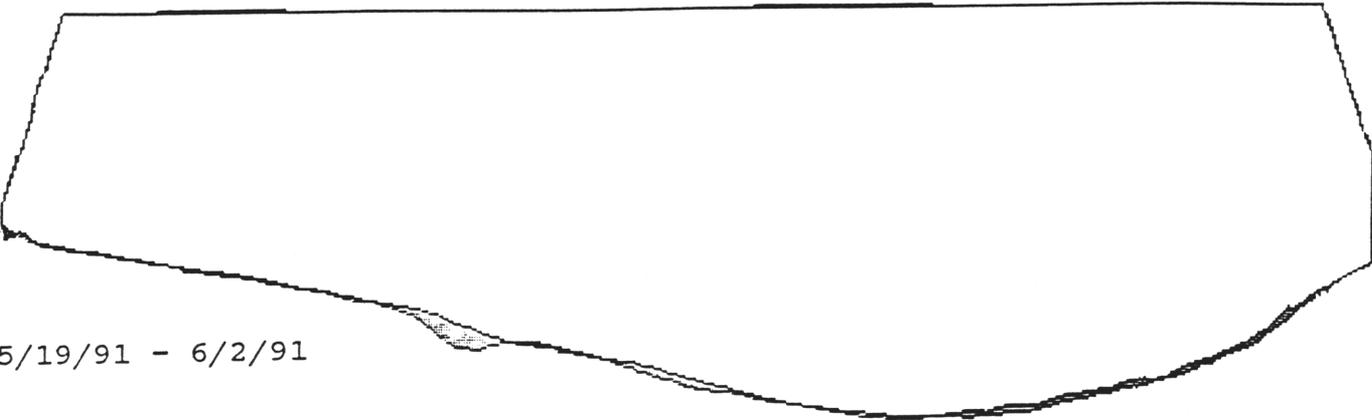
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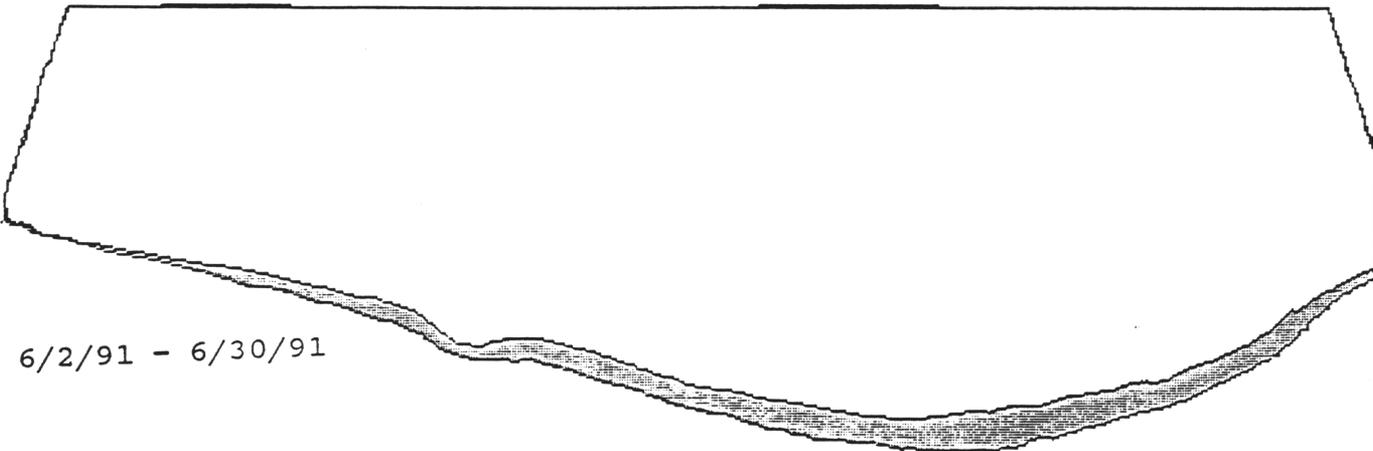
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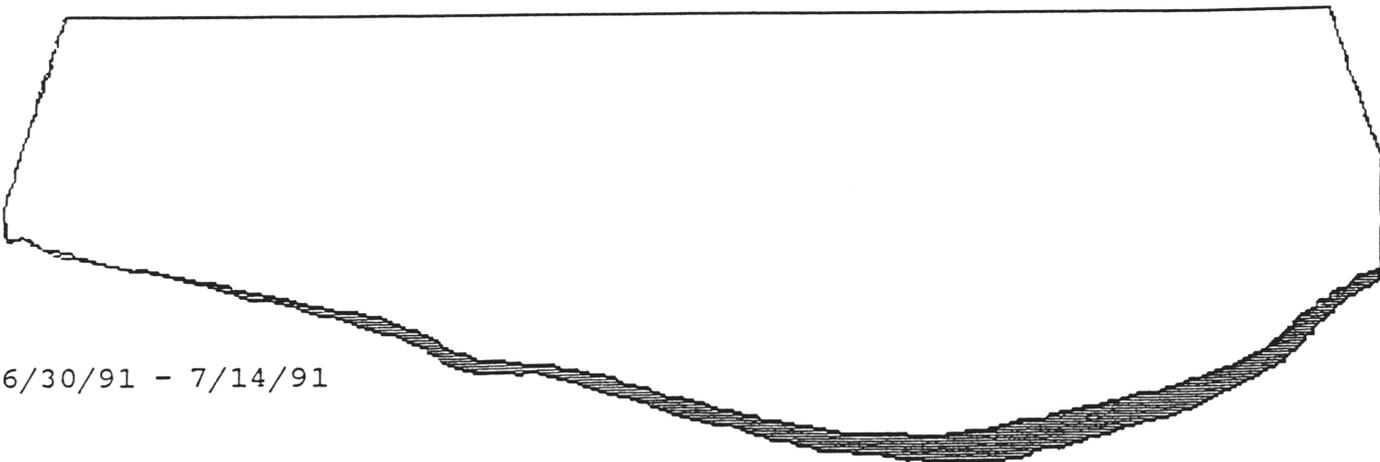
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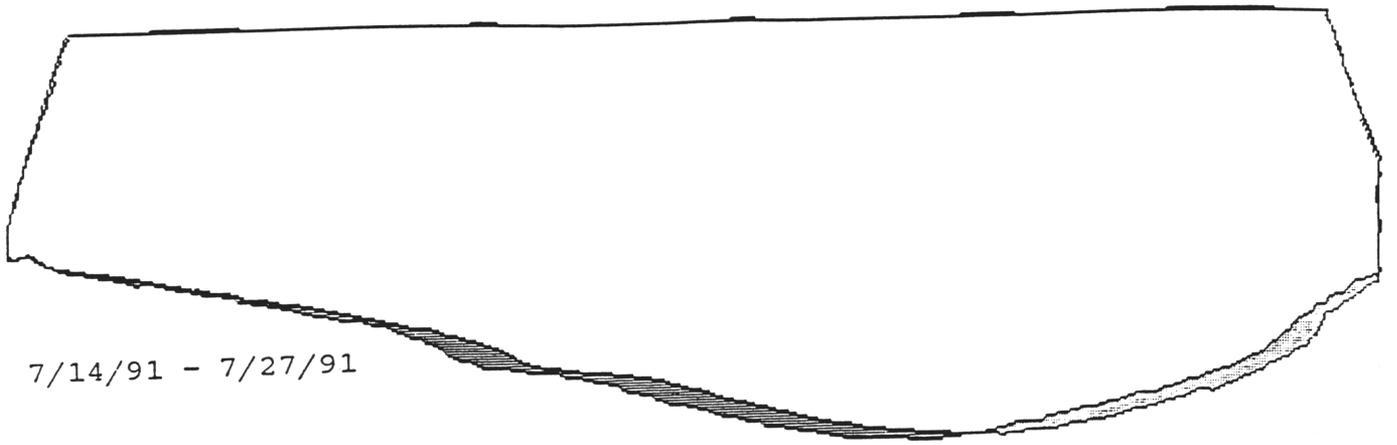
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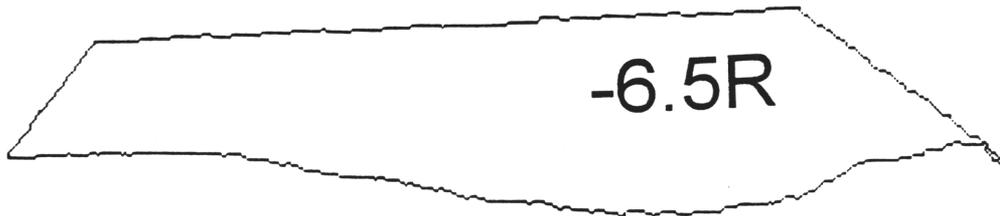
6/2/91 - 6/30/91



6/30/91 - 7/14/91



7/14/91 - 7/27/91



12/17/90



12/17/90-12/30/90



12/30/90-01/12/91



01/12/91-01/26/91



01/26/91-02/09/91



02/09/91-04/20/91



04/20/91-05/05/91



05/05/91-05/19/91



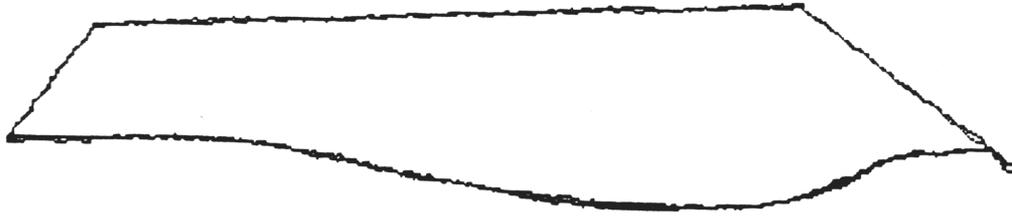
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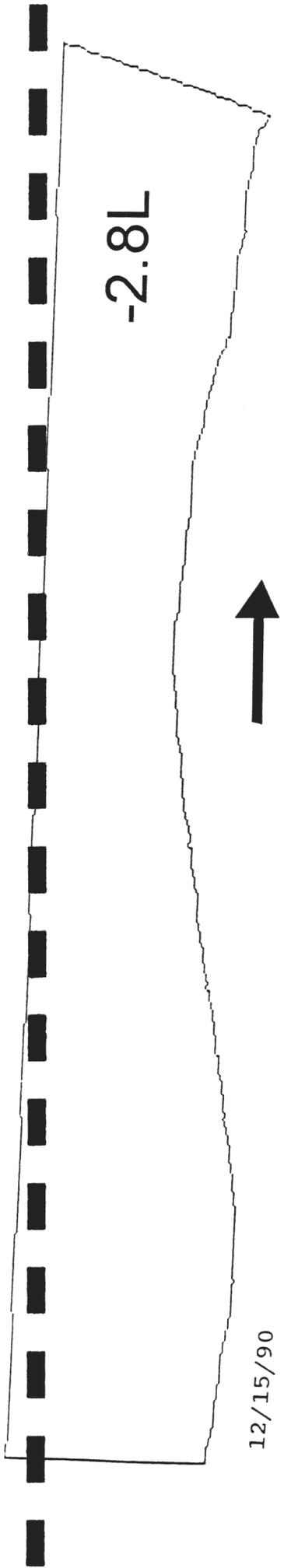
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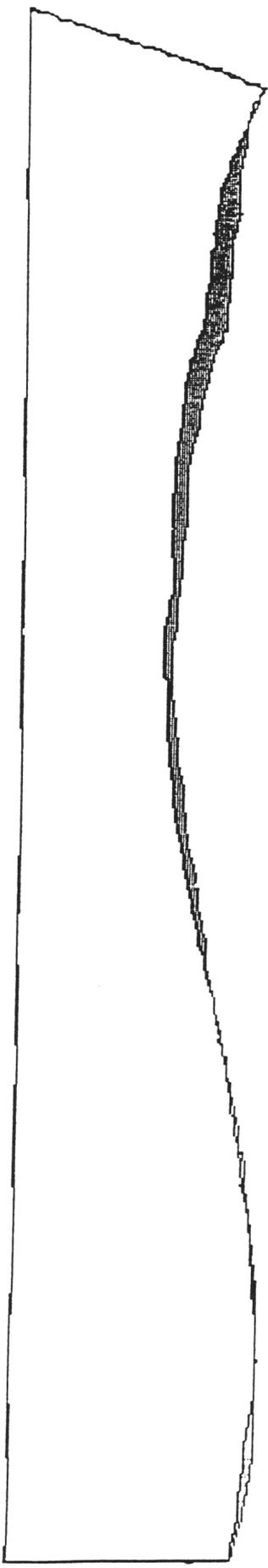
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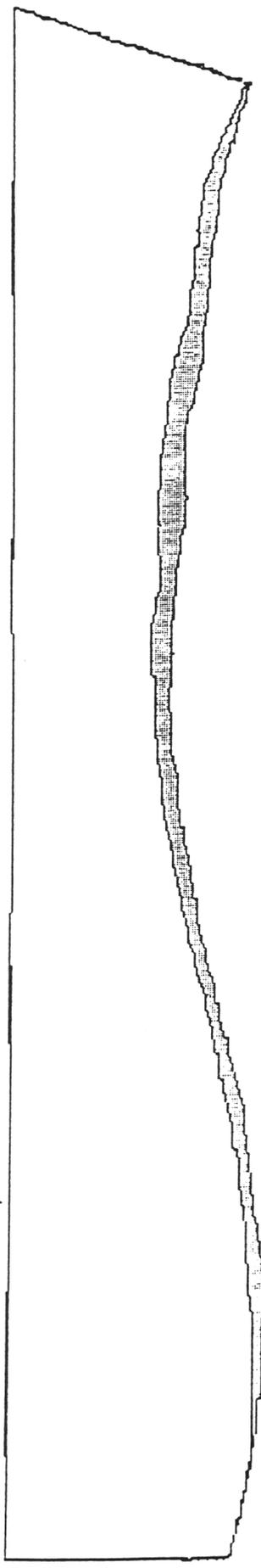
07/14/91-07/27/91



12/15/90



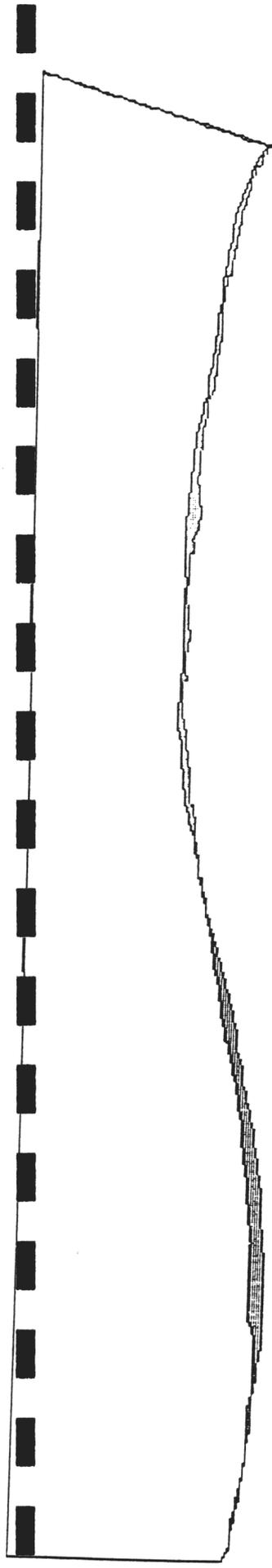
12/15/90 - 12/30/90



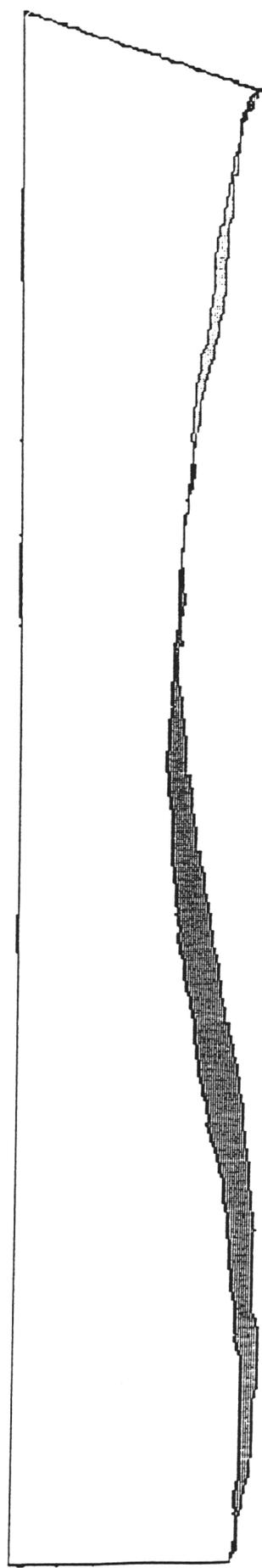
12/30/90 - 1/12/91



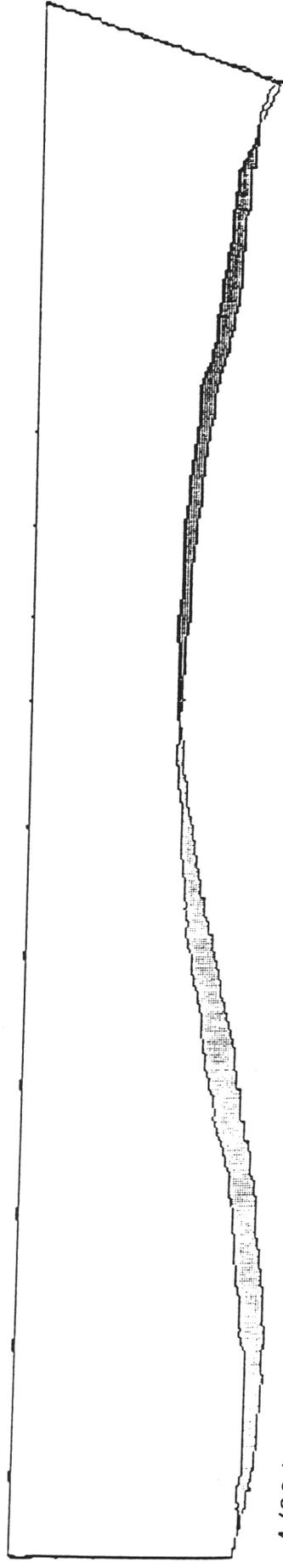
1/12/91 - 1/26/91



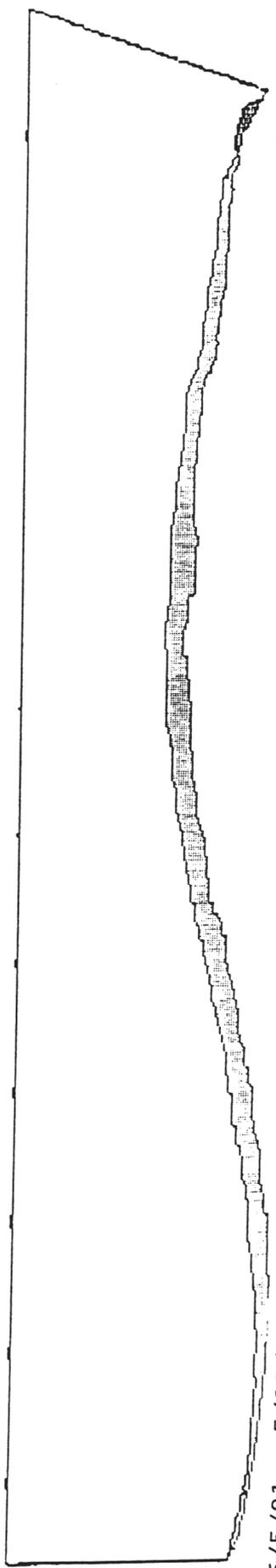
1/26/91 - 2/9/91



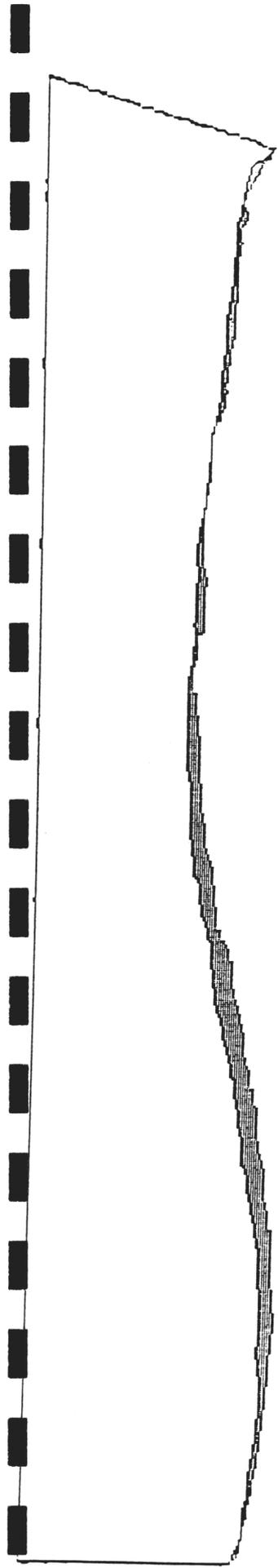
2/9/91 - 4/20/91



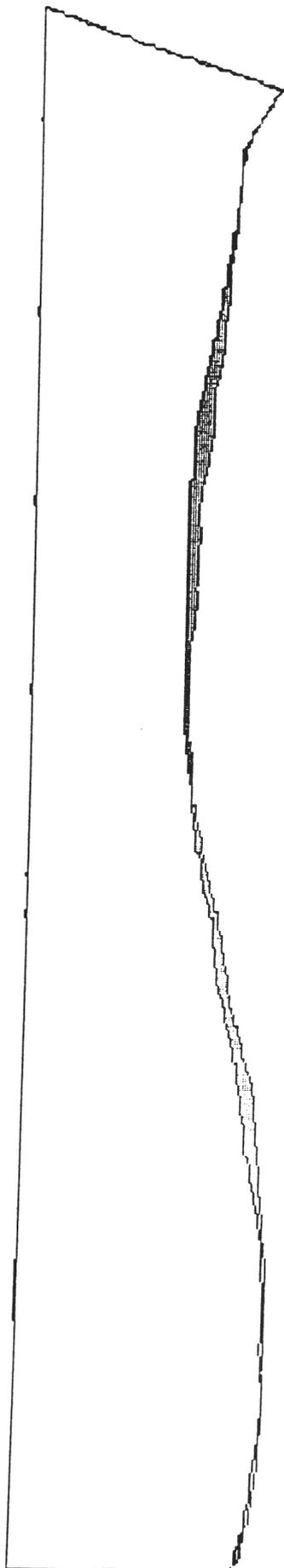
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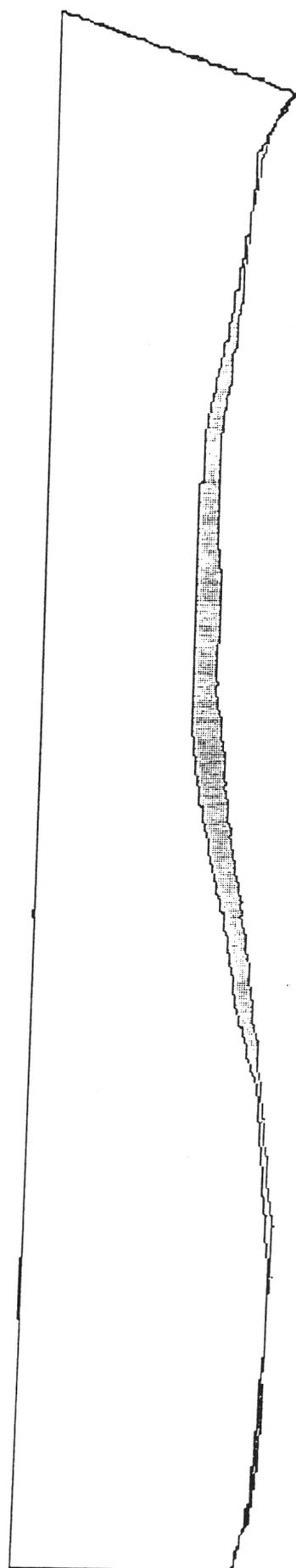
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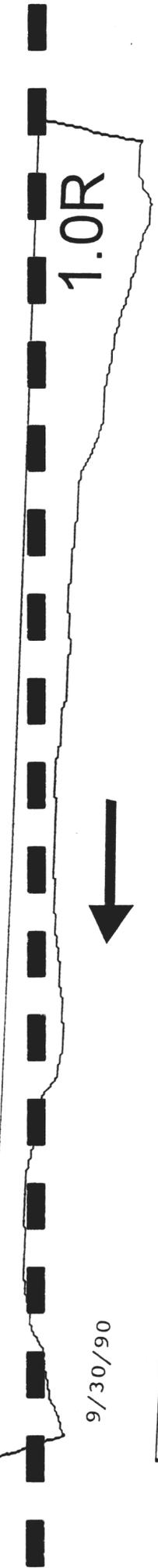
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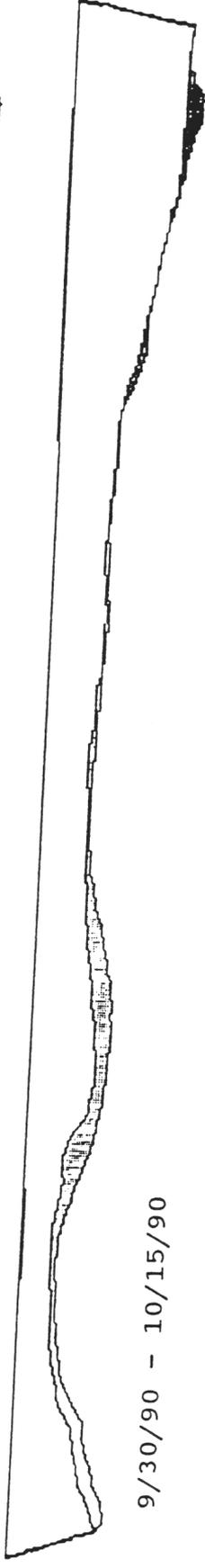
6/2/91 - 6/30/91



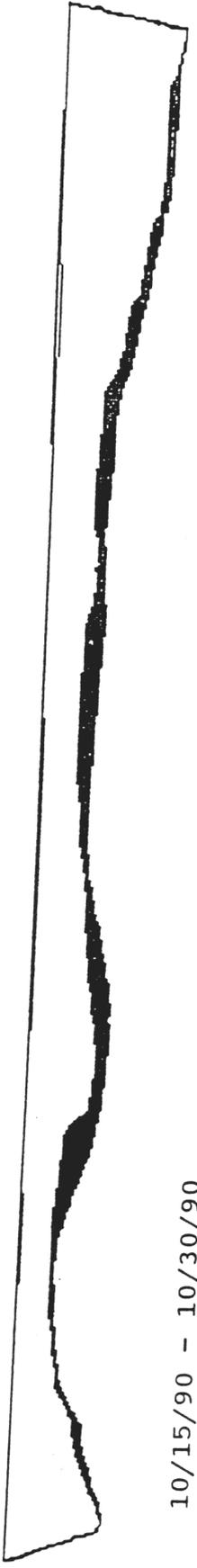
6/30/91 - 7/14/91



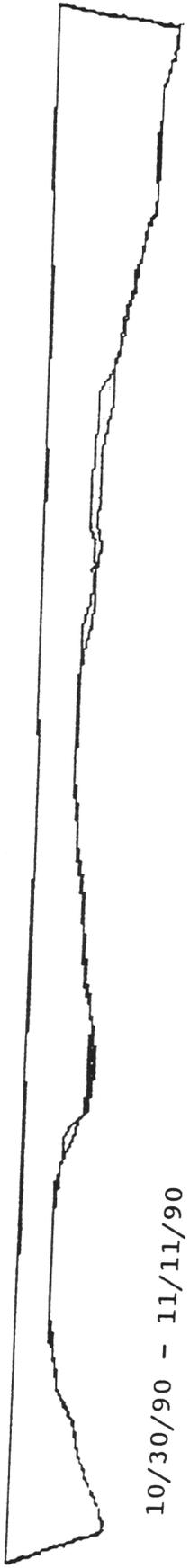
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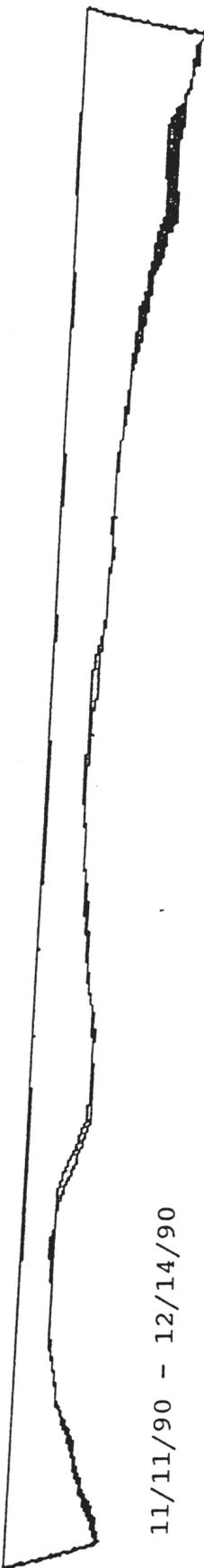
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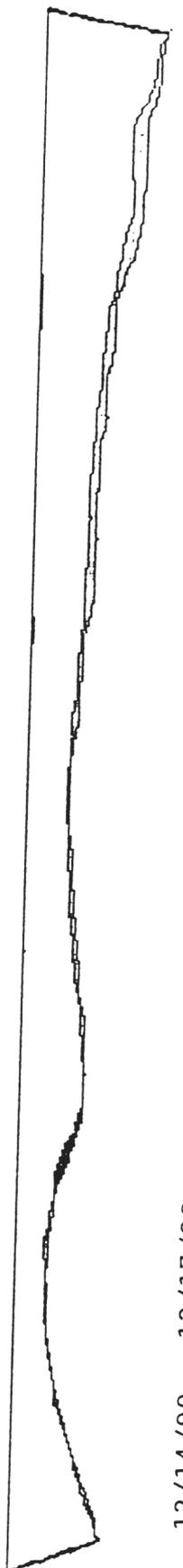
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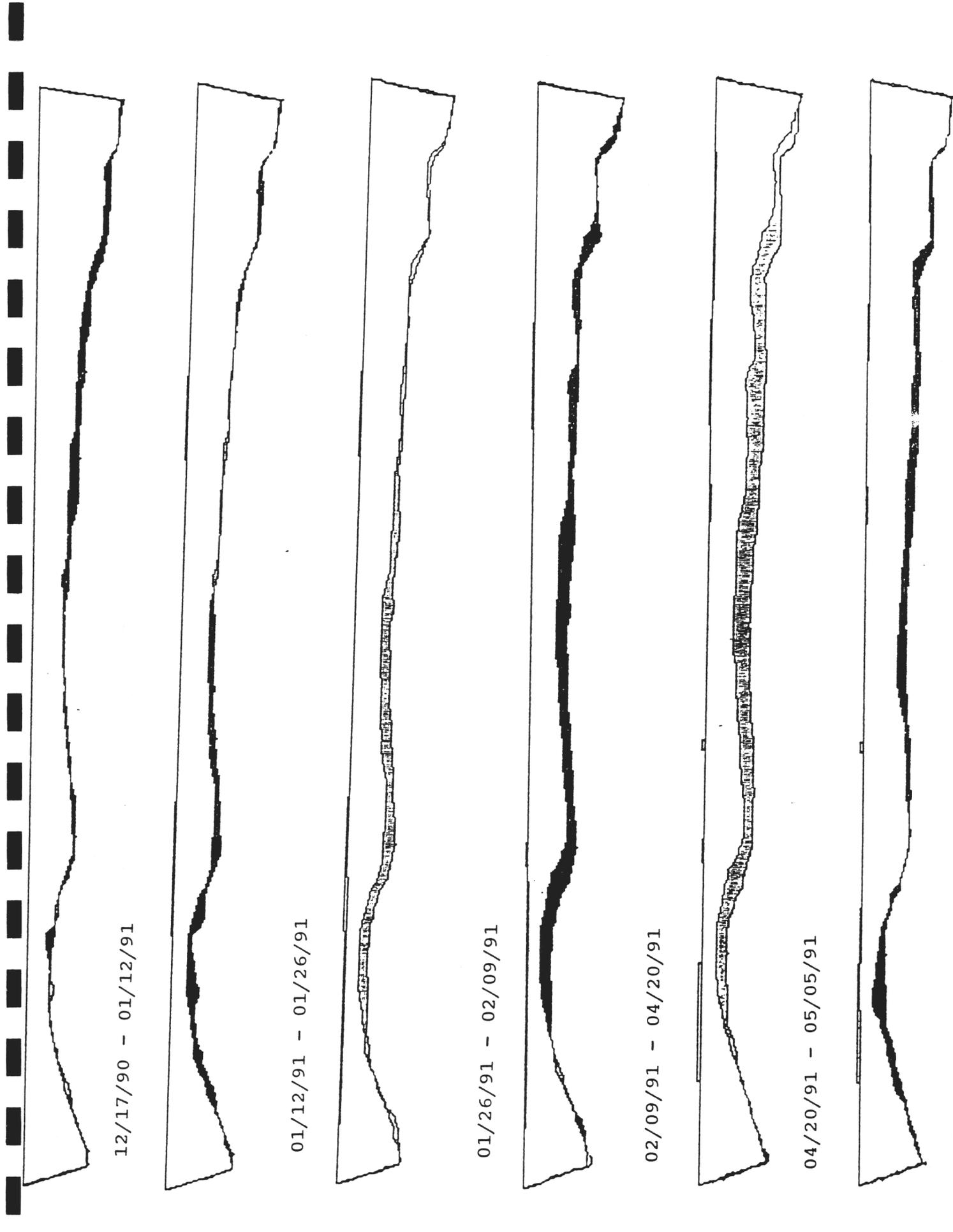
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11/11/90 - 12/14/90



12/14/90 - 12/17/90



12/17/90 - 01/12/91

01/12/91 - 01/26/91

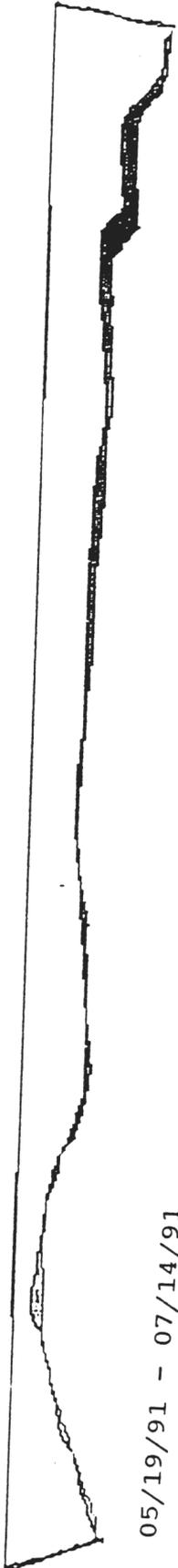
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02/09/91 - 04/20/91

04/20/91 - 05/05/91

05/05/91 - 05/19/91

05/19/91 - 07/14/91



4.0L



10/30/90

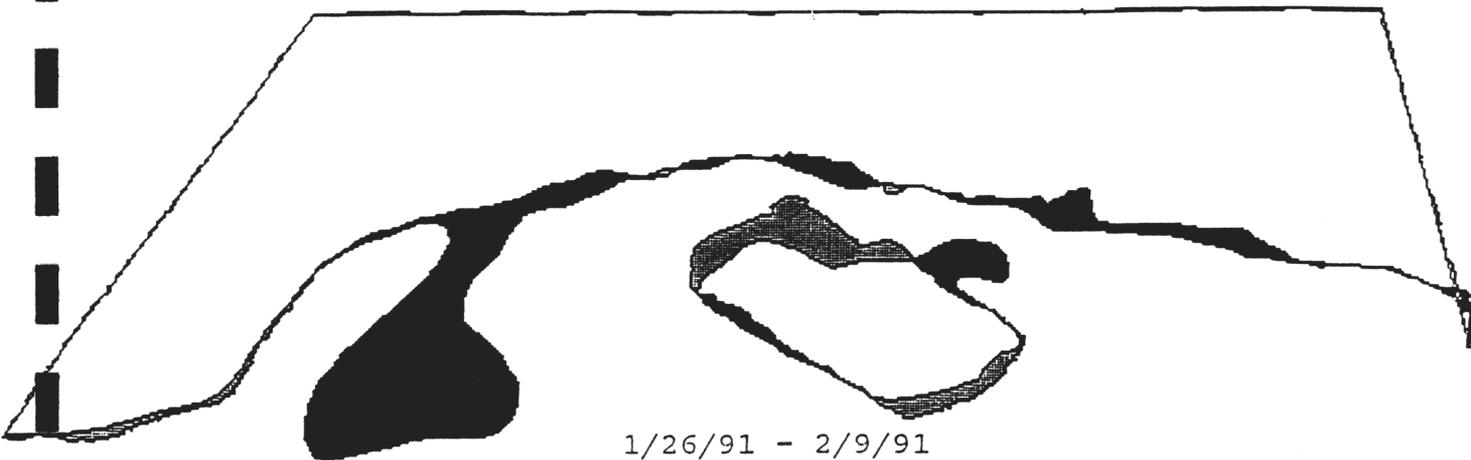
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11/11/90 - 12/30/90

12/30/90 - 1/12/91



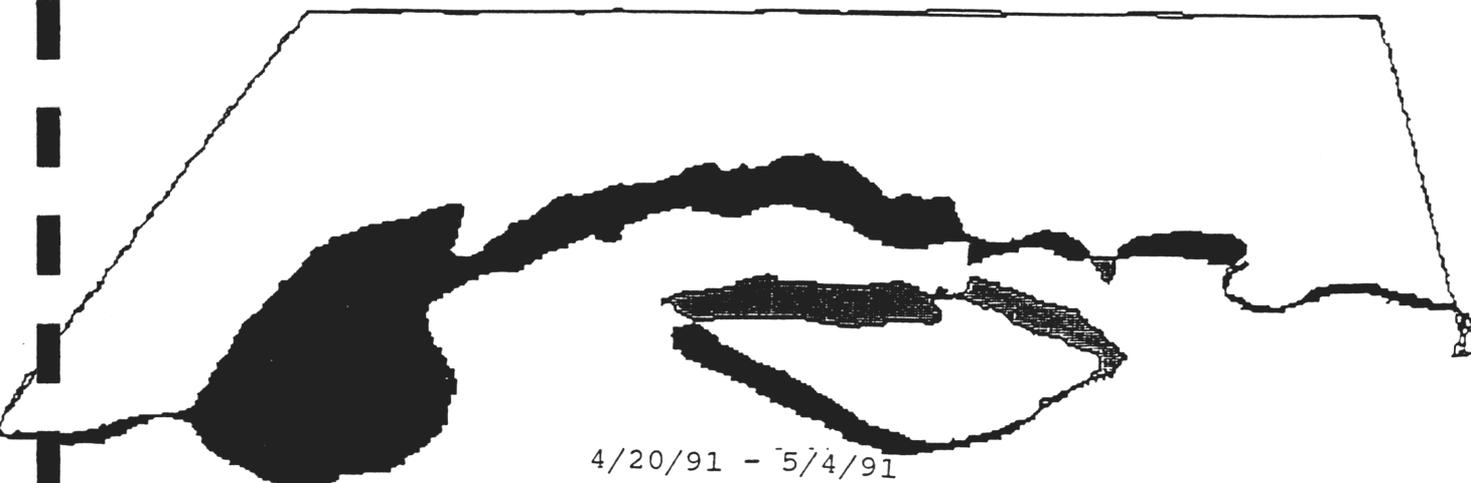
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1/26/91 - 2/9/91



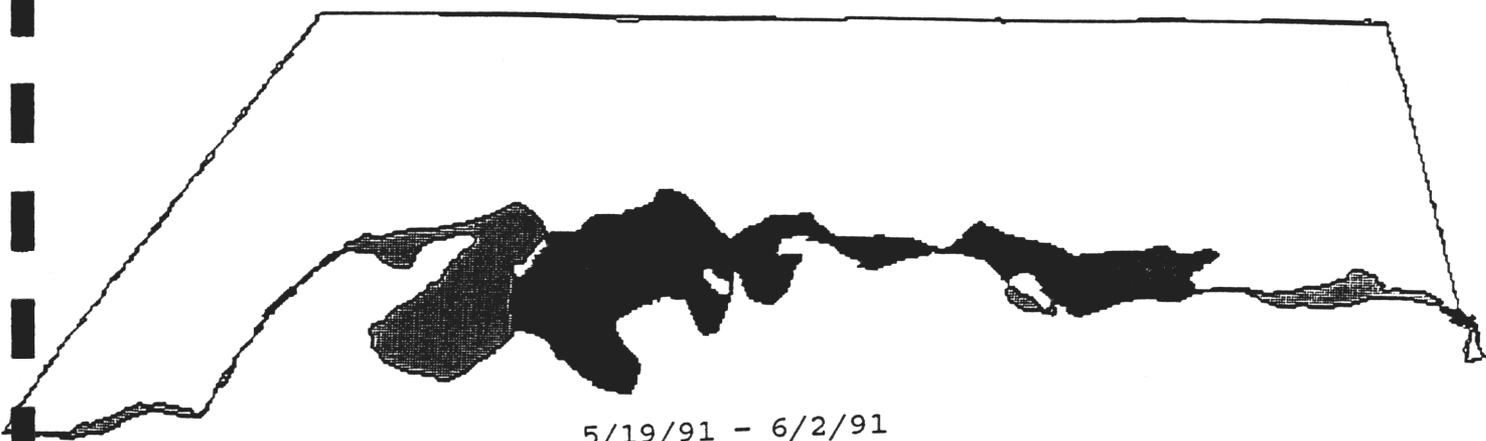
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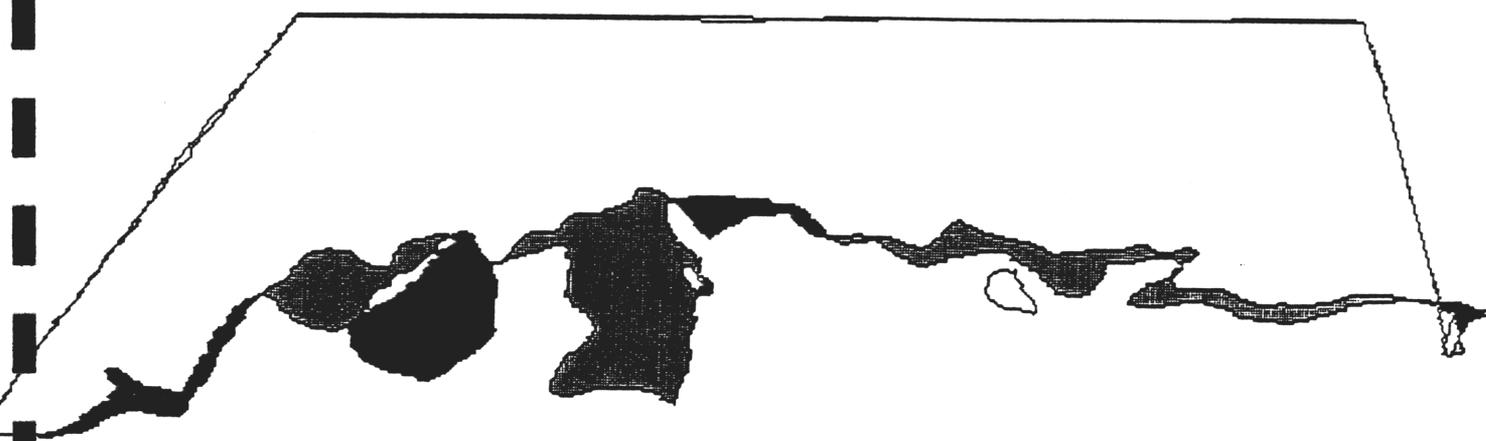
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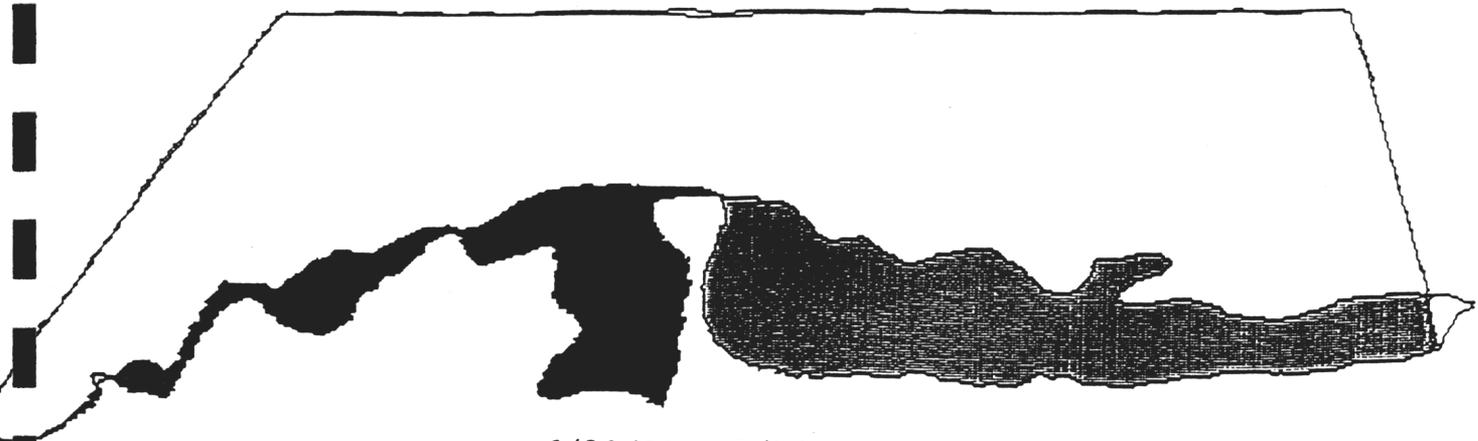
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5/19/91 - 6/2/91



6/2/91 - 6/30/91



6/30/91 - 7/14/91

2.6L



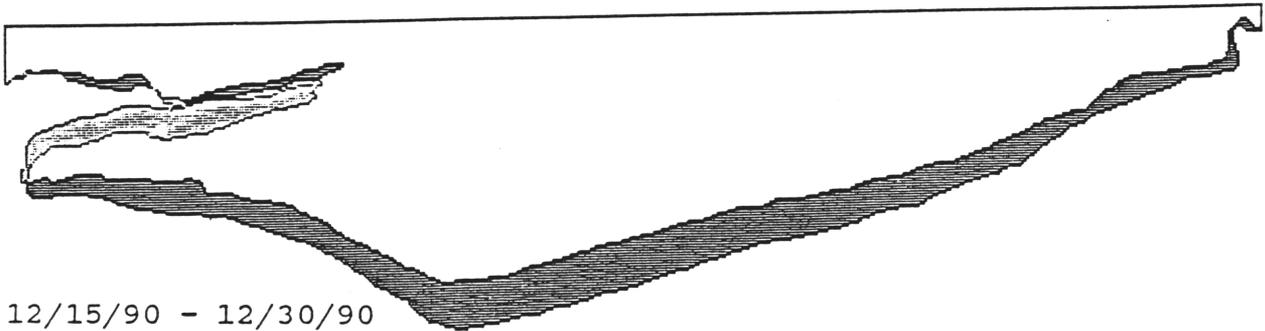
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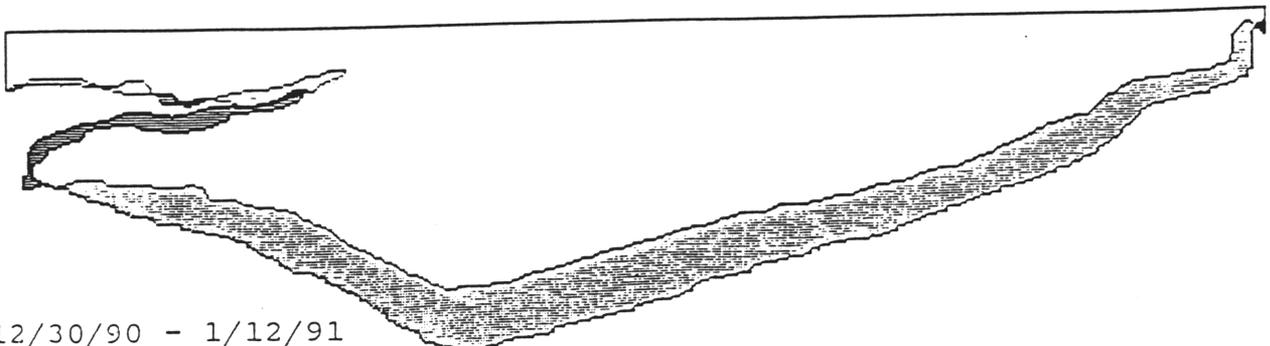
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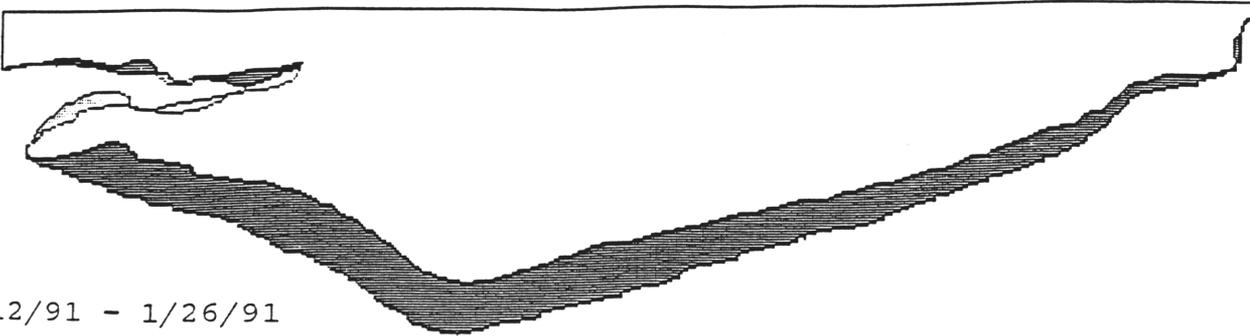
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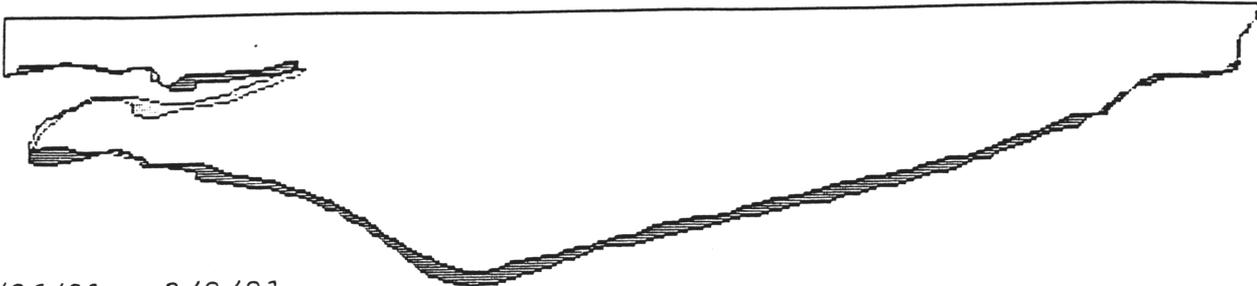
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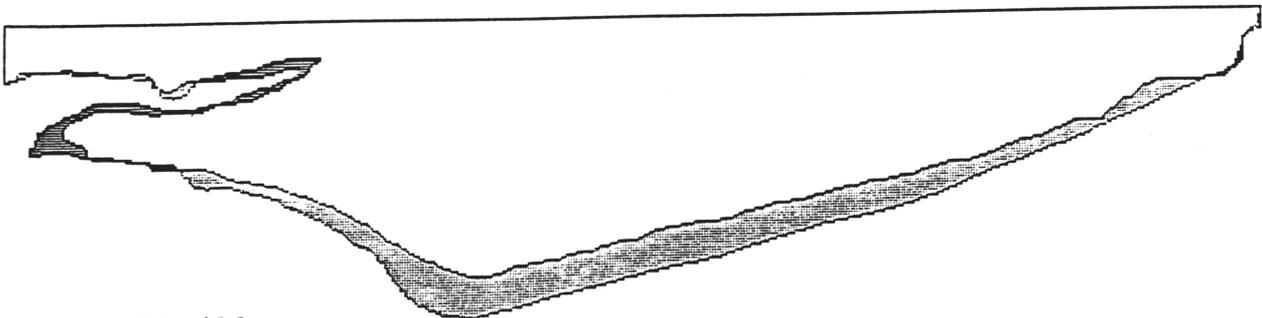
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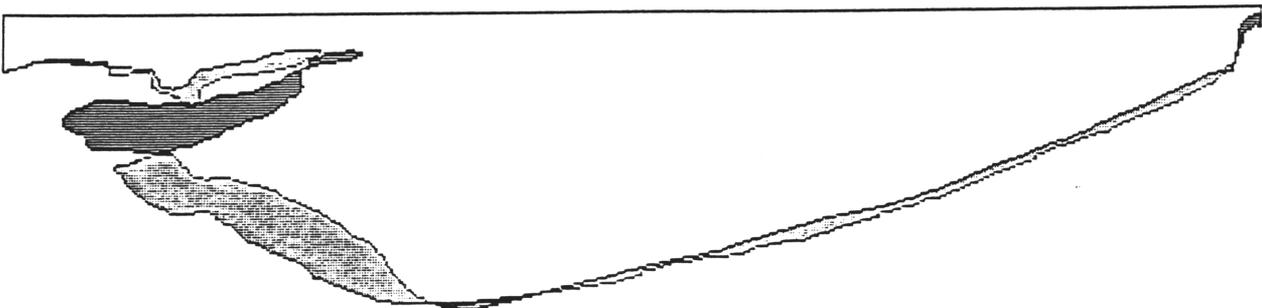
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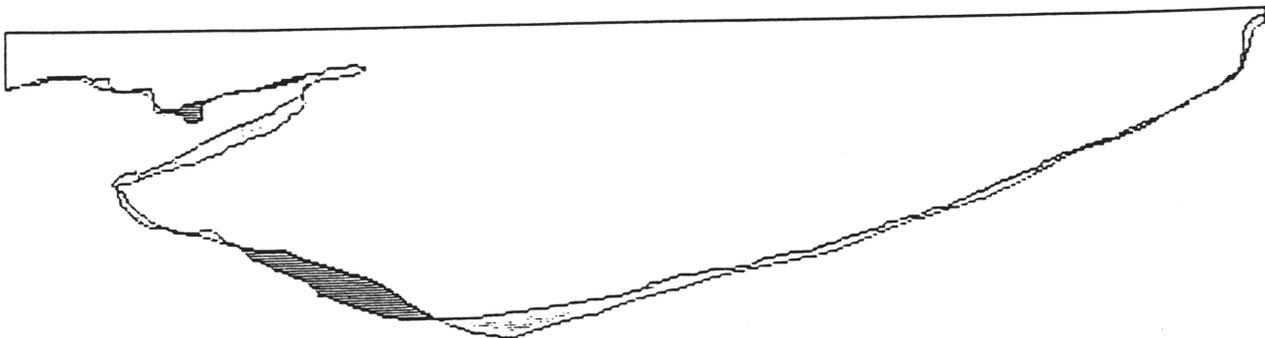
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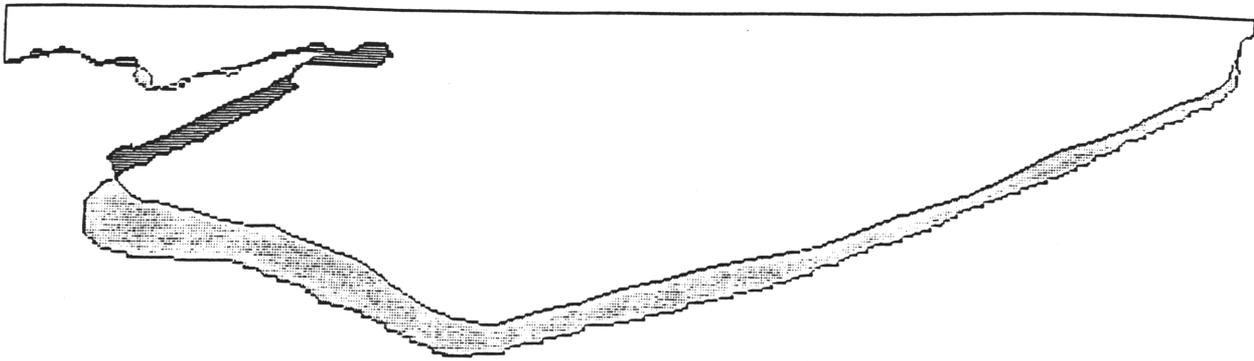
2/9/91 - 5/5/91



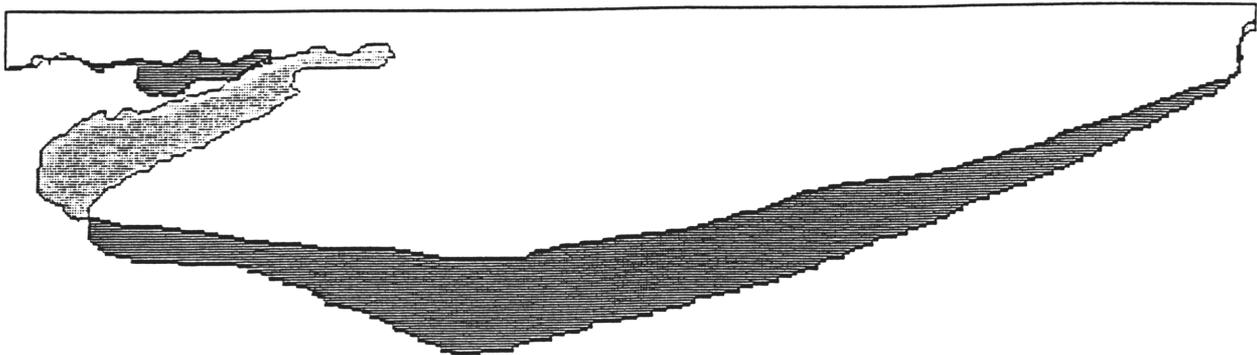
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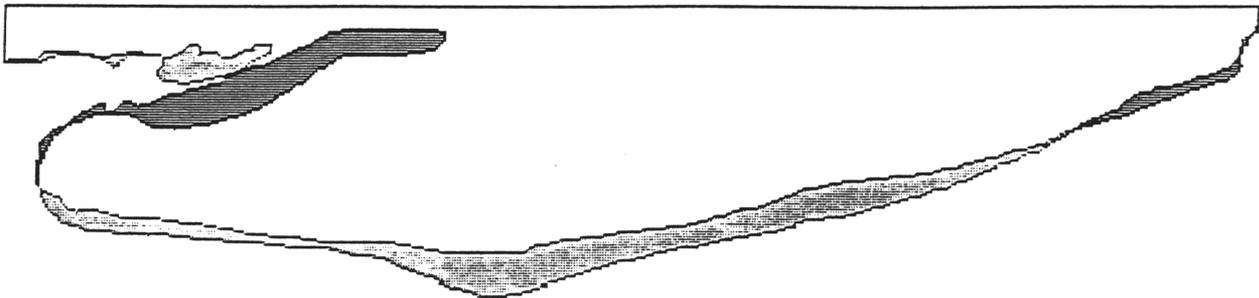
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6/2/91 - 6/30/91



6/30/91 - 7/14/91



7/14/91 - 7/27/91

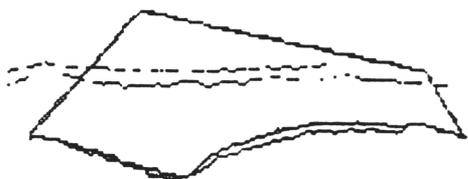
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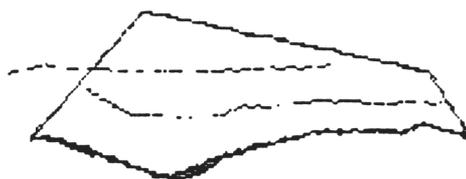
10/30/90



10/30/90-11/11/90



11/11/90-12/17/90



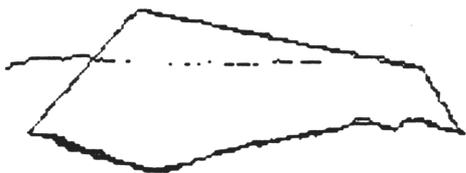
12/17/90-12/30/90



12/30/90-01/12/91



01/12/91-01/26/91



01/26/91-02/09/91



02/09/91-04/20/91



04/20/91-05/05/91



05/05/91-05/19/91



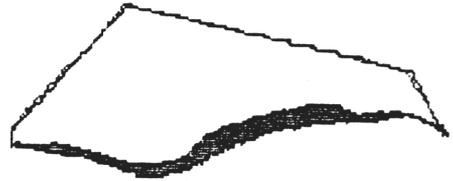
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06/02/91-06/30/91

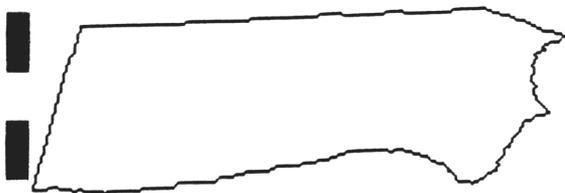


06/30/91-07/14/91



07/14/91-07/27/91

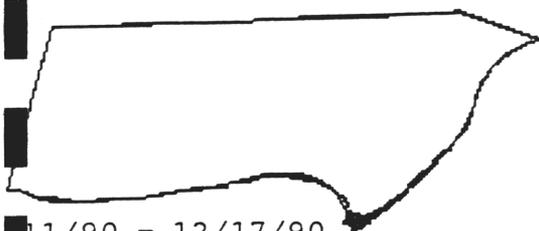
16.4L



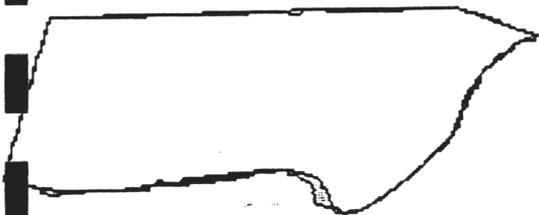
9/30/90



10/14/90 - 10/30/90



11/1/90 - 12/17/90



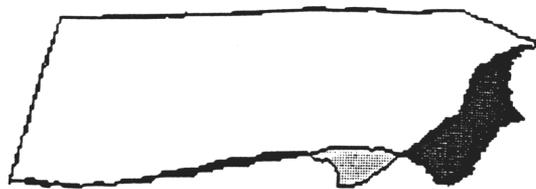
12/30/90 - 1/12/91



1/16/91 - 2/9/91



2/20/91 - 5/5/91



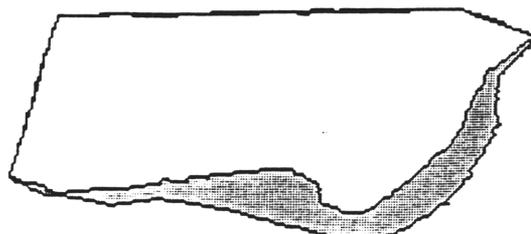
9/30/90 - 10/14/90



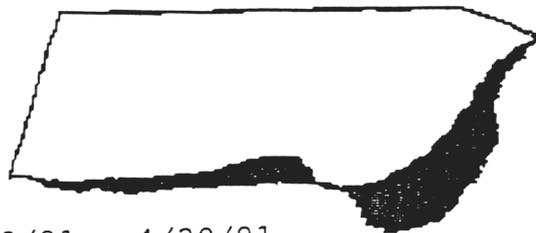
10/30/90 - 11/11/90



12/17/90 - 12/30/90



1/12/91 - 1/26/91



2/9/91 - 4/20/91



5/5/91 - 7/14/91

20.0L



9/30/90



10/30/90 - 12/17/90



9/30/90 - 10/14/90



12/17/90 - 12/30/90



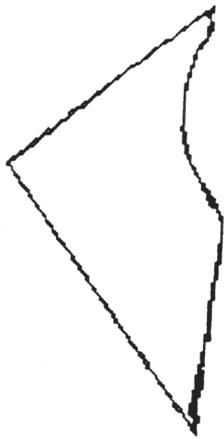
10/14/90 - 10/30/90



12/30/90 - 1/12/91



1/12/91 - 1/26/91



4/20/91 - 5/4/91



1/26/91 - 2/9/91



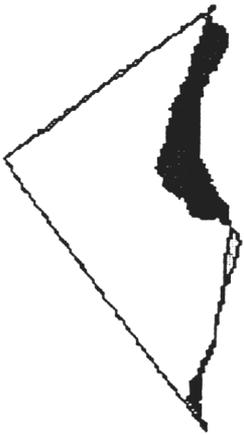
5/4/91 - 5/19/91



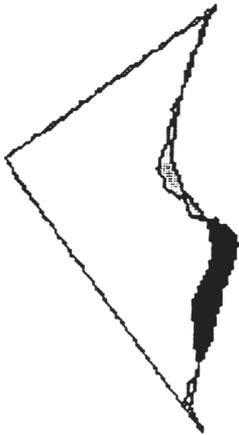
2/9/91 - 4/20/91



5/19/91 - 6/2/91



6/2/91 - 7/14/91



7/14/91 - 10/11/91

20.5R



9/30/90



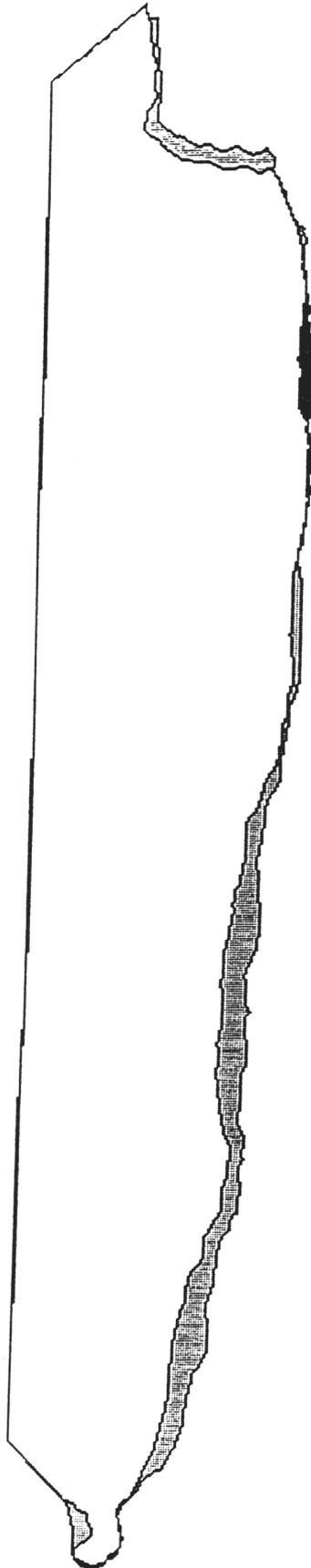
9/30/90 - 12/17/90



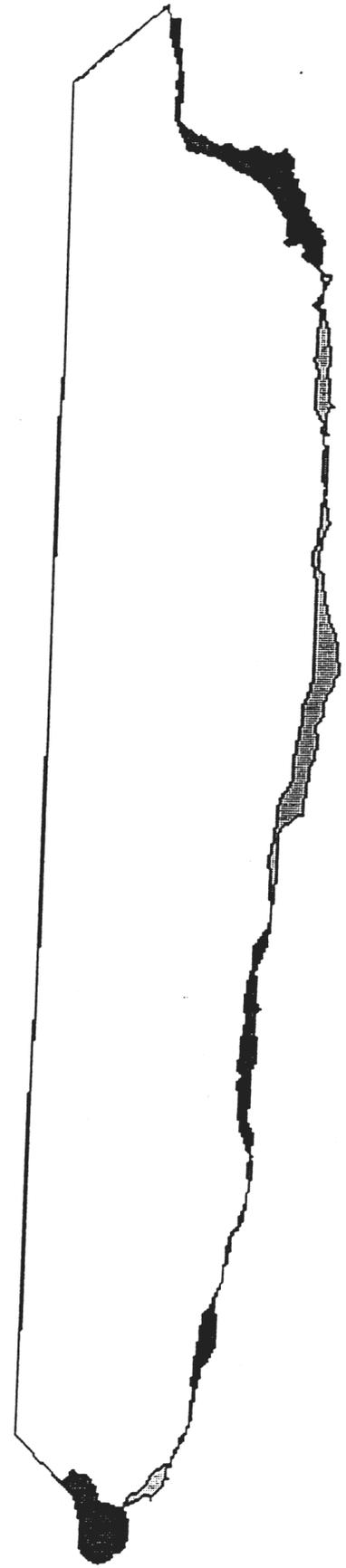
12/17/90 - 12/30/90



12/30/90 - 1/12/91



01/12/91 - 1/26/91



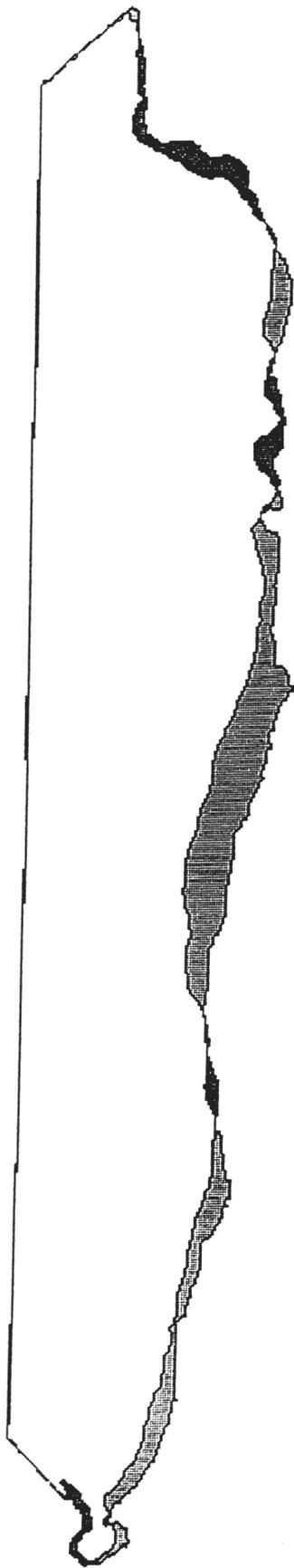
1/26/91 - 2/9/91



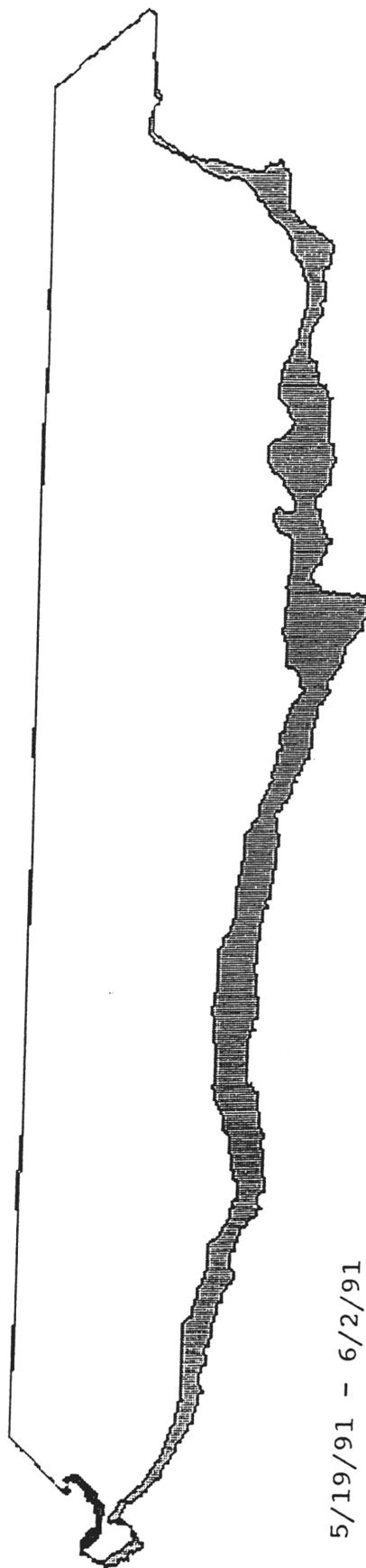
2/9/91 - 4/20/91



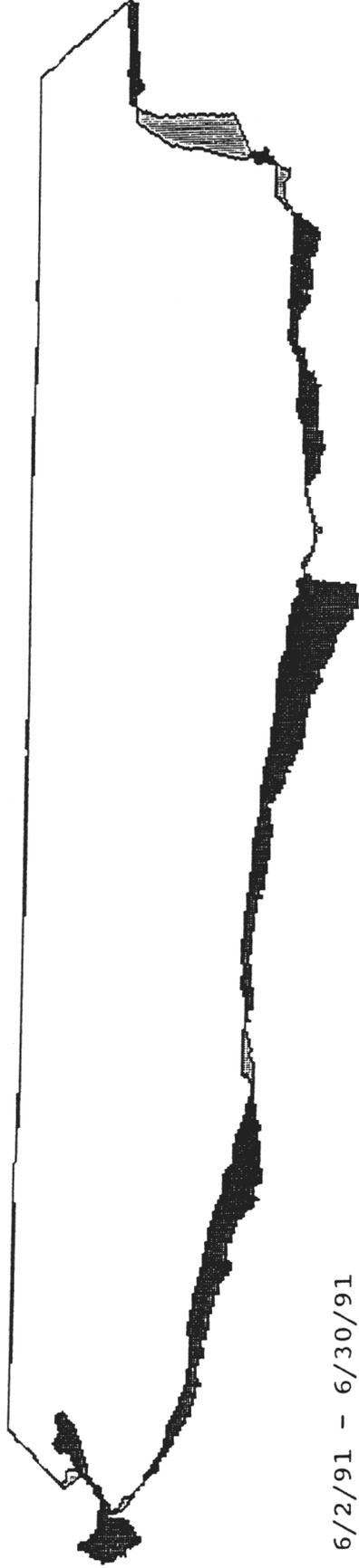
4/20/91 - 5/5/91



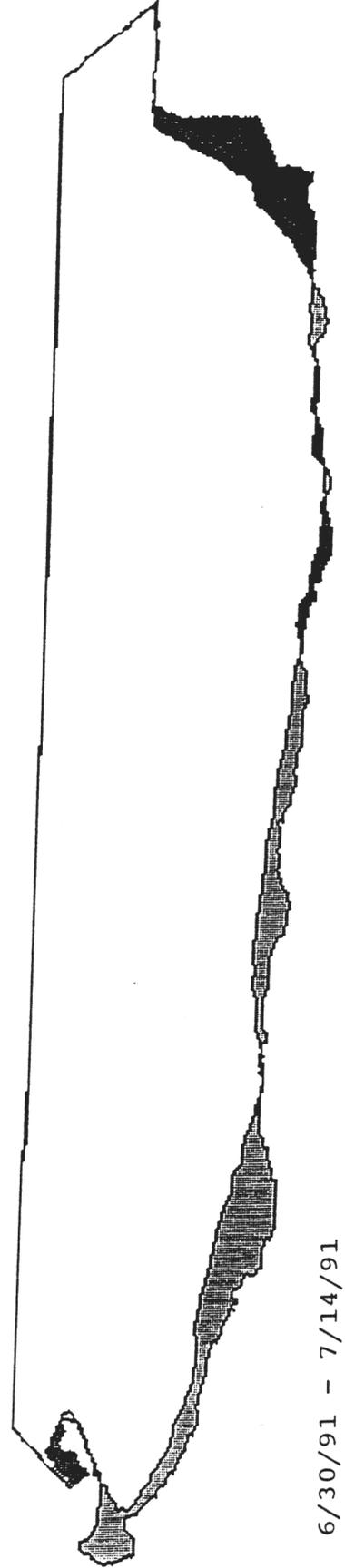
5/5/91 - 5/19/91



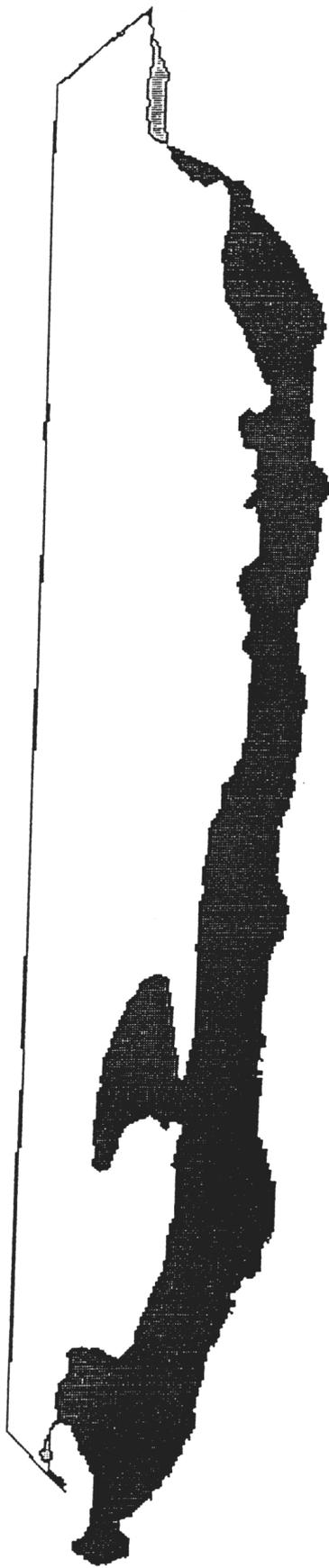
5/19/91 - 6/2/91



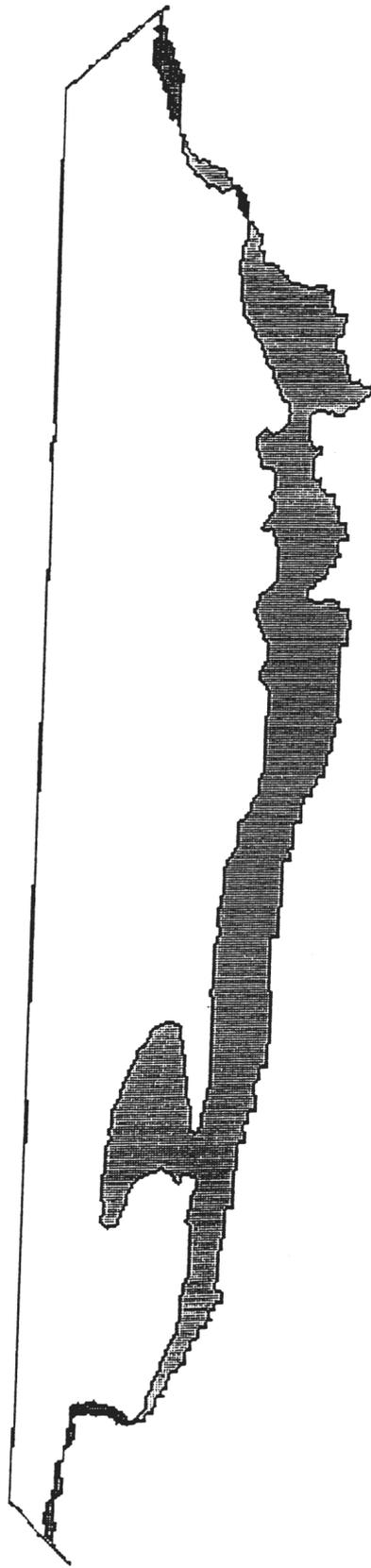
6/2/91 - 6/30/91



6/30/91 - 7/14/91



7/14/91 - 10/11/91



10/11/91 - 5/30/92

21.8R



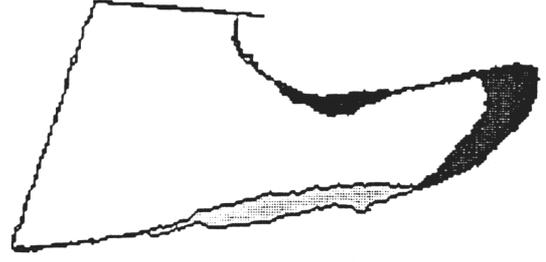
9/30/90



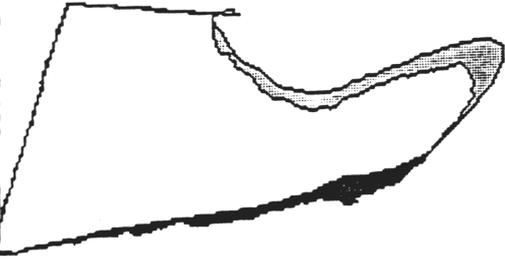
9/30/90 - 10/15/90



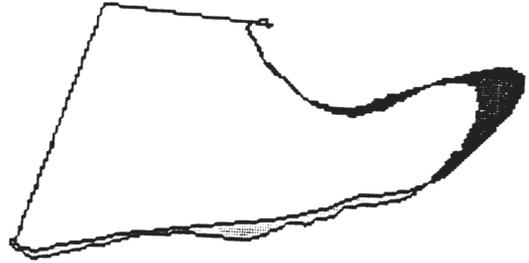
10/15/90 - 10/30/90



10/30/90 - 12/17/90



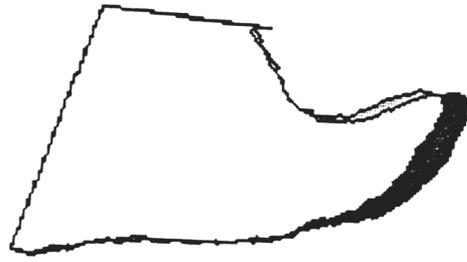
12/17/90 - 12/30/90



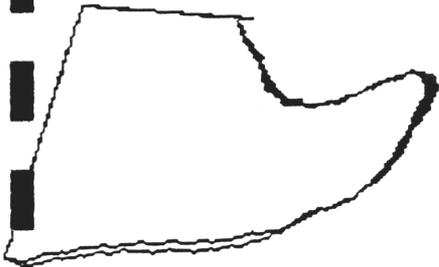
12/30/90 - 1/26/91



1/26/91 - 2/9/91



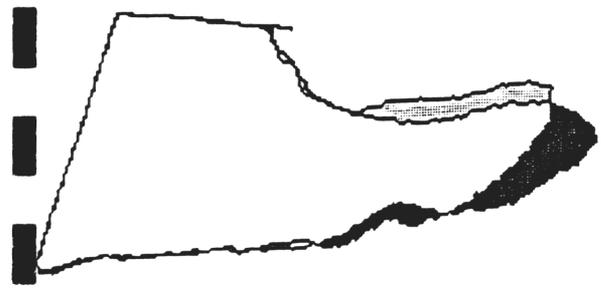
2/9/91 - 4/20/91



4/20/91 - 5/4/91



5/4/91 - 5/19/91



5/19/91 - 6/2/91



6/2/91 - 6/30/91

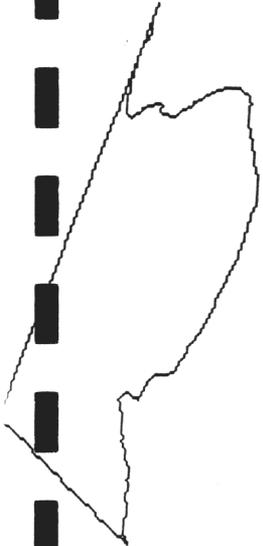


6/30/91 - 7/14/91



7/14/91 - 7/27/91

29.1R



10/14/90



1/12/91 - 1/26/91



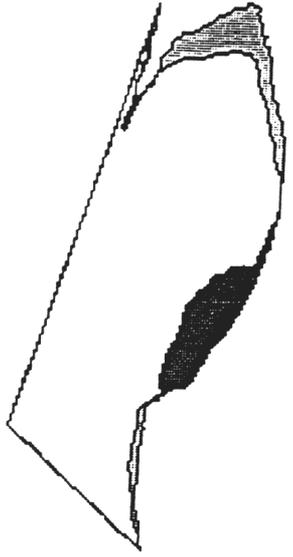
10/14/90 - 12/30/90



1/26/91 - 2/9/91



12/30/90 - 1/12/91



2/10/91



6/2/91 - 6/30/91



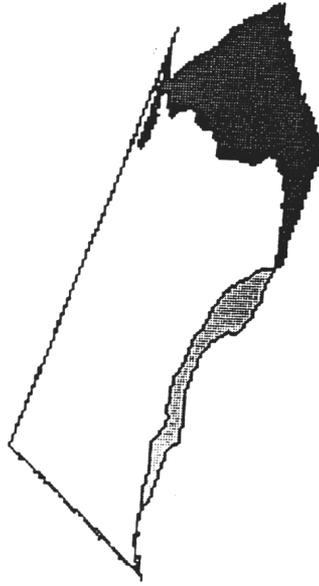
6/30/91 - 7/14/91



7/14/91 - 7/27/91



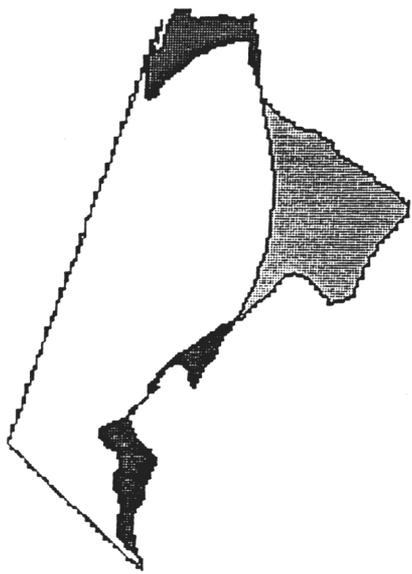
4/20/91 - 5/4/91



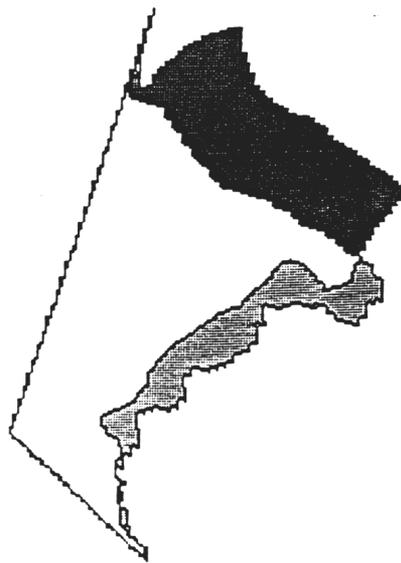
5/4/91 - 5/19/91



5/19/91 - 6/2/91

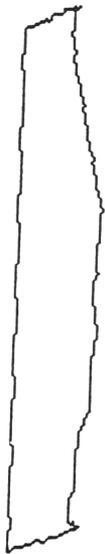


7/27/91 - 10/11/91



10/11/91 - 5/30/92

29.2L



10/14/90



12/30/90 - 1/12/91



4/20/91 - 5/4/91



10/14/90 - 10/30/90



1/12/91 - 1/26/91



5/4/91 - 5/19/91



10/30/90 - 12/17/90



1/26/91 - 2/9/91



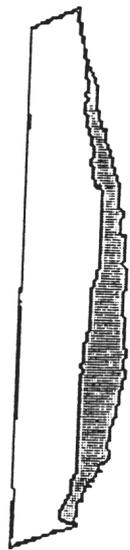
5/19/91 - 6/2/91



2/17/90 - 12/30/90



2/9/91 - 4/20/91



6/2/91 - 7/14/91



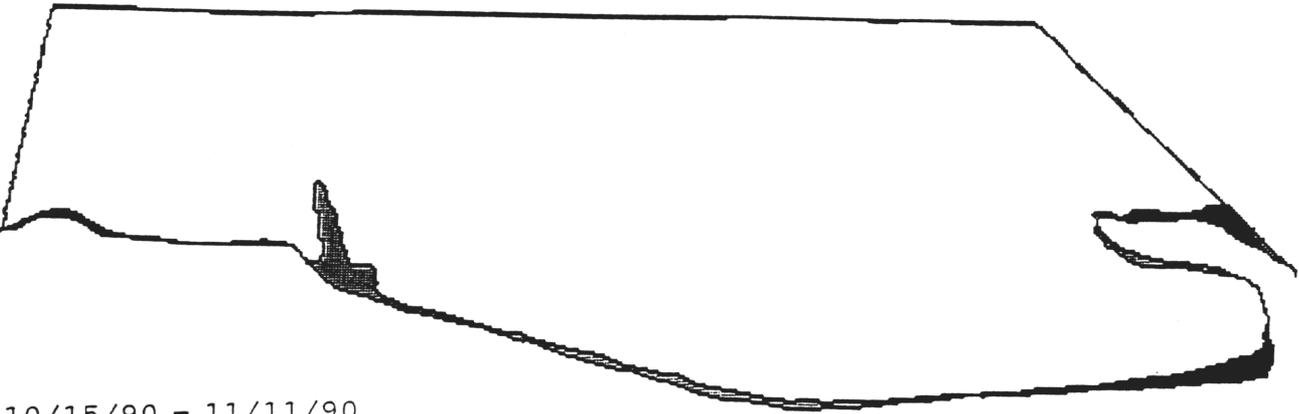
7/14/91 - 7/27/91

30.4R

9/30/90

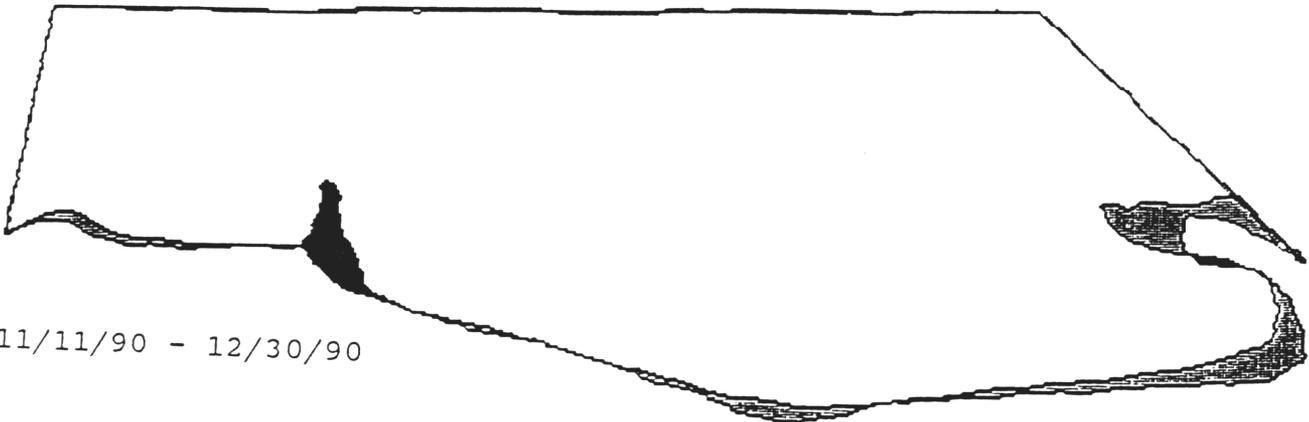


9/30/90 - 10/15/90



10/15/90 - 11/11/90

11/11/90 - 12/30/90

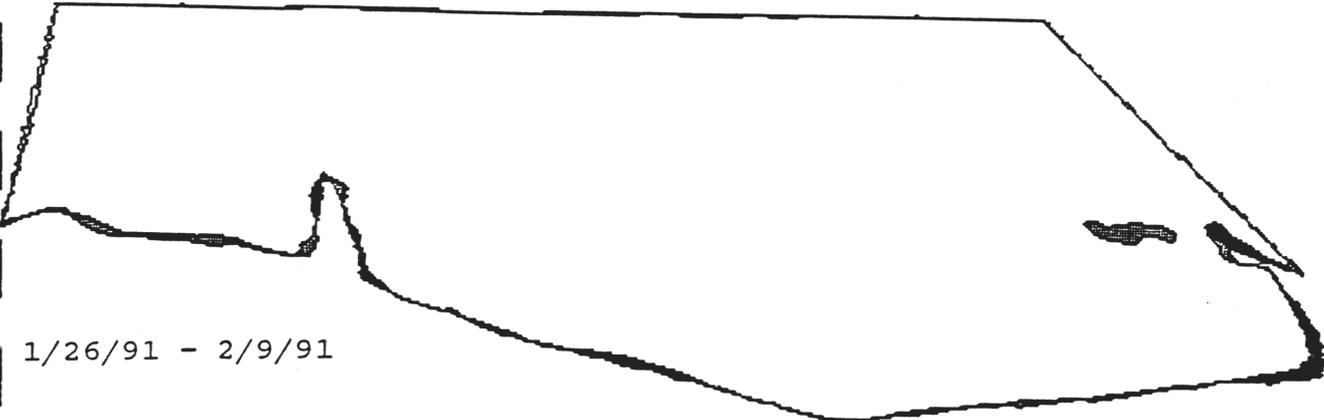




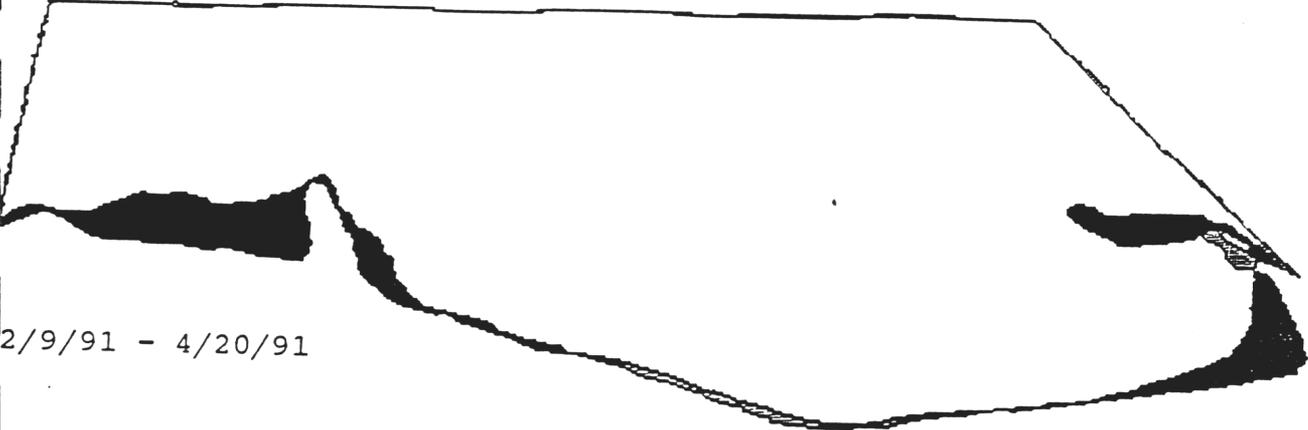
12/30/90 - 1/12/91



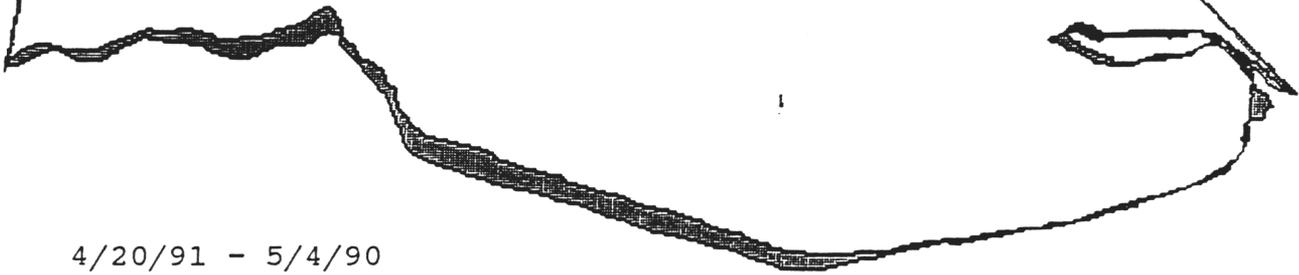
1/12/91 - 1/26/91



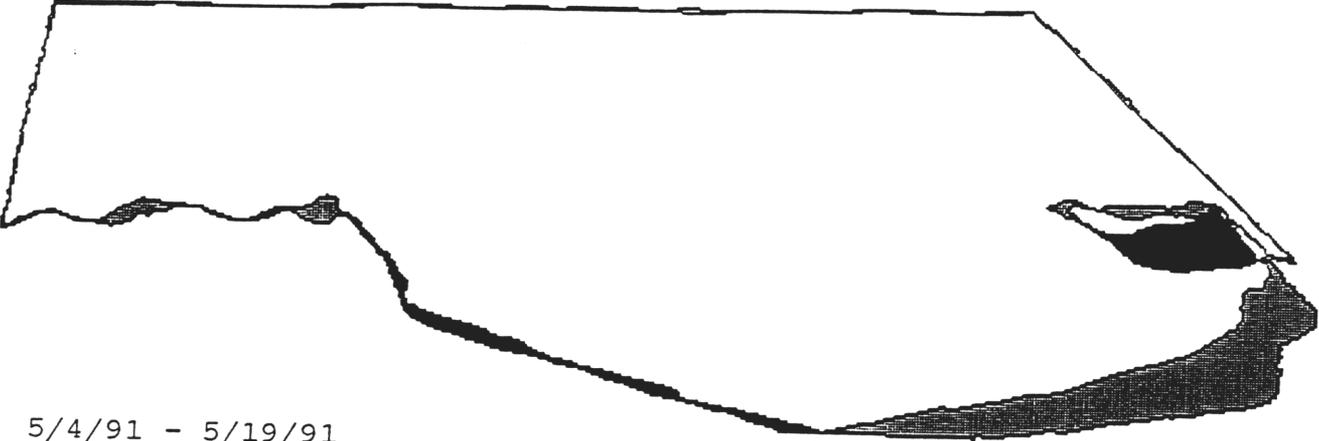
1/26/91 - 2/9/91



2/9/91 - 4/20/91



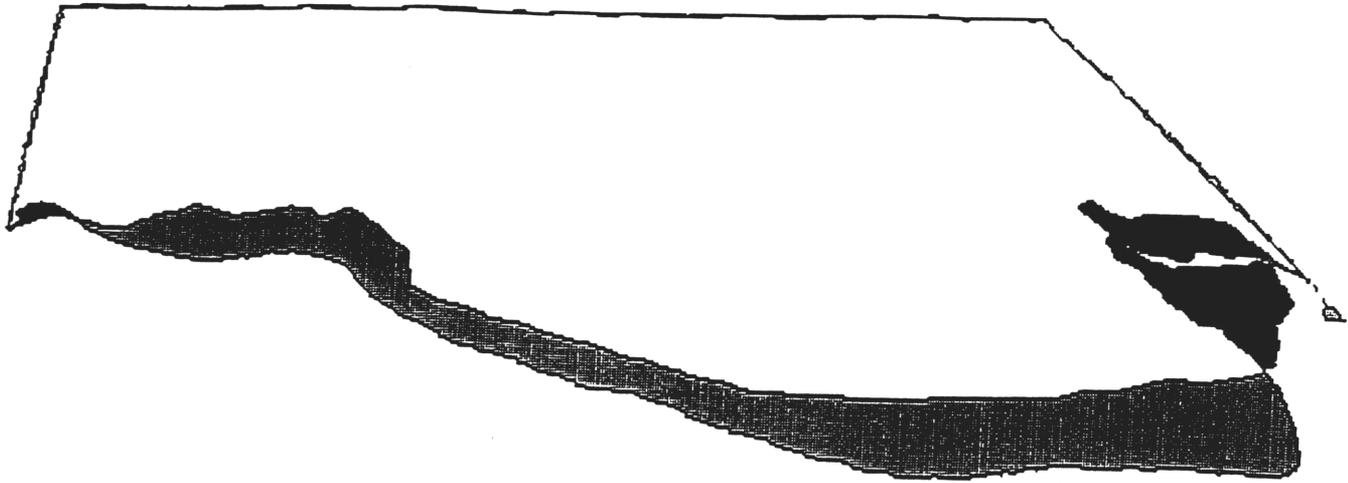
4/20/91 - 5/4/90



5/4/91 - 5/19/91



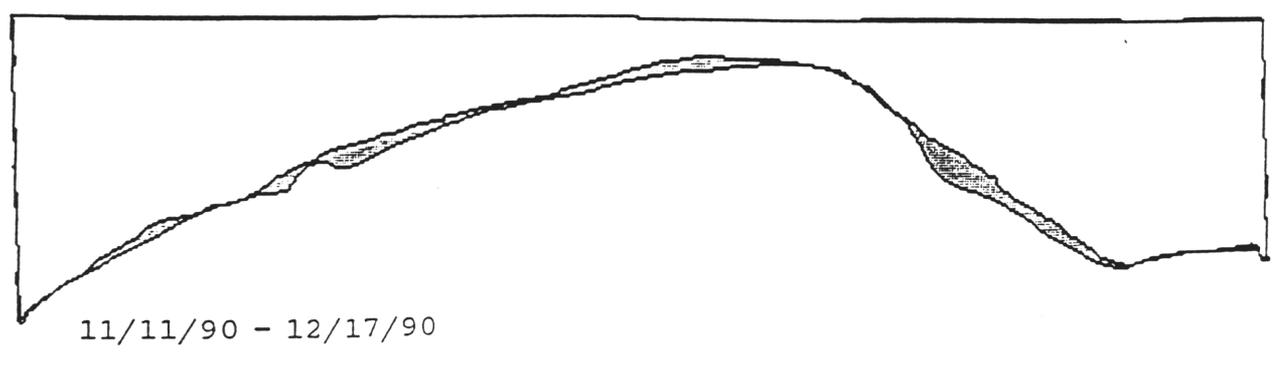
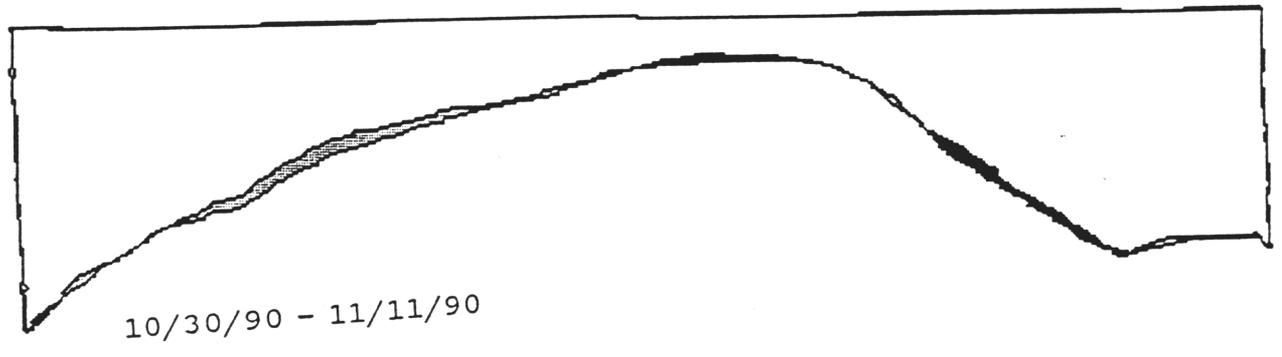
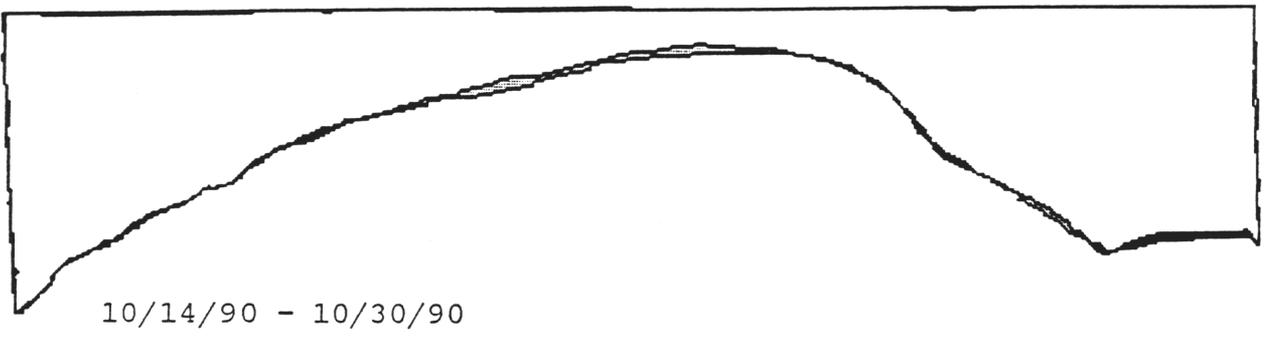
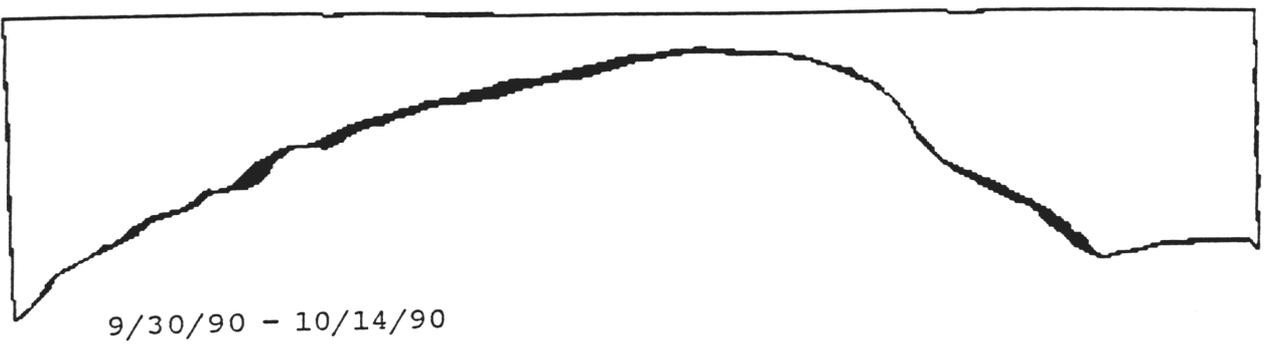
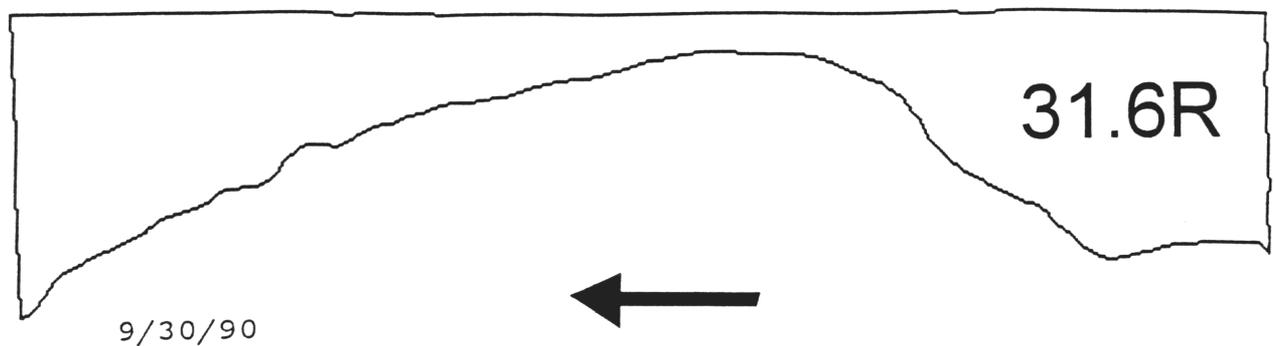
5/19/91 - 6/2/91

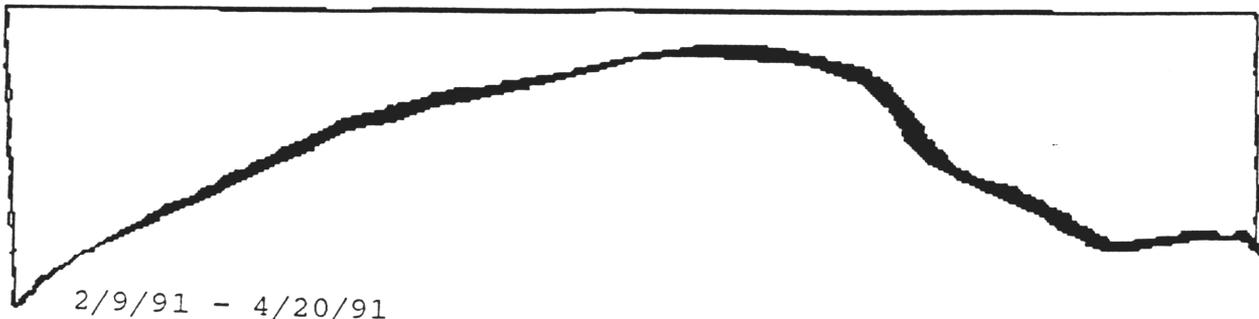
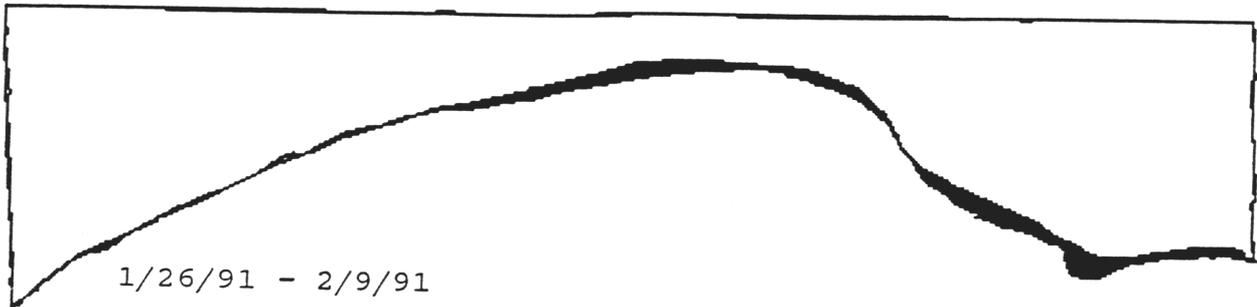
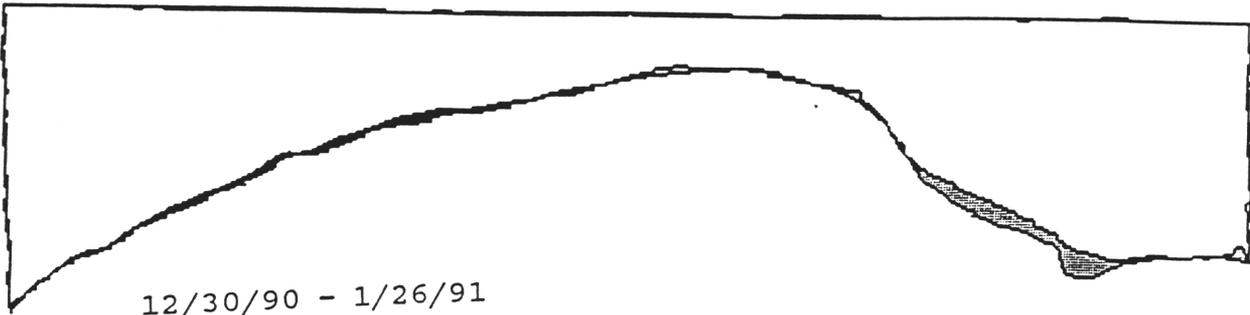
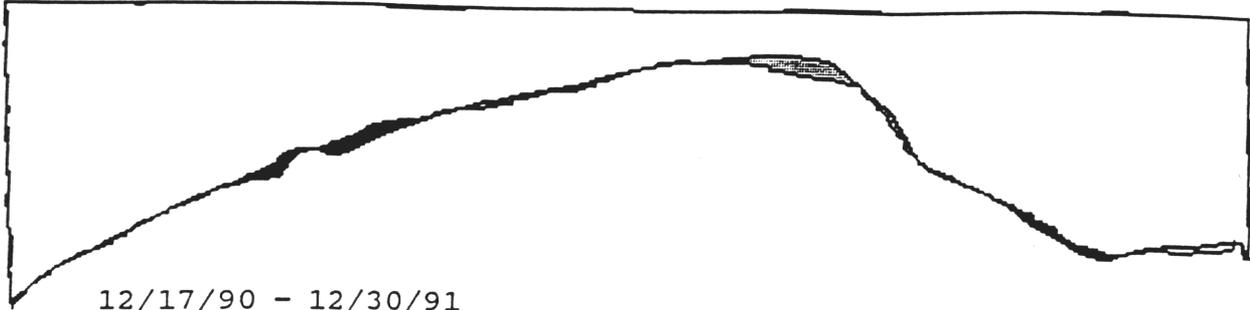


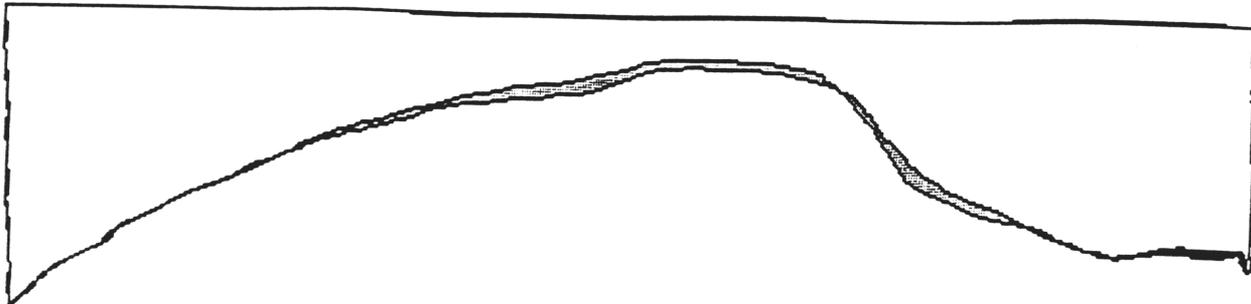
6/2/91 - 7/14/91



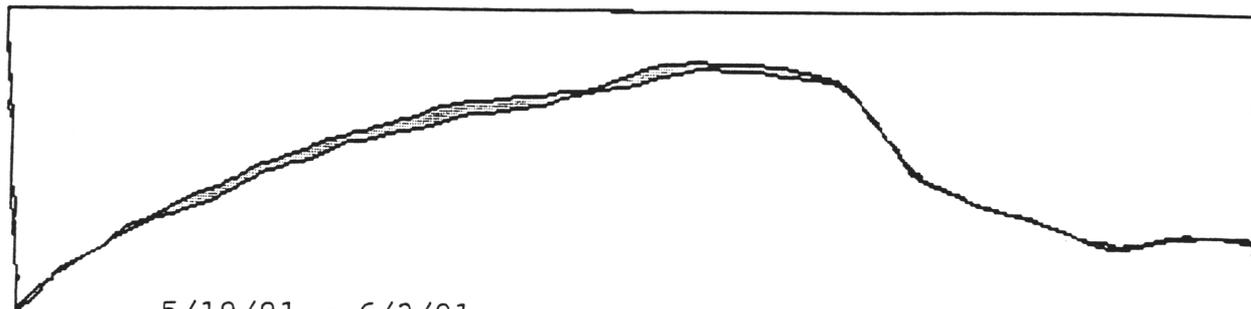
7/14/91 - 7/27/91



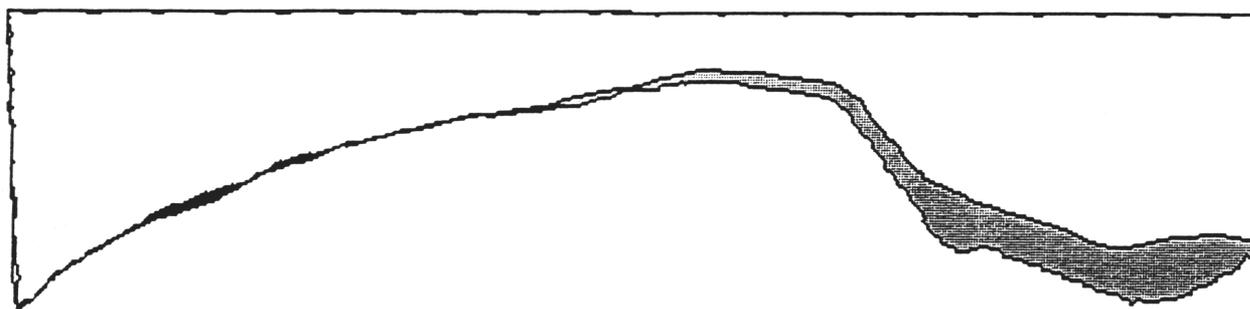




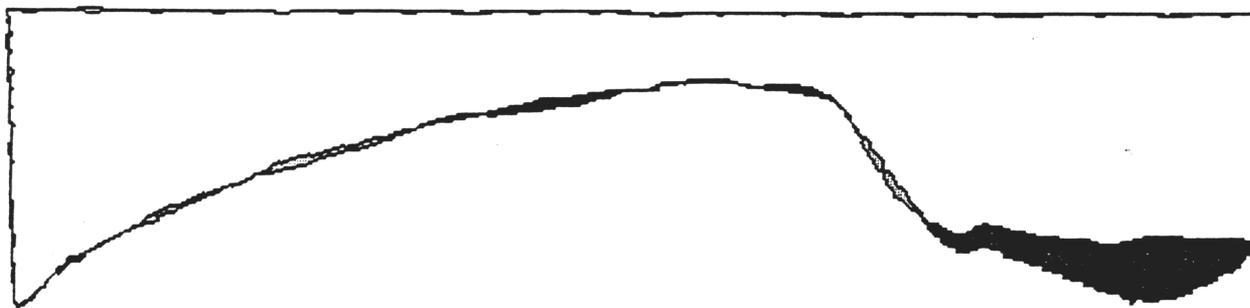
5/4/91 - 5/19/91



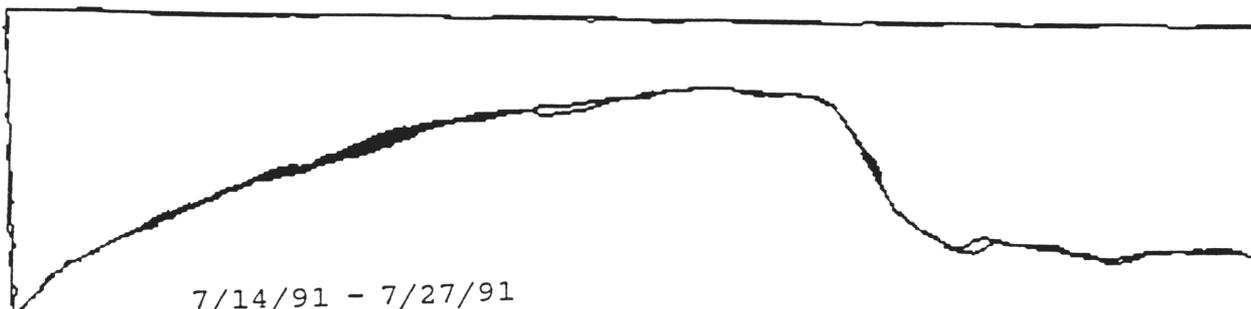
5/19/91 - 6/2/91



6/2/91 - 6/30/91



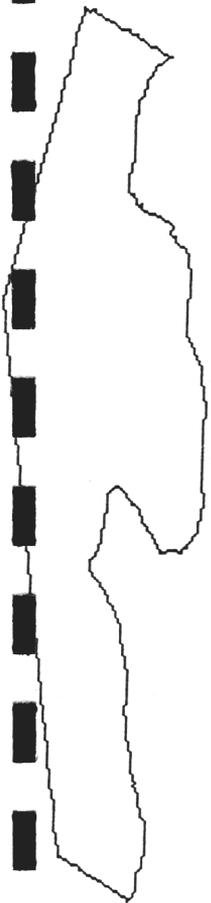
6/30/91 - 7/14/91



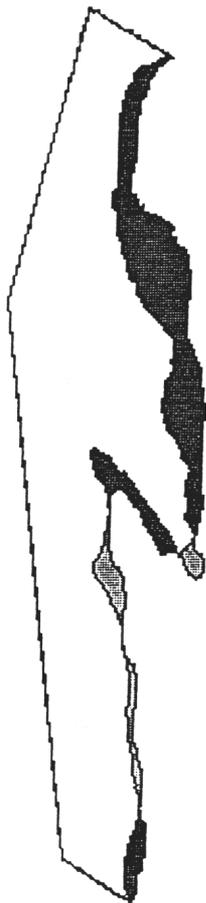
7/14/91 - 7/27/91



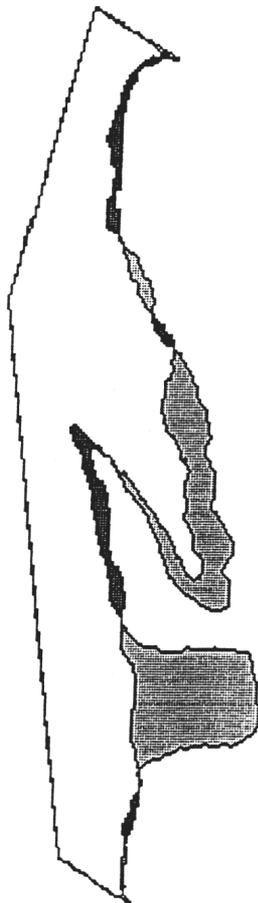
33.0L



10/15/90



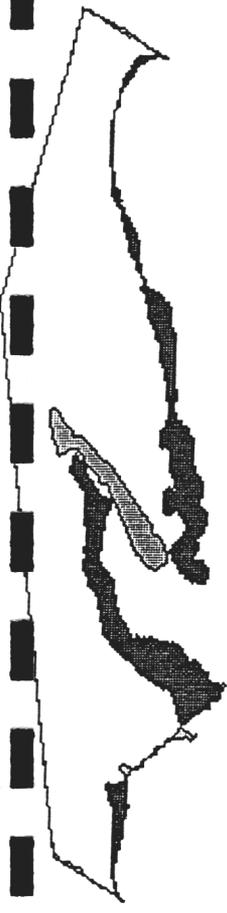
10/15/90 - 10/30/90



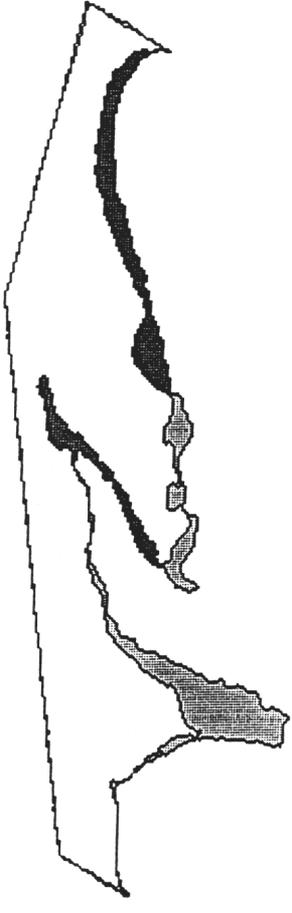
10/30/90 - 11/11/90



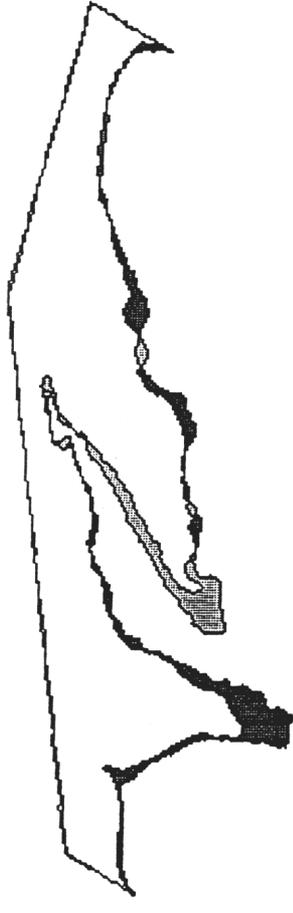
11/11/90 - 12/17/90



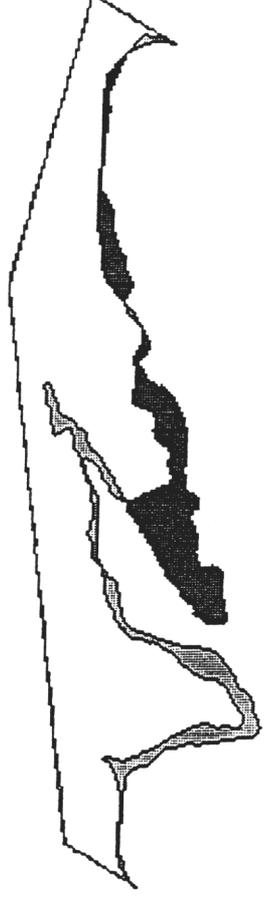
12/17/90 - 1/12/91



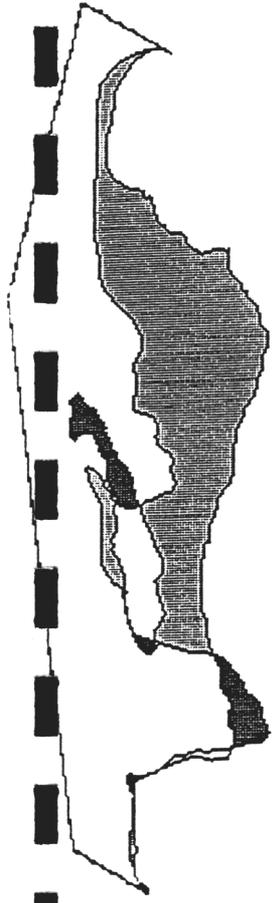
1/12/91 - 1/26/91



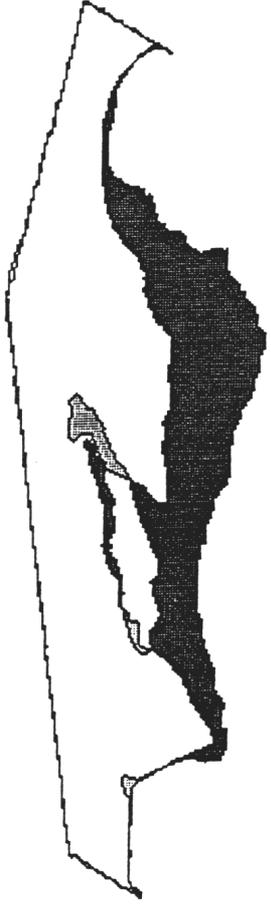
1/12/91 - 2/9/91



2/9/91 - 4/20/91



4/20/91 - 5/5/91



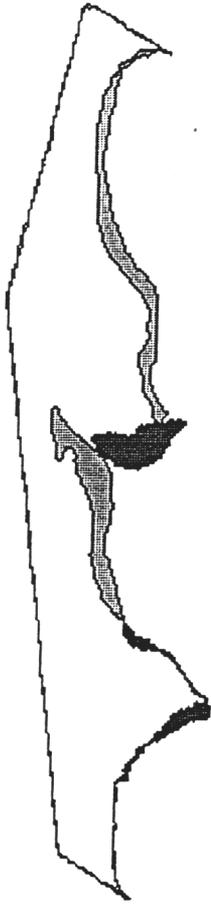
5/5/91 - 5/19/91



5/19/91 - 6/2/91

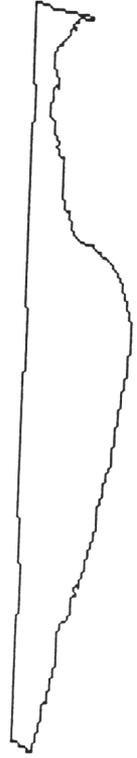


6/2/91 - 6/30/91

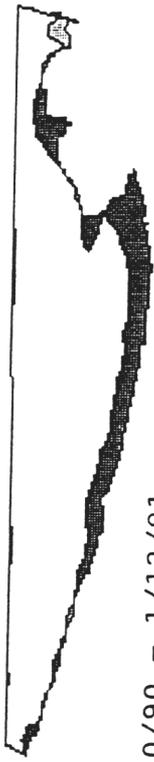


6/30/91 - 7/27/91

35.1R



10/30/90



12/30/90 - 1/12/91



10/30/90 - 11/11/90



1/12/91 - 1/26/91



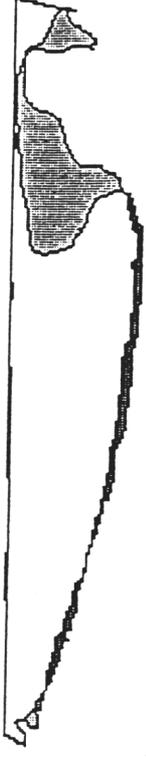
11/11/90 - 12/17/90



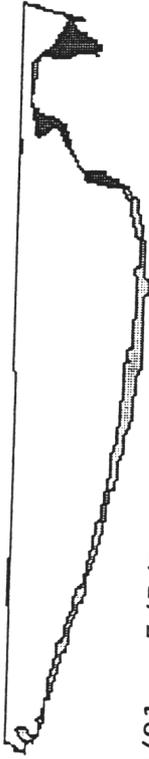
1/26/91 - 2/9/91



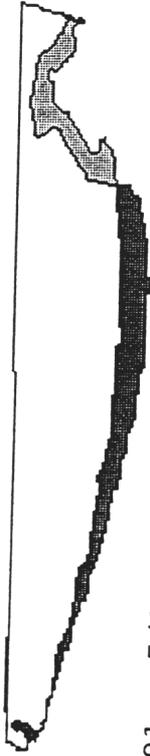
12/17/90 - 12/30/90



2/9/91 - 4/20/91



4/20/91 - 5/5/91

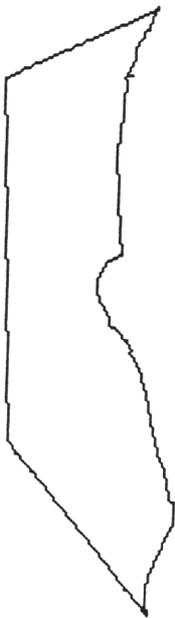


5/5/91 - 5/19/91



5/19/91 - 5/30/91

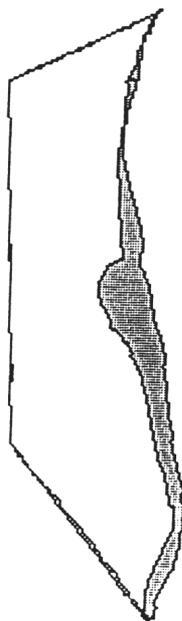
37.5L



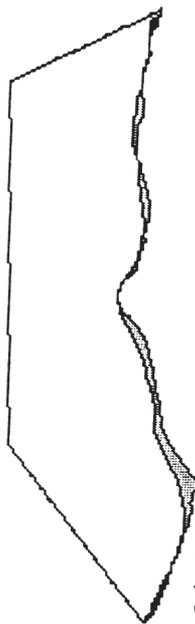
10/30/90



12/30/90 - 1/12/91



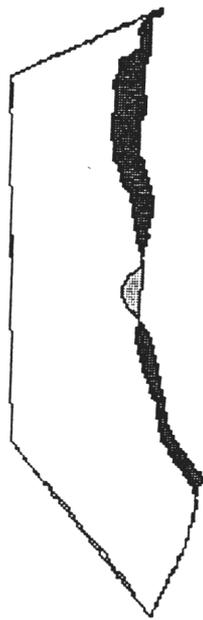
10/30/90 - 12/17/90



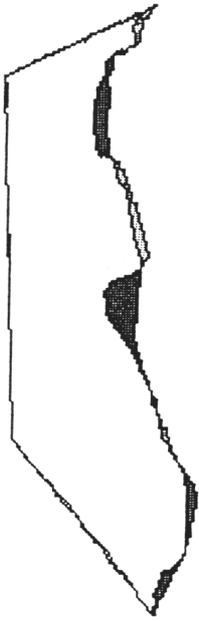
1/12/91 - 1/26/91



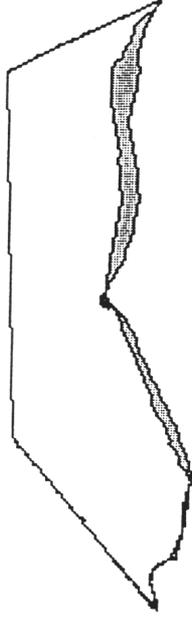
12/17/90 - 12/30/90



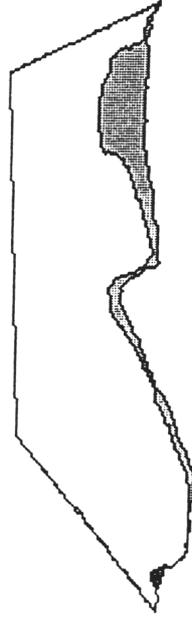
1/26/91 - 2/9/91



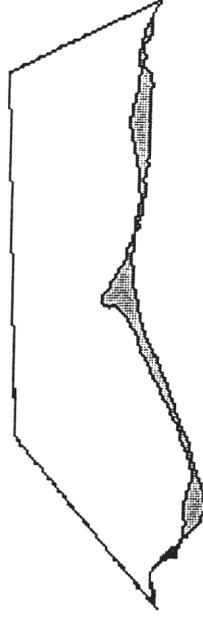
2/9/91 - 4/20/91



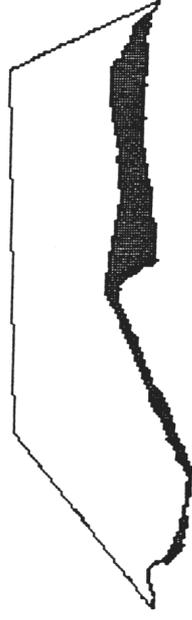
5/19/91 - 6/2/91



4/20/91 - 5/5/91



6/2/91 - 6/30/91

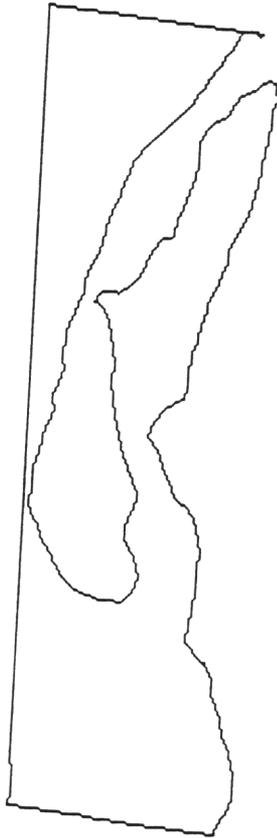


5/5/91 - 5/19/91

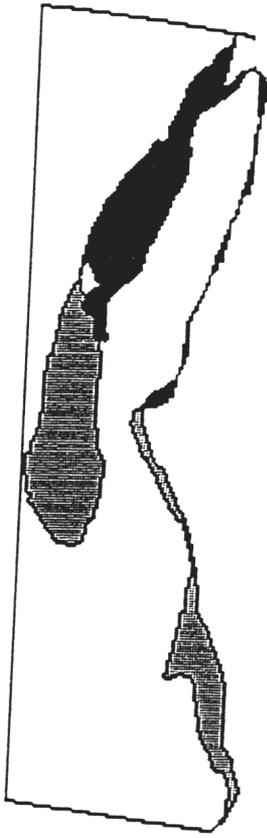


6/30/91 - 7/27/91

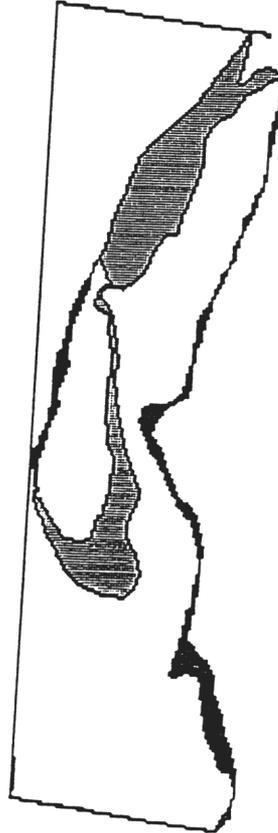
40.0L



10/15/90



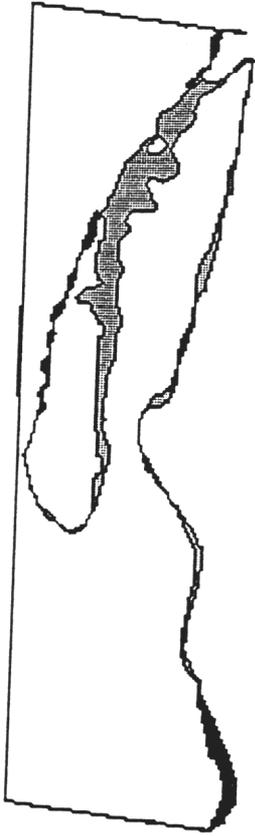
10/30/90 - 11/11/90



10/15/90 - 10/30/90



11/11/90 - 12/17/90



12/17/90 - 12/30/90



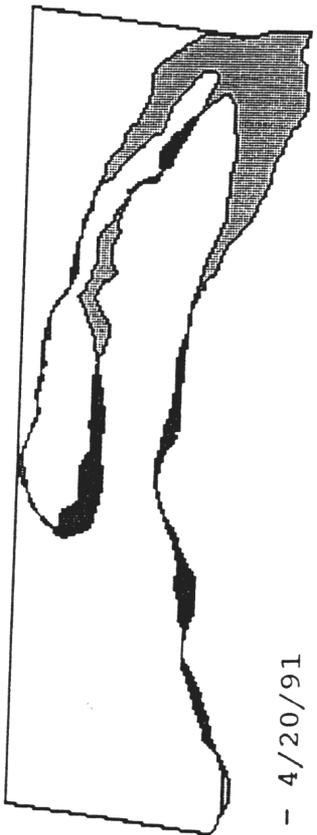
1/12/91 - 1/26/91



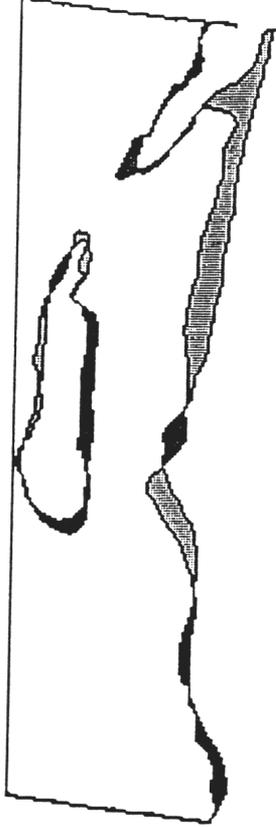
12/30/90 - 1/12/91



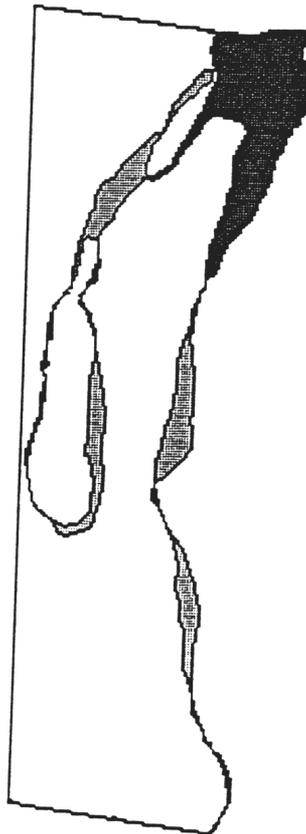
1/26/91 - 2/9/91



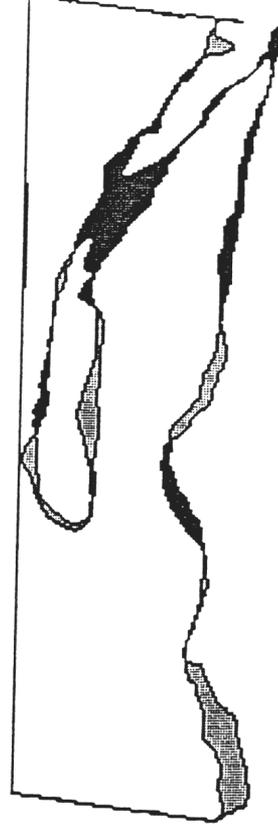
2/9/91 - 4/20/91



5/5/91 - 5/19/91



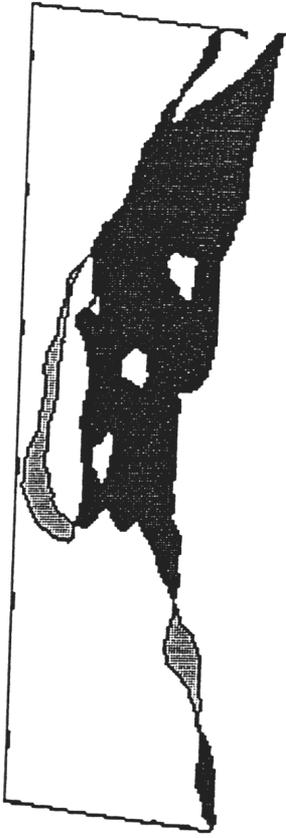
4/20/91 - 5/5/91



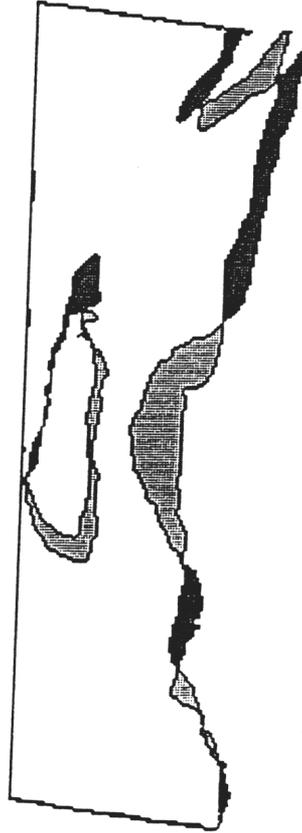
5/19/91 - 6/2/91



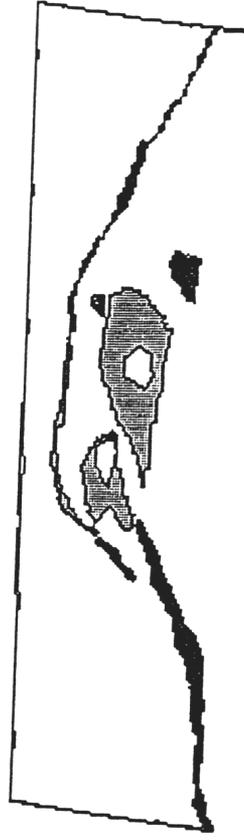
6/2/91 - 6/30/91



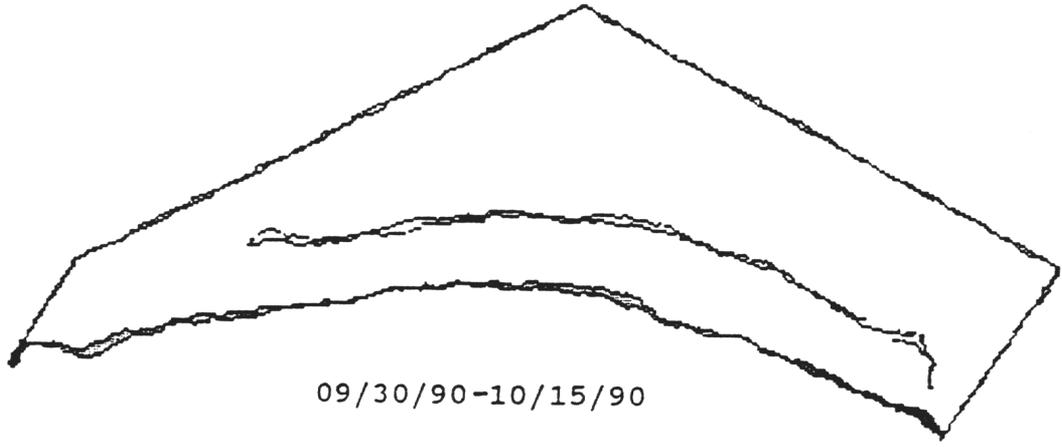
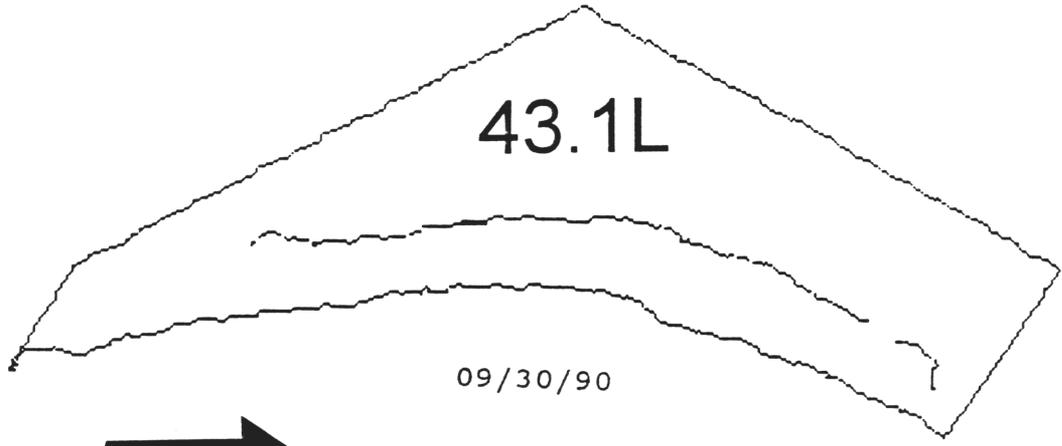
7/27/91 - 10/11/91

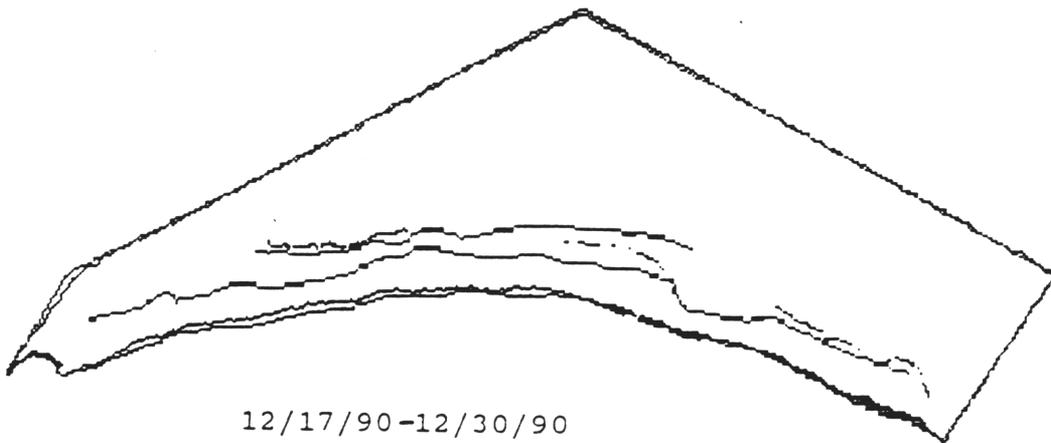
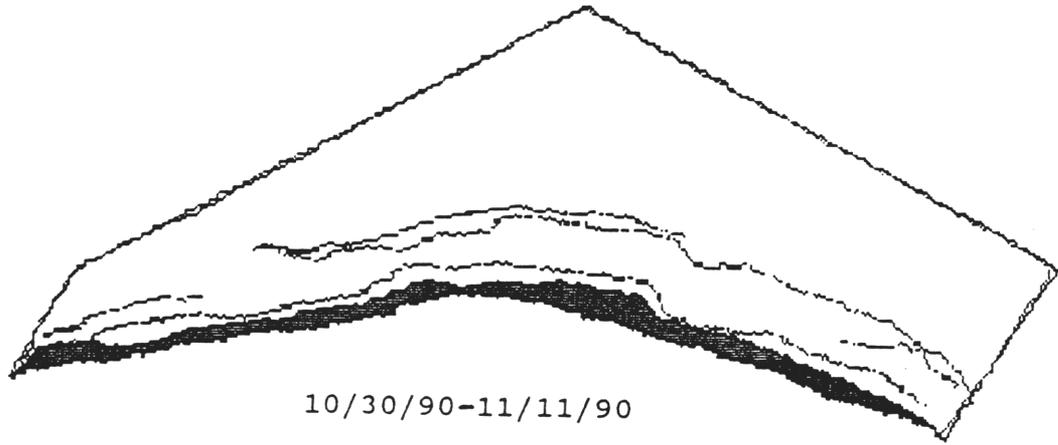


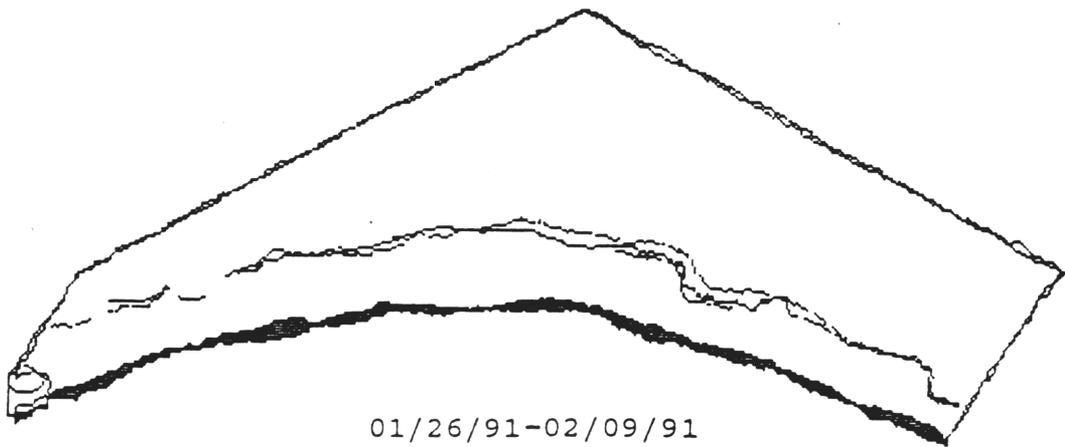
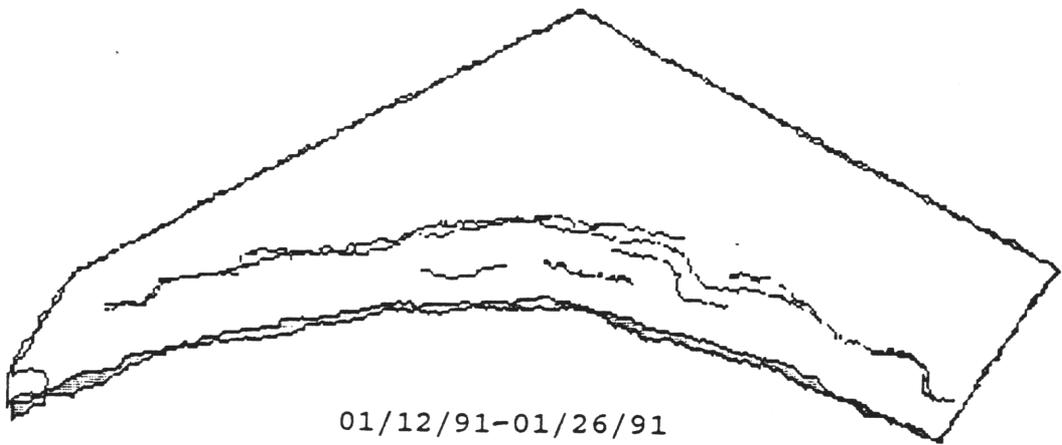
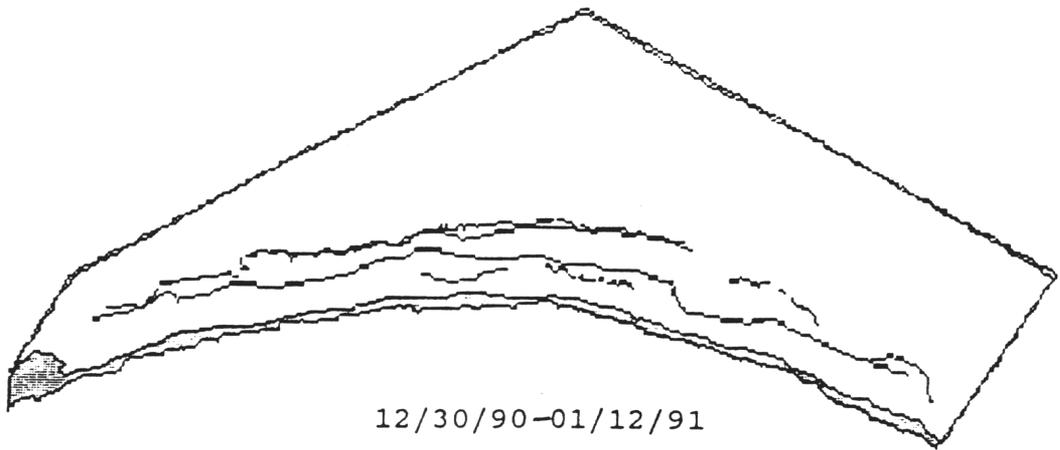
6/30/91 - 7/27/91

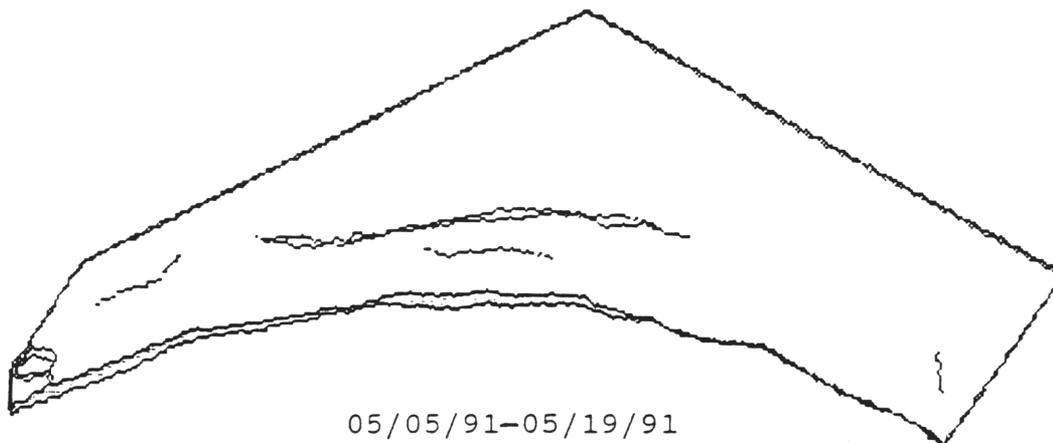
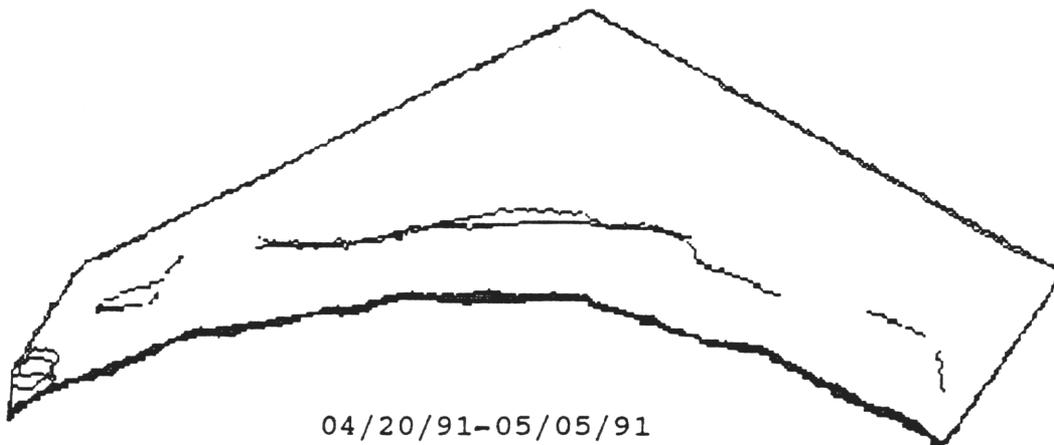
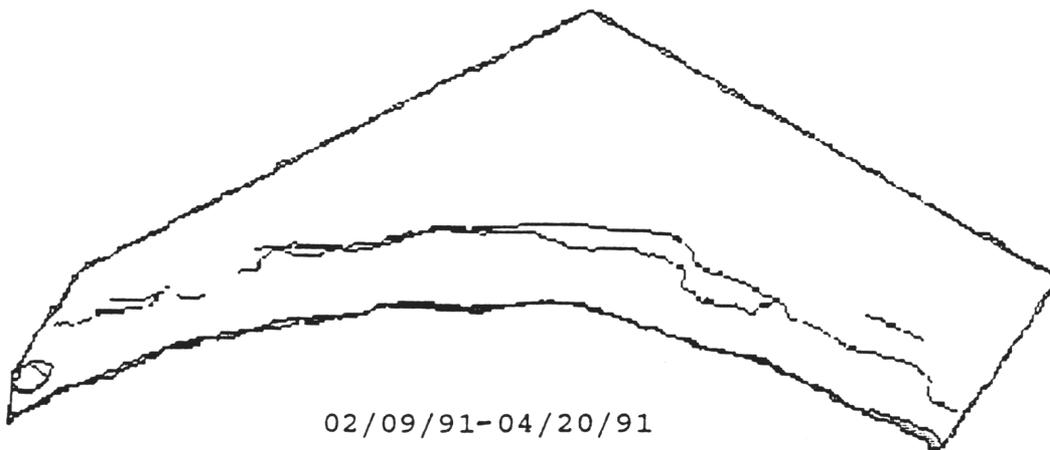


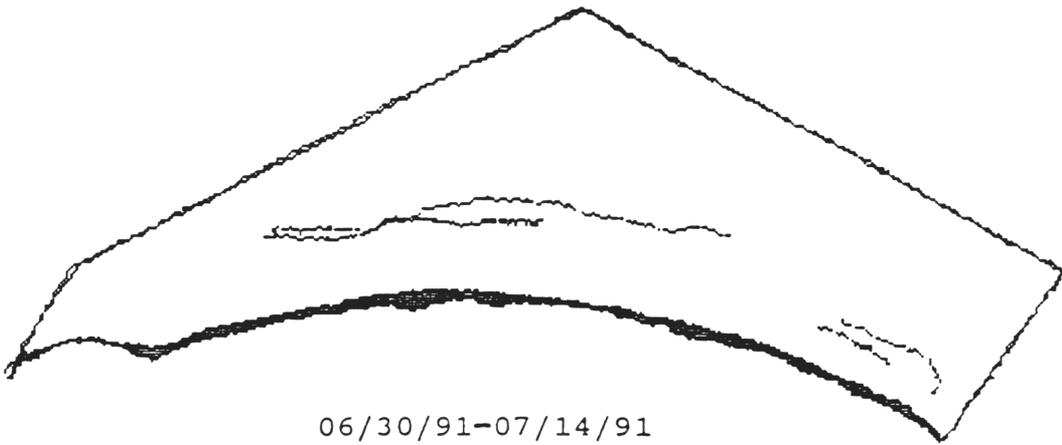
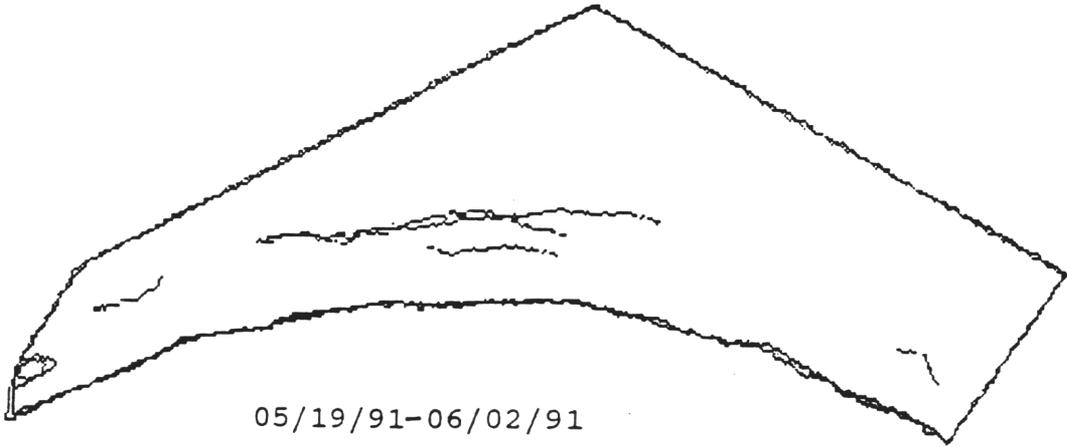
10/11/91 - 5/30/92





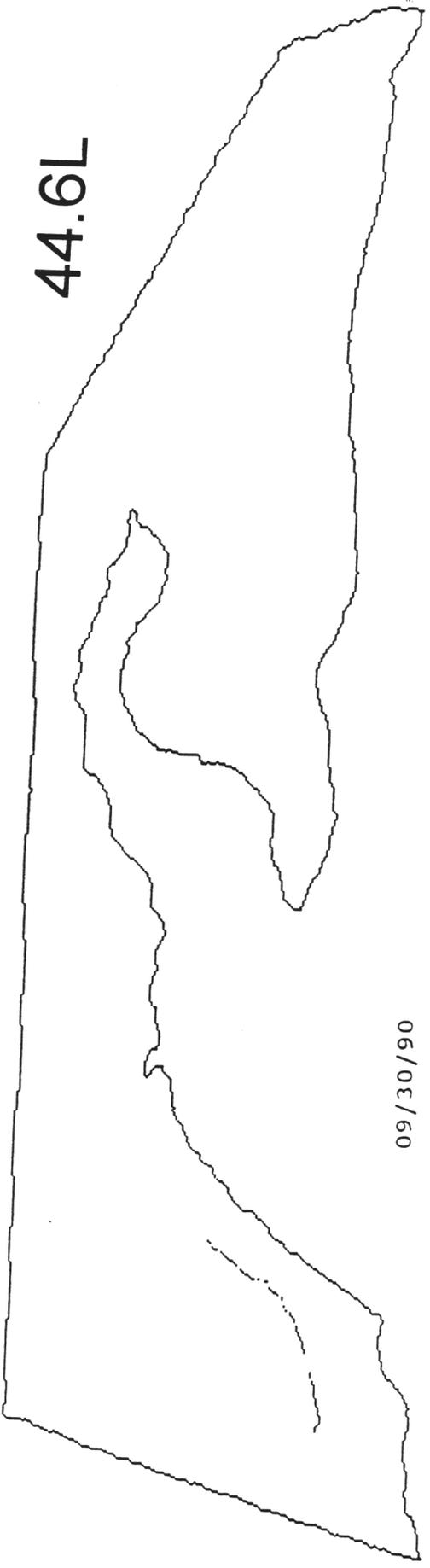




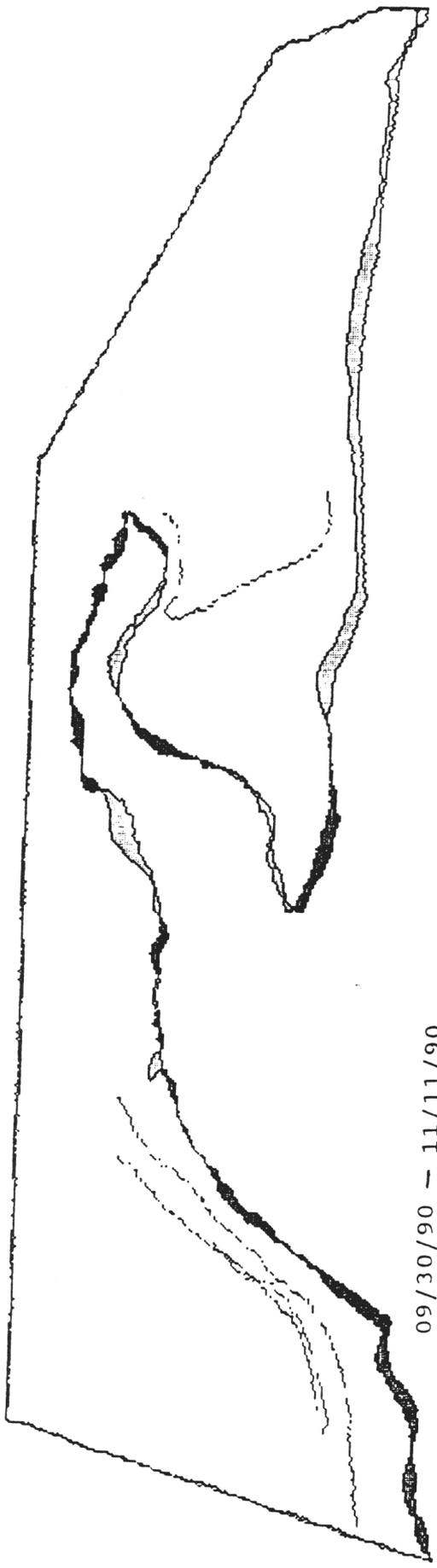


07/14/91-07/27/91

44.6L



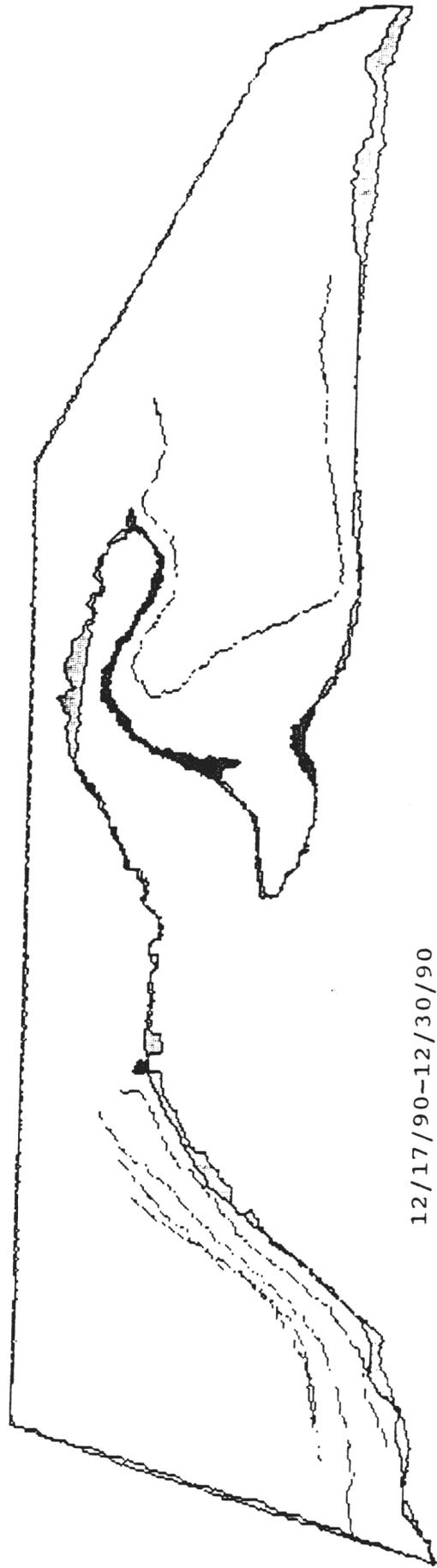
09/30/90



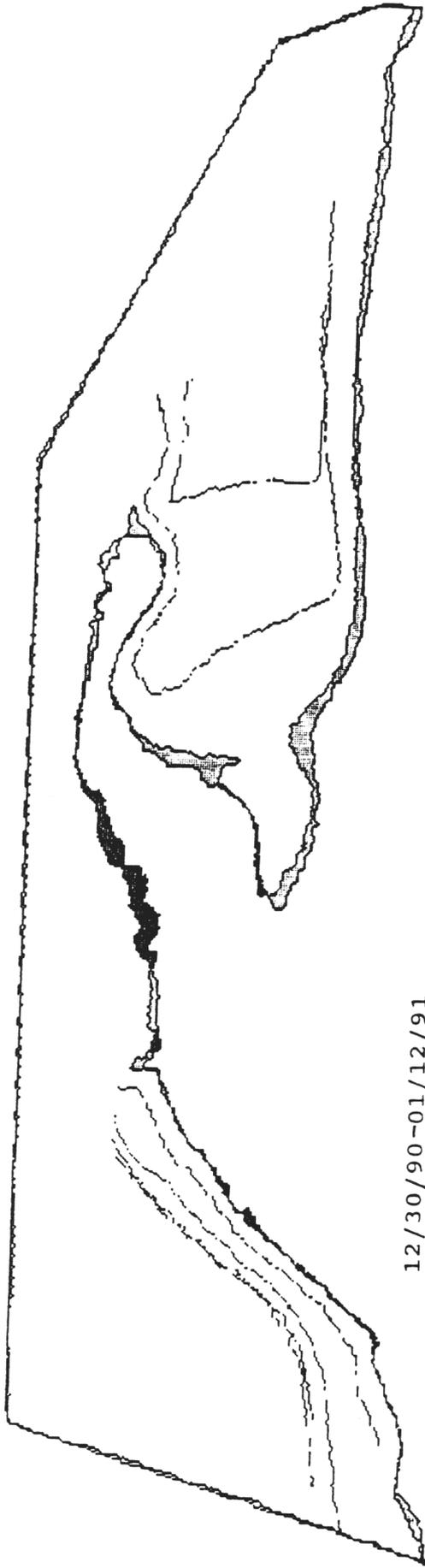
09/30/90 - 11/11/90



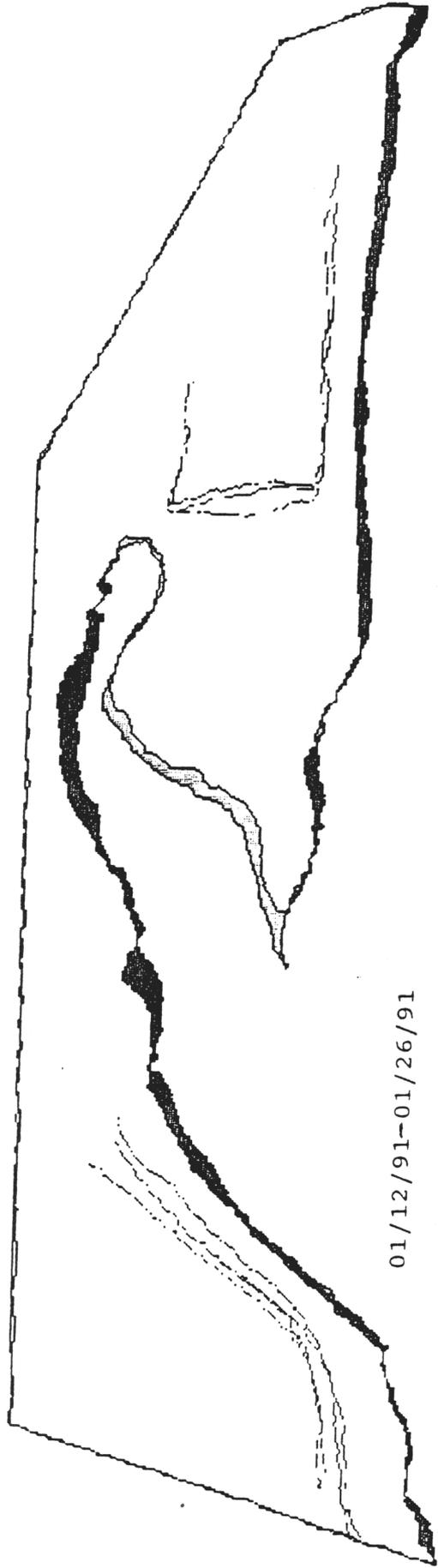
11/11/90-12/17/90



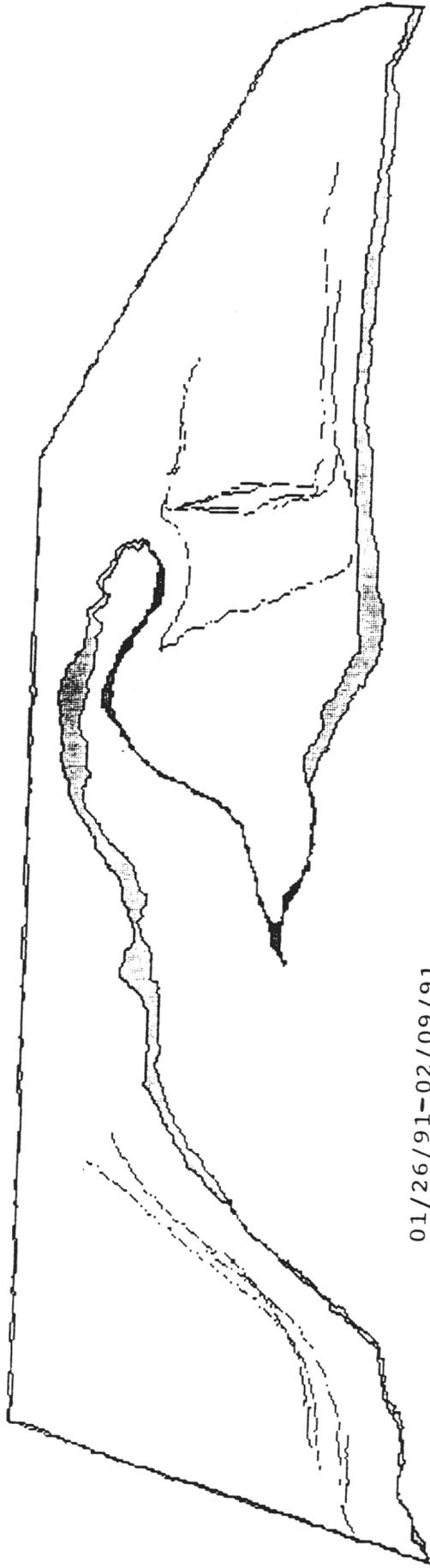
12/17/90-12/30/90



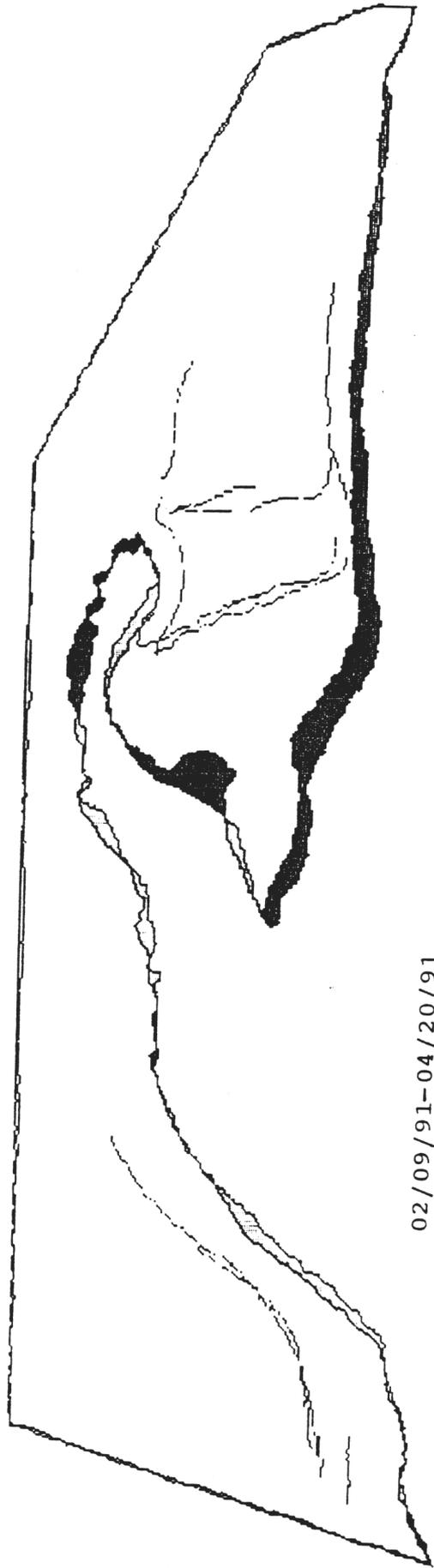
12/30/90-01/12/91



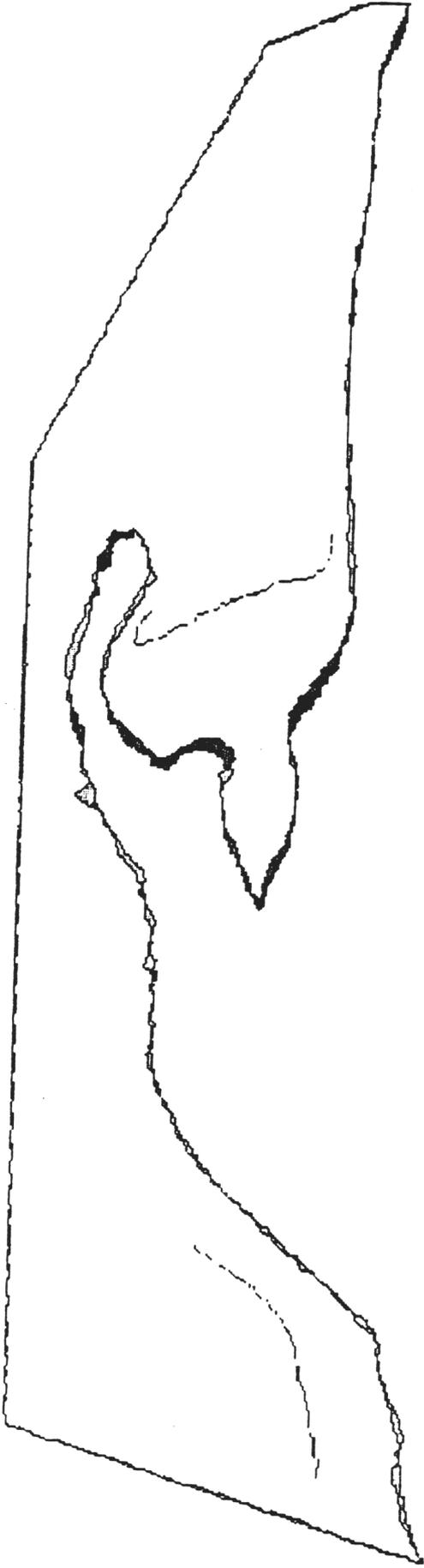
01/12/91-01/26/91



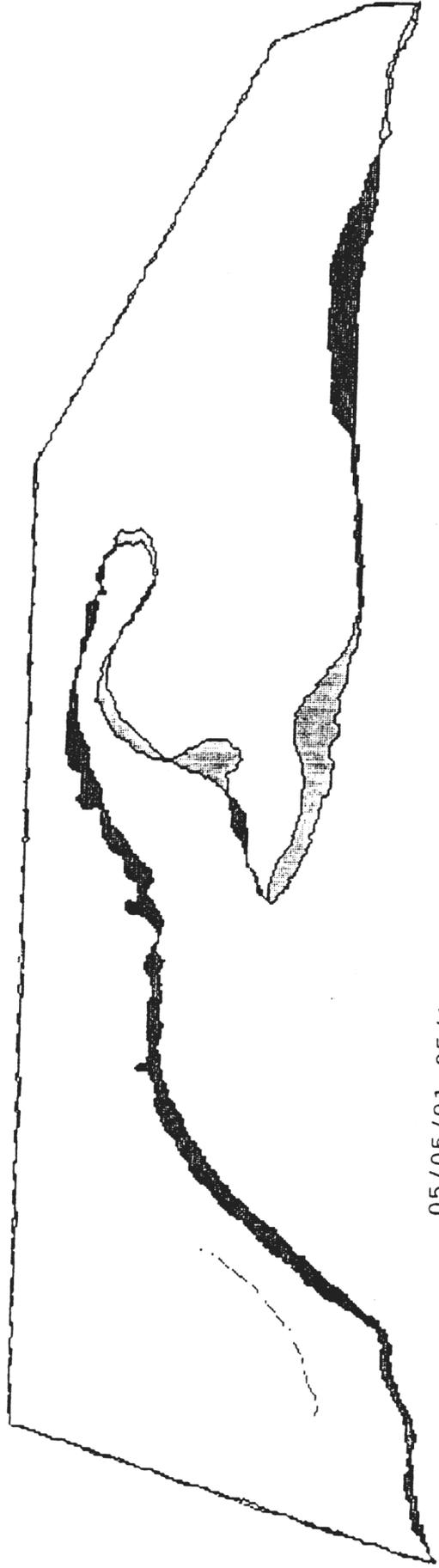
01/26/91-02/09/91



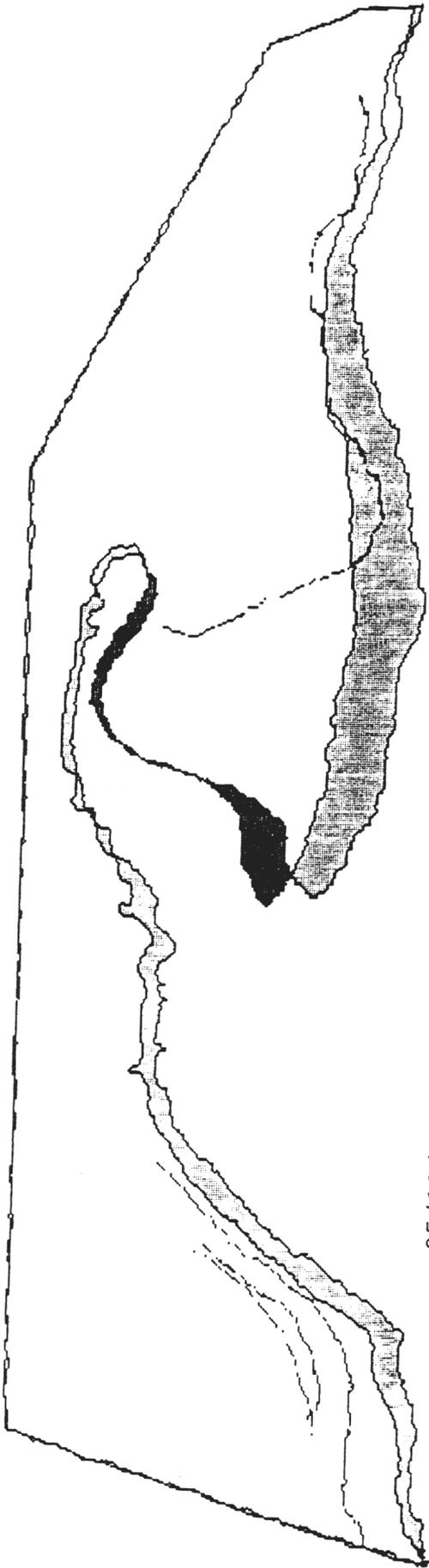
02/09/91-04/20/91



04/20/91-05/05/91



05/05/91-05/19/91

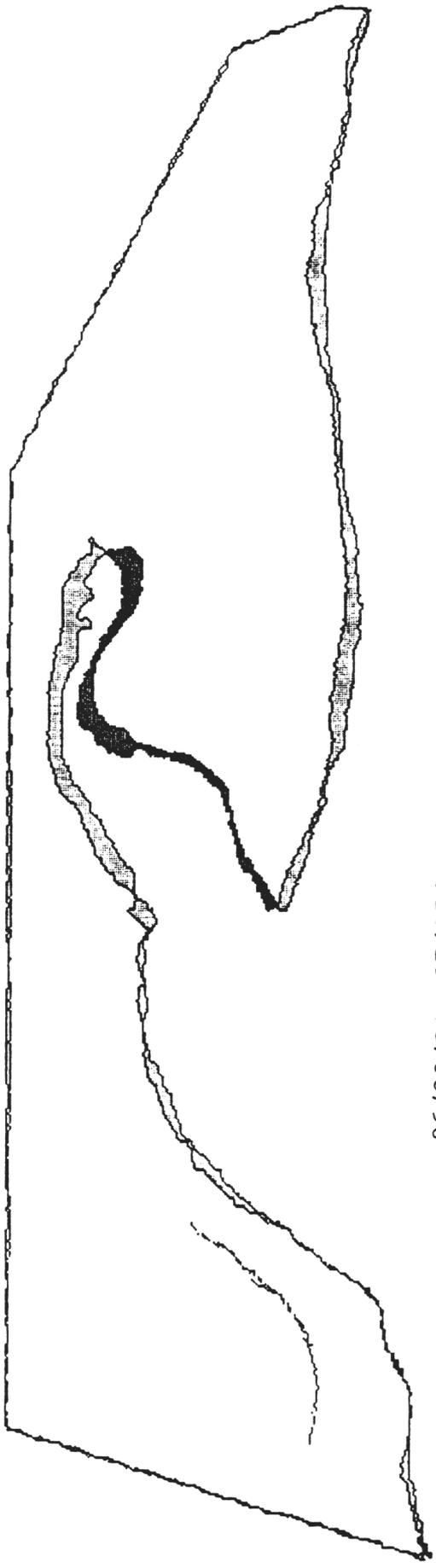


05/19/91-06/20/91

A41



06/02/91-06/30/91



06/30/91 - 07/27/91

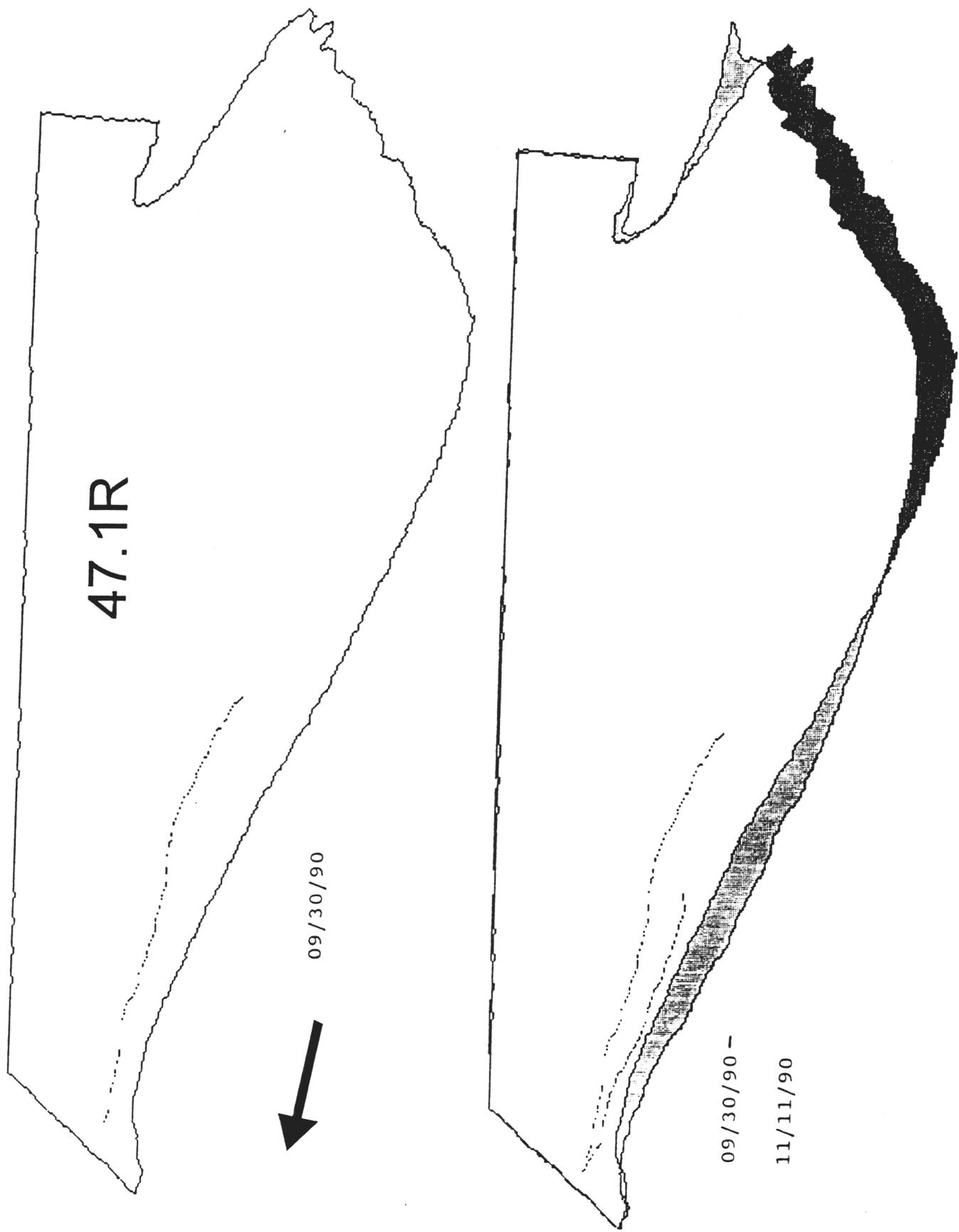
47.1R

09/30/90



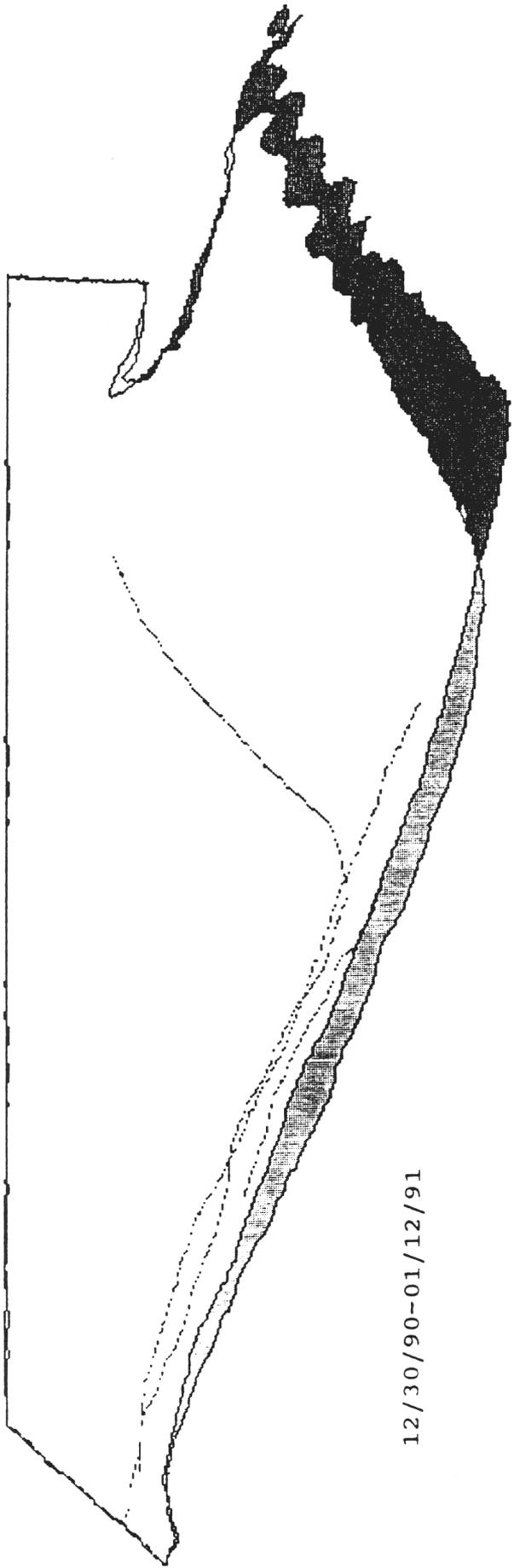
09/30/90 -

11/11/90





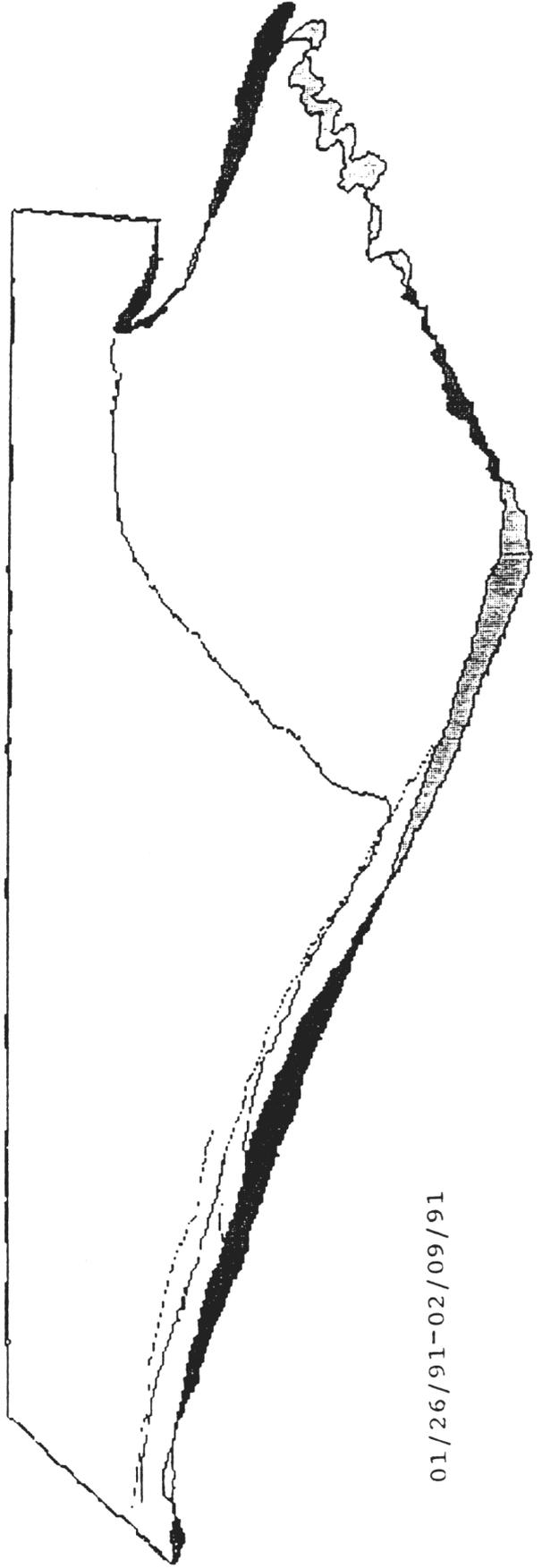
11/11/90 -
12/30/90



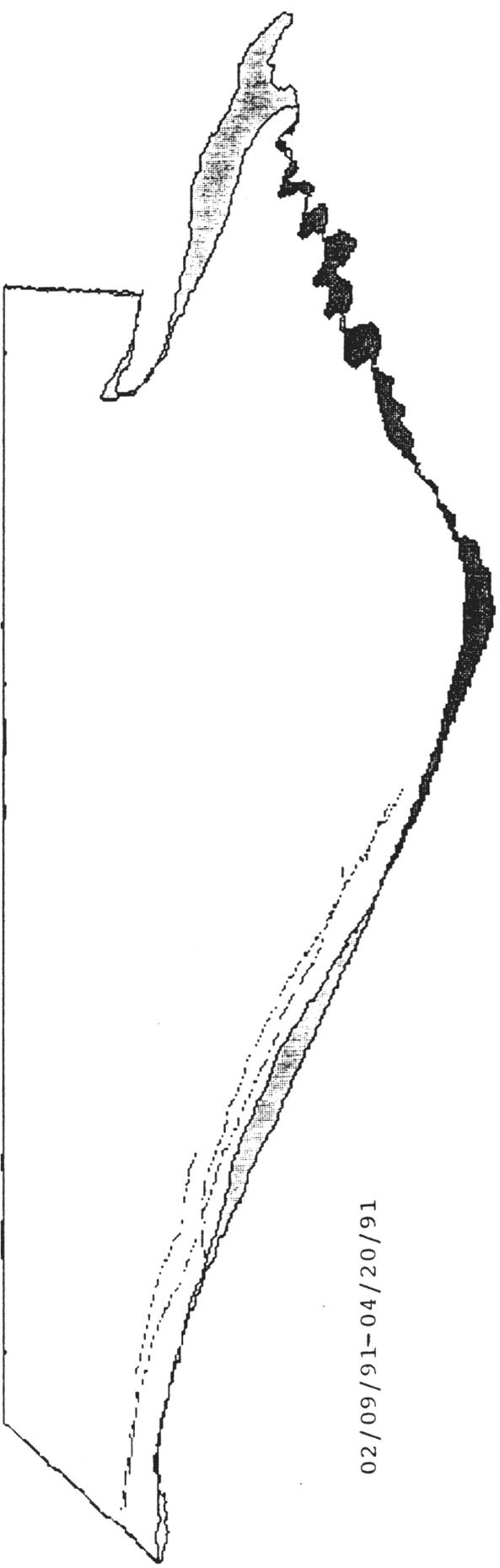
12/30/90-01/12/91



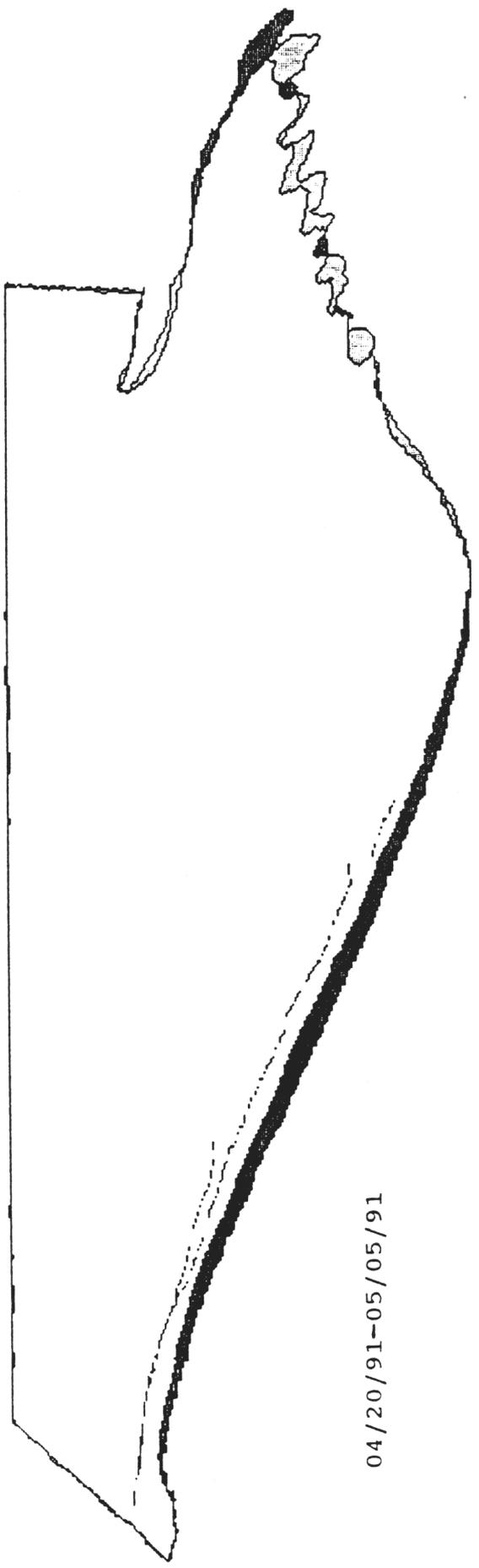
01/12/91-01/26/91 WINTER



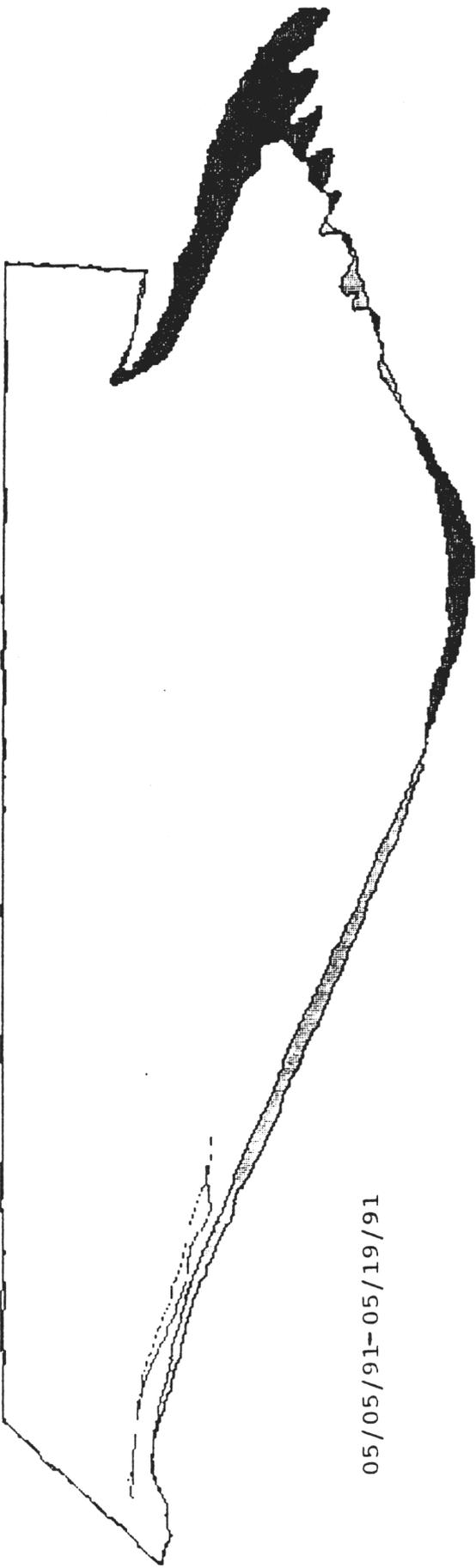
01/26/91-02/09/91



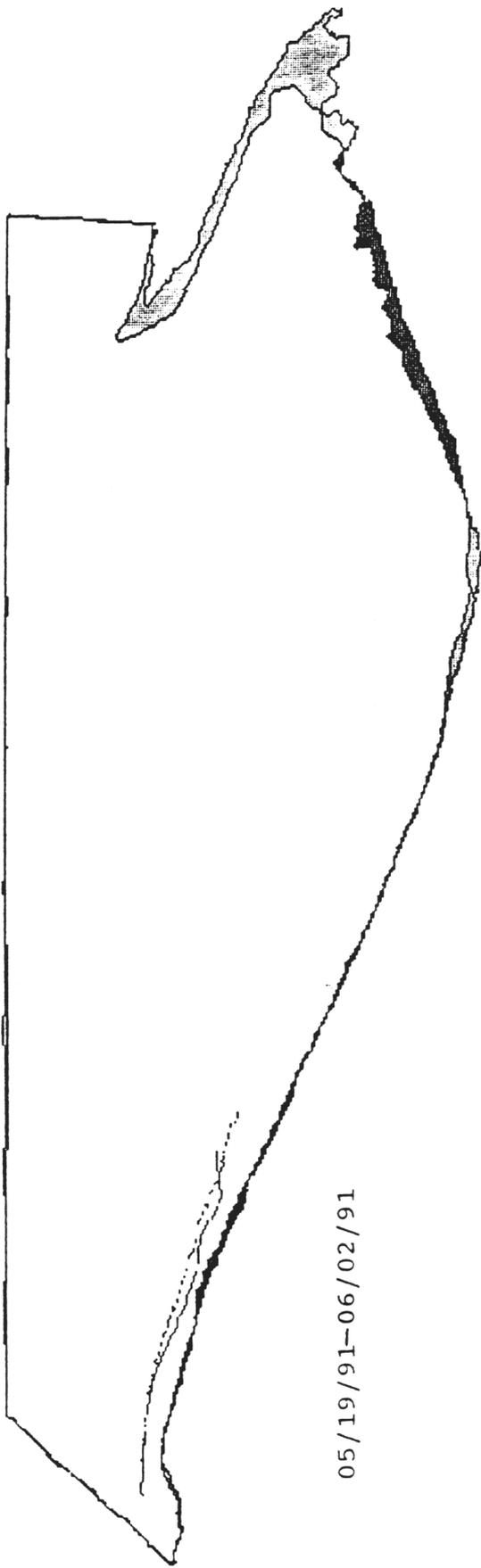
02/09/91-04/20/91



04/20/91-05/05/91



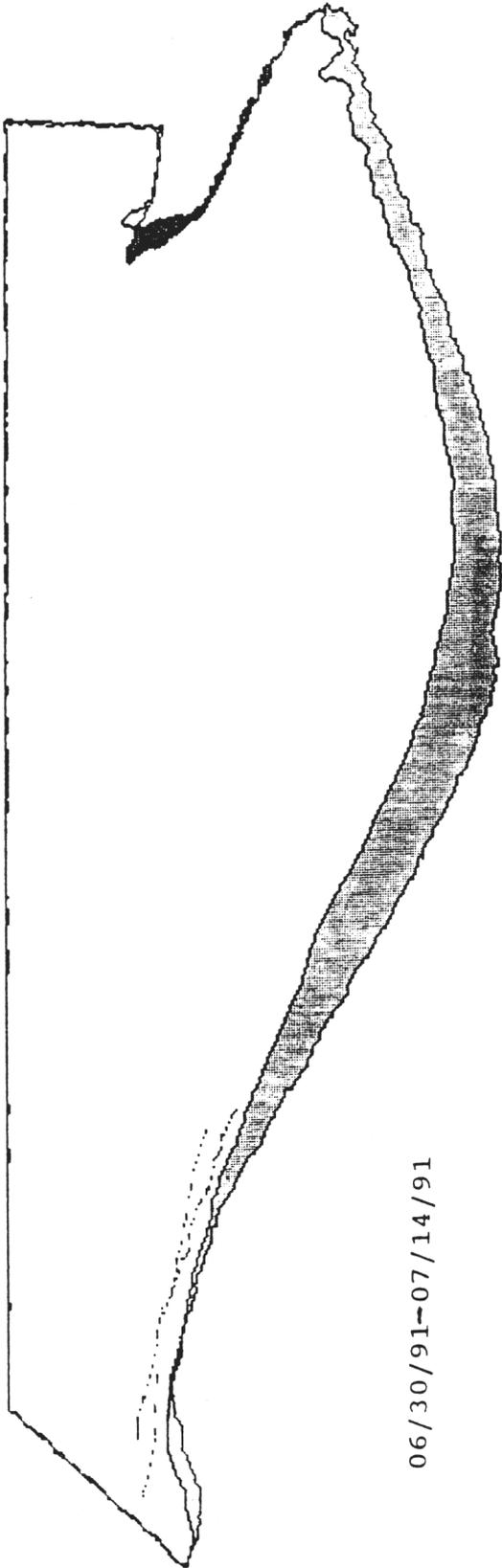
05/05/91-05/19/91



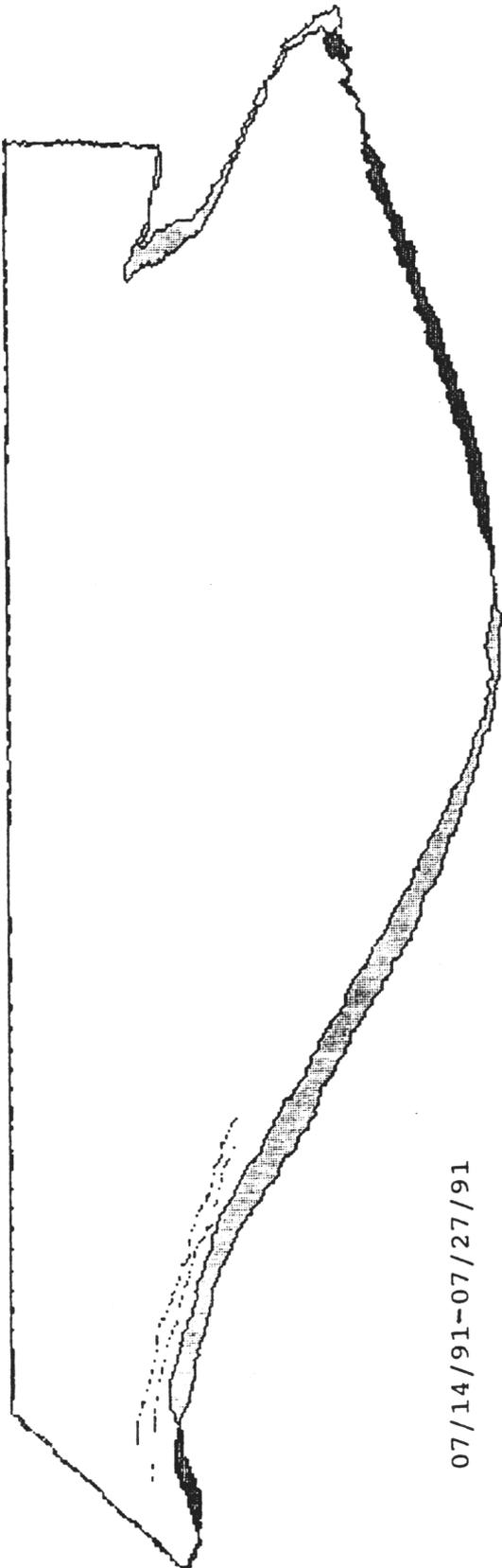
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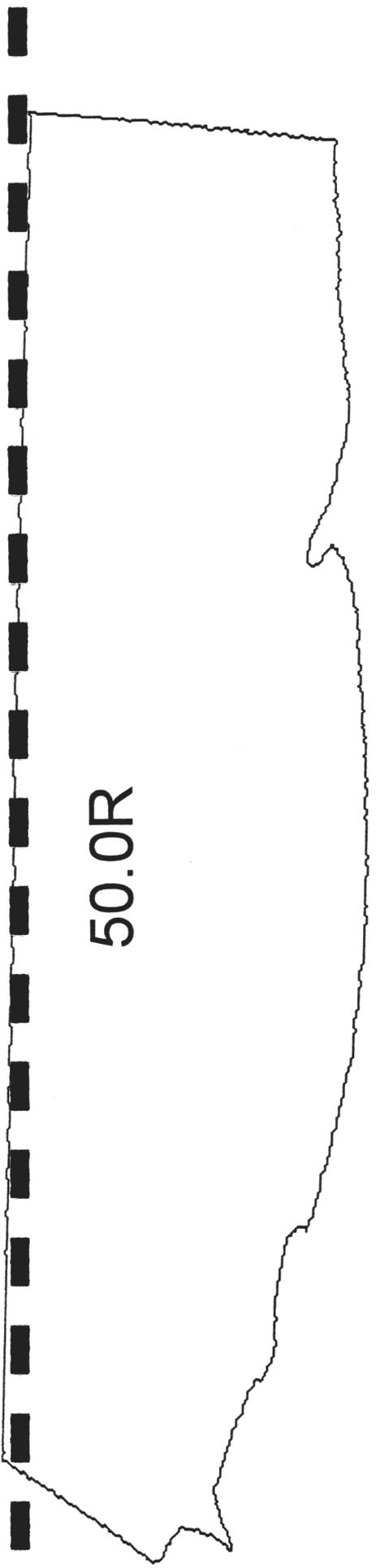
06/02/91-06/30/91



06/30/91-07/14/91

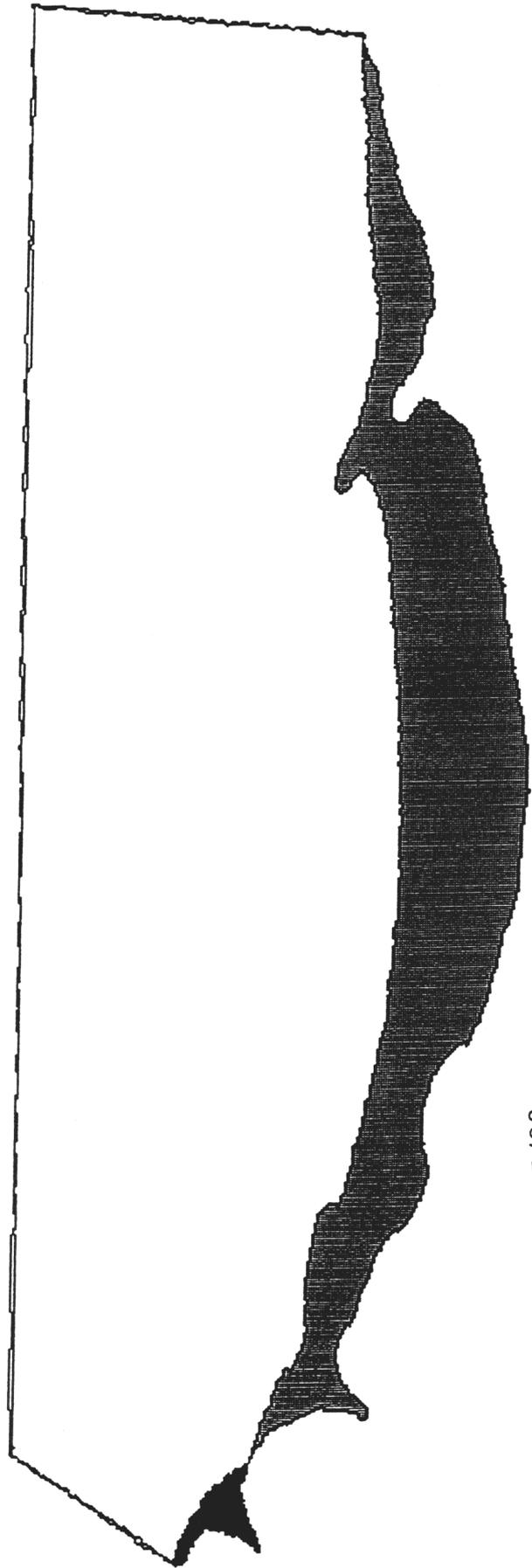


07/14/91-07/27/91



50.0R

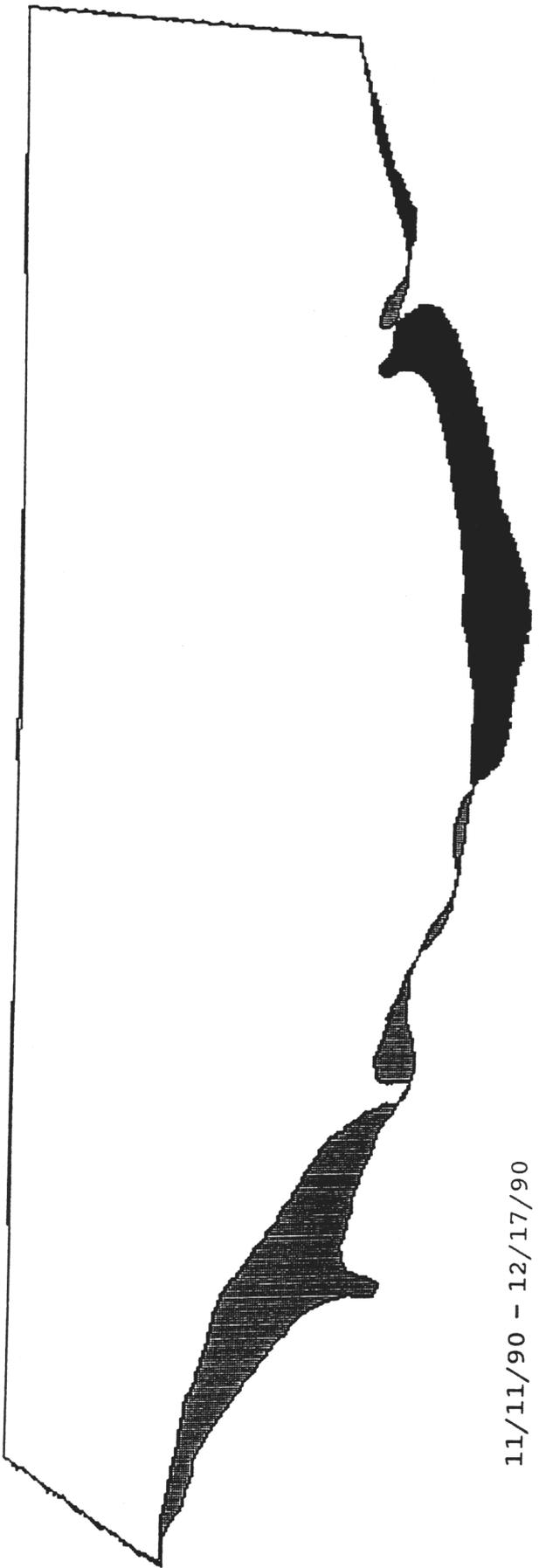
9/30/90



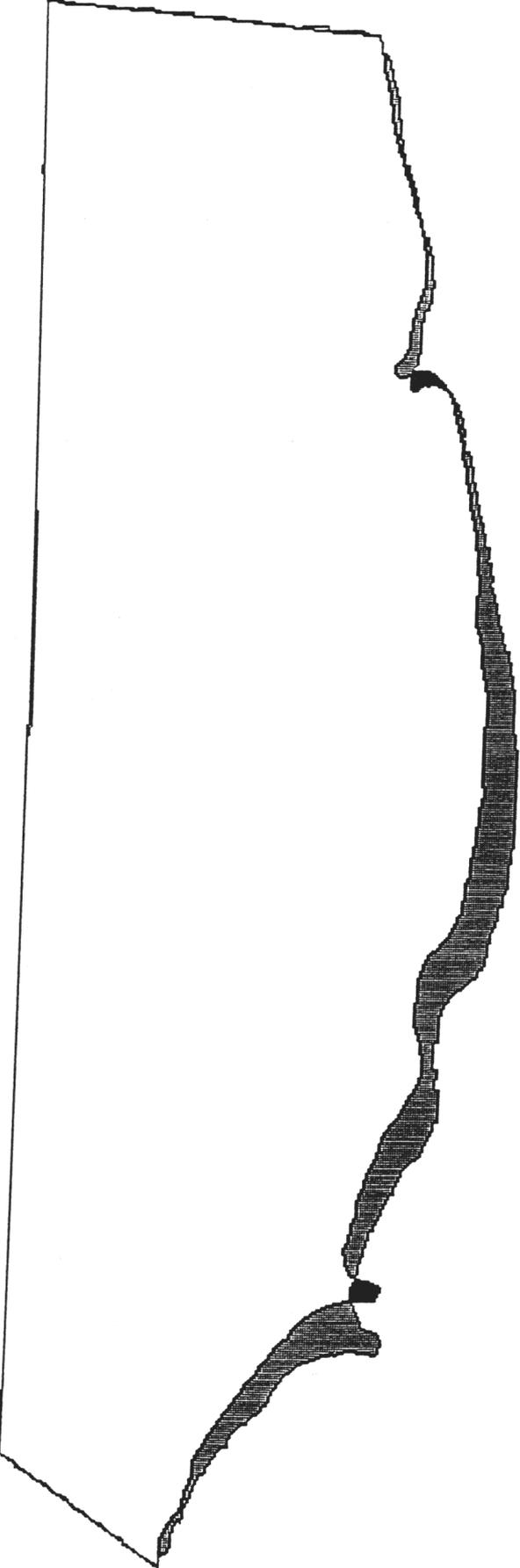
9/30/90 - 10/15/90



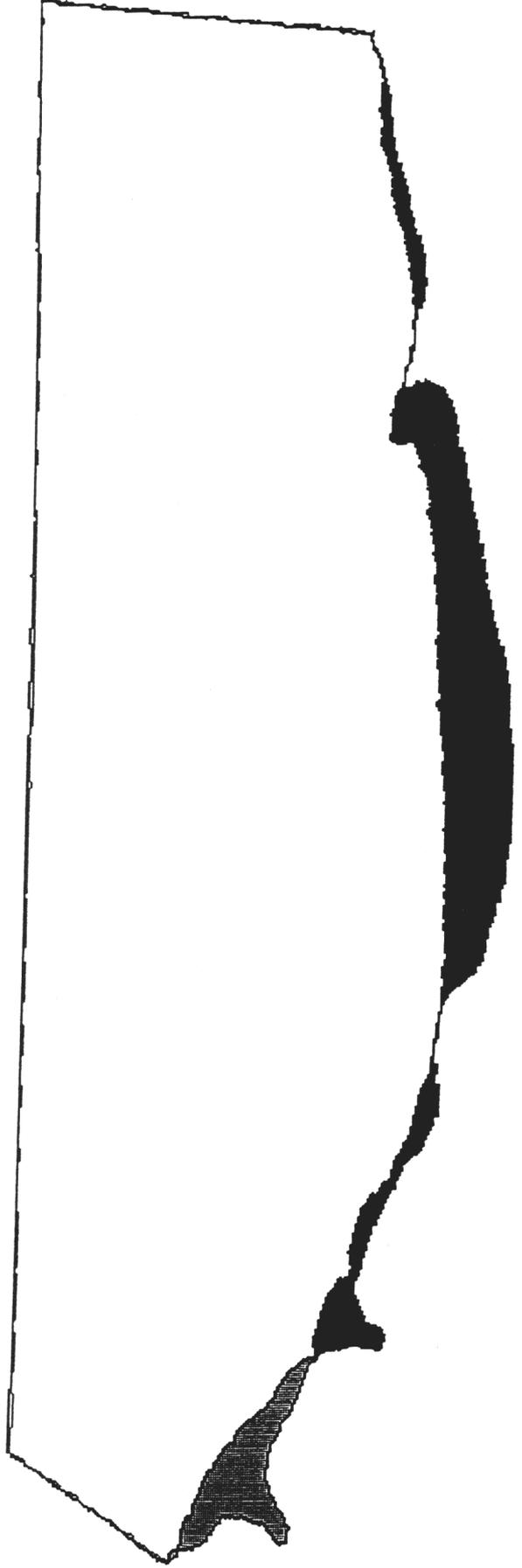
10/15/90 - 11/11/90



11/11/90 - 12/17/90



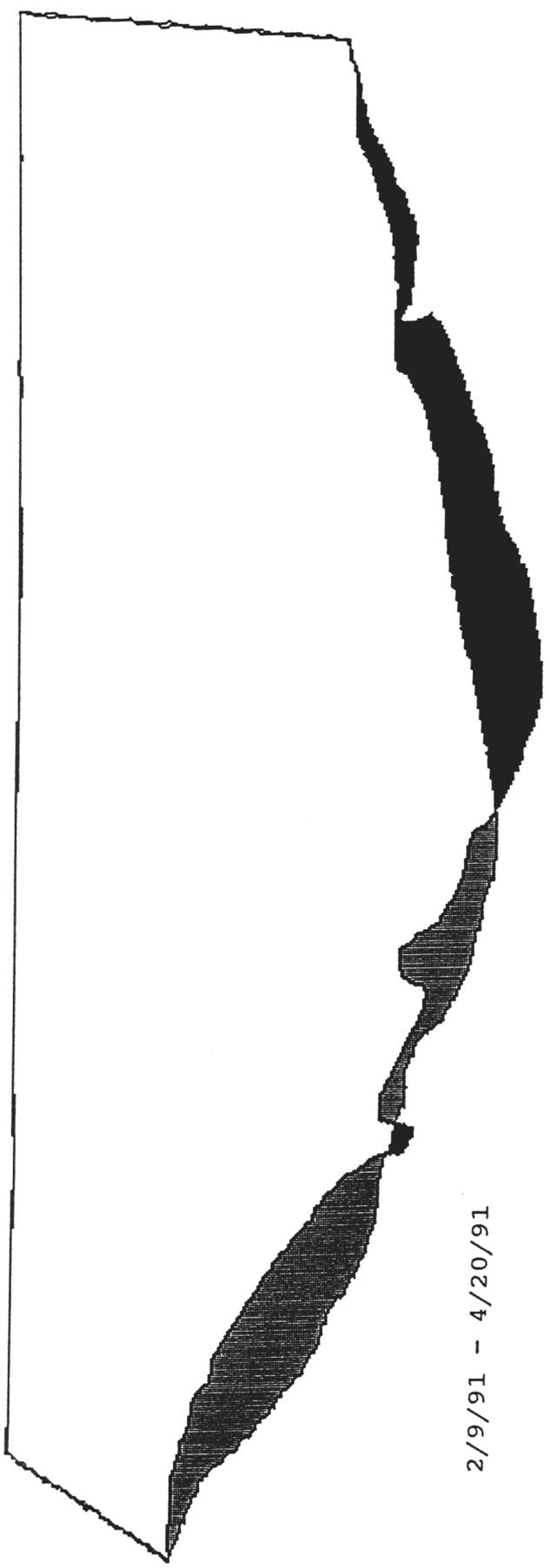
12/17/90 - 12/30/90



12/30/90 - 1/26/91



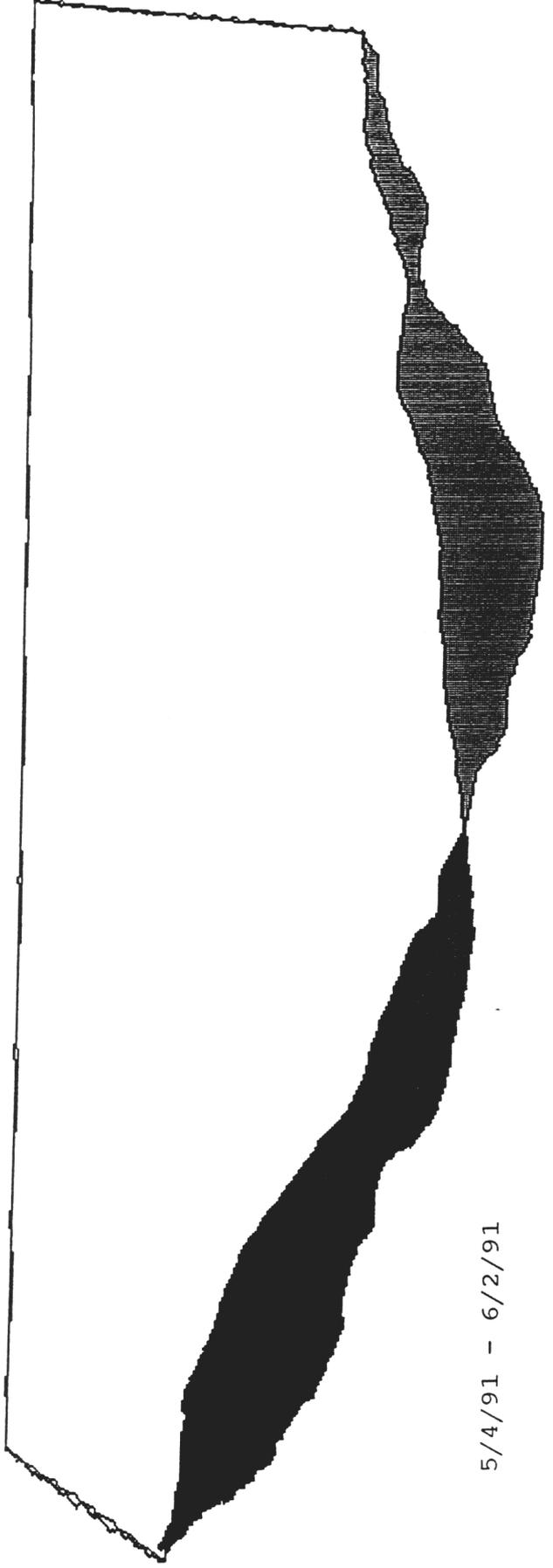
1/26/91 - 2/9/91



2/9/91 - 4/20/91



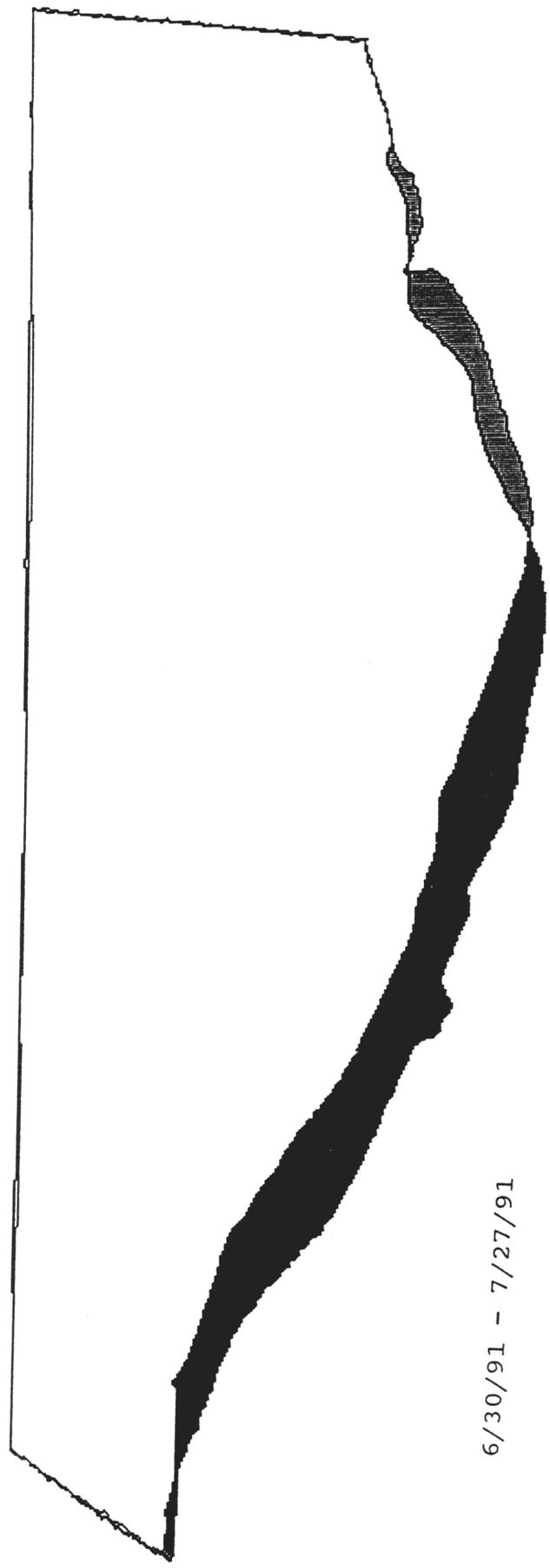
4/20/91 - 5/4/91



5/4/91 - 6/2/91



6/2/91 - 6/30/91

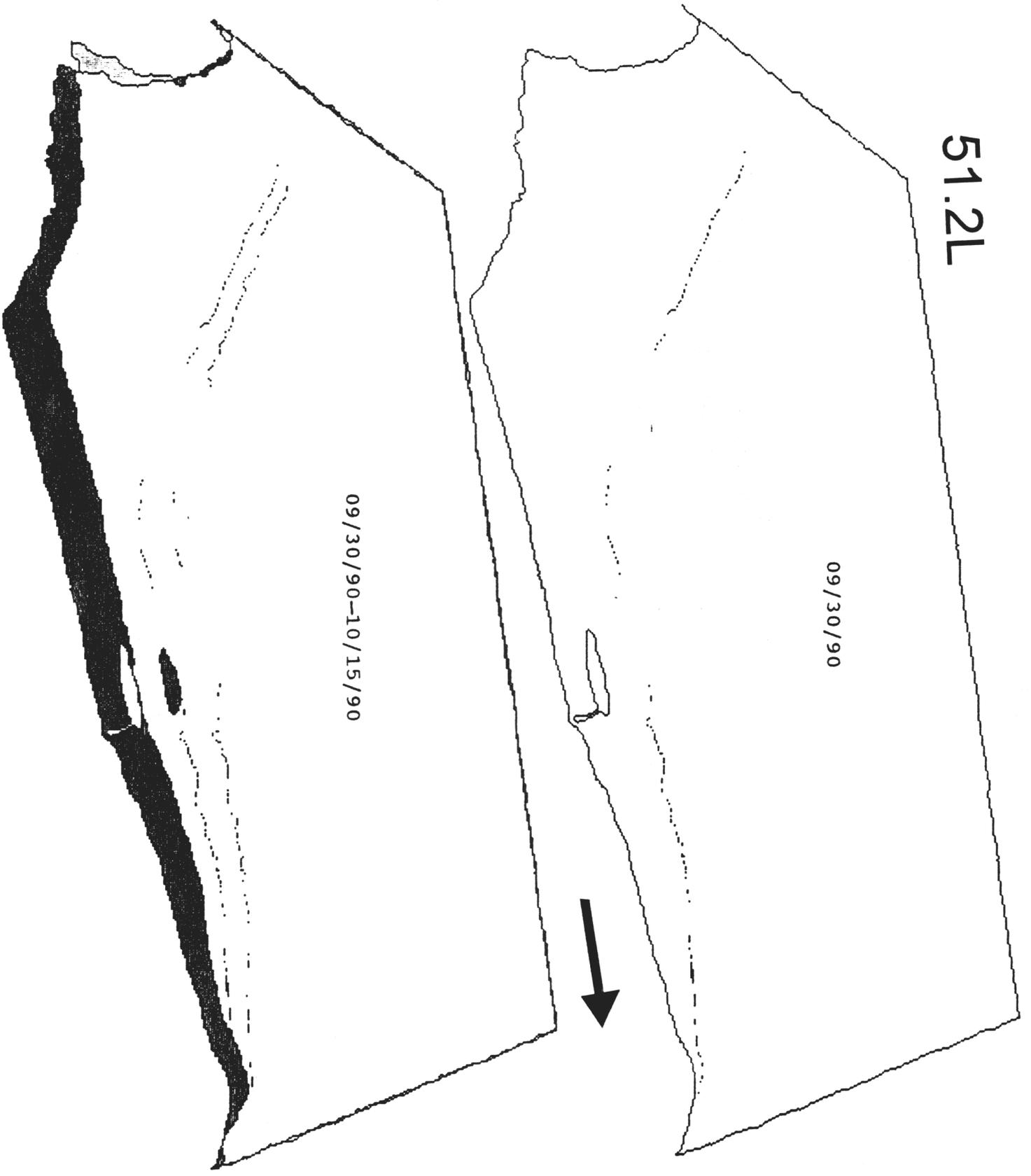


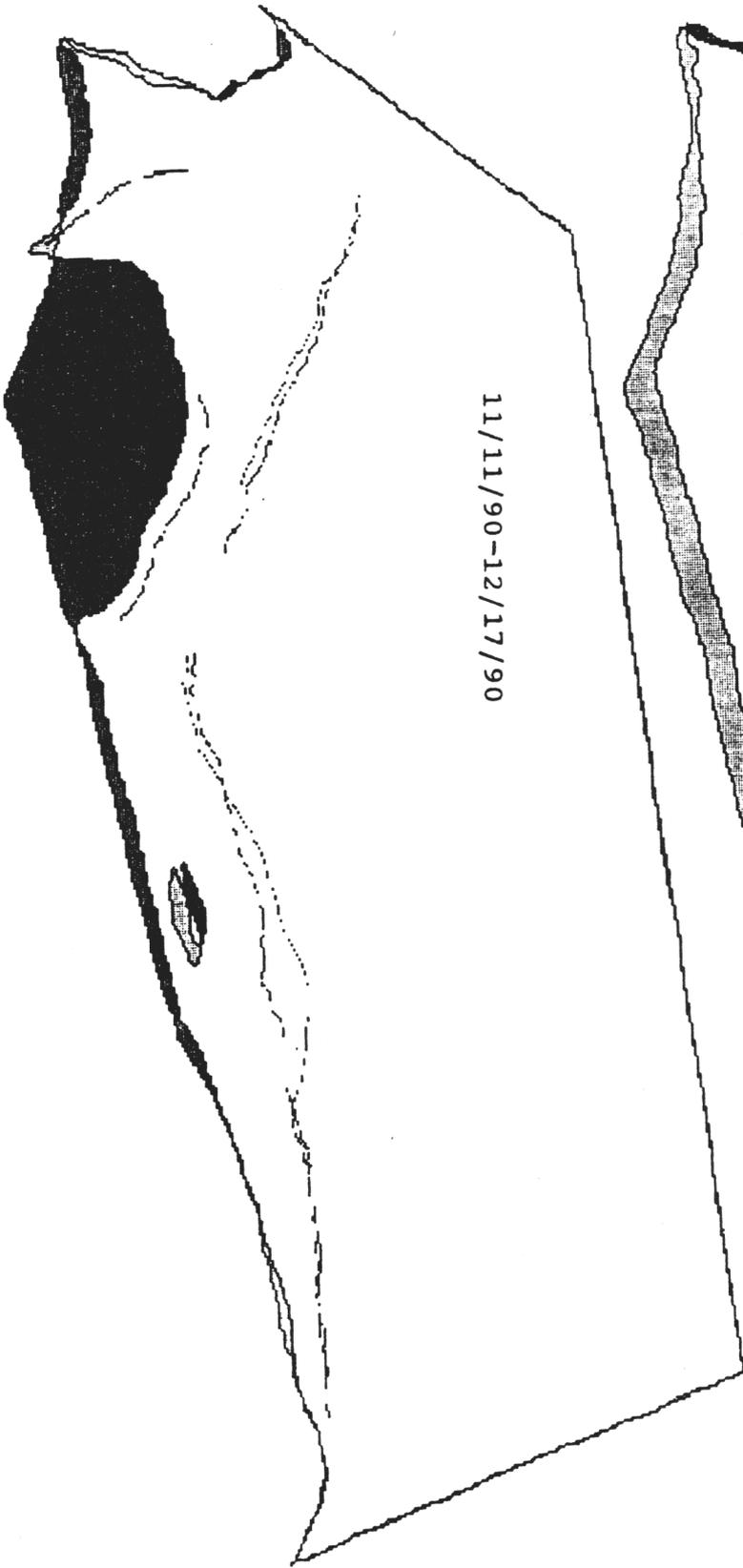
6/30/91 - 7/27/91

51.2L

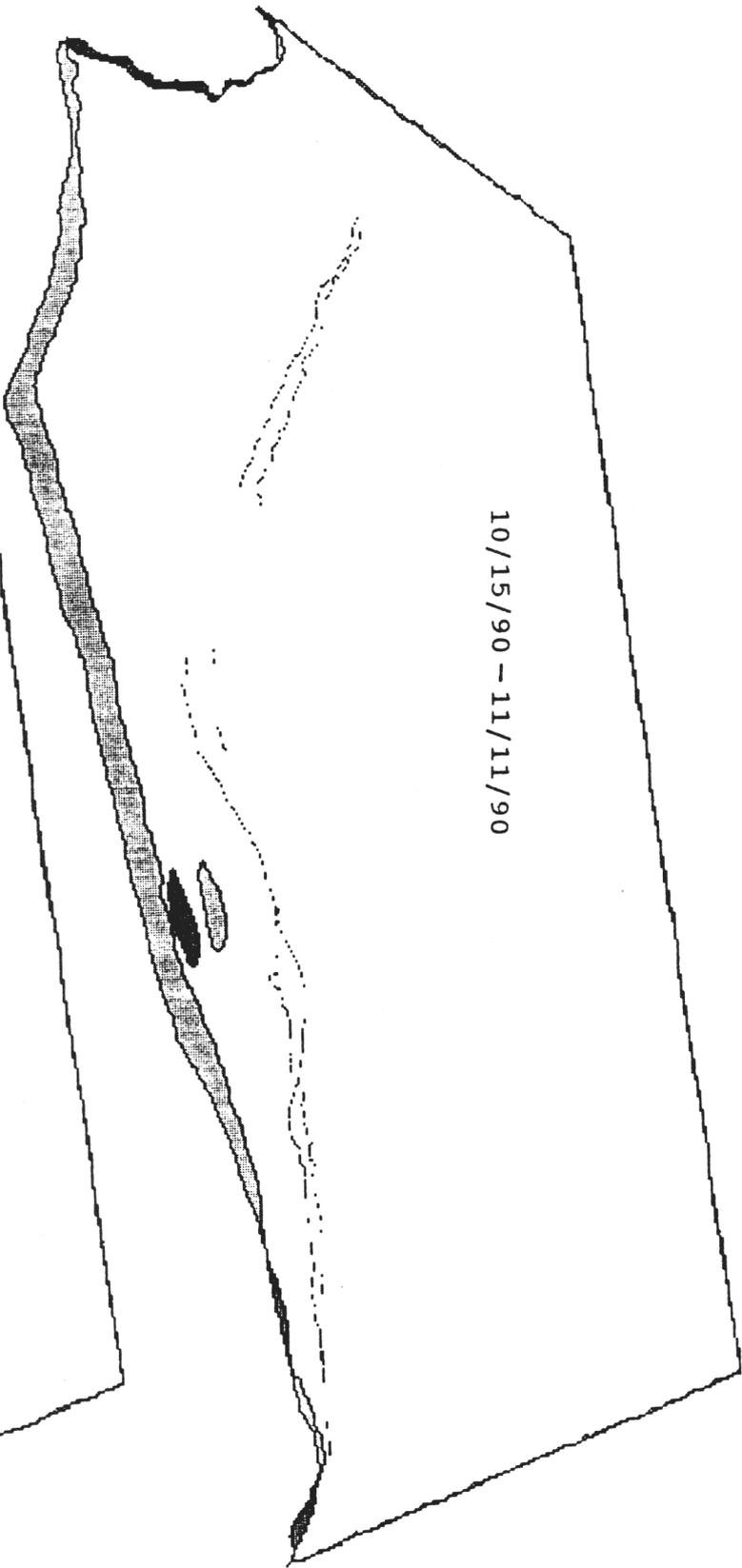
09/30/90

09/30/90-10/15/90

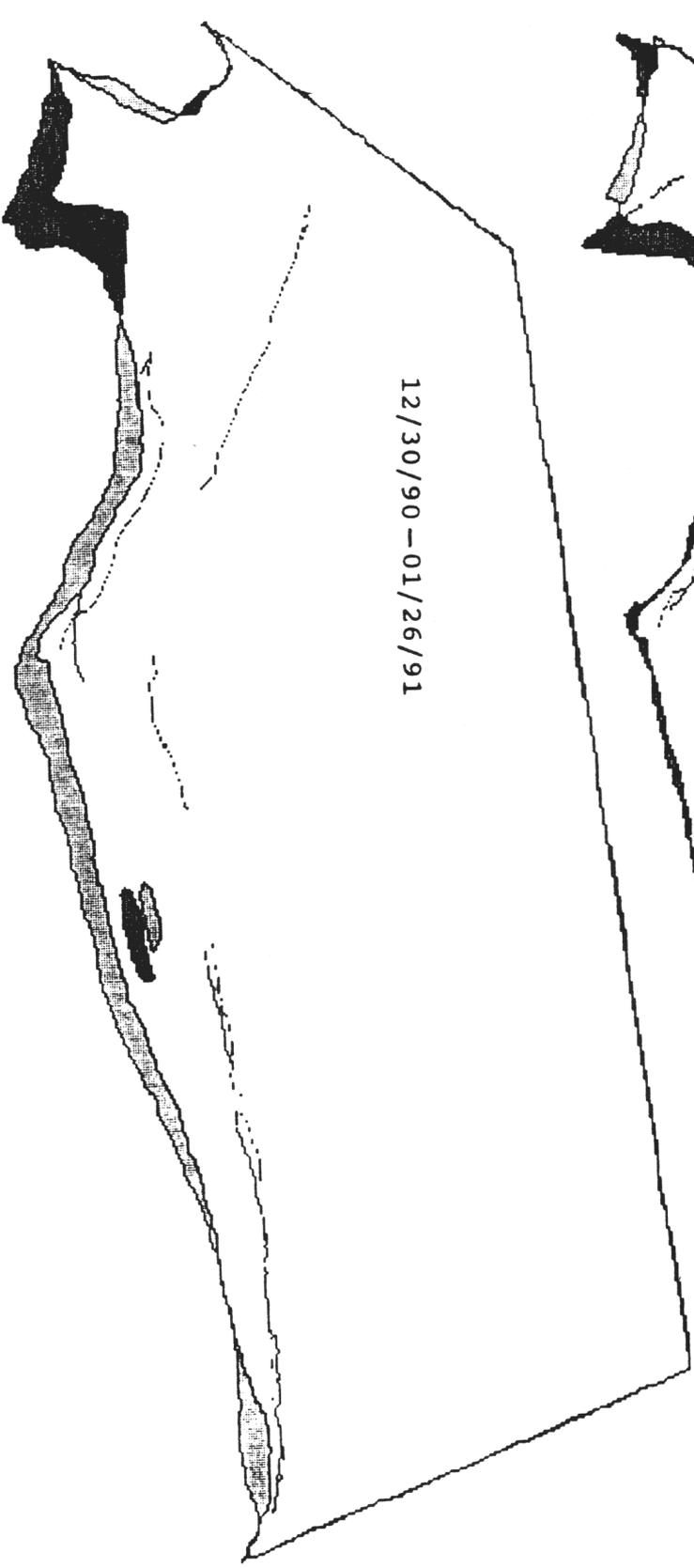




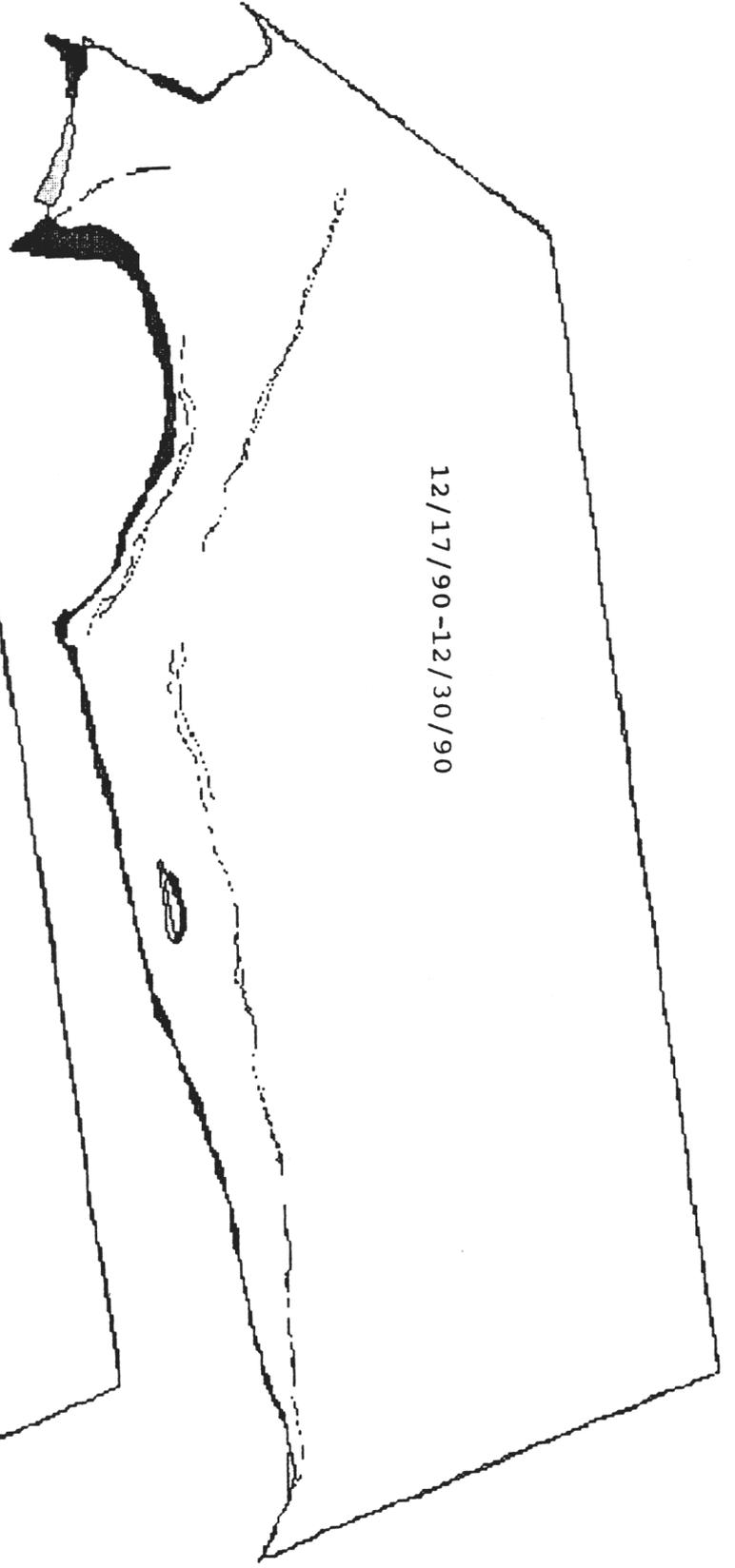
11/11/90-12/17/90



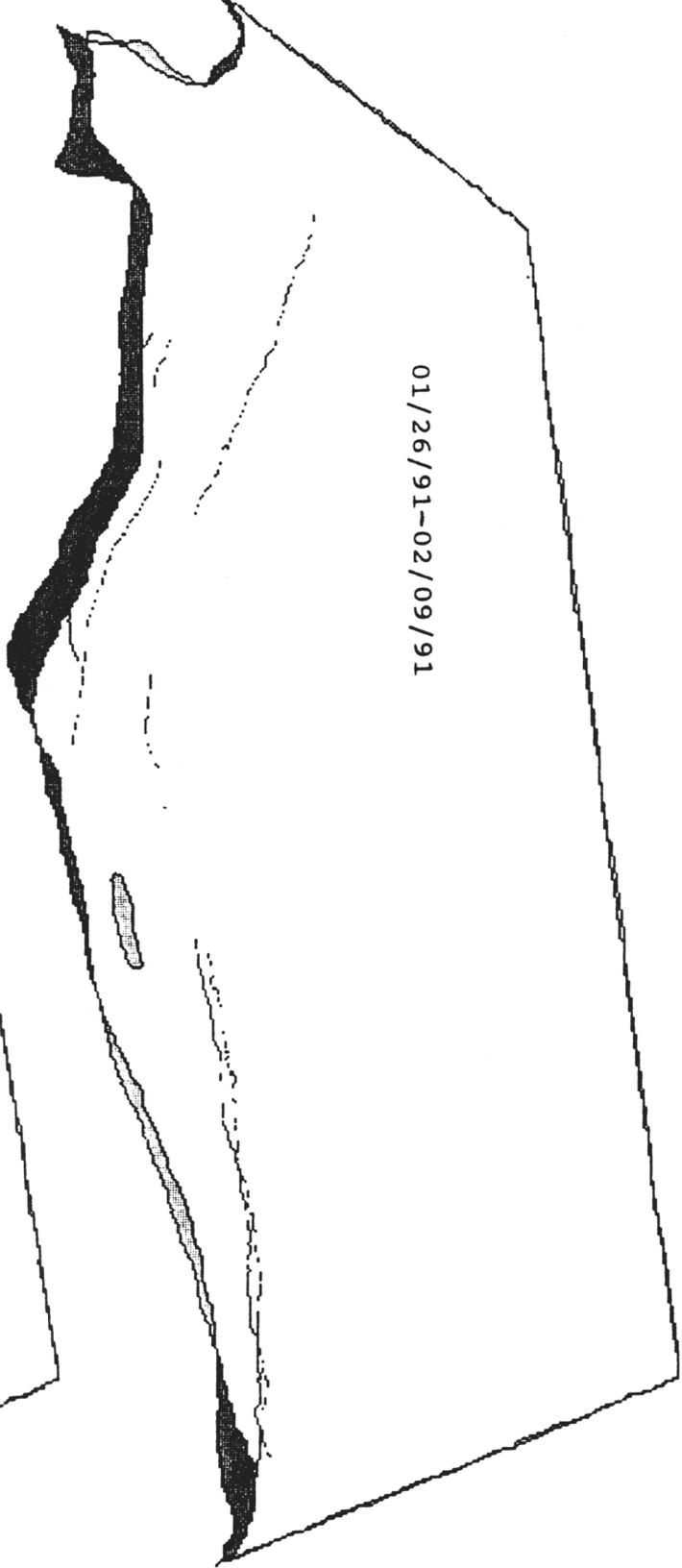
10/15/90 - 11/11/90



12/30/90 - 01/26/91

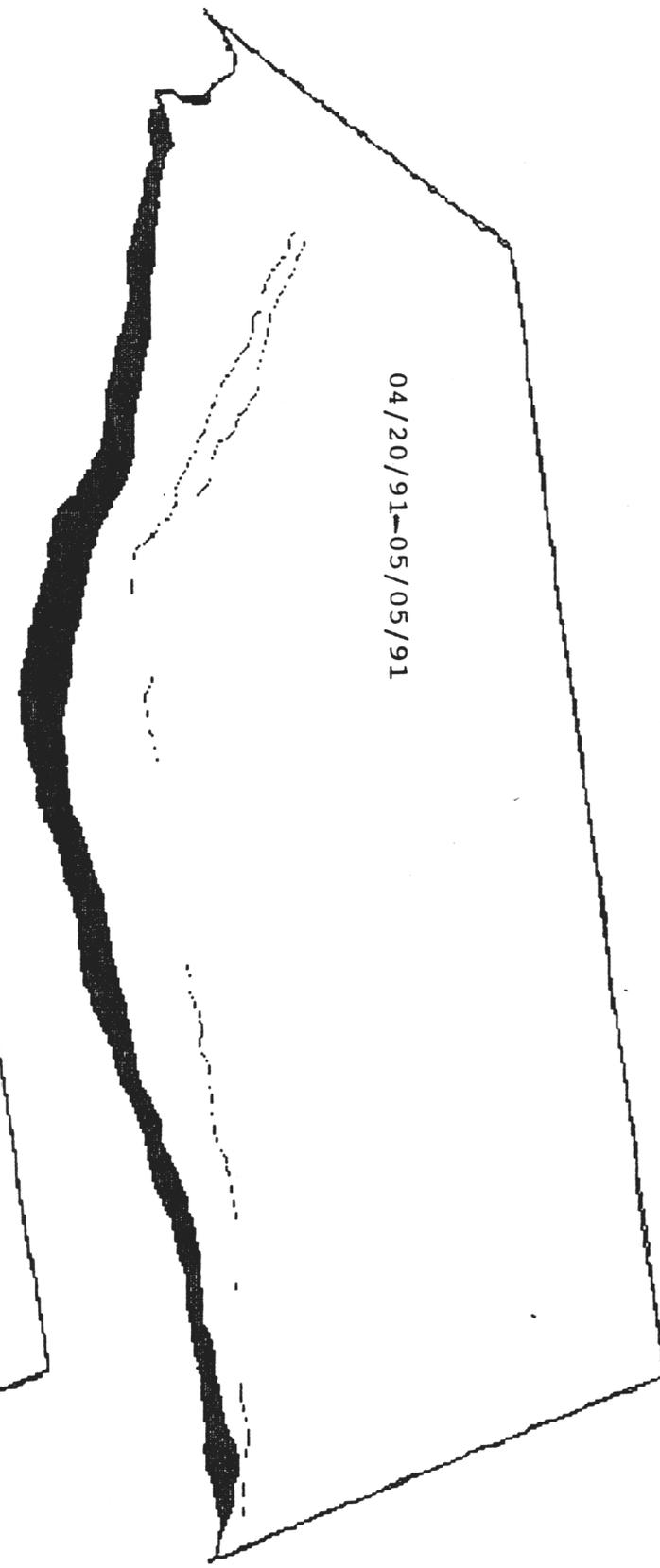


12/17/90 - 12/30/90





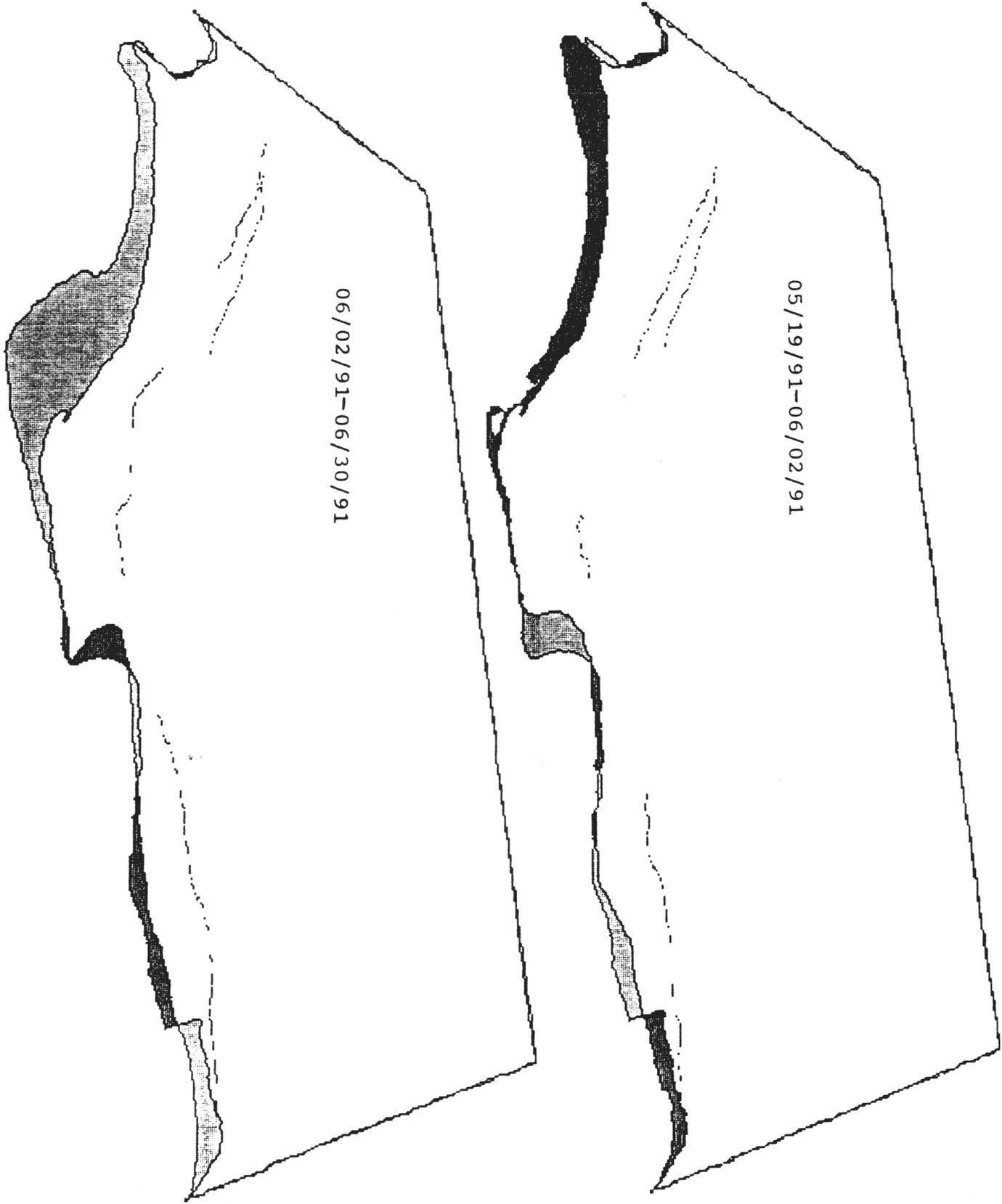
05/05/91-05/19/91



04/20/91-05/05/91

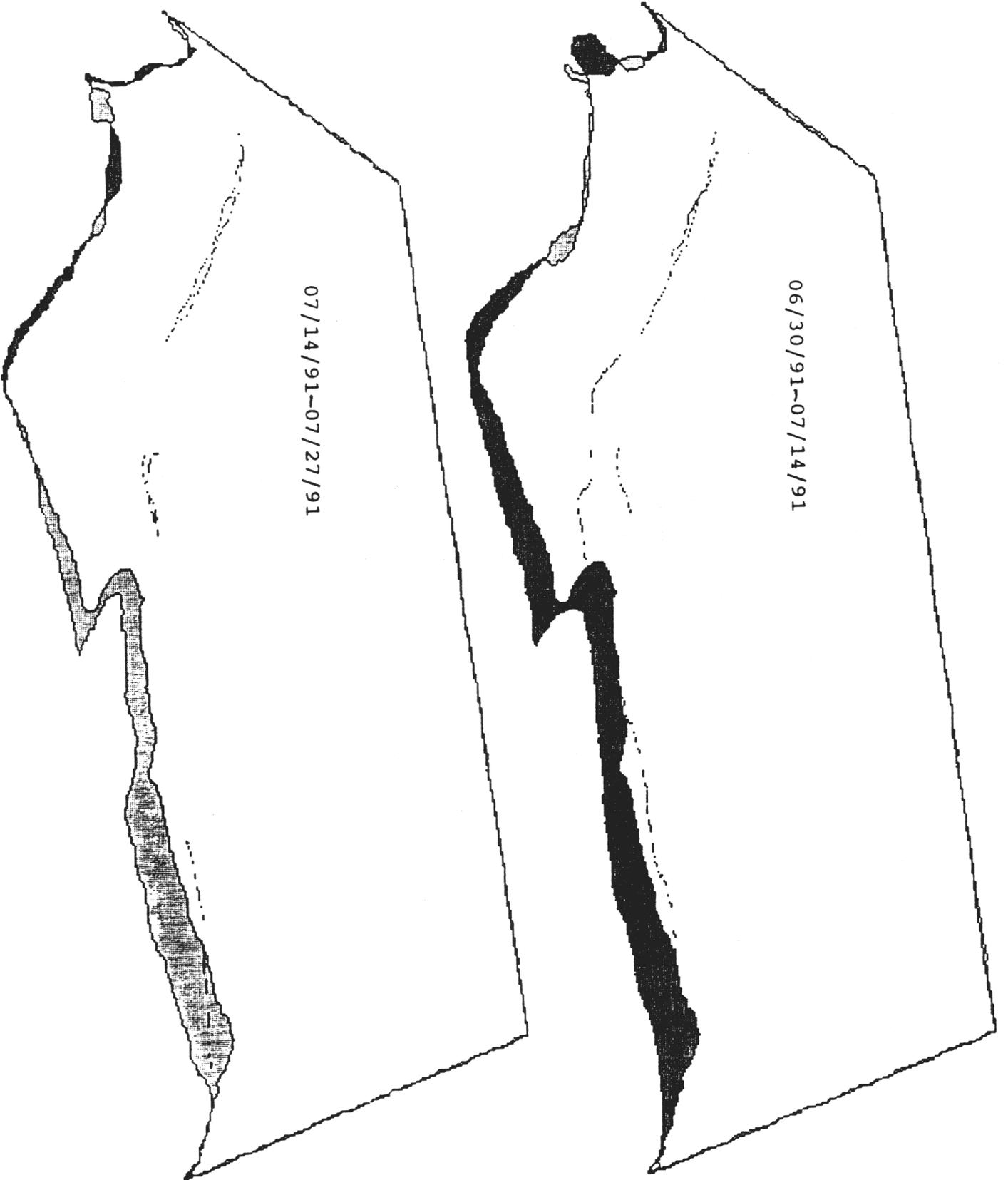
05/19/91-06/02/91

06/02/91-06/30/91



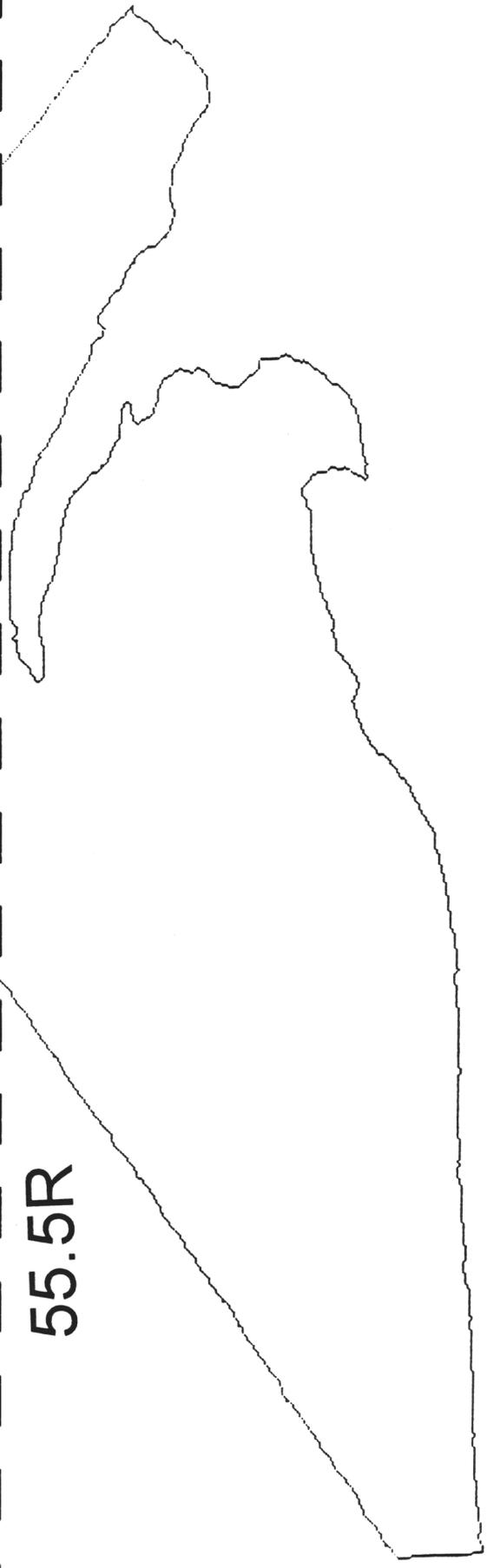
06/30/91-07/14/91

07/14/91-07/27/91

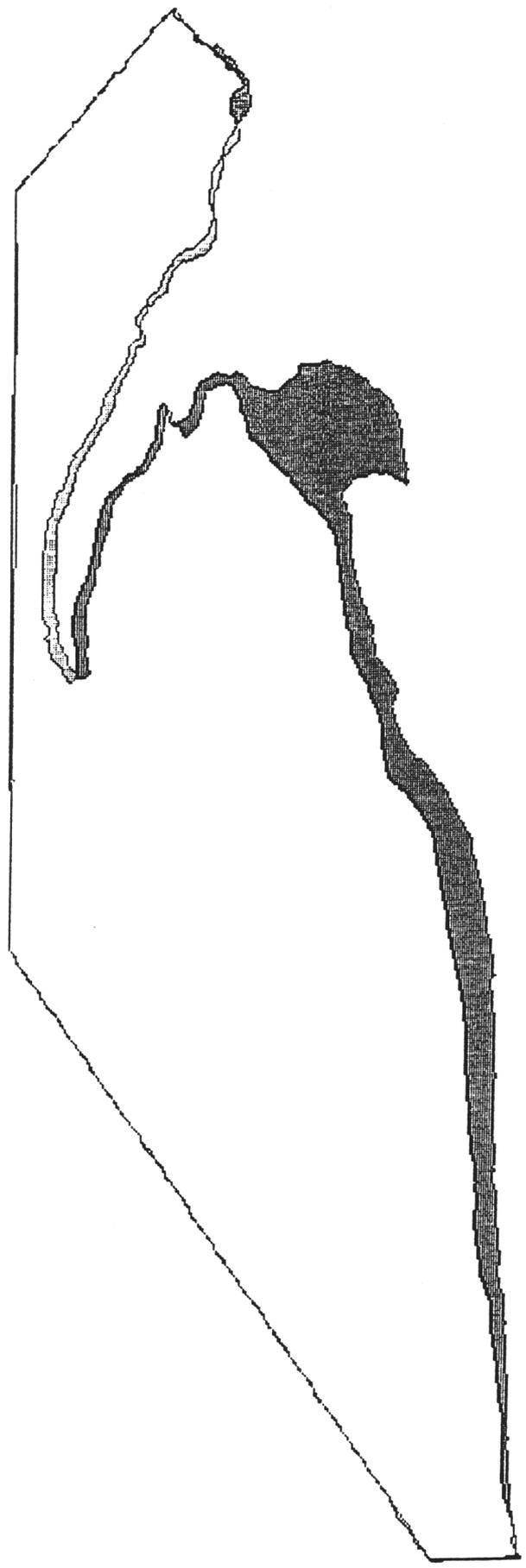




55.5R



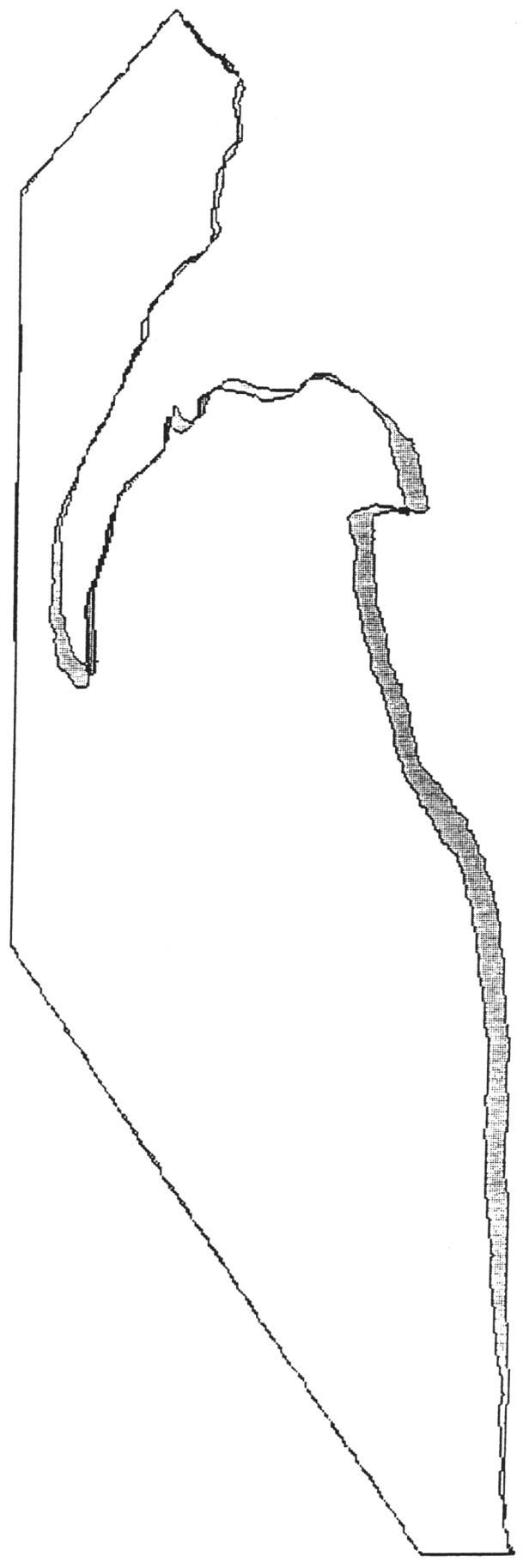
9/30/90



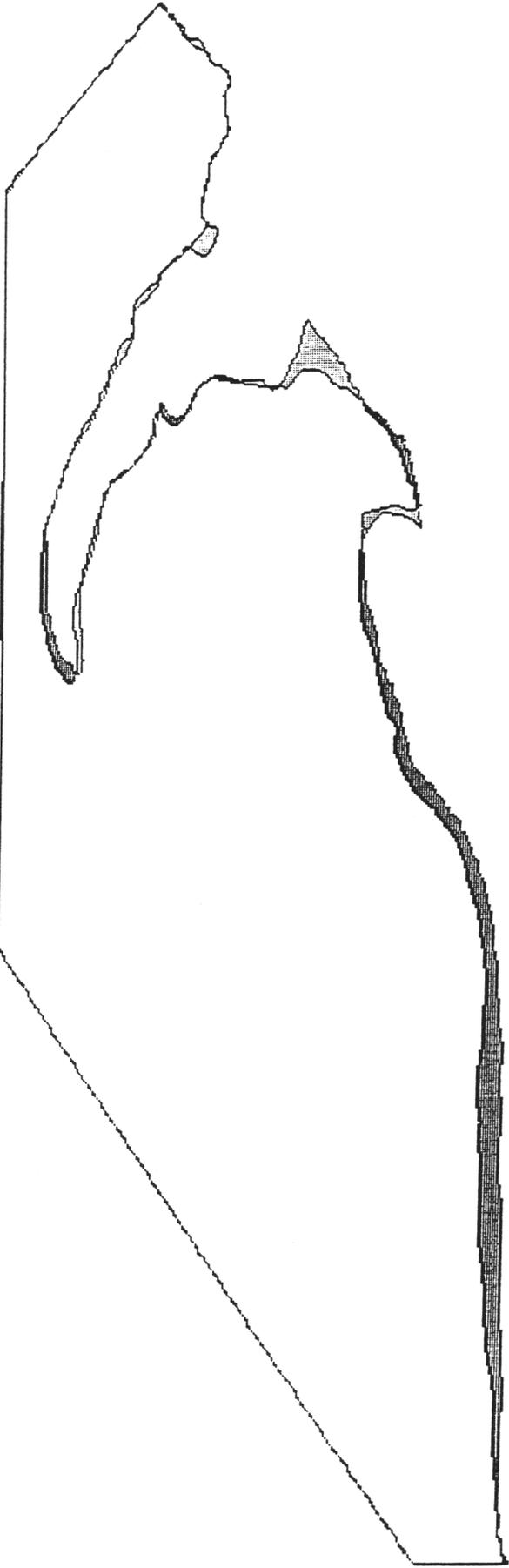
9/30/90 - 10/15/90



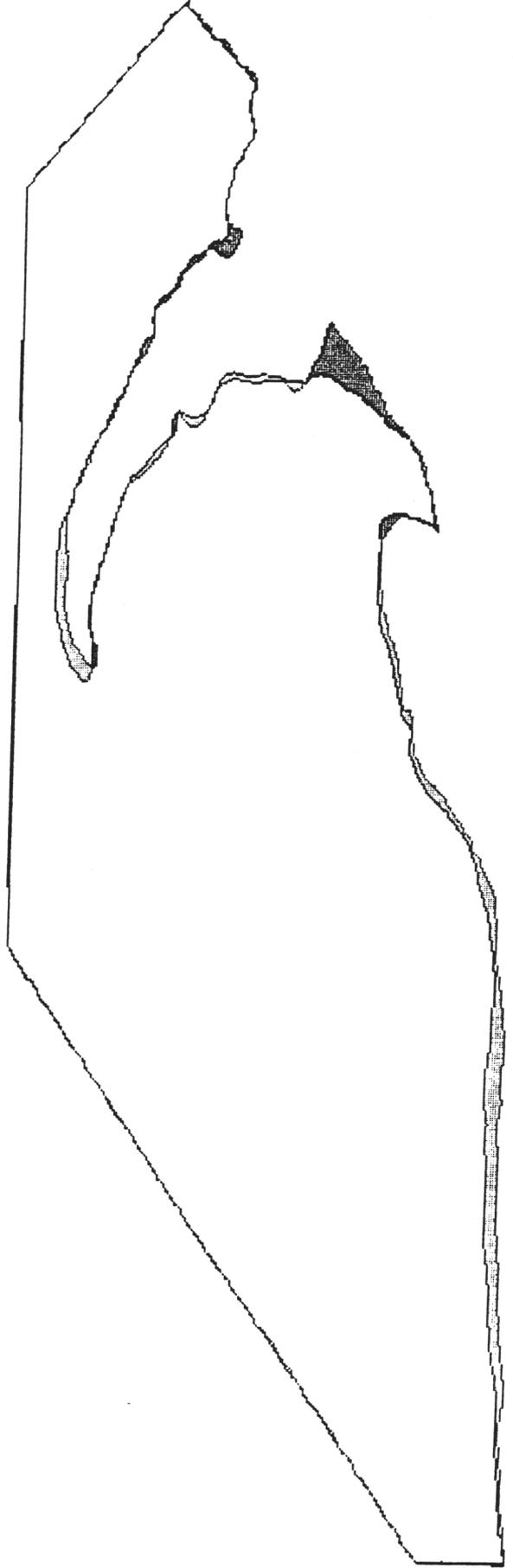
10/15/90 - 11/11/90



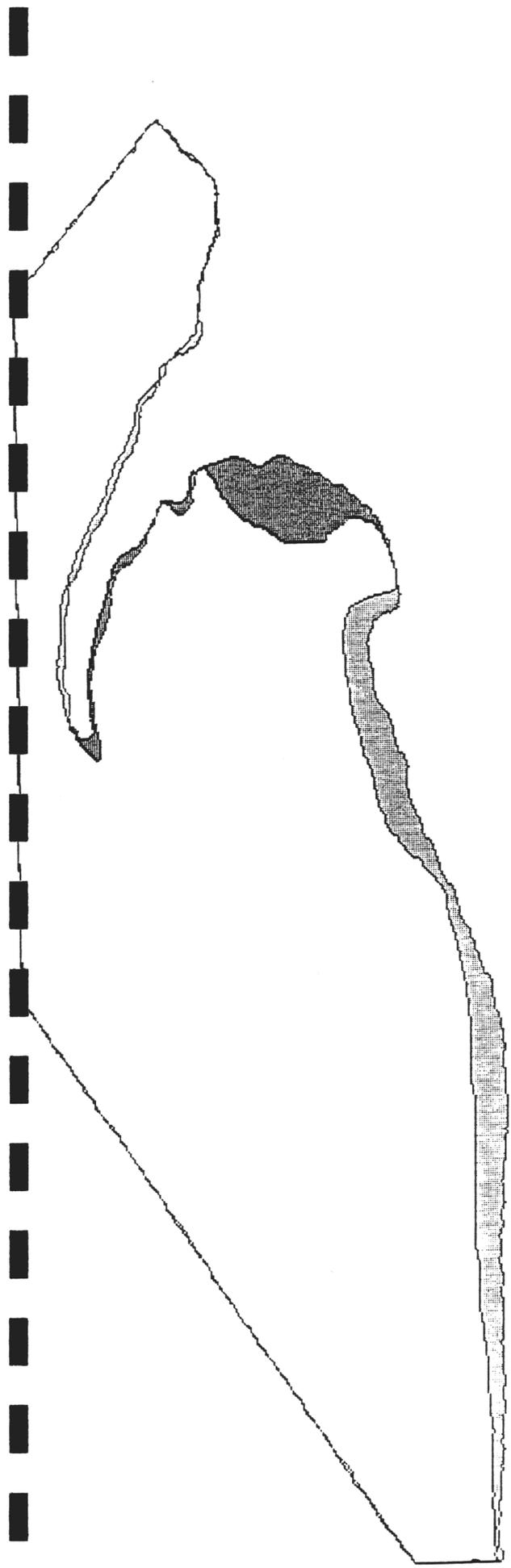
11/11/90 - 12/17/90



12/17/90 - 01/12/91



01/12/91 - 02/09/91



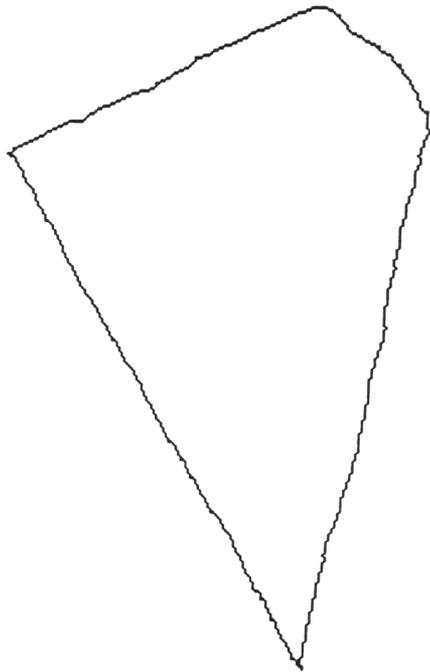
05/05/91 - 05/19/91



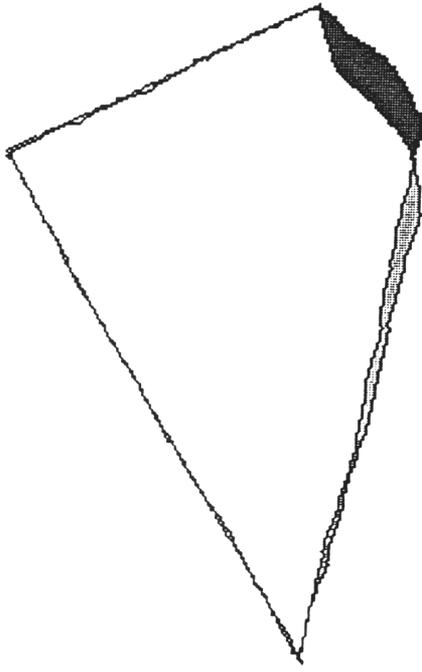
05/19/91 - 06/02/91



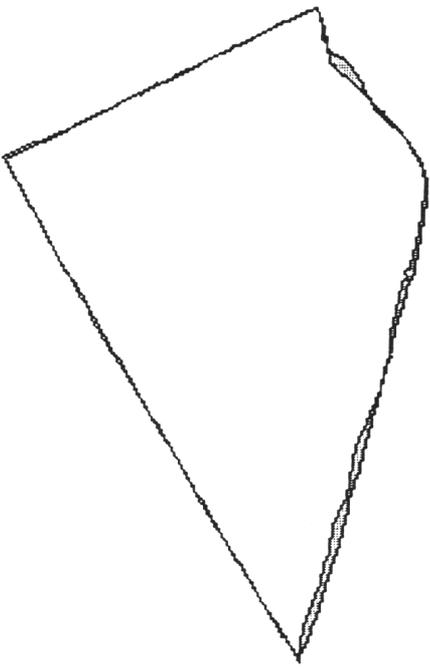
56.2R



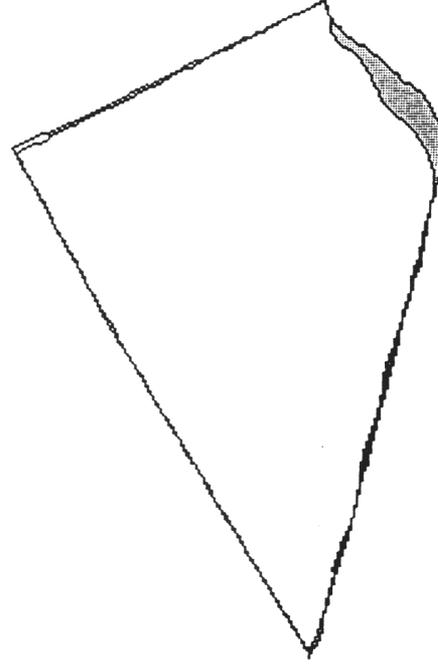
11/11/90



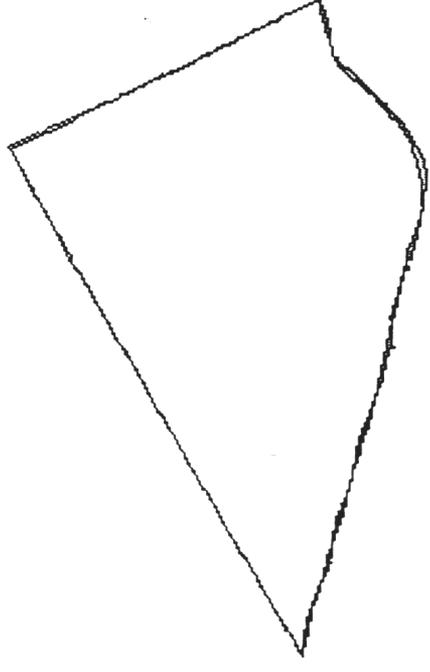
11/11/90 - 12/17/90



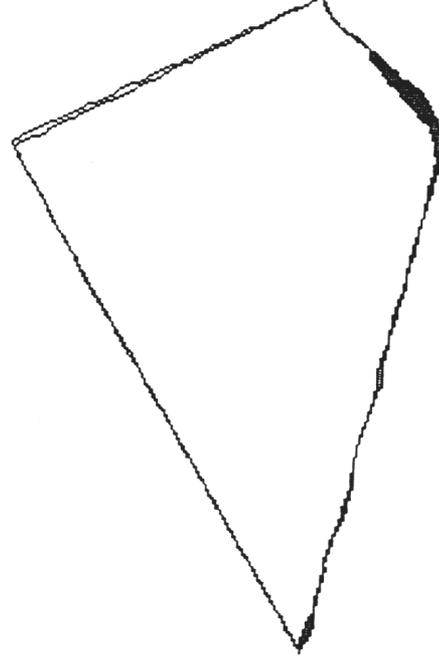
12/30/90 - 1/12/91



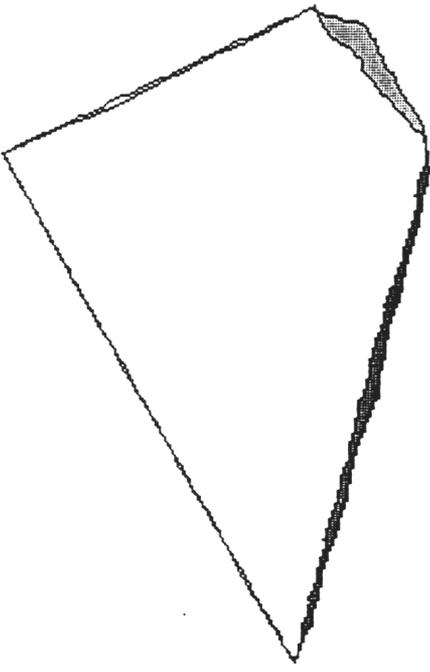
1/12/90 - 1/26/91



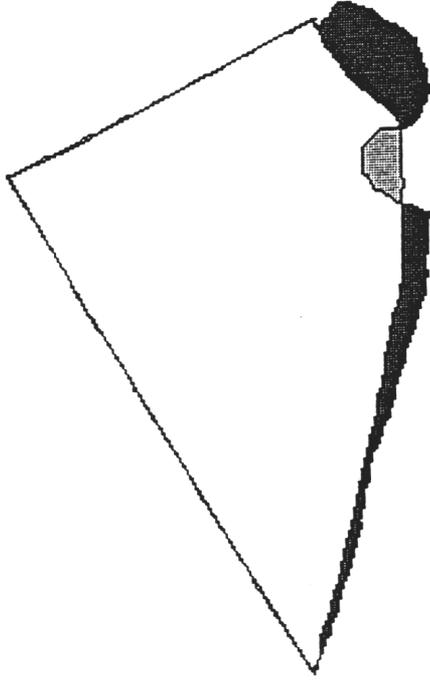
12/17/90 - 12/30/90



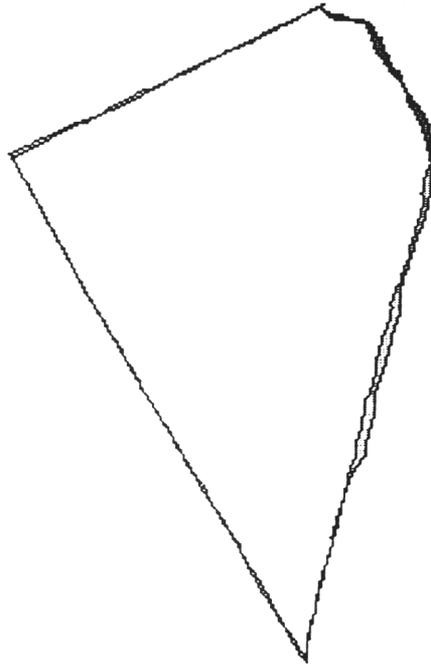
1/26/91 - 2/10/91



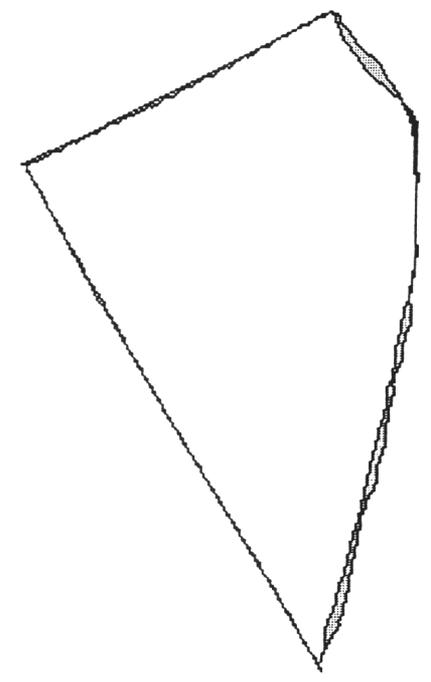
2/9/91 - 4/20/91



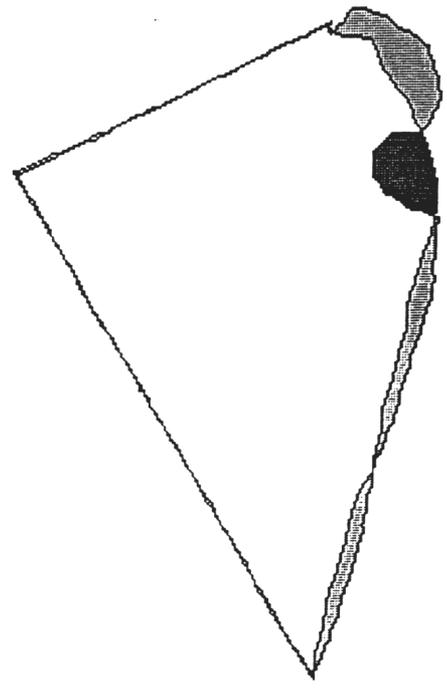
5/19/91 - 6/30/91



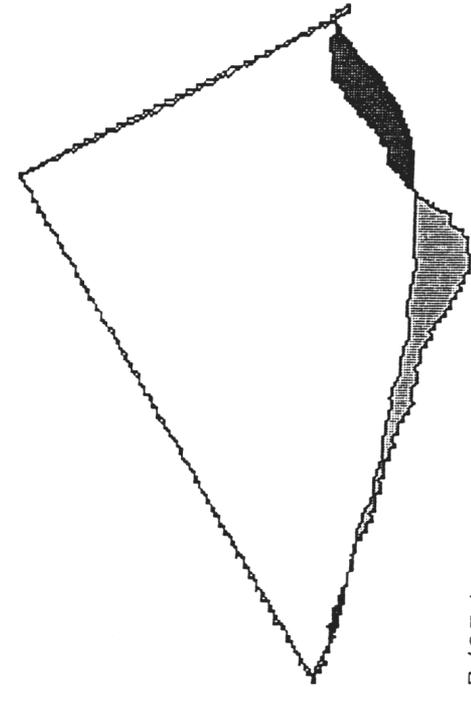
4/20/91 - 5/4/91



6/30/91 - 7/27/91



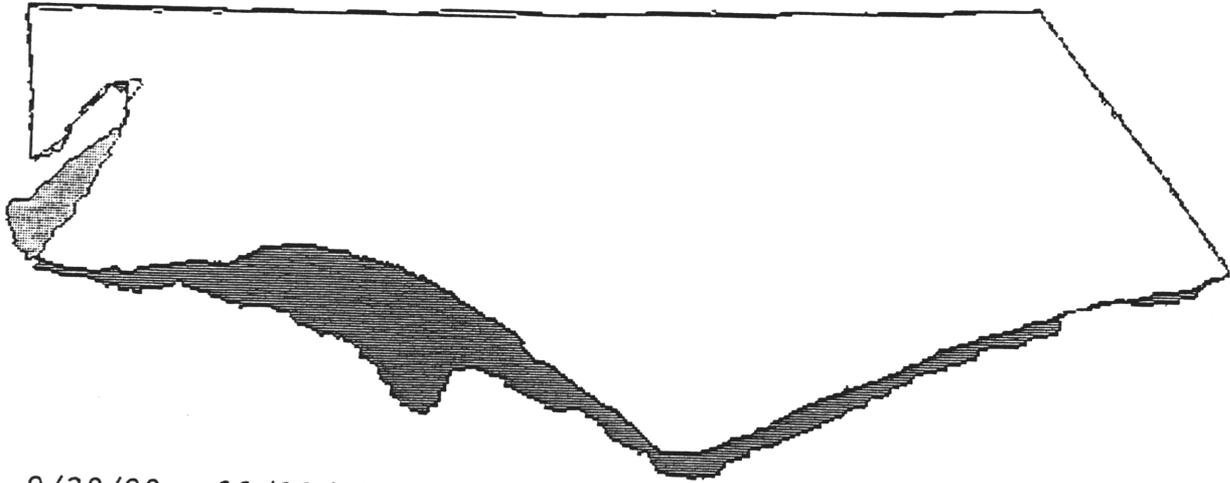
5/4/91 - 5/19/91



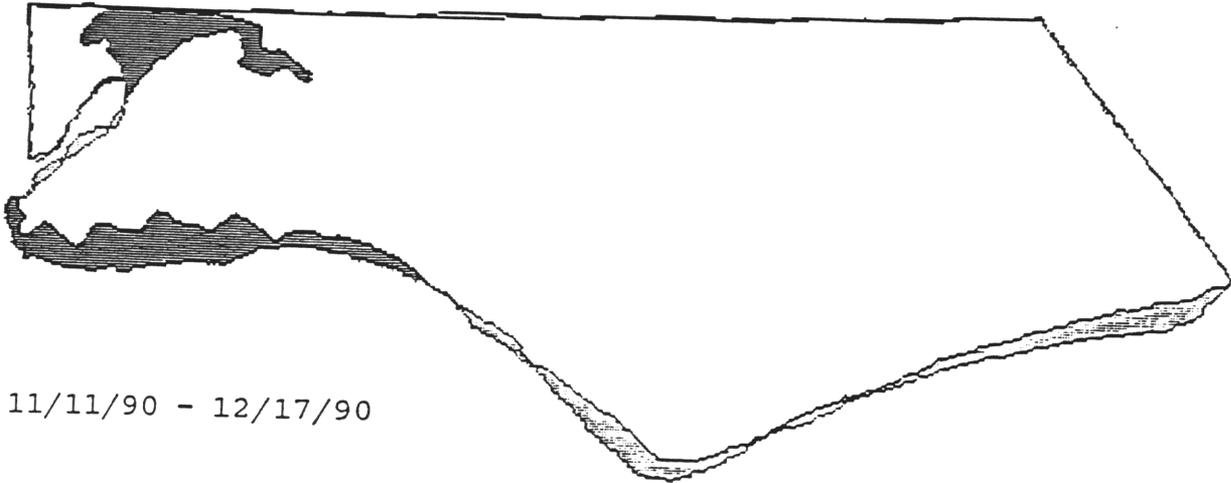
7/27/91 - 5/19/91

64.0L

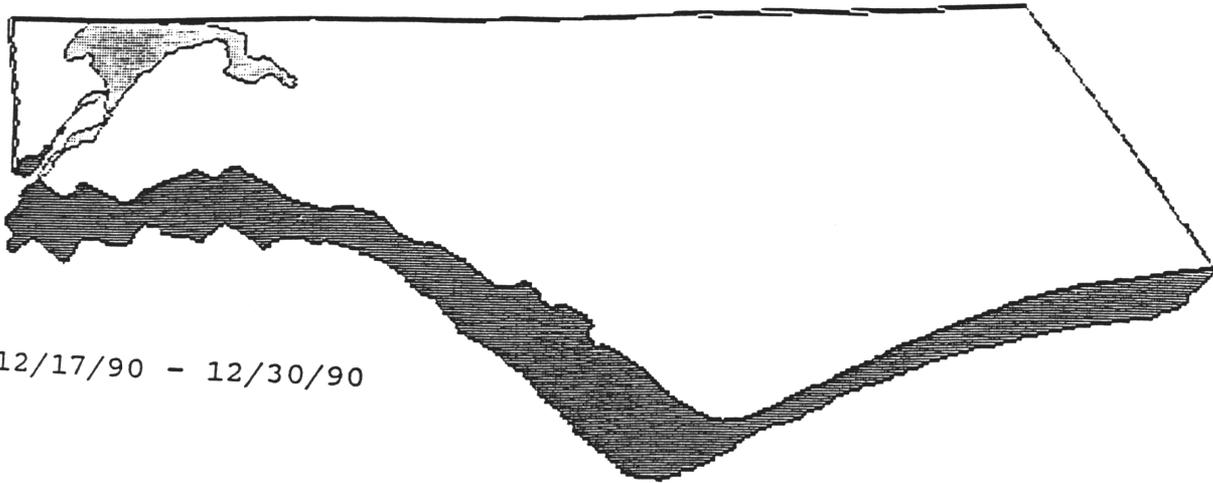
9/30/90



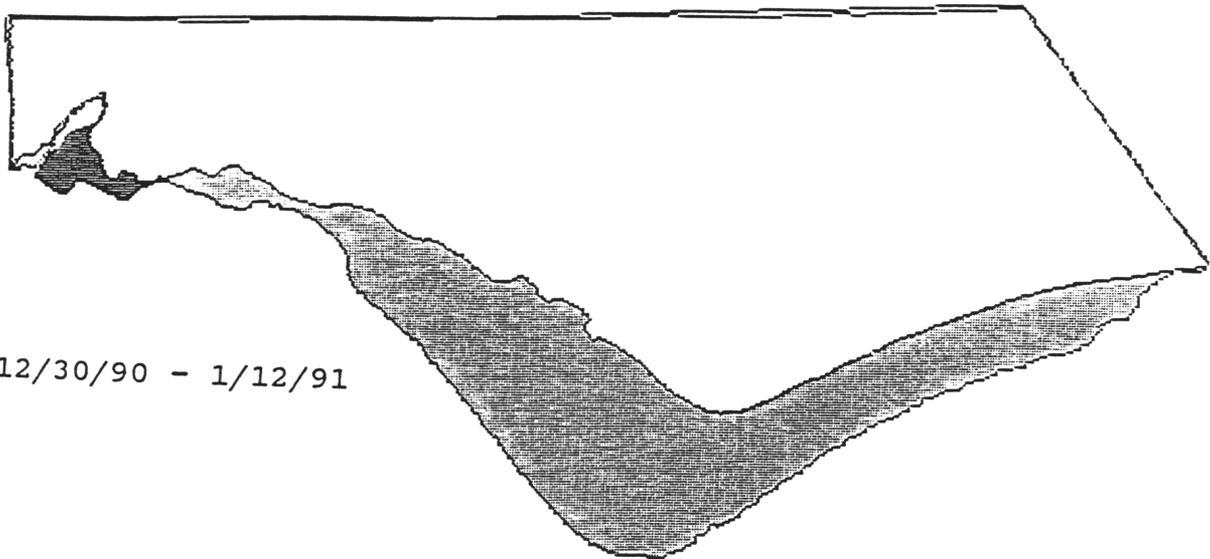
9/30/90 - 11/11/90



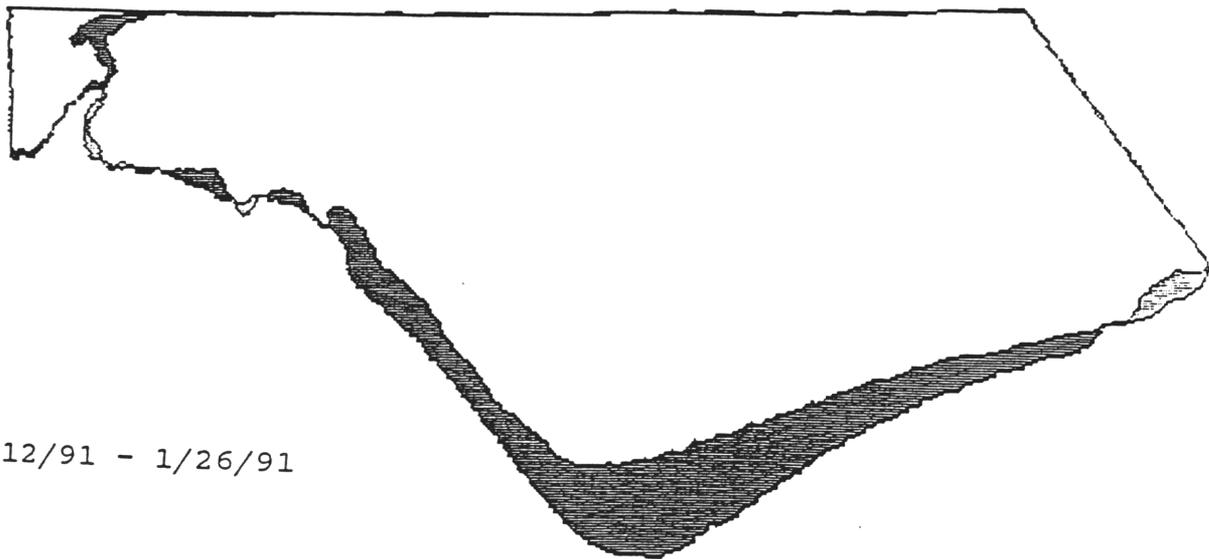
11/11/90 - 12/17/90



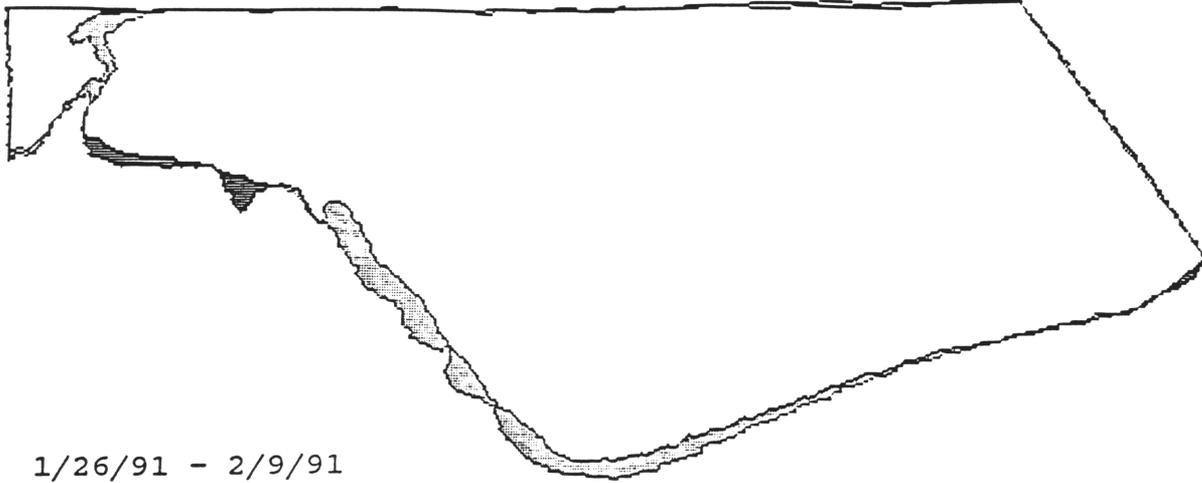
12/17/90 - 12/30/90



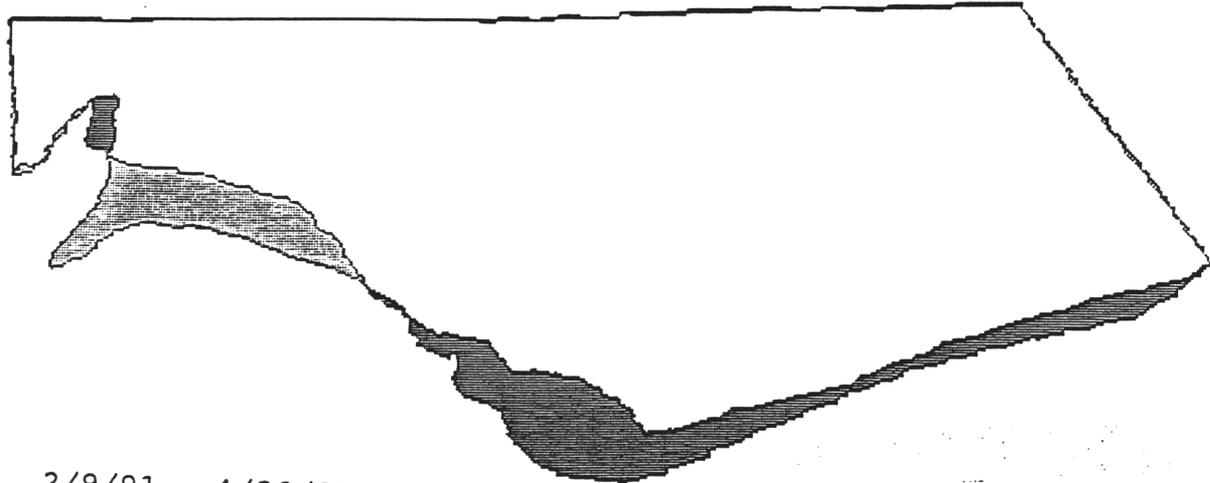
12/30/90 - 1/12/91



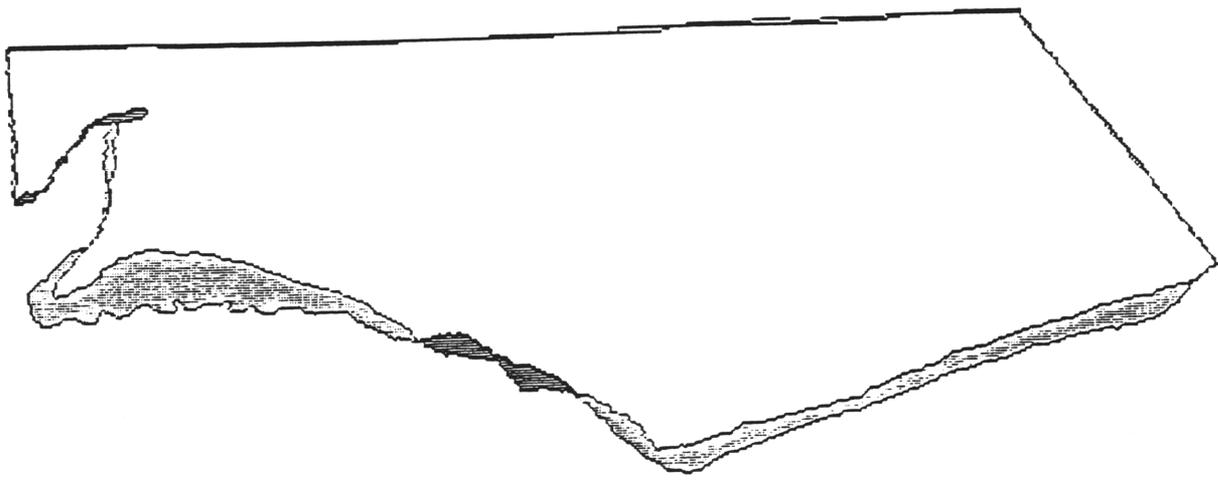
1/12/91 - 1/26/91



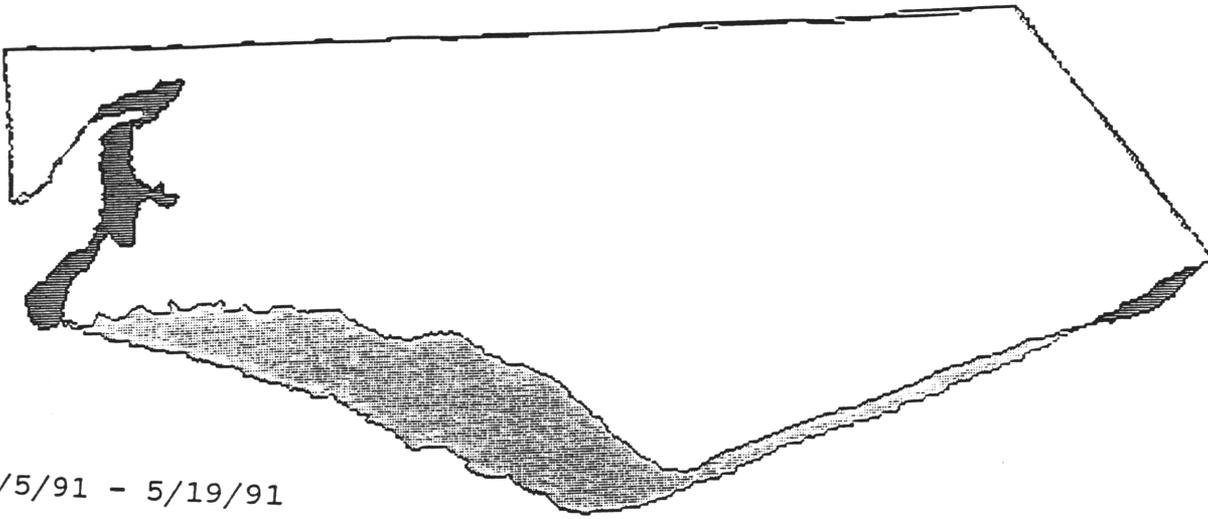
1/26/91 - 2/9/91



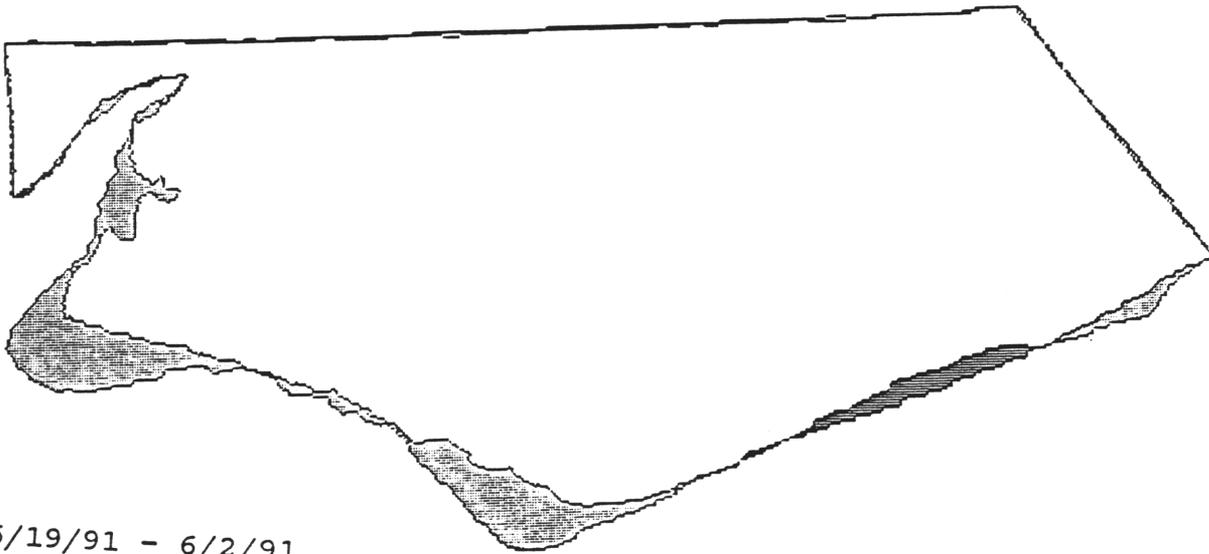
2/9/91 - 4/20/91



4/20/91 - 5/5/91



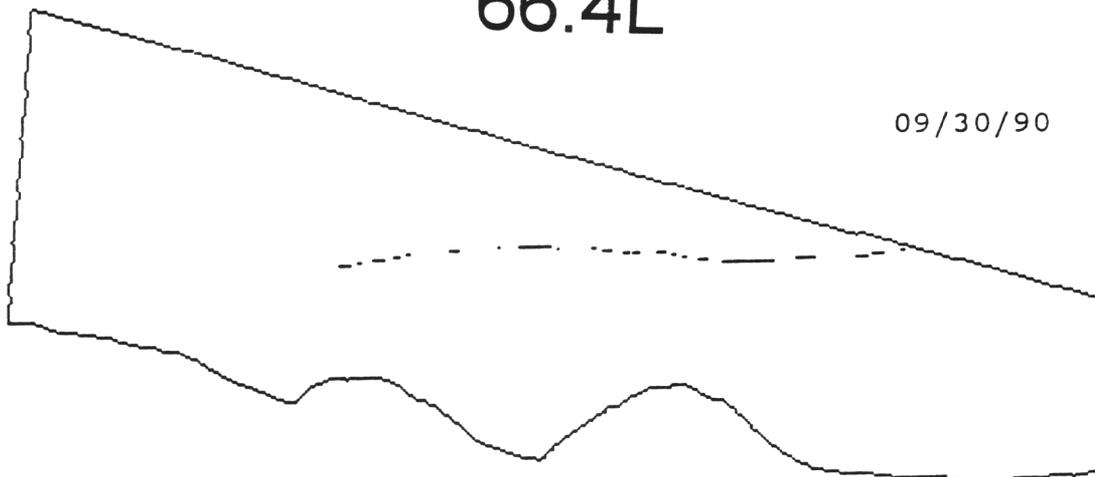
5/5/91 - 5/19/91



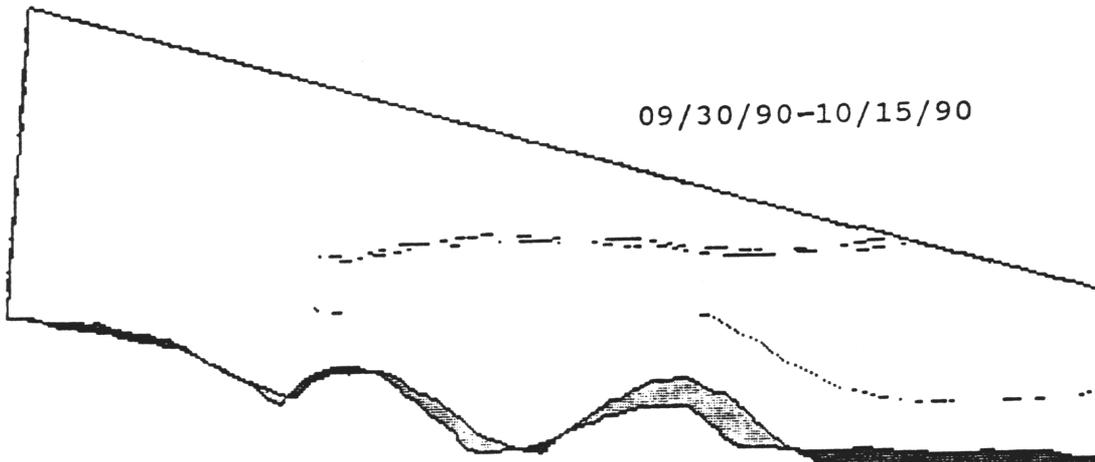
5/19/91 - 6/2/91

66.4L

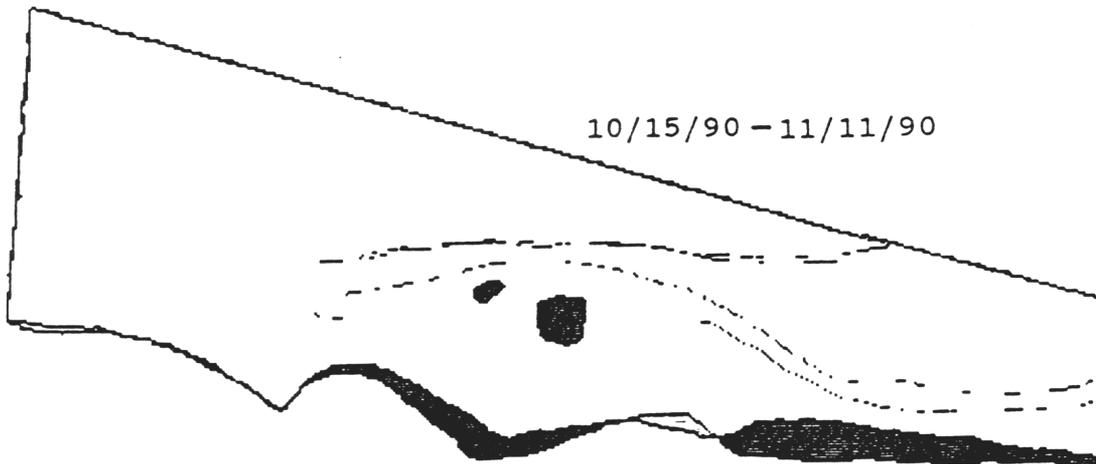
09/30/90



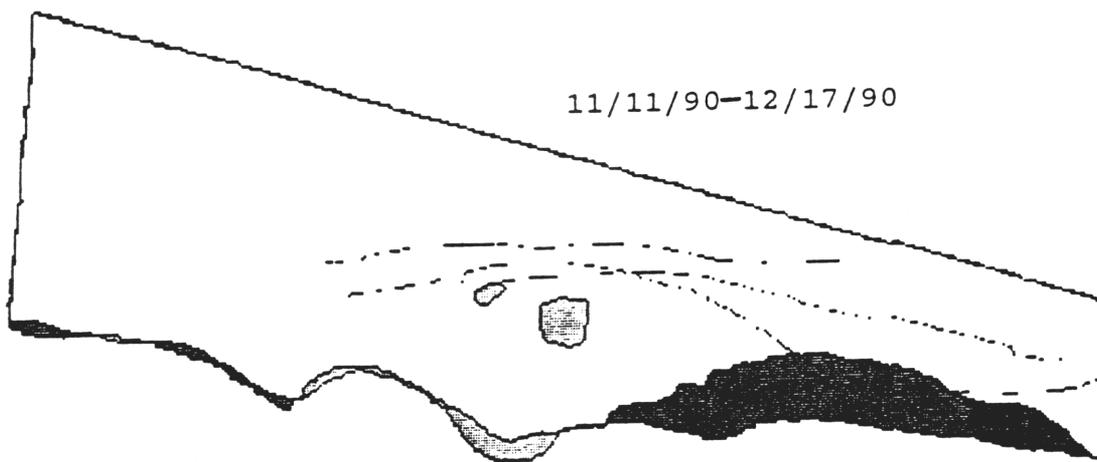
09/30/90-10/15/90



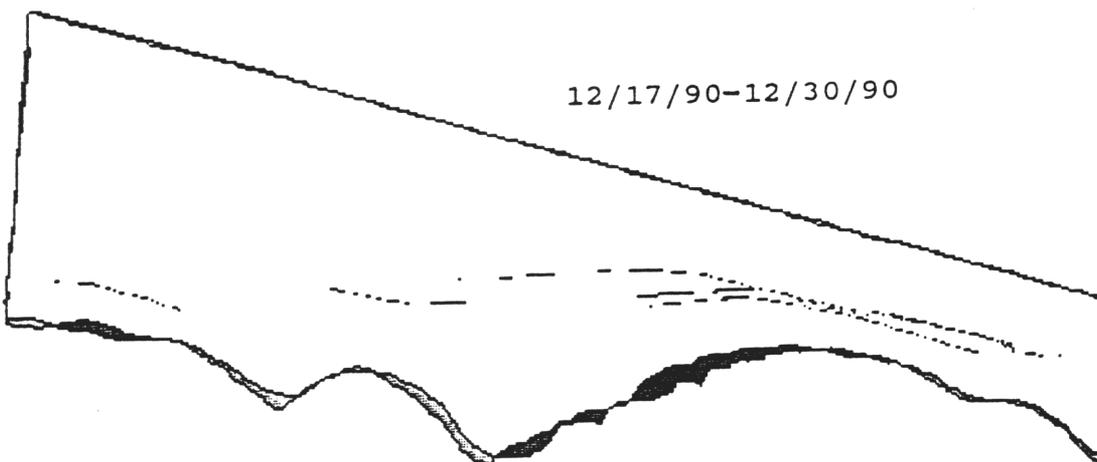
10/15/90 - 11/11/90



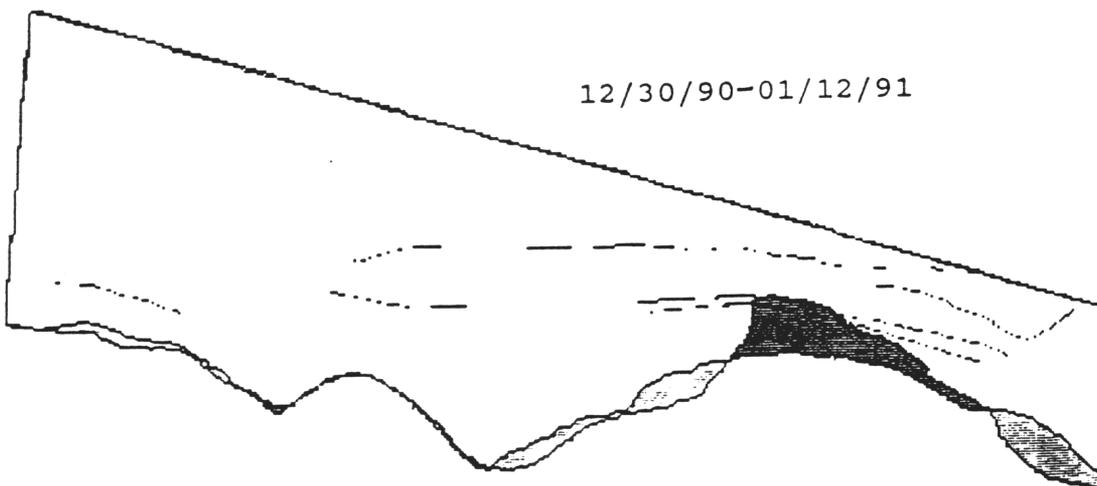
11/11/90-12/17/90



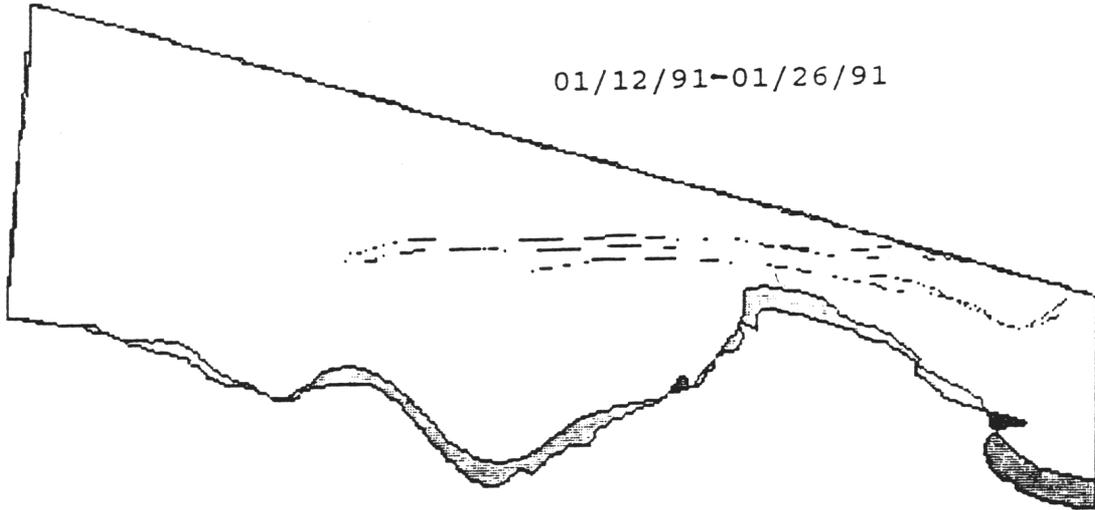
12/17/90-12/30/90



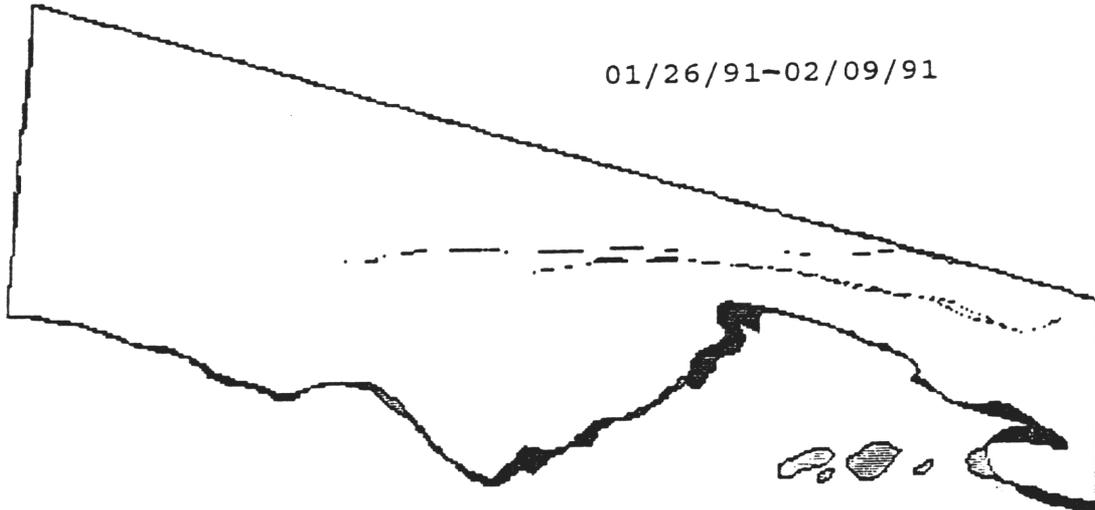
12/30/90-01/12/91



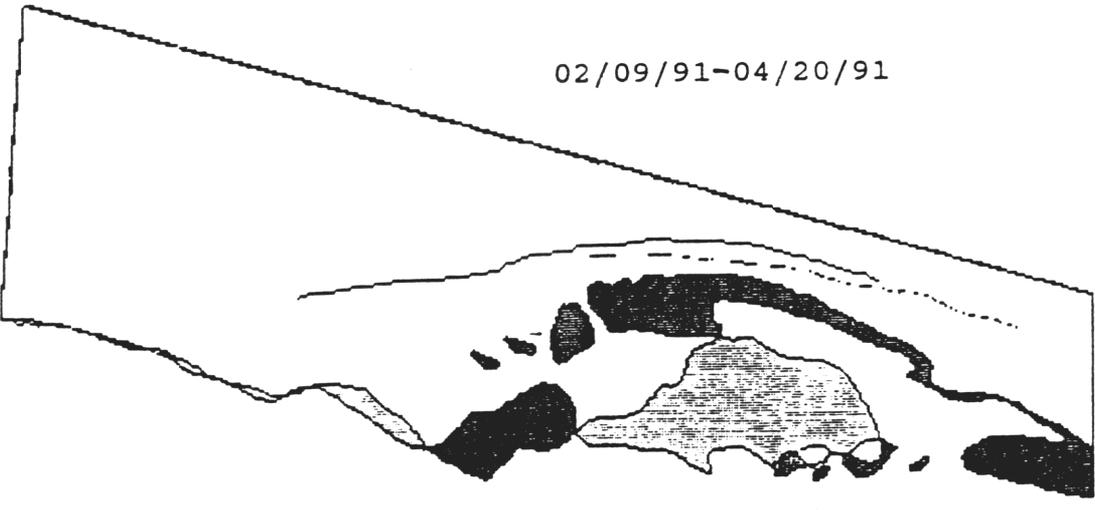
01/12/91-01/26/91



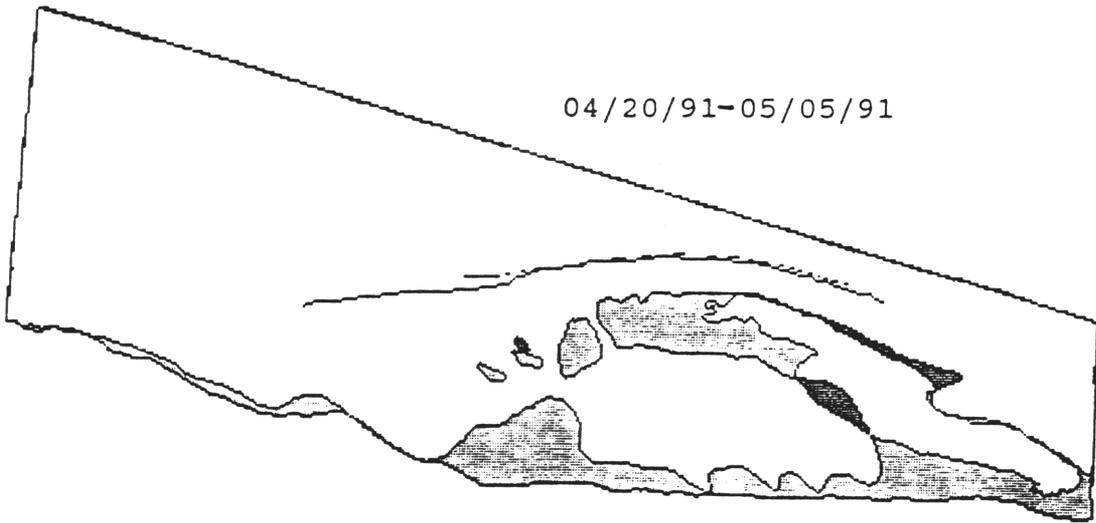
01/26/91-02/09/91



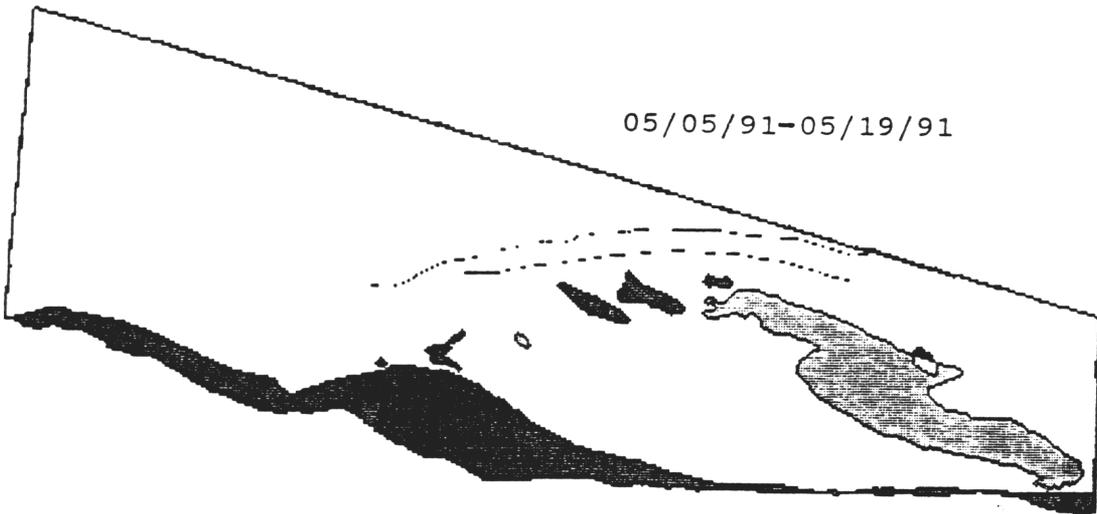
02/09/91-04/20/91



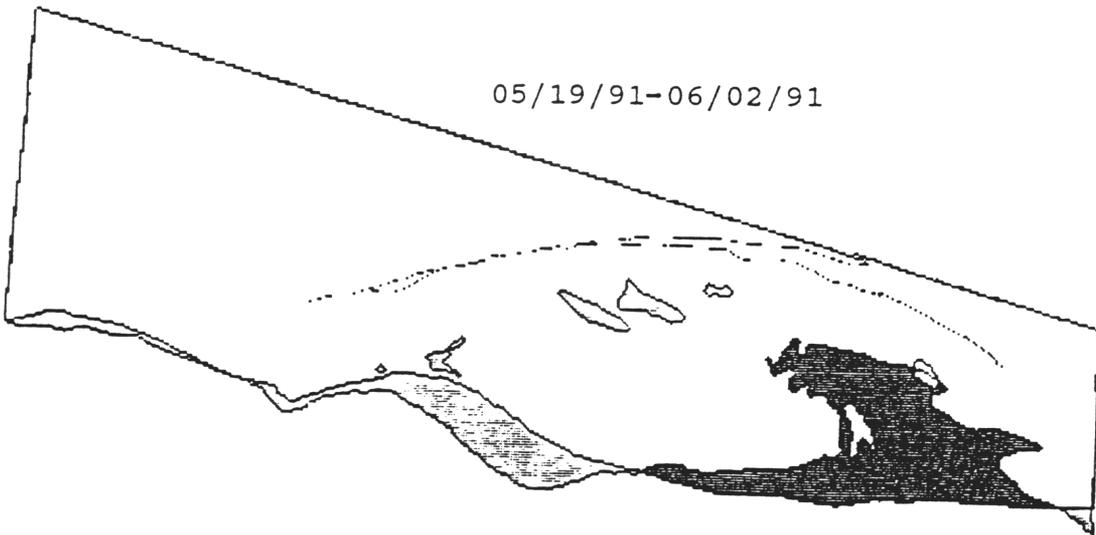
04/20/91-05/05/91



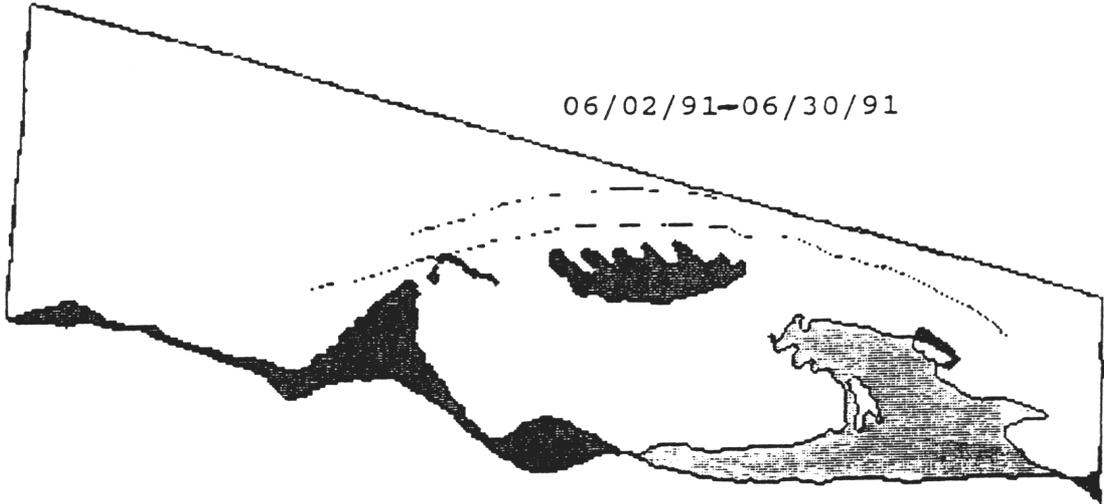
05/05/91-05/19/91



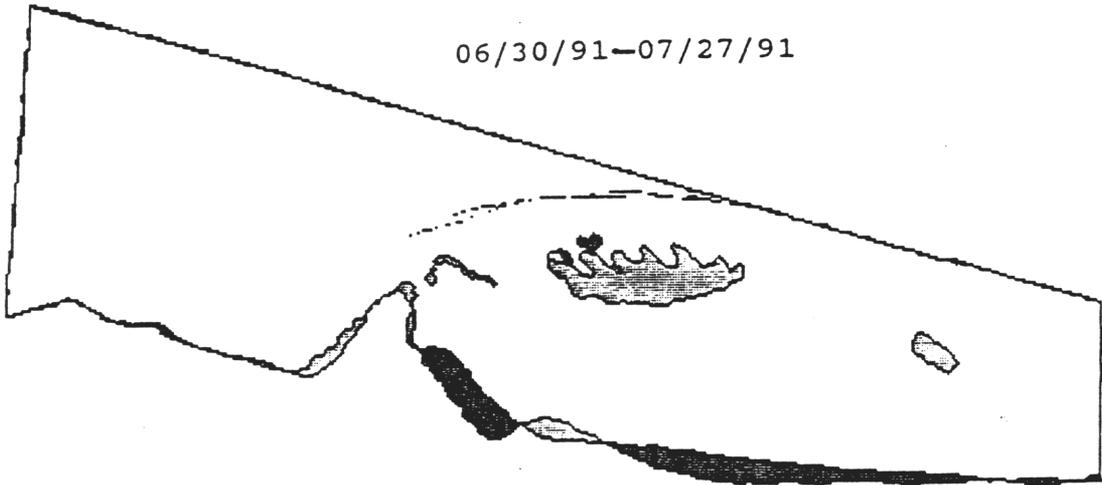
05/19/91-06/02/91



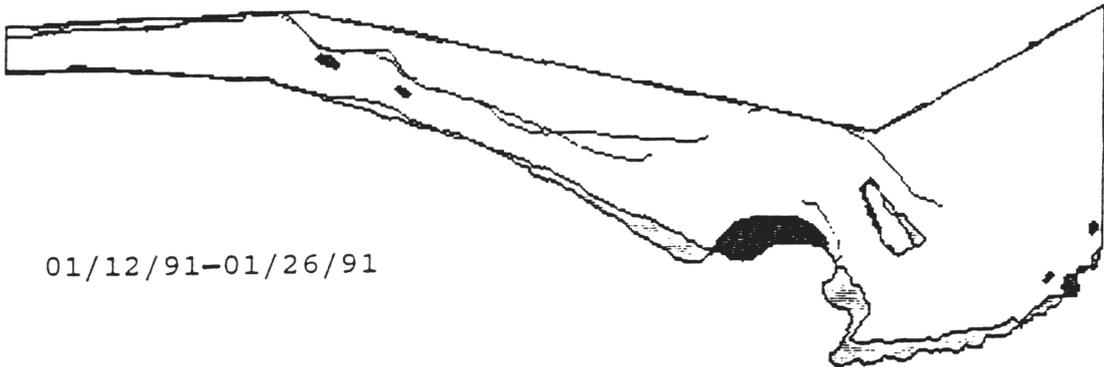
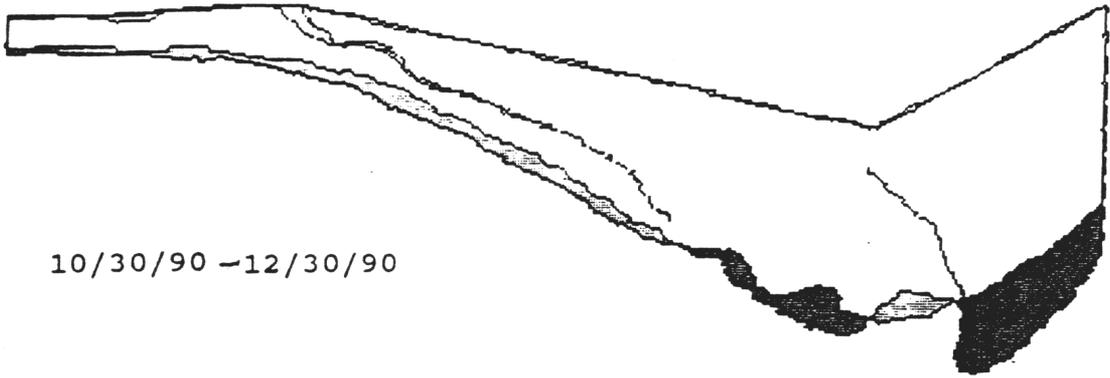
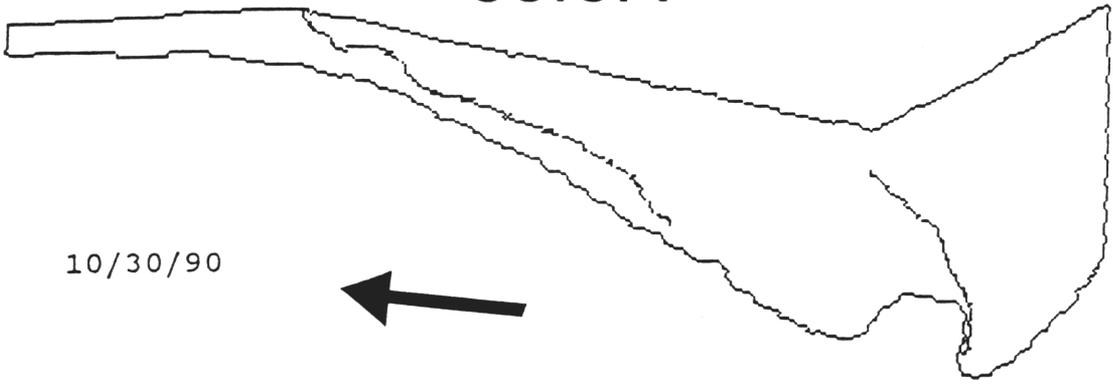
06/02/91-06/30/91

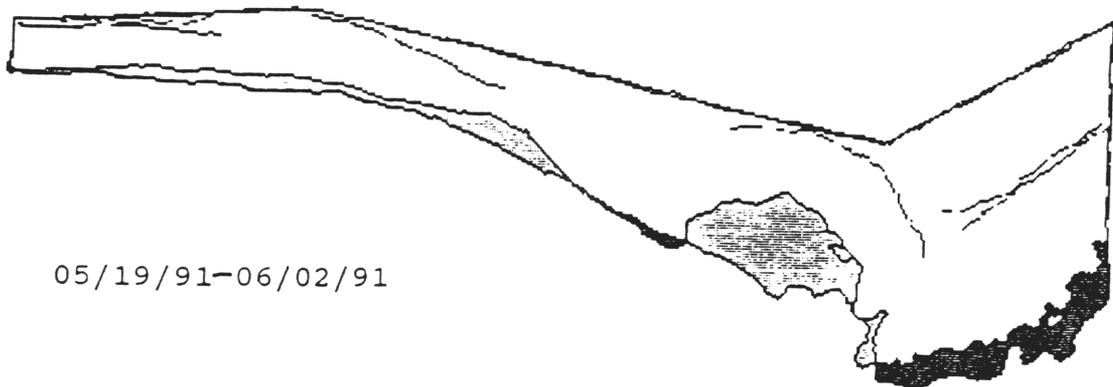
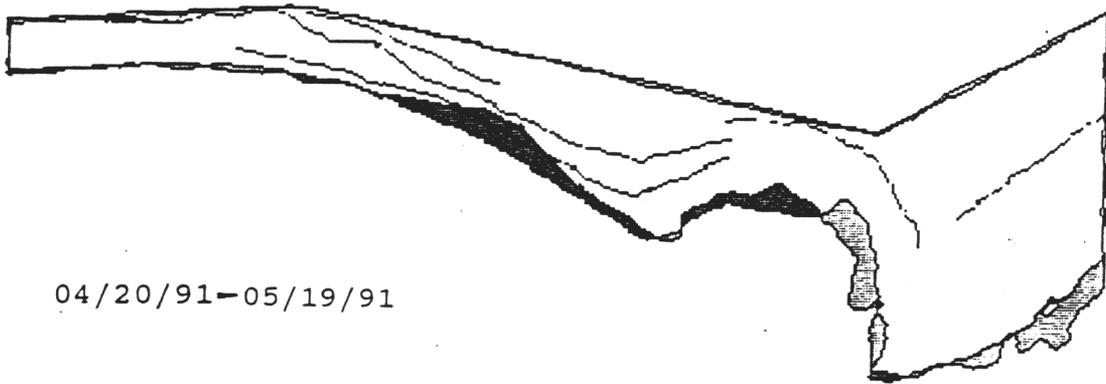
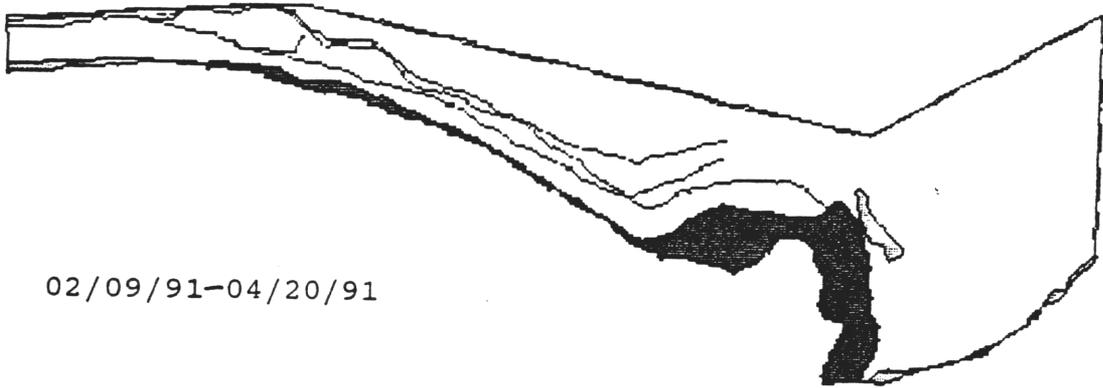
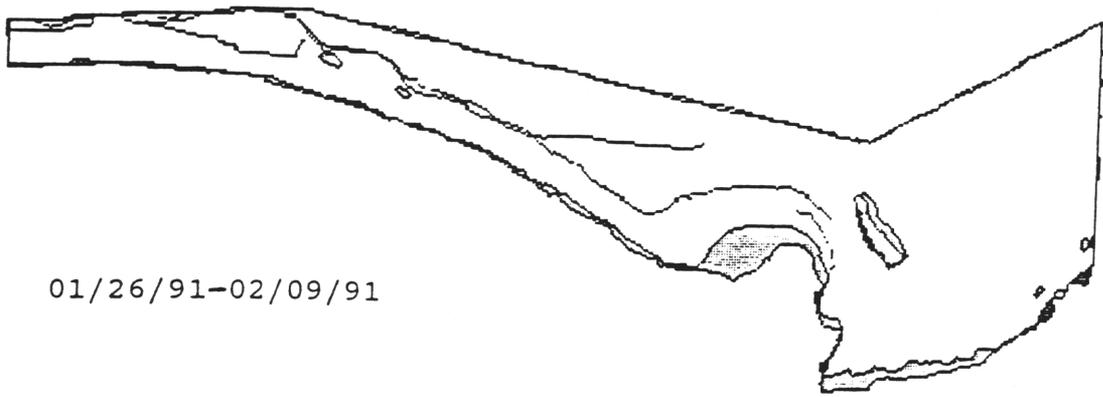


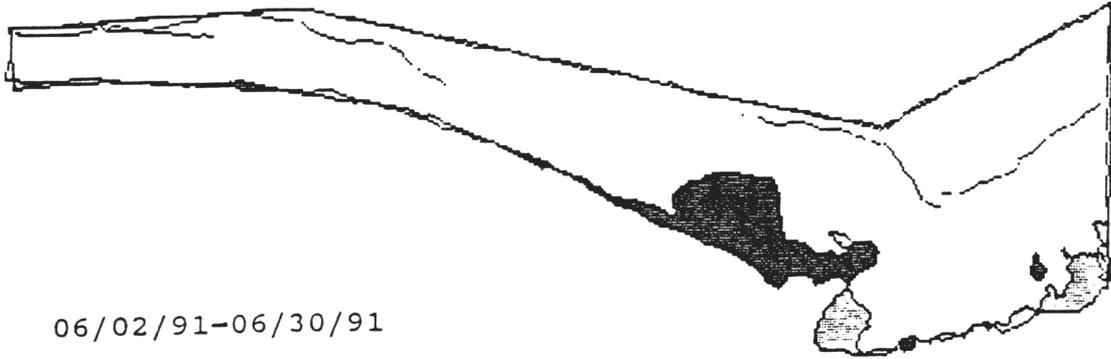
06/30/91-07/27/91



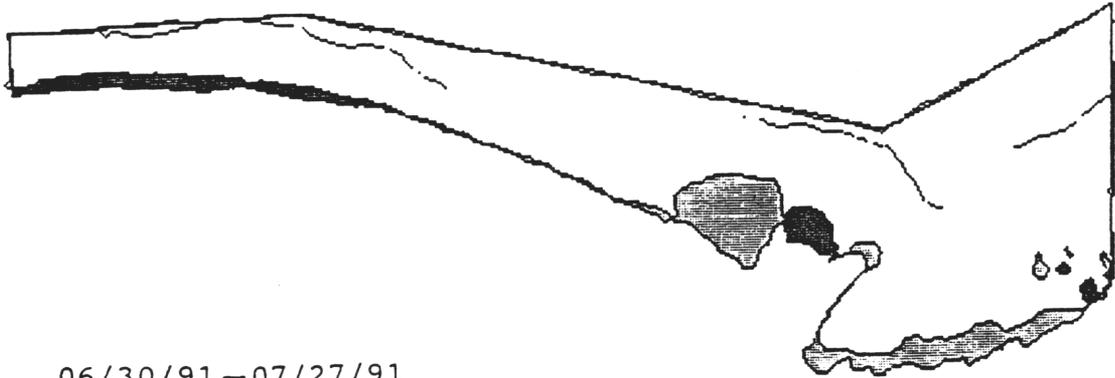
68.3R







06/02/91-06/30/91



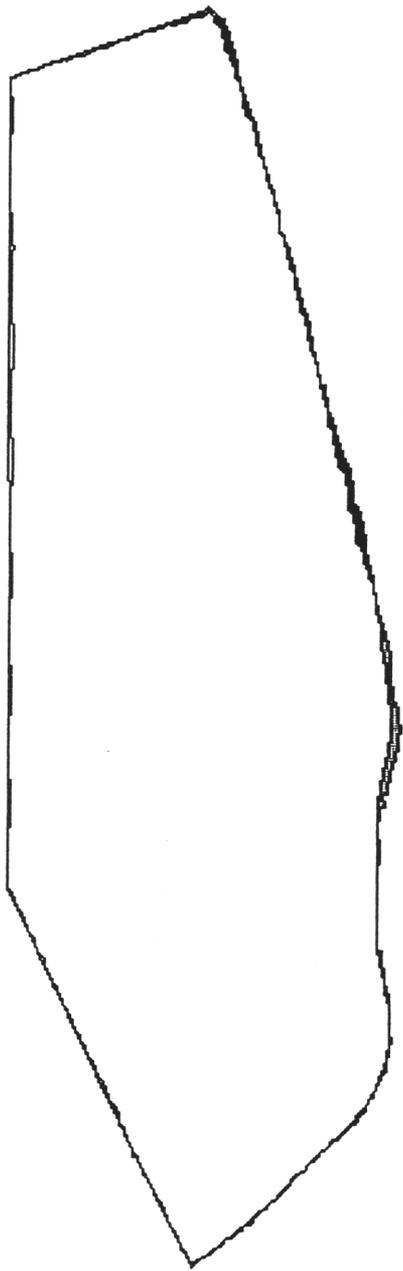
06/30/91-07/27/91

75.8R

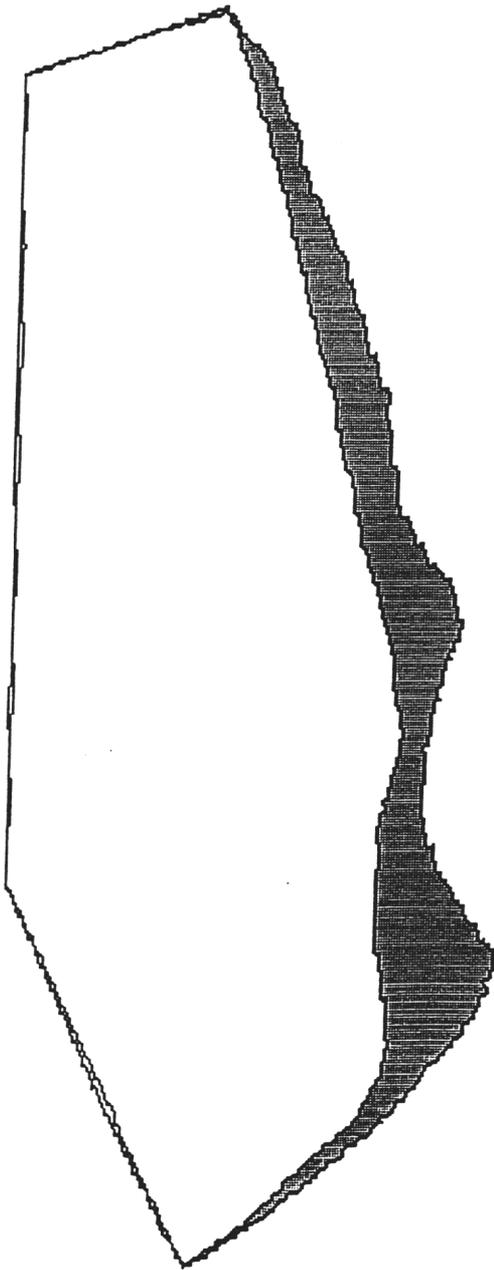


10/30/90

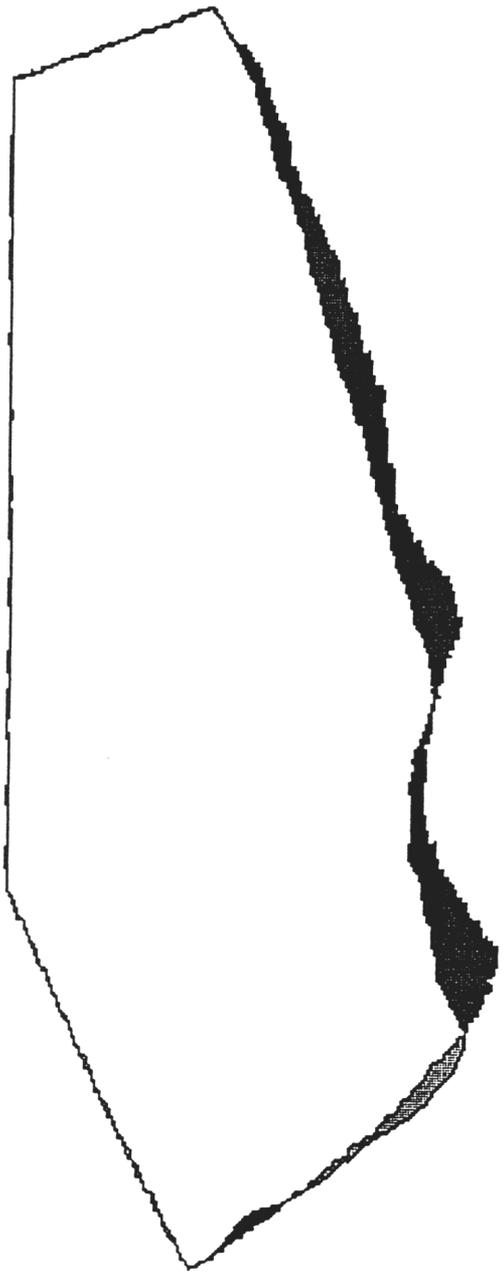
10/30/90 - 12/17/90



12/17/90 - 12/30/90



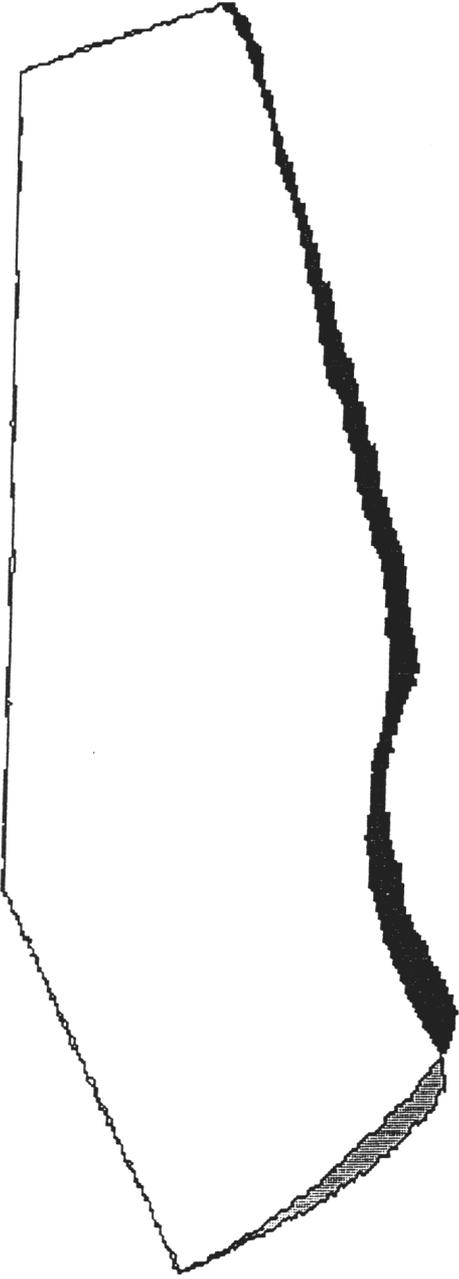
12/30/90 - 1/12/91



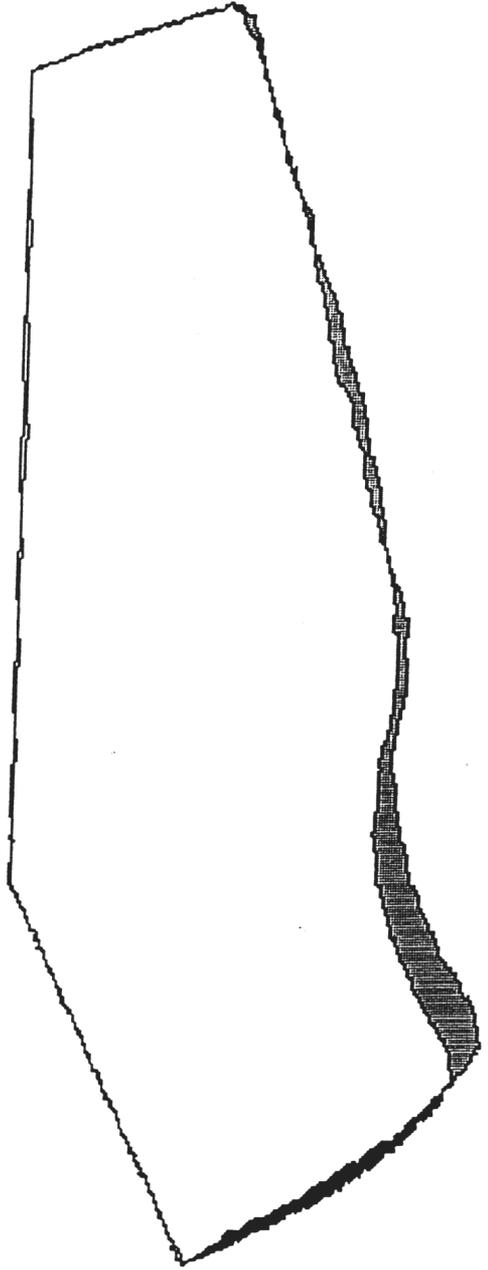
1/12/91 - 1/26/91



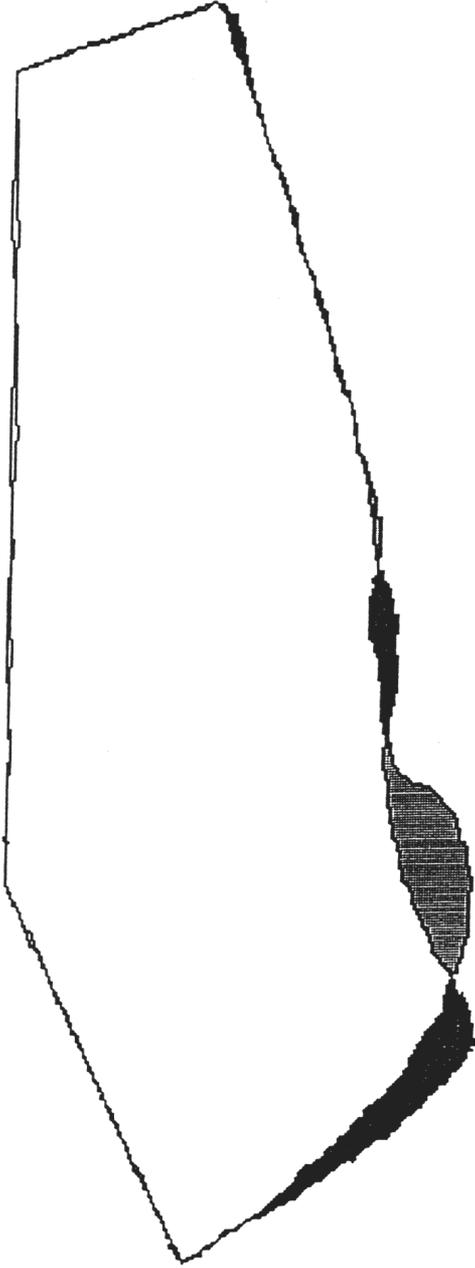
1/26/91 - 2/9/91



2/9/91 - 4/20/91



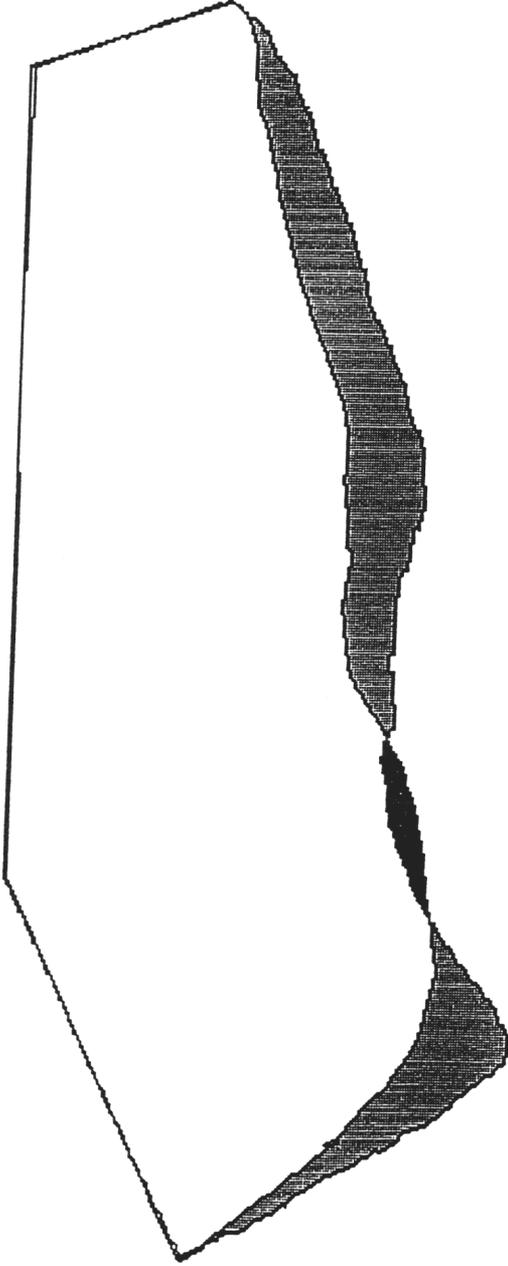
4/20/91 - 5/4/91



5/4/91 - 5/19/91



5/19/91 - 6/29/91



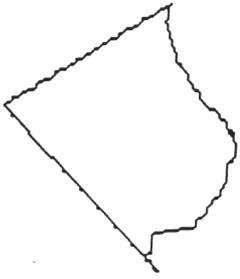
6/29/91 - 10/12/91



10/12/91 - 5/31/92



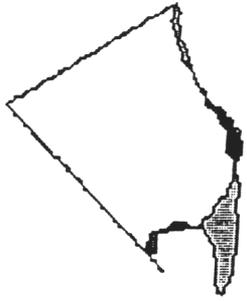
76.5L



10/30/90



1/12/91 - 1/26/91



10/30/90 - 12/17/90



1/26/91 - 2/9/91



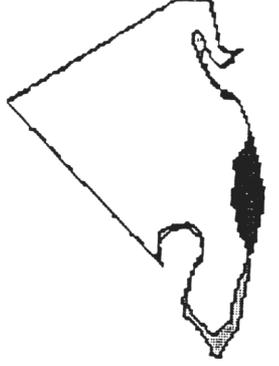
12/17/90 - 12/30/90



2/9/91 - 4/20/91



12/30/90 - 1/12/91



4/20/91 - 5/4/91



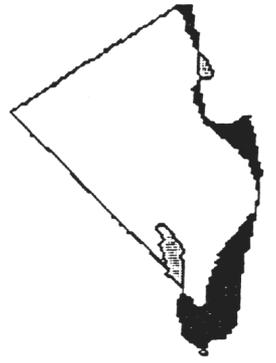
5/4/91 - 5/19/91



5/19/91 - 6/2/91



6/2/91 - 7/27/91

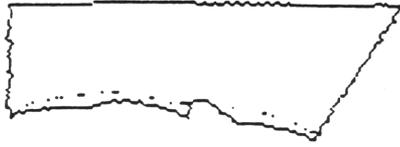


7/27/91 - 10/12/91

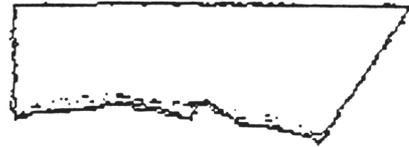


10/12/91 - 5/31/92

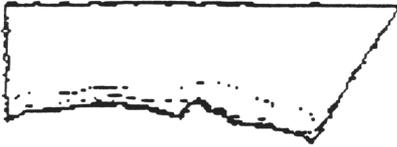
81.2L



10/15/90



10/15/90-10/30/90



10/30/90-12/17/90



12/17/90-12/30/90



12/30/90-01/12/91



01/12/91-01/26/91



01/26/91-02/09/91



02/09/91-04/20/91



04/20/91-05/05/91



05/05/91-05/19/91



05/19/91-06/02/91



06/02/91-06/30/91



06/30/91-07/27/91

83.9R

9/30/90

9/30/90 - 10/14/90

10/14/90 - 10/30/90

10/30/90 - 12/17/90

12/17/90 - 12/30/90

12/30/90 - 1/12/91

1/12/91 - 1/26/91

1/26/91 - 2/9/91

2/9/91 - 4/20/91

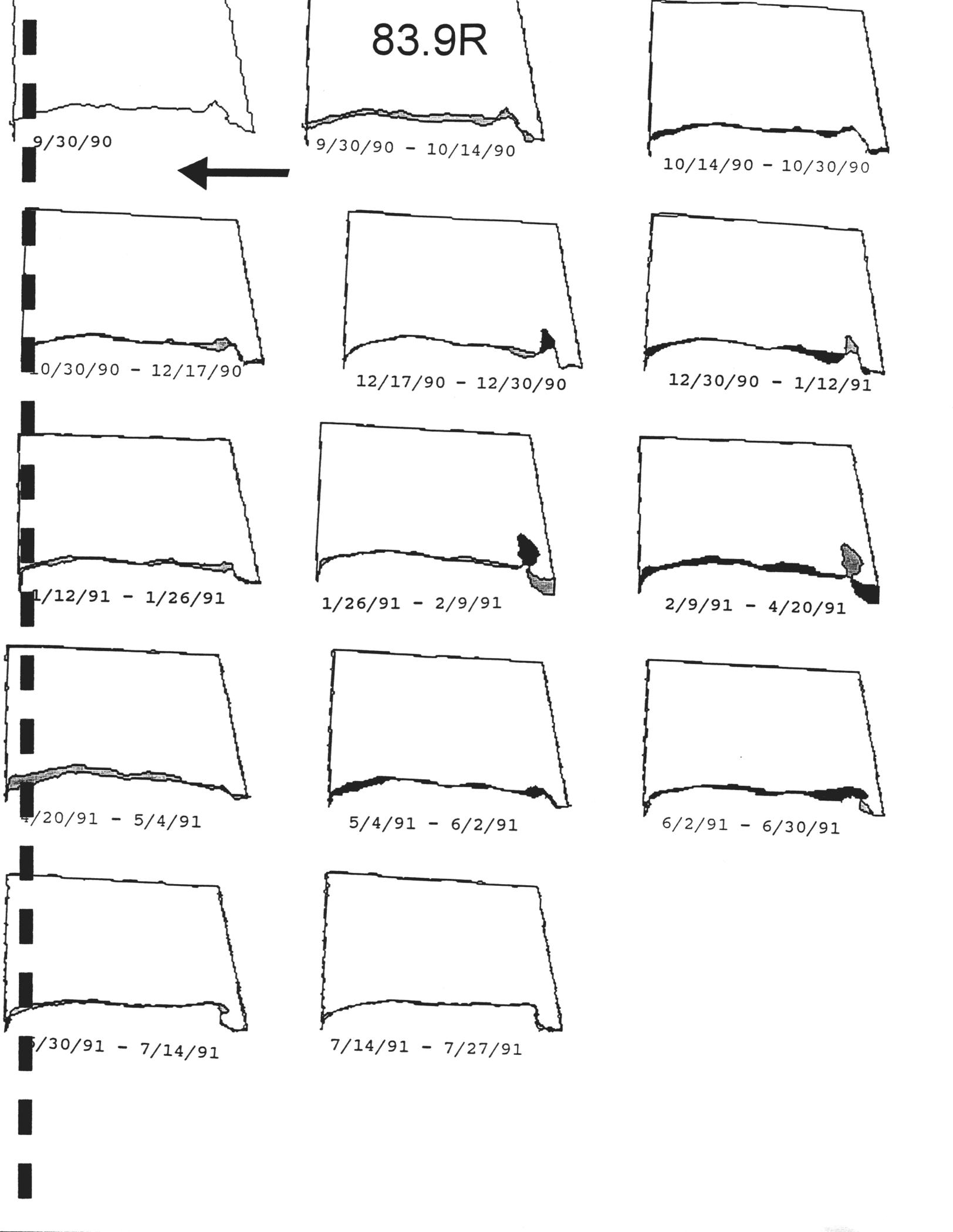
4/20/91 - 5/4/91

5/4/91 - 6/2/91

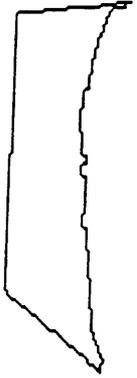
6/2/91 - 6/30/91

6/30/91 - 7/14/91

7/14/91 - 7/27/91



87.1L



9/30/90



11/11/90 - 12/17/90



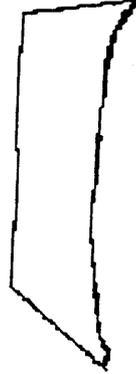
9/30/90 - 10/14/90



12/17/90 - 12/30/90



10/14/90 - 10/30/90



12/30/90 - 1/12/91



10/30/90 - 11/11/90



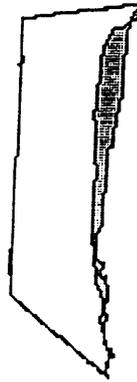
1/12/91 - 1/26/91



1/26/91 - 2/9/91



6/2/91 - 6/29/91



2/9/91 - 4/20/91



6/29/91 - 7/14/91



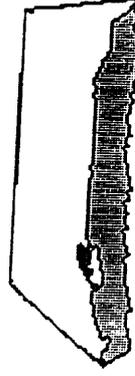
4/20/91 - 5/4/91



7/14/91 - 7/27/91

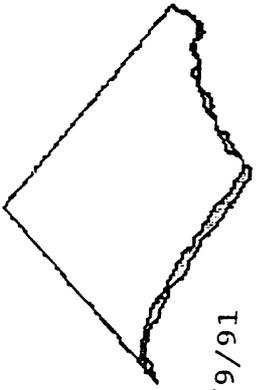


5/4/91 - 6/2/91

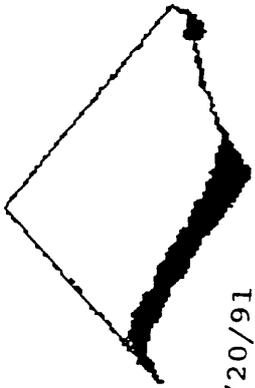


7/27/91 - 5/31/92

91.1R



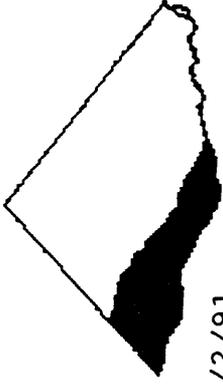
1/26/91 - 2/9/91



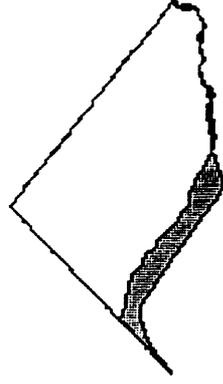
2/9/91 - 4/20/91



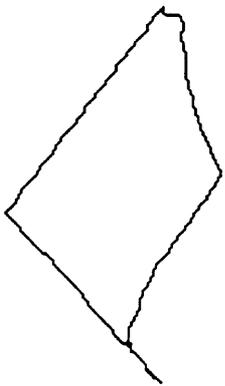
5/4/91 - 5/19/91



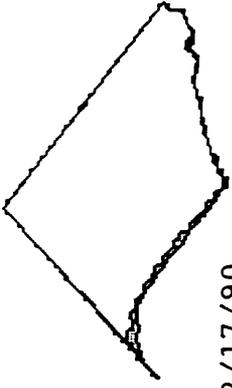
5/19/91 - 6/2/91



6/2/91 - 6/29/91



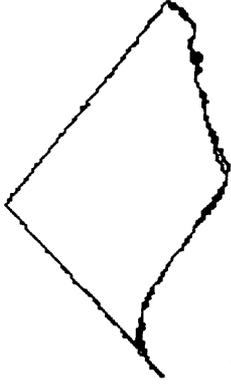
10/14/90



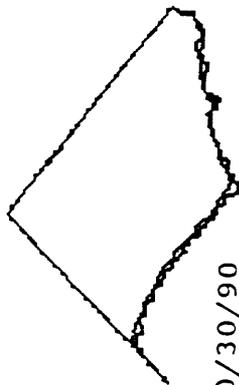
10/30/90 - 12/17/90



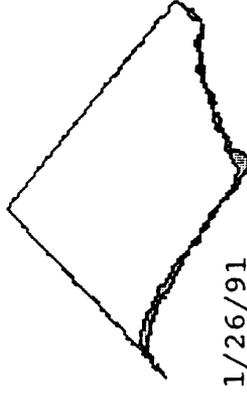
10/14/90 - 10/15/90



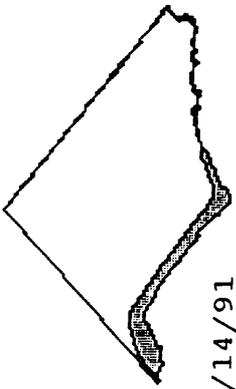
12/17/90 - 12/30/90



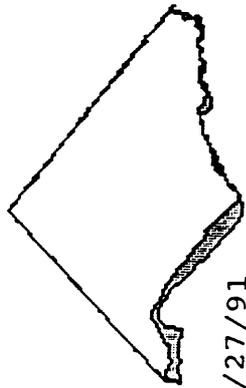
10/15/90 - 10/30/90



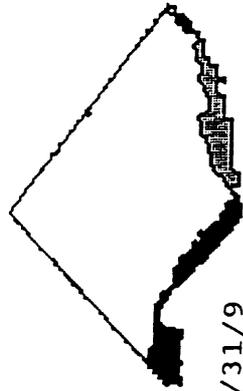
12/30/90 - 1/26/91



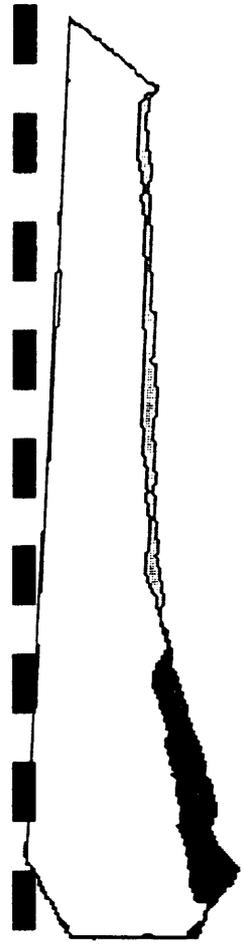
6/29/91 - 7/14/91



7/14/91 - 7/27/91



7/27/91 - 5/31/9



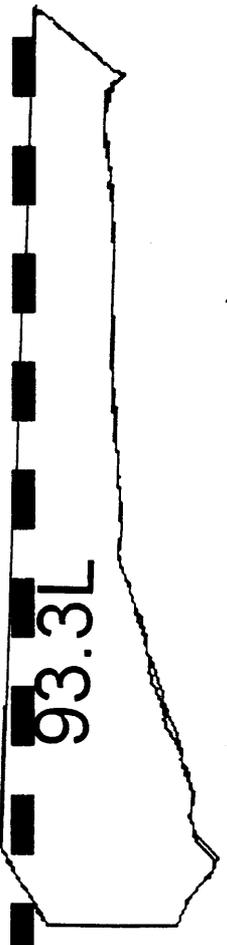
2/9/91 - 4/20/91



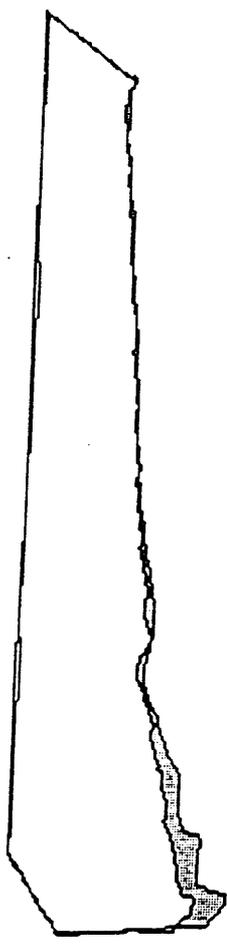
5/4/91 - 6/2/91



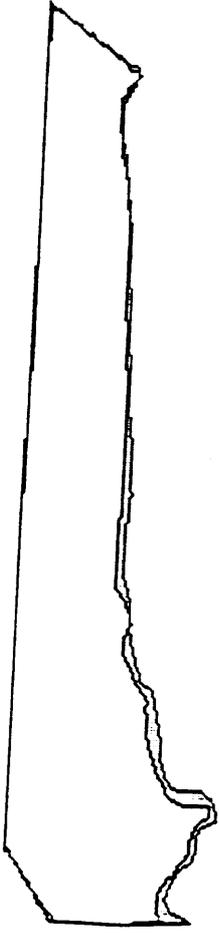
6/2/91 - 6/29/91



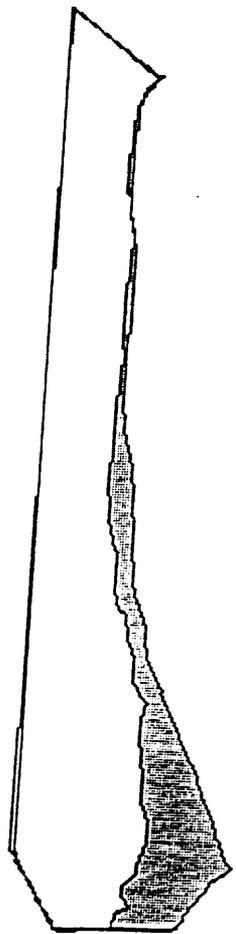
1/26/91 - 2/9/91



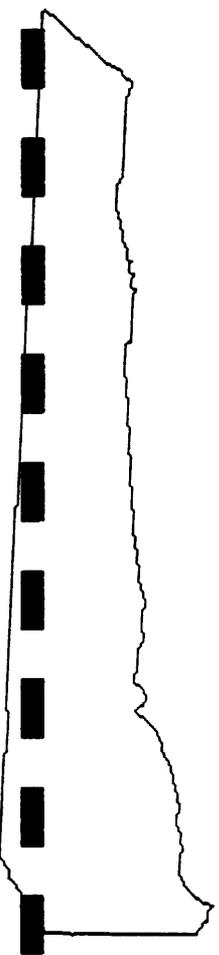
4/20/91 - 5/4/91



5/19/91 - 6/2/91



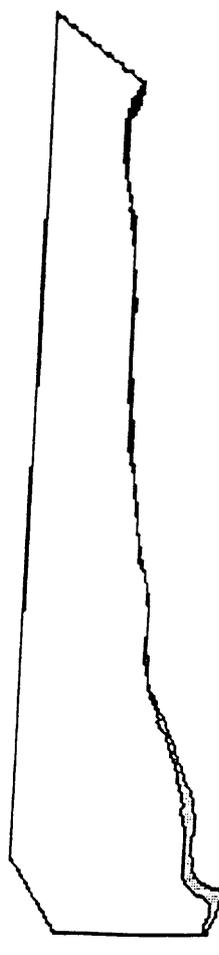
6/29/91 - 7/27/91



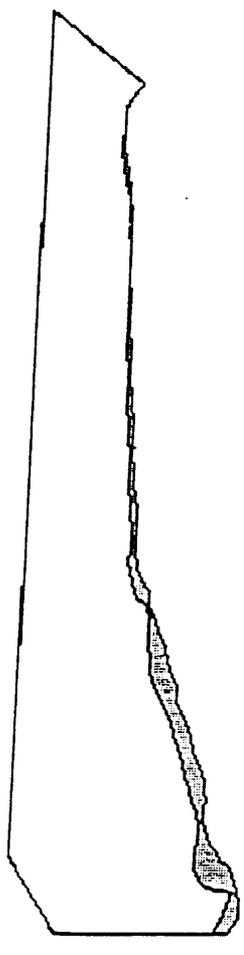
9/30/90



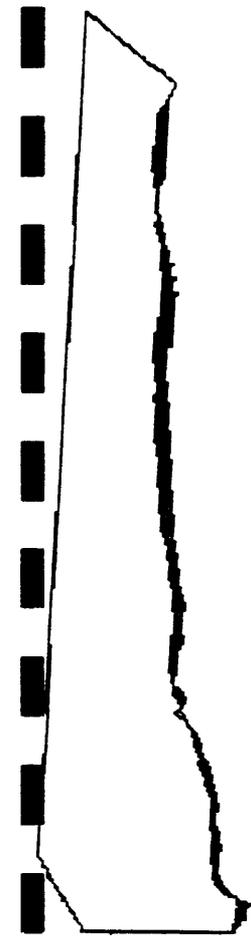
10/14/90 - 10/30/90



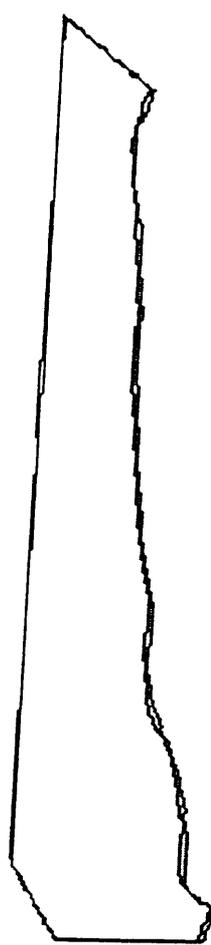
11/11/90 - 12/17/90



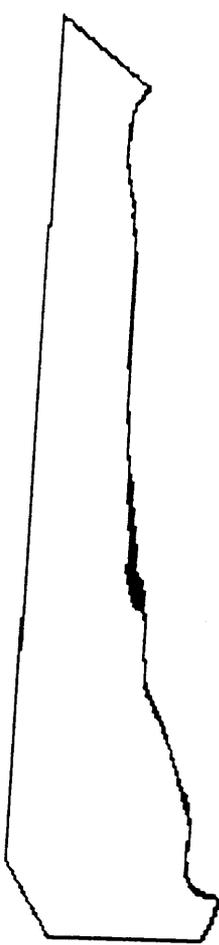
12/30/90 - 1/12/91



9/30/90 - 10/14/90



10/30/90 - 11/11/90



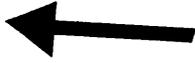
12/17/90 - 12/30/90



1/12/91 - 1/26/91

98.0R

9/30/90



9/30/90 - 10/15/90

10/15/90 - 10/30/90

10/30/90 - 11/11/90

1/1/90 - 12/17/90

12/17/90 - 12/30/90

2/30/90 - 1/12/91

1/12/91 - 1/26/91

1/26/91 - 2/9/91

2/9/91 - 4/20/91

4/20/91 - 5/4/91

5/4/91 - 5/19/91

5/19/91 - 6/2/91

6/2/91 - 6/30/91

6/30/91 - 7/27/91

103.9R



9/30/90



12/17/90 - 12/30/90



9/30/90 - 10/30/90



12/30/90 - 1/12/91



10/30/90 - 11/11/90



1/12/91 - 1/26/91



11/11/90 - 12/17/90



1/26/91 - 2/9/91



2/9/91 - 4/20/91



6/29/91 - 7/27/91



4/20/91 - 5/4/91

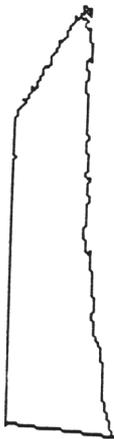


5/4/91 - 6/2/91

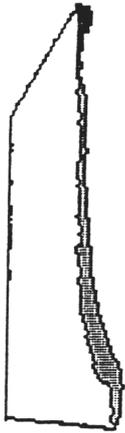


6/2/91 - 6/29/91

107.8L



9/30/90



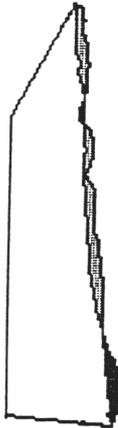
12/17/90 - 12/30/90



2/9/91 - 4/20/91



9/30/90 - 10/30/90



12/30/90 - 1/12/91



4/20/91 - 5/4/91



10/30/90 - 11/11/90



1/12/91 - 1/26/91



5/4/91 - 5/19/91



11/11/90 - 12/17/90



1/26/91 - 2/9/91



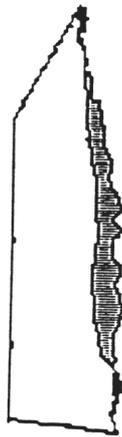
5/19/91 - 6/2/91



6/2/91 - 6/29/91



6/29/91 - 7/27/91



7/27/91 - 10/11/91

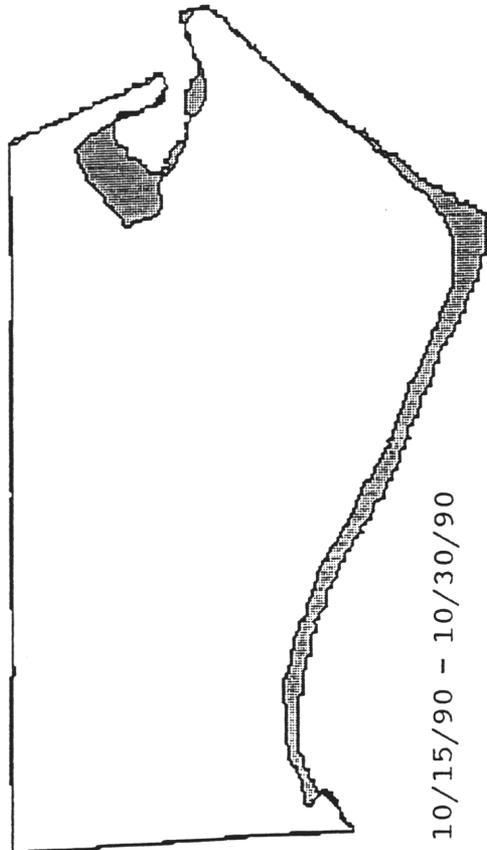


10/11/91 - 5/31/92

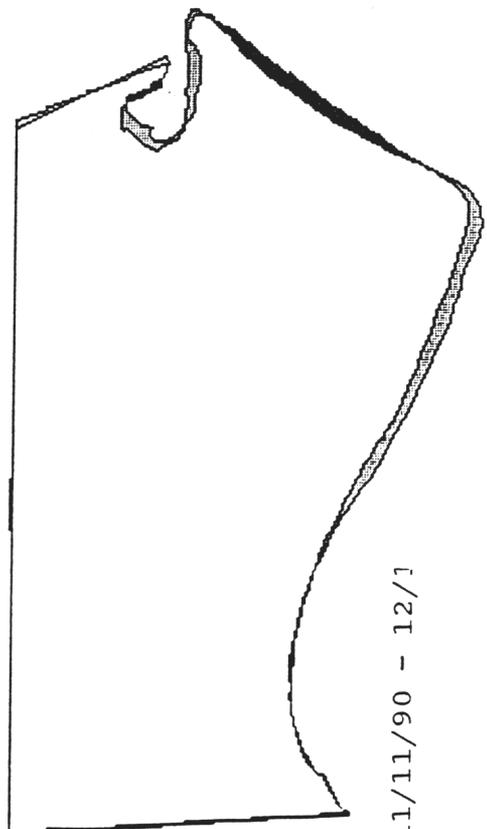
119.0R



9/30/90

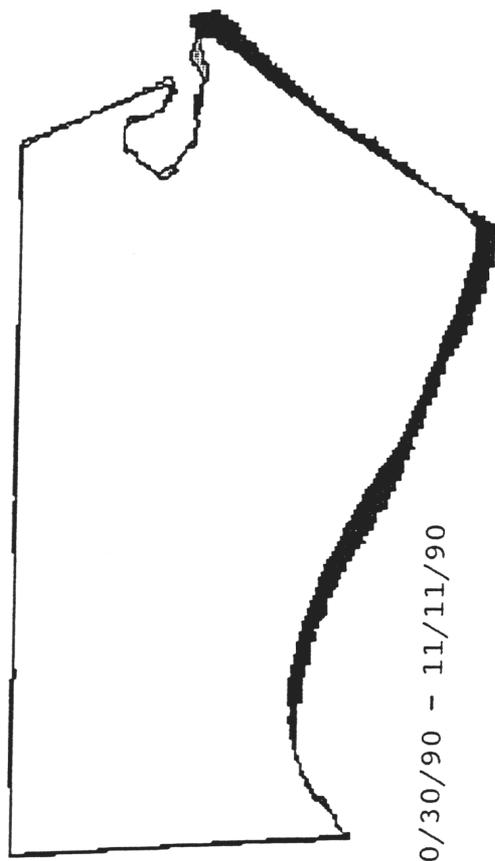


10/15/90 - 10/30/90

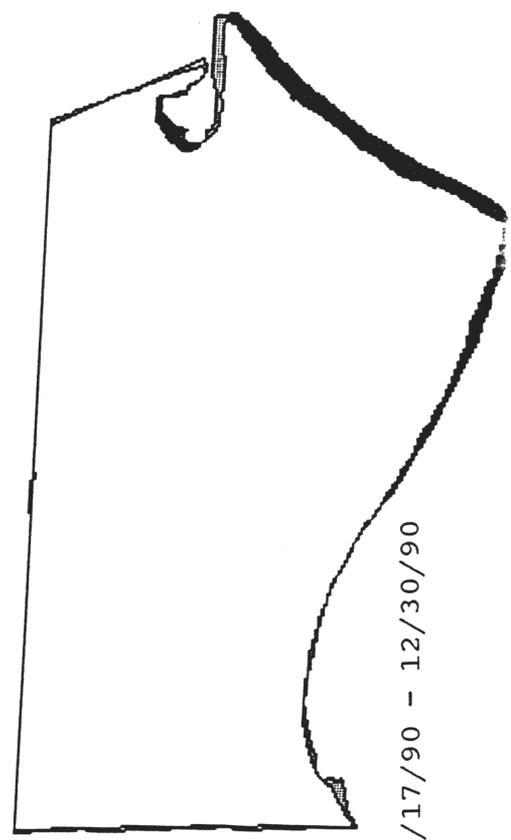


11/11/90 - 12/1/90

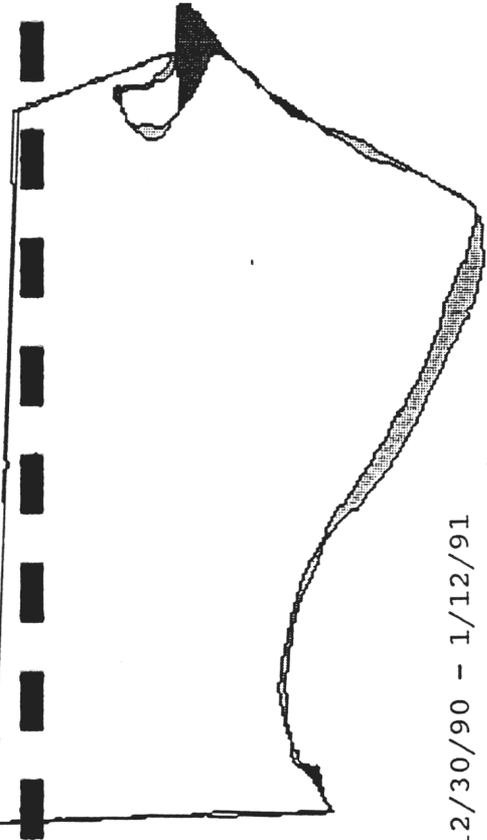
9/30/90 - 10/15/90



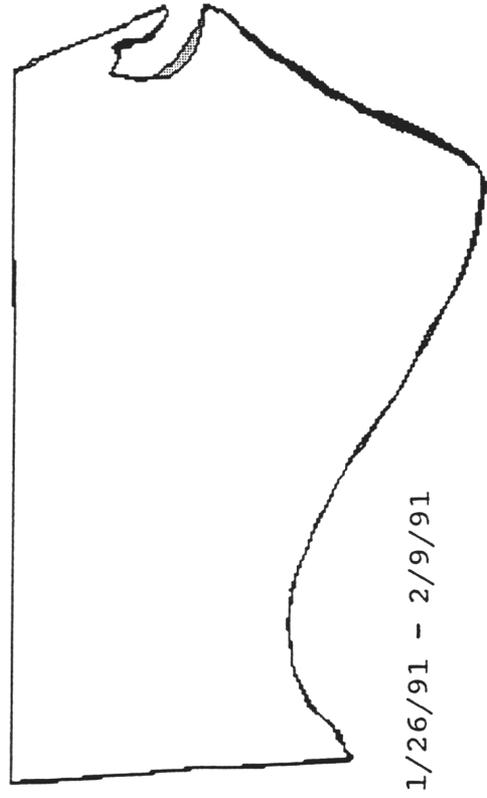
10/30/90 - 11/11/90



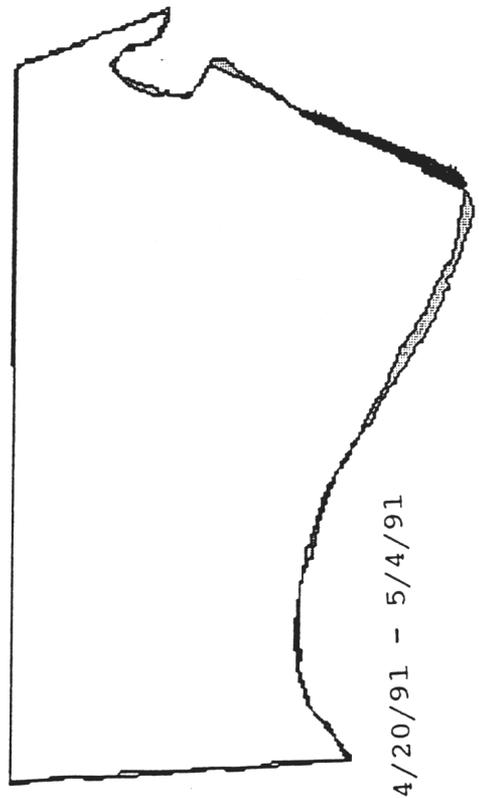
12/17/90 - 12/30/90



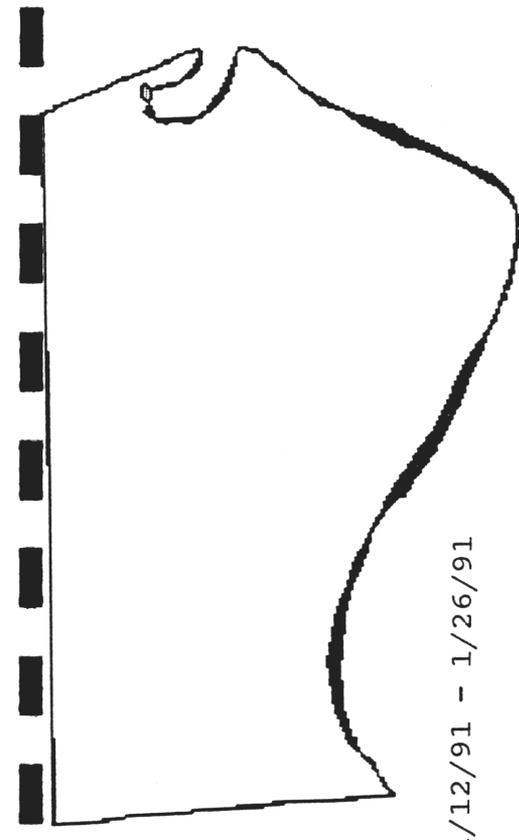
12/30/90 - 1/12/91



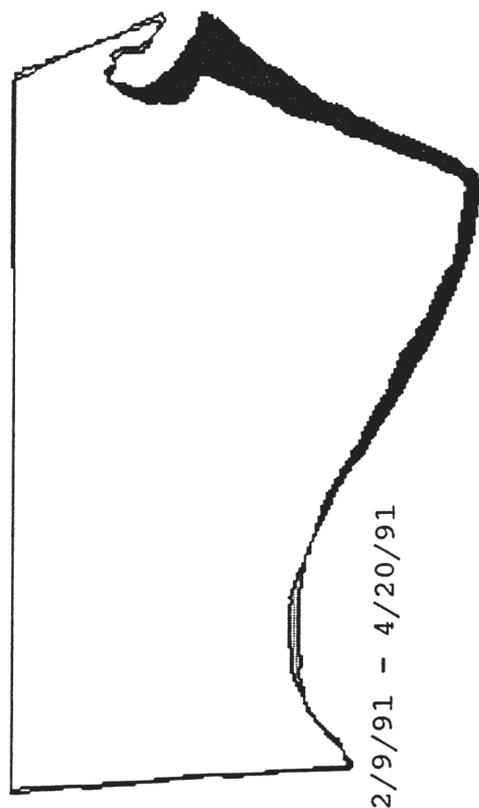
1/26/91 - 2/9/91



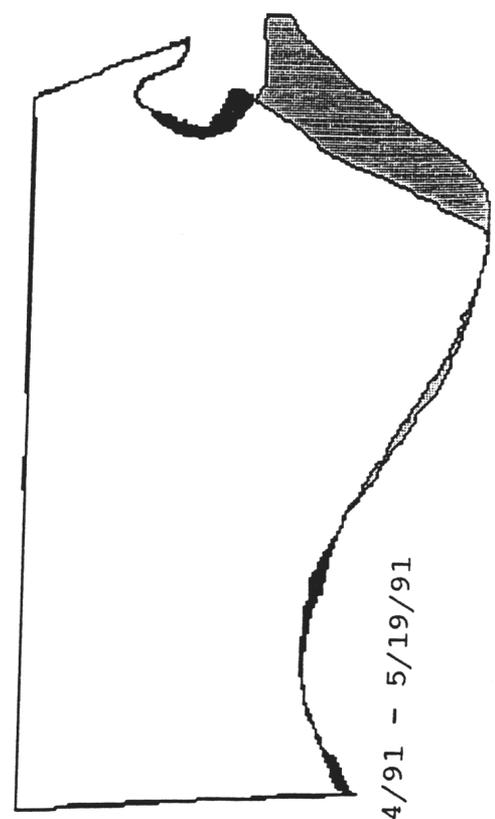
4/20/91 - 5/4/91



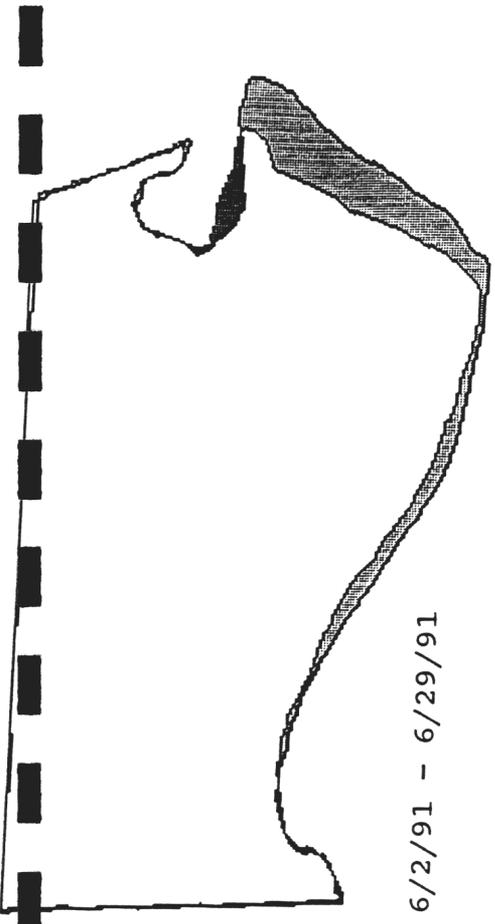
1/12/91 - 1/26/91



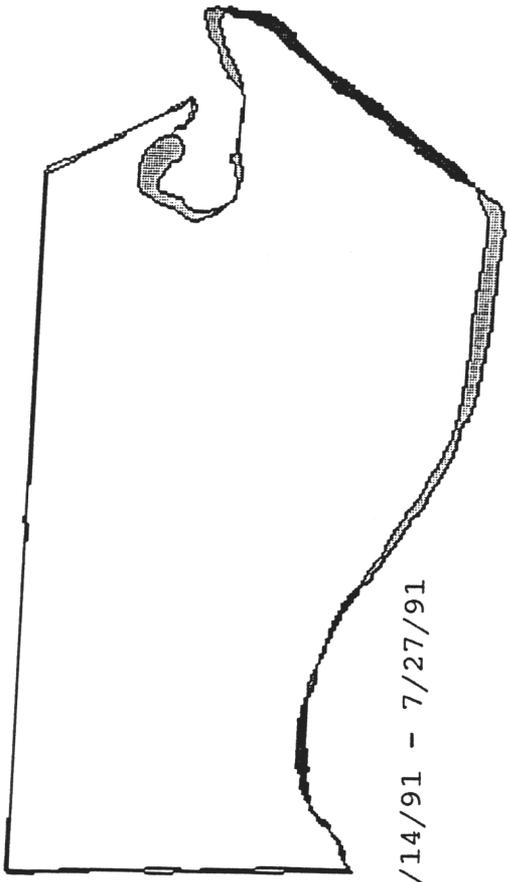
2/9/91 - 4/20/91



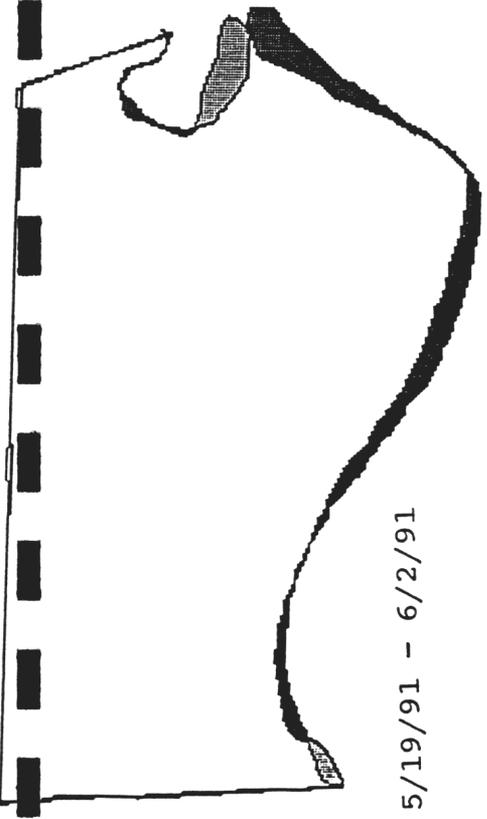
5/4/91 - 5/19/91



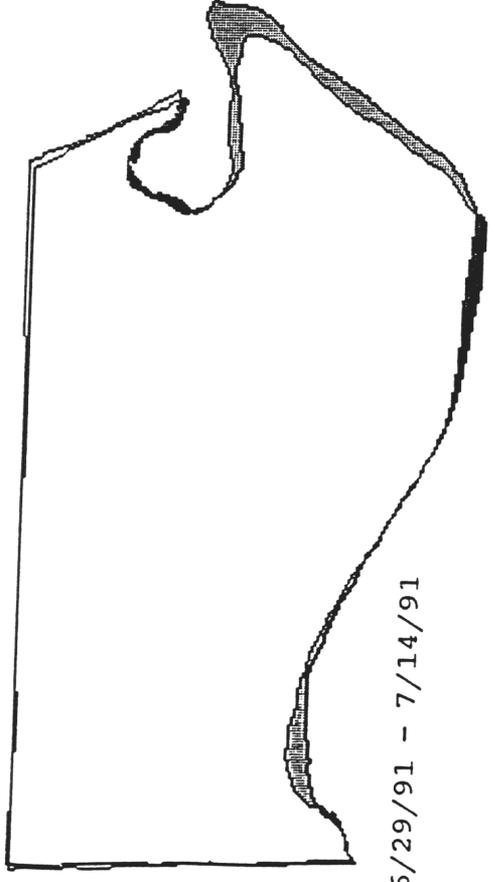
6/2/91 - 6/29/91



7/14/91 - 7/27/91

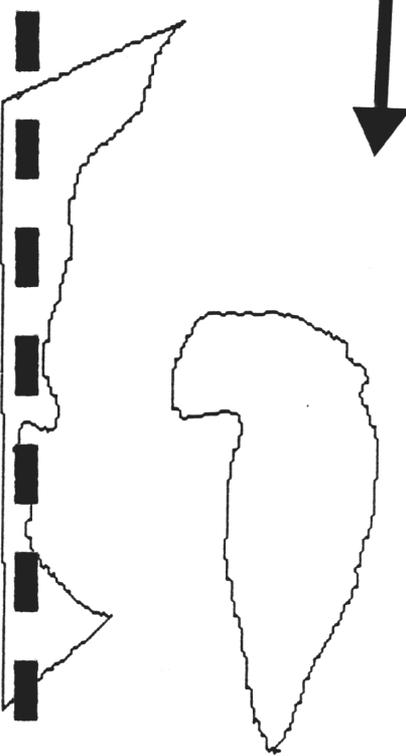


5/19/91 - 6/2/91

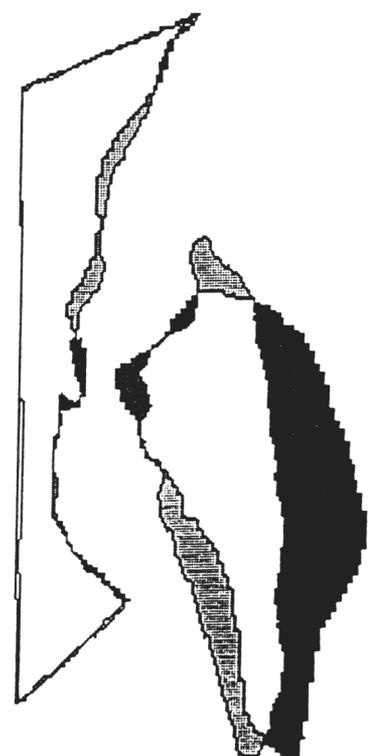


6/29/91 - 7/14/91

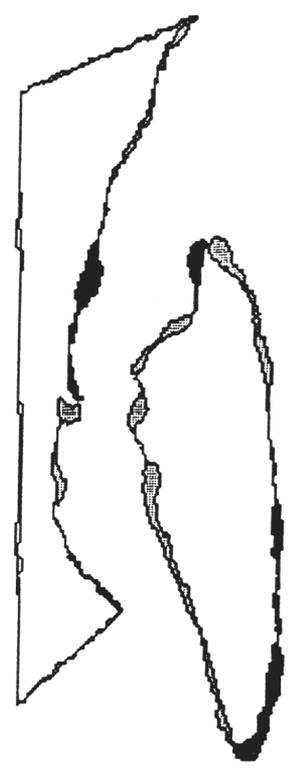
120.1R



10/15/90

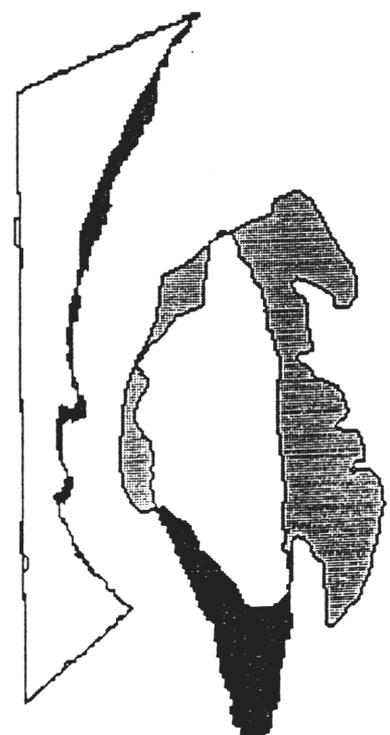


10/30/90 - 12/17/90

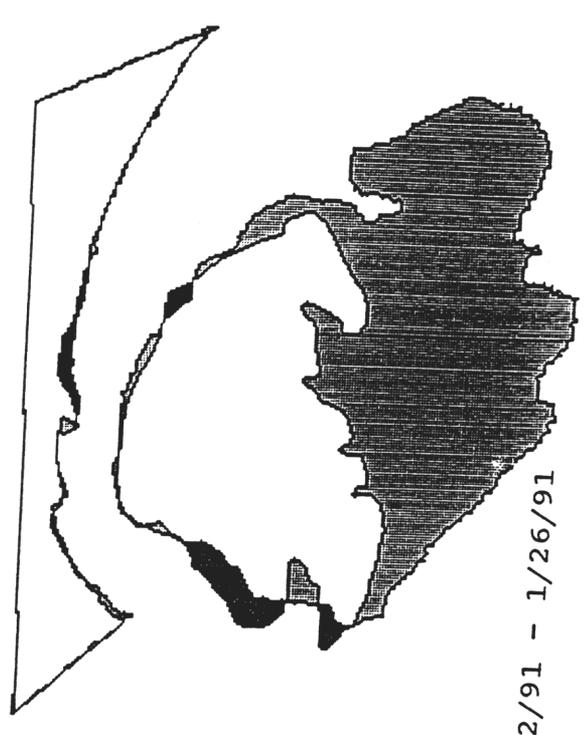


10/15/90 - 10/30/90

12/17/90 - 12/30/90



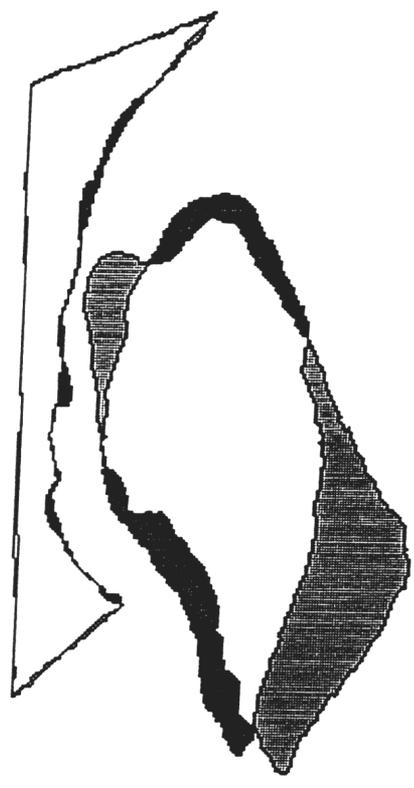
12/30/90 - 1/12/91



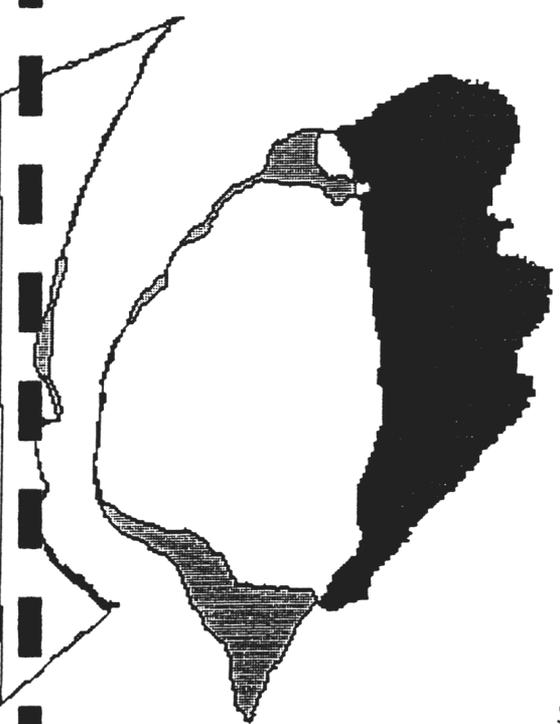
1/12/91 - 1/26/91



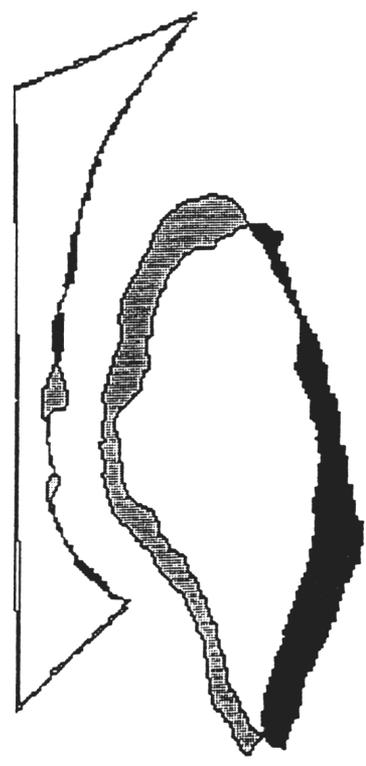
2/9/91 - 4/20/91



5/4/91 - 5/19/91



1/26/91 - 2/9/91

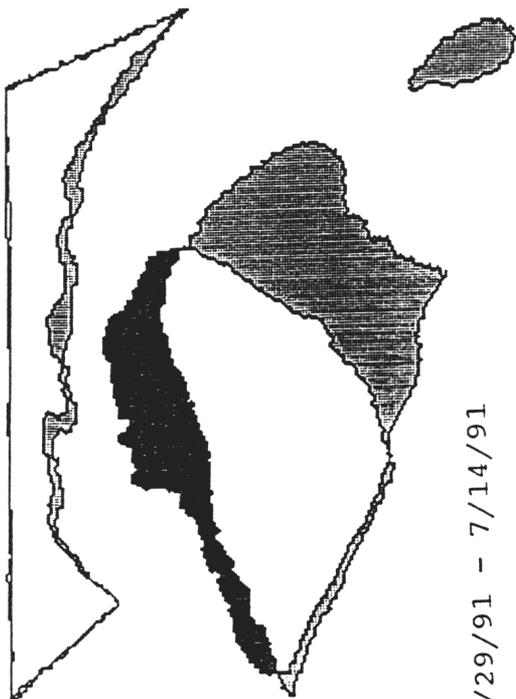


4/20/91 - 5/4/91



5/19/91 - 6/2/91

6/2/91 - 6/29/91



6/29/91 - 7/14/91

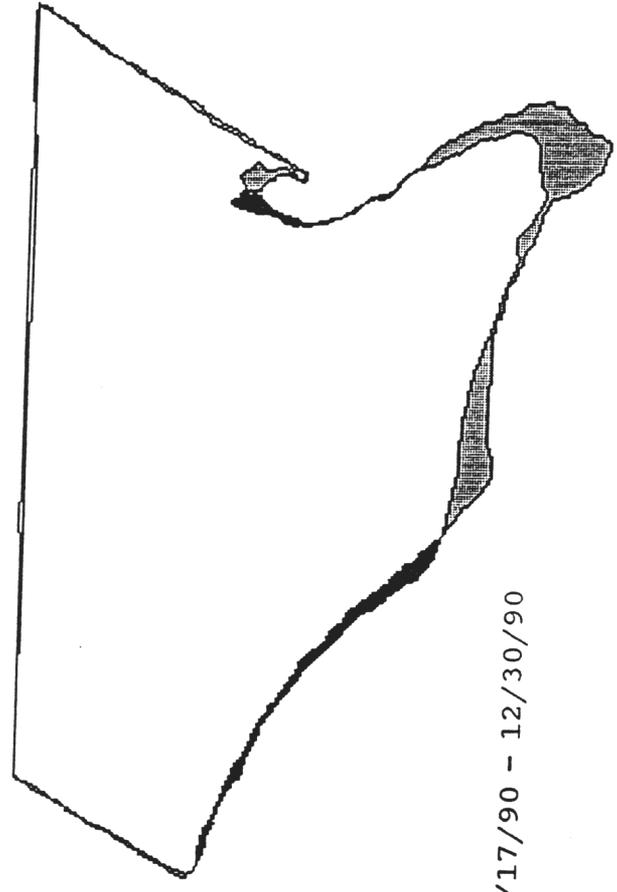




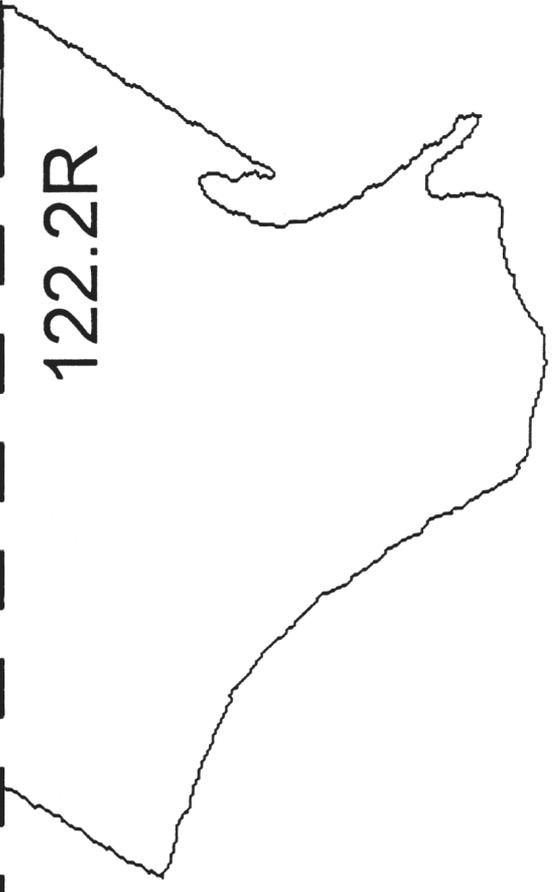
122.2R



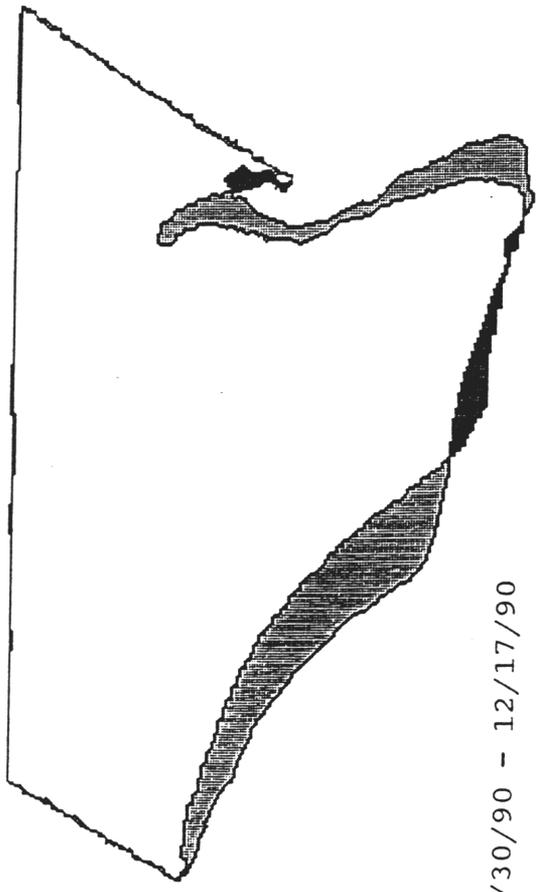
9/30/90 - 10/30/90



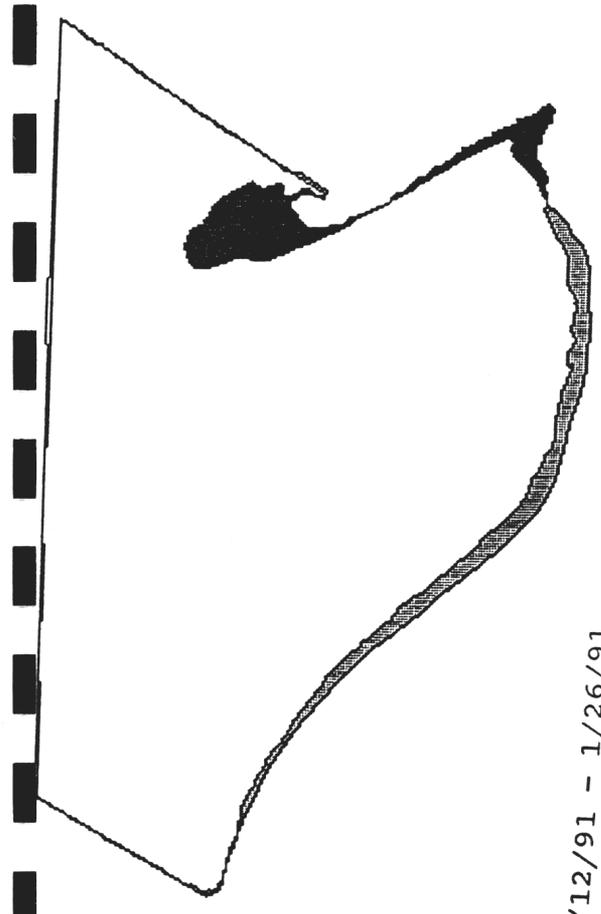
12/17/90 - 12/30/90



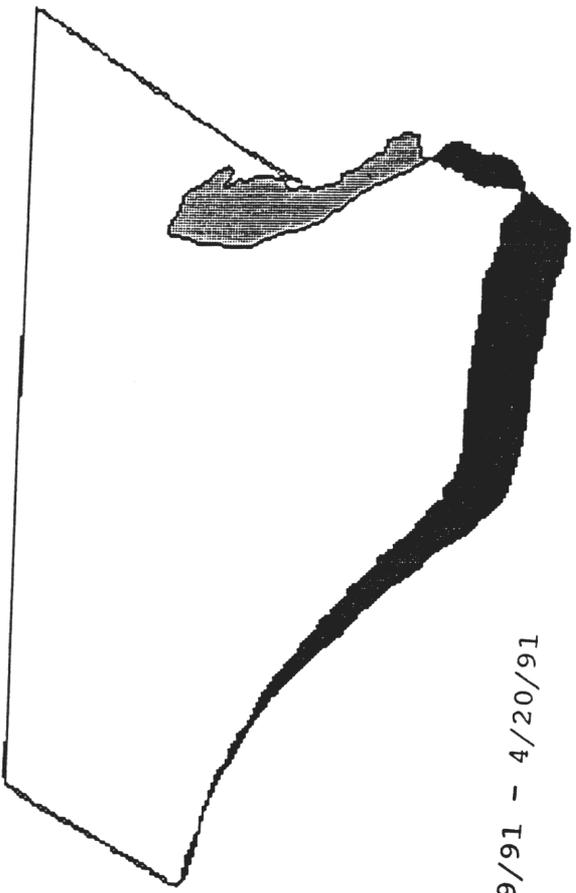
9/30/90



10/30/90 - 12/17/90



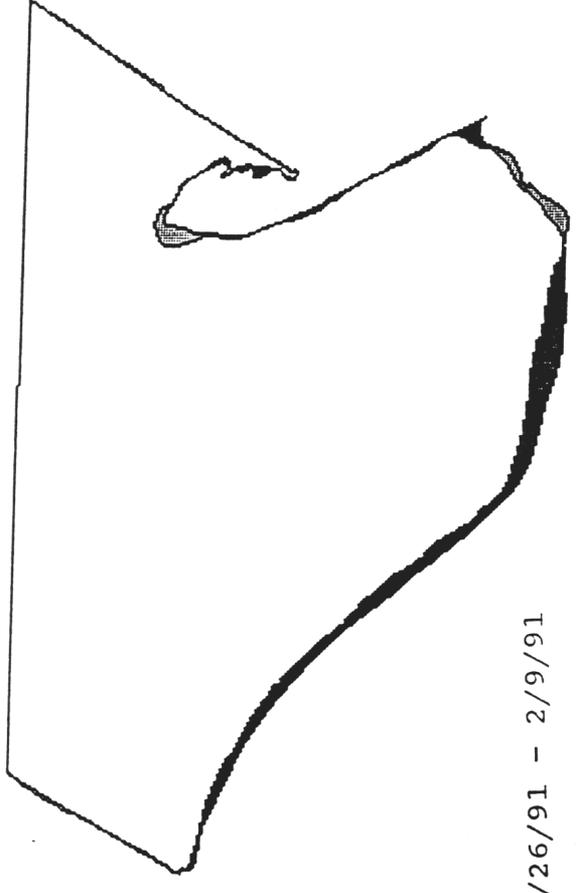
1/12/91 - 1/26/91



2/9/91 - 4/20/91



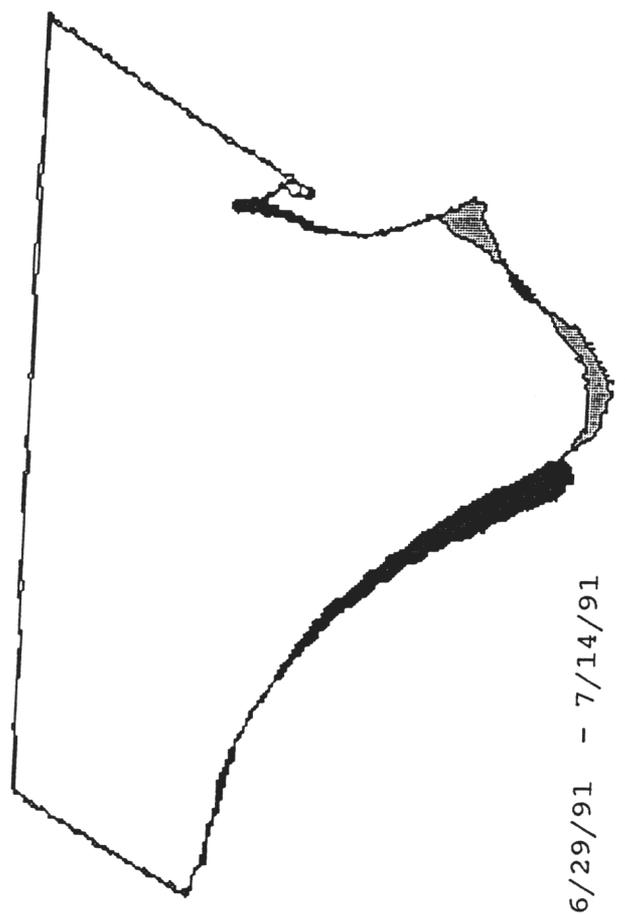
12/30/90 - 1/12/91



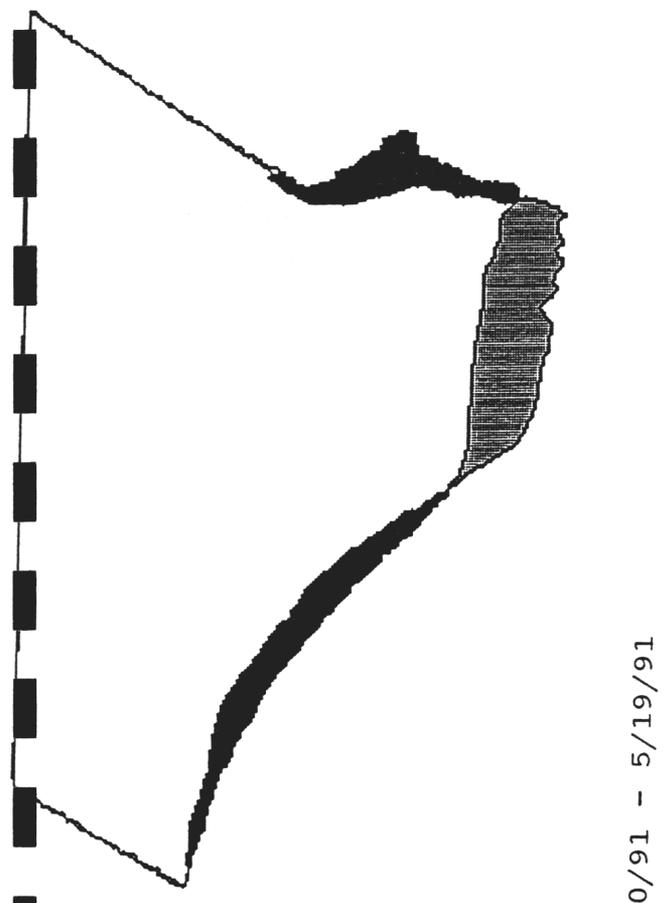
1/26/91 - 2/9/91



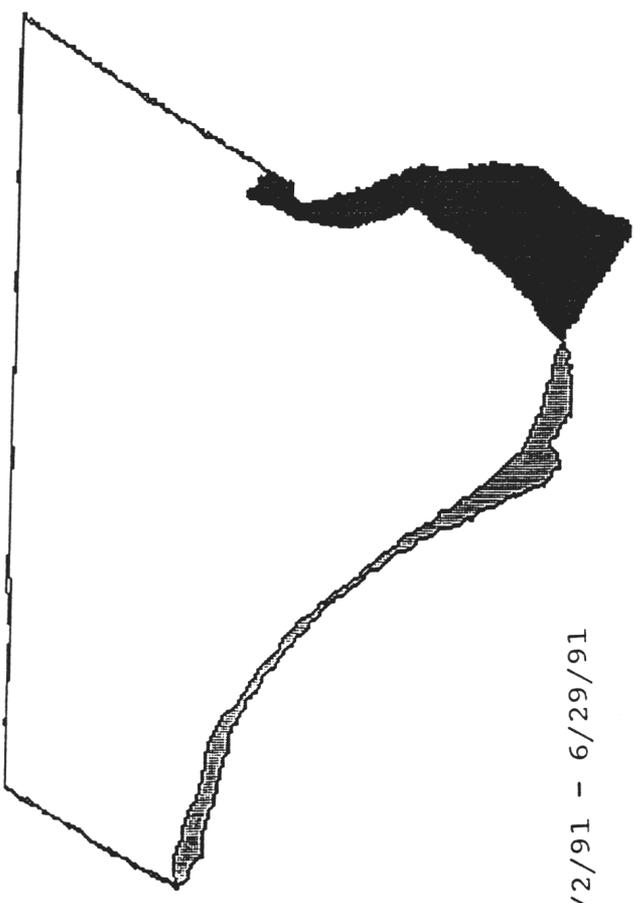
5/19/91 - 6/2/91



6/29/91 - 7/14/91



4/20/91 - 5/19/91



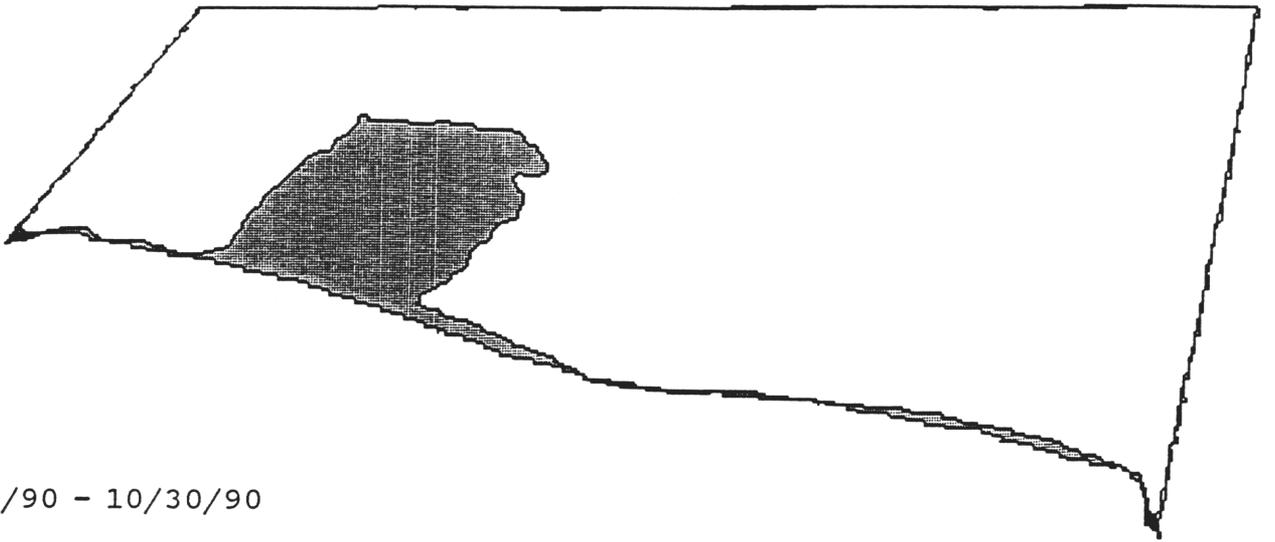
6/2/91 - 6/29/91



7/14/91 - 7/27/91

122.7L

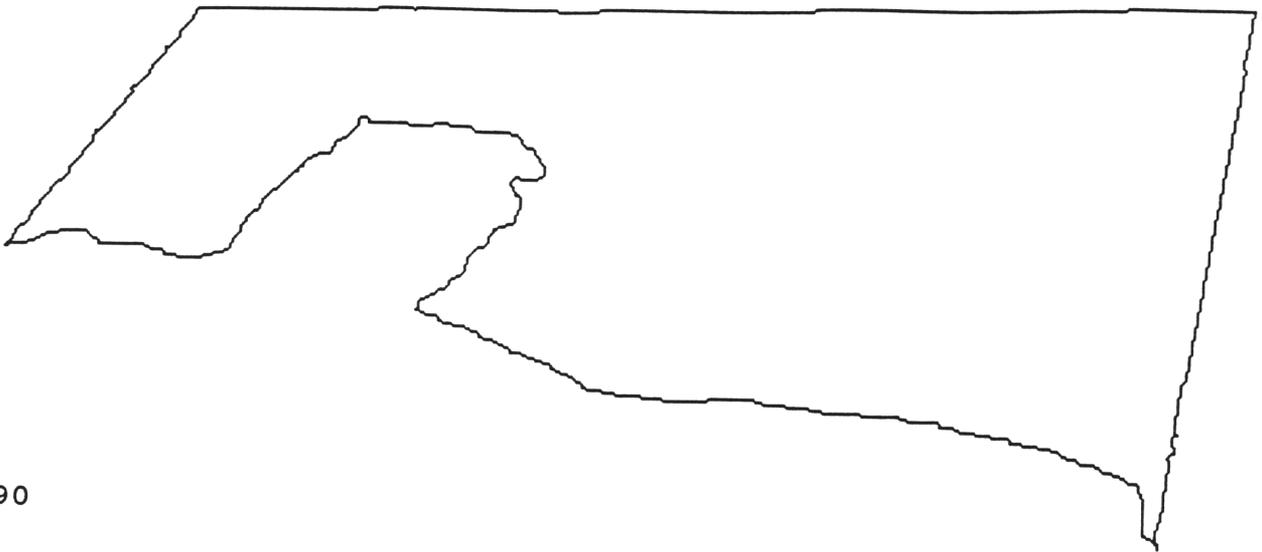
9/30/90



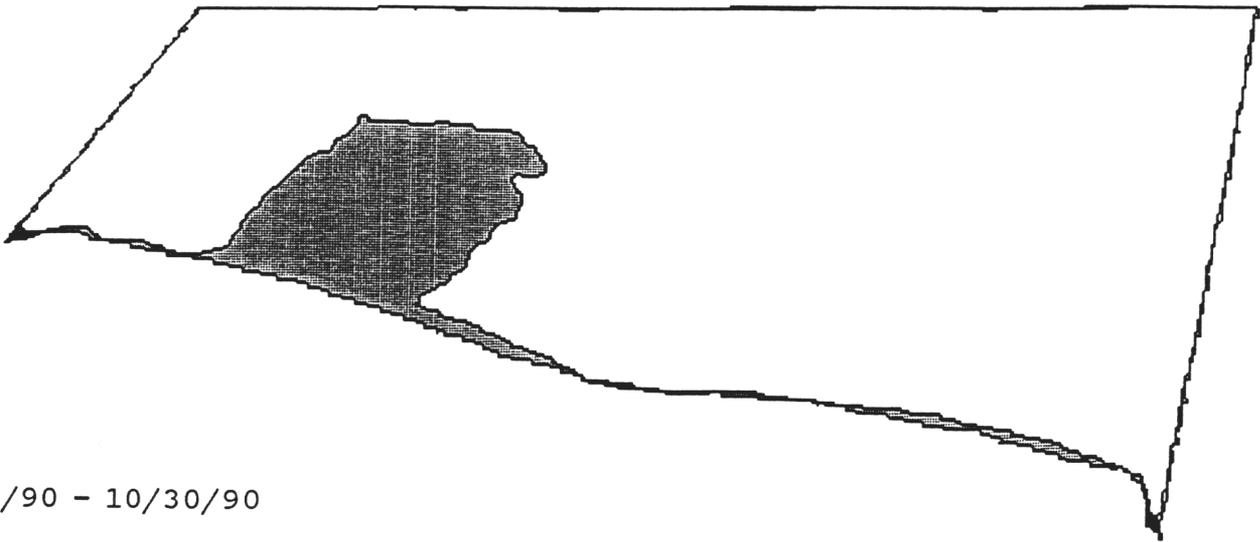
9/30/90 - 10/30/90



10/30/90 - 12/17/90



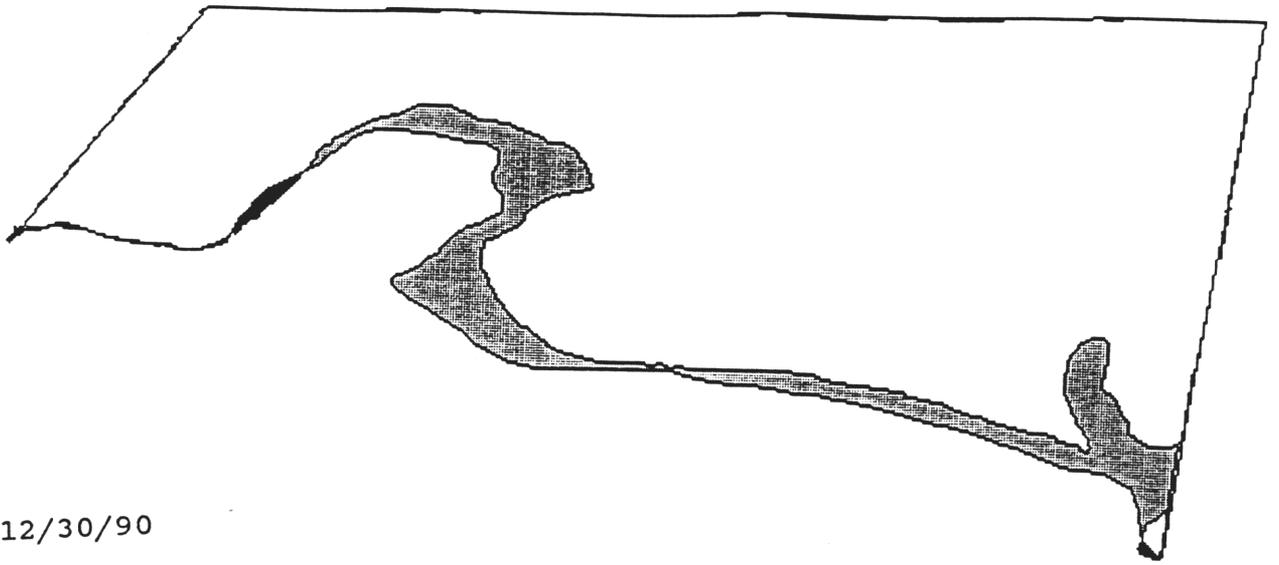
9/30/90



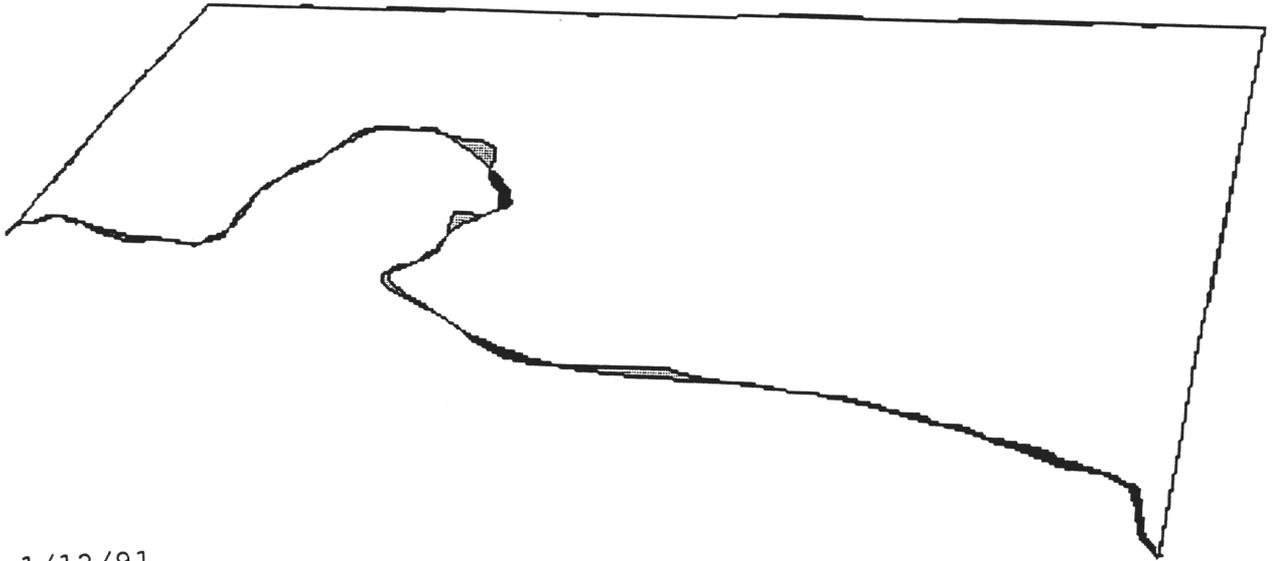
9/30/90 - 10/30/90



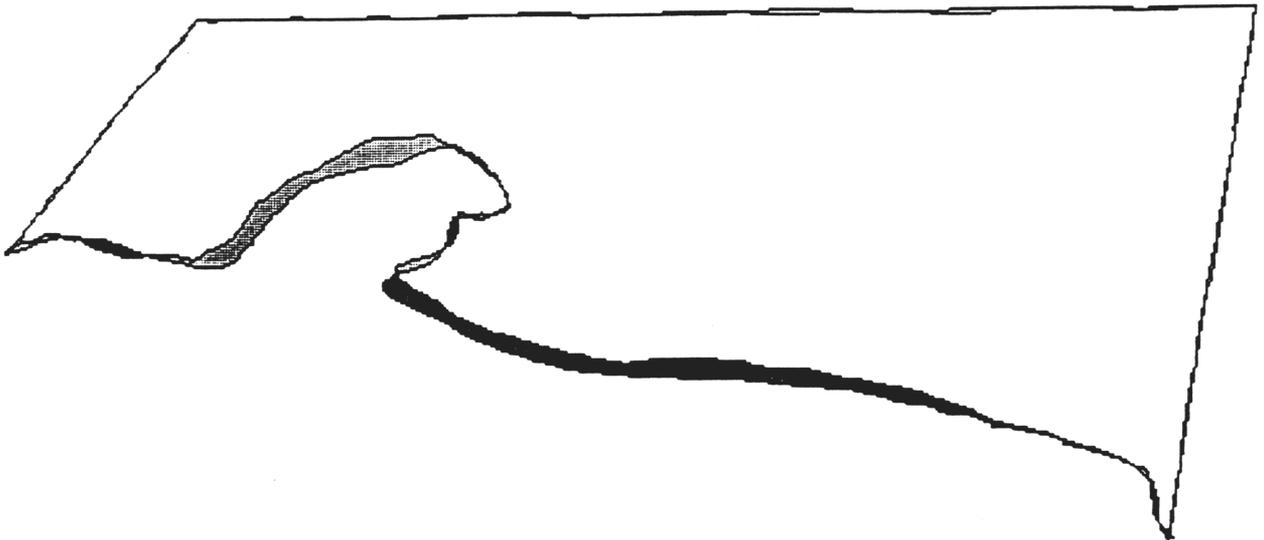
10/30/90 - 12/17/90



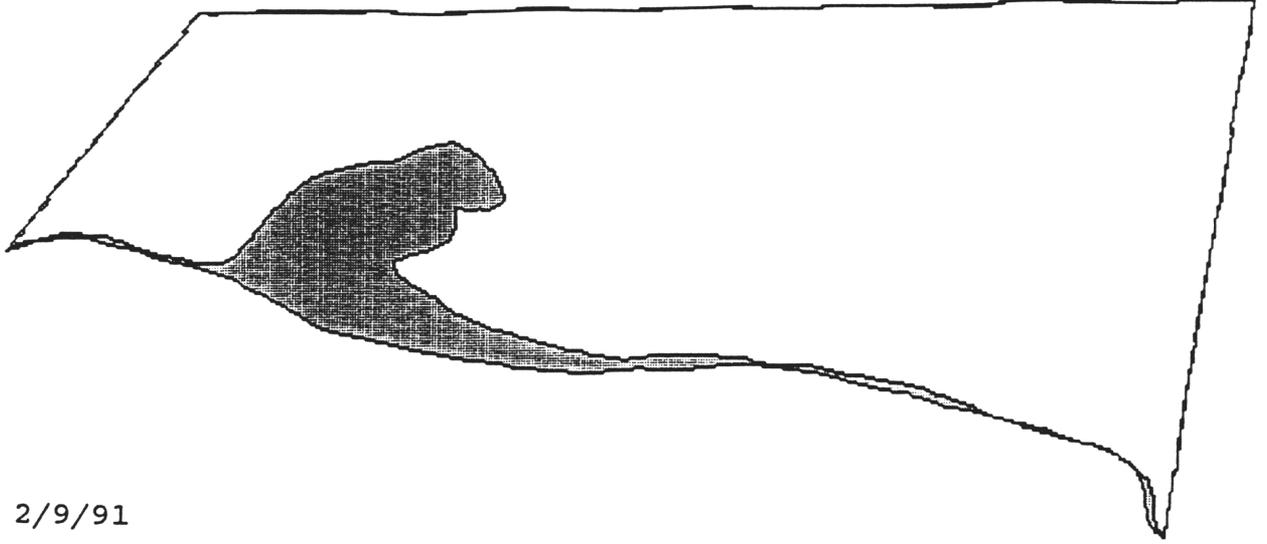
12/17/90 - 12/30/90



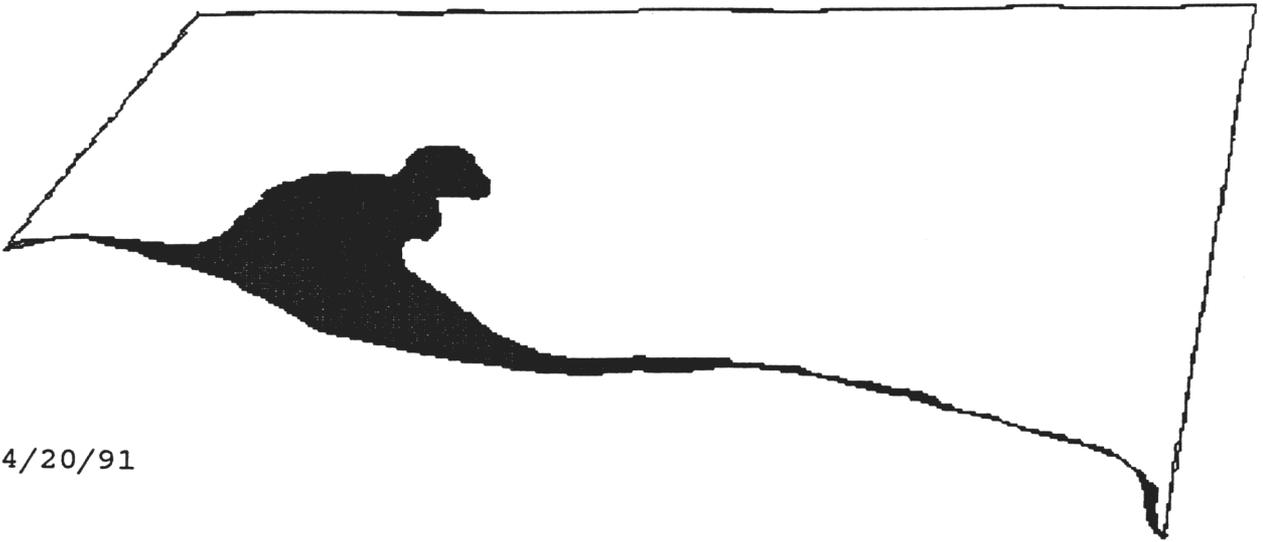
12/30/90 - 1/12/91



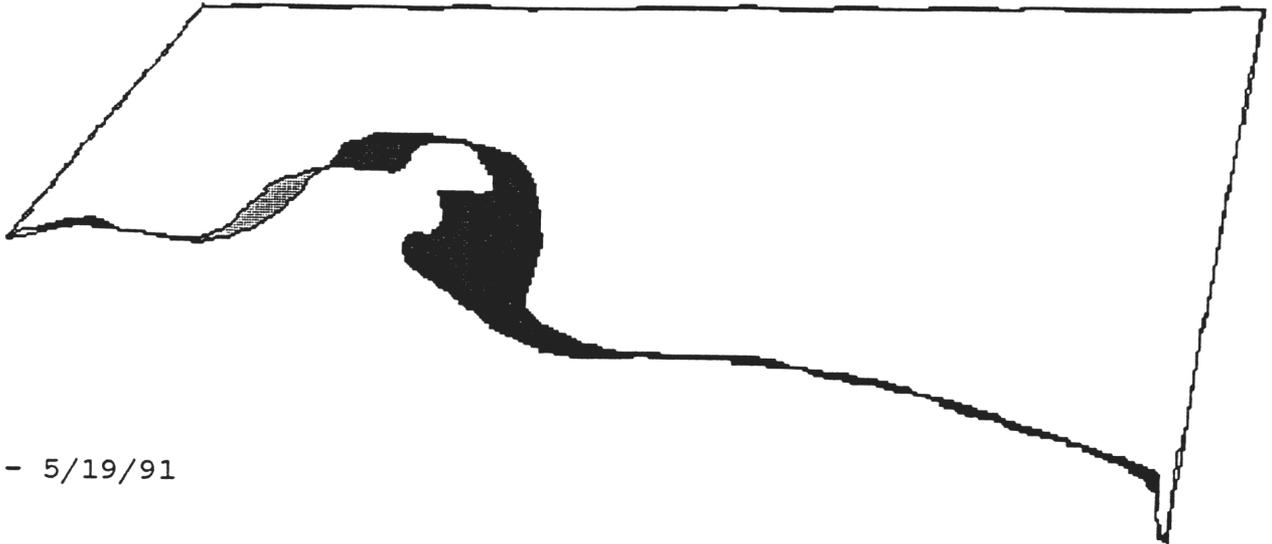
1/12/91 - 1/26/91



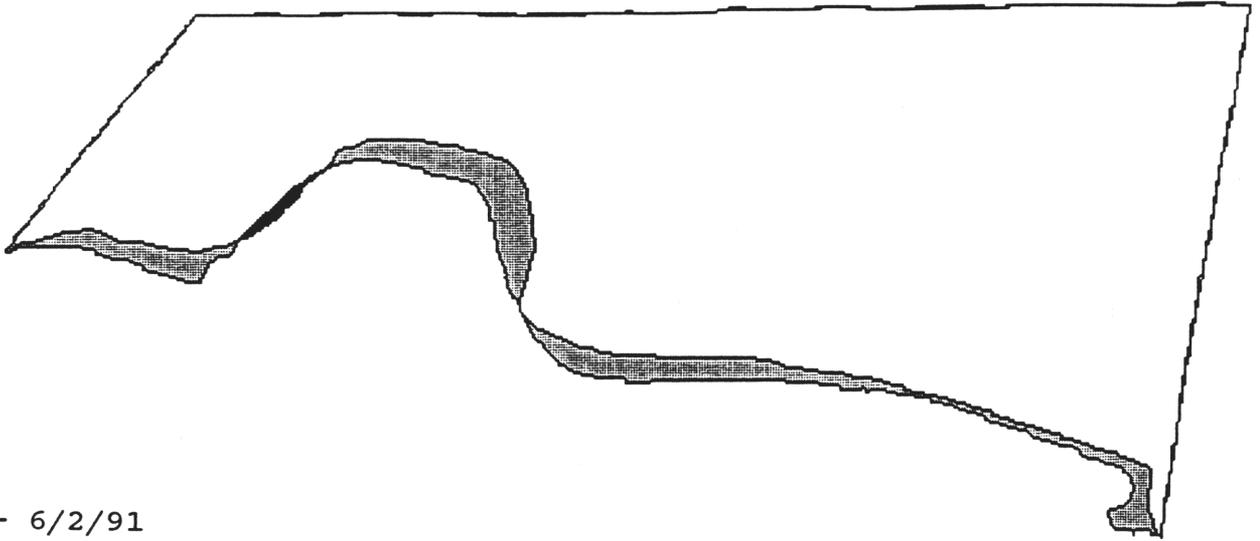
1/26/91 - 2/9/91



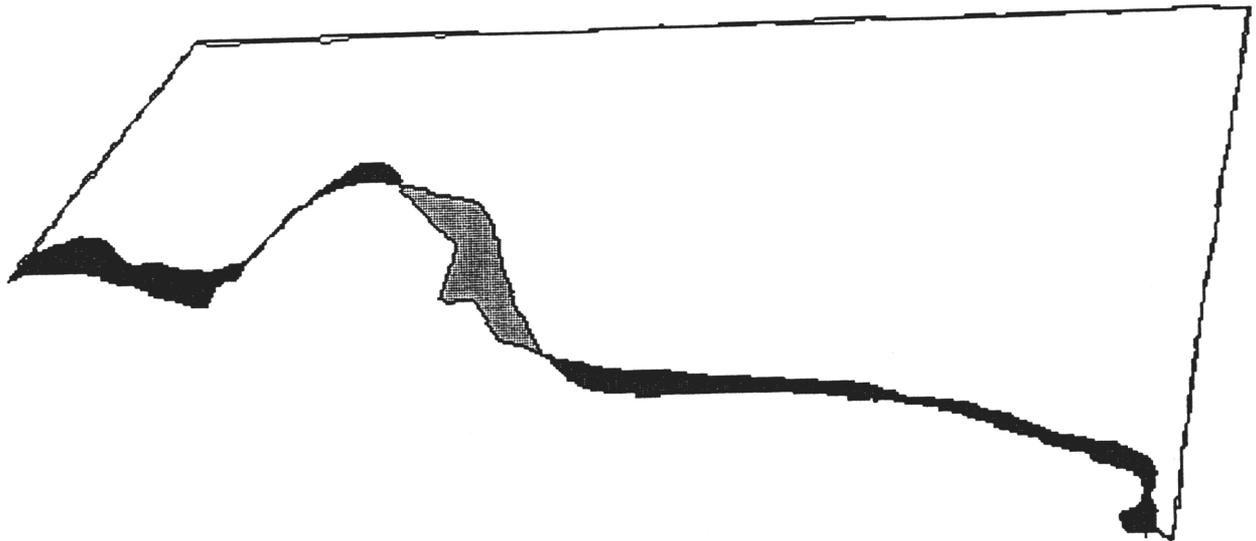
2/9/91 - 4/20/91



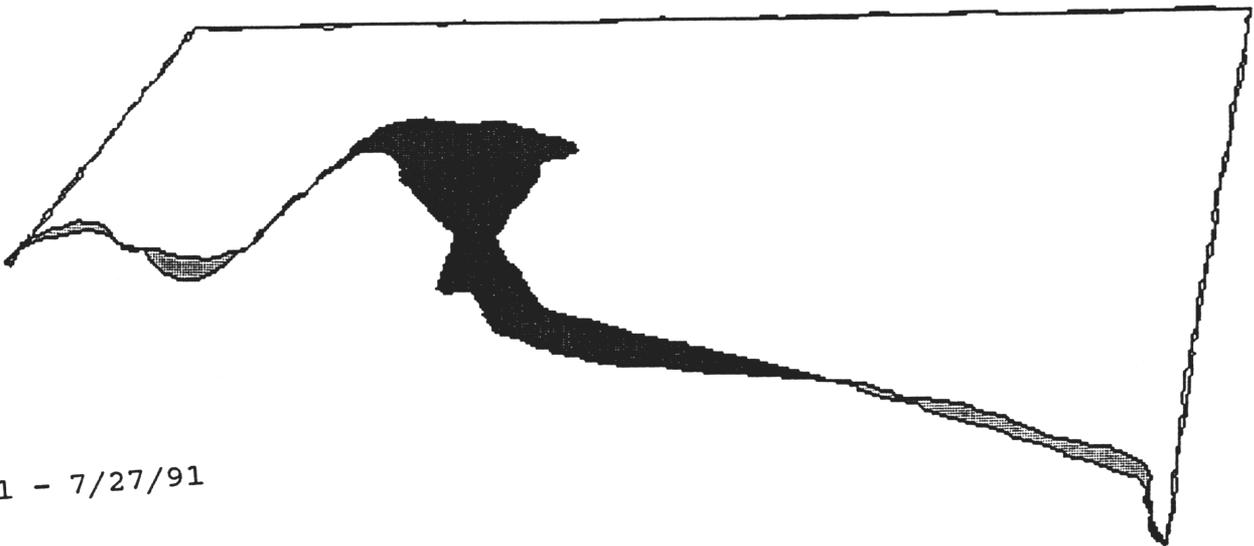
4/20/91 - 5/19/91



5/19/91 - 6/2/91

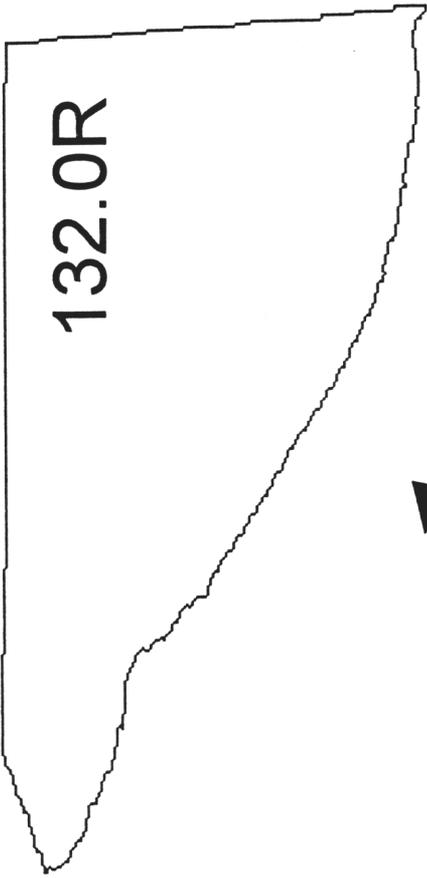


6/2/91 - 6/29/91

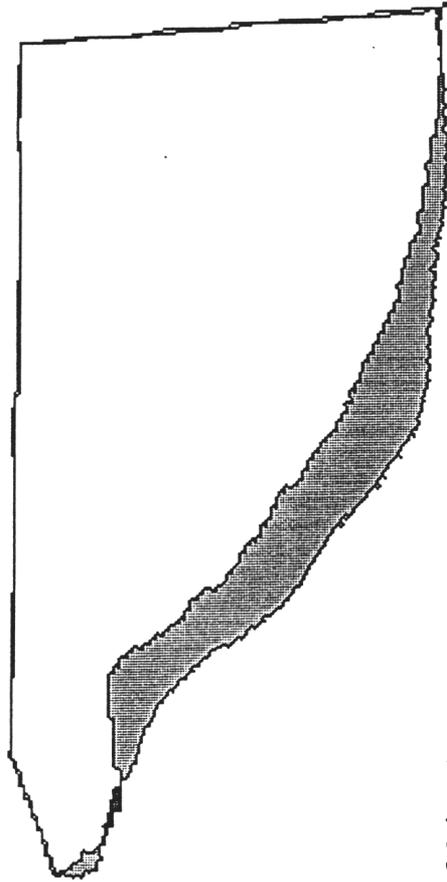


6/29/91 - 7/27/91

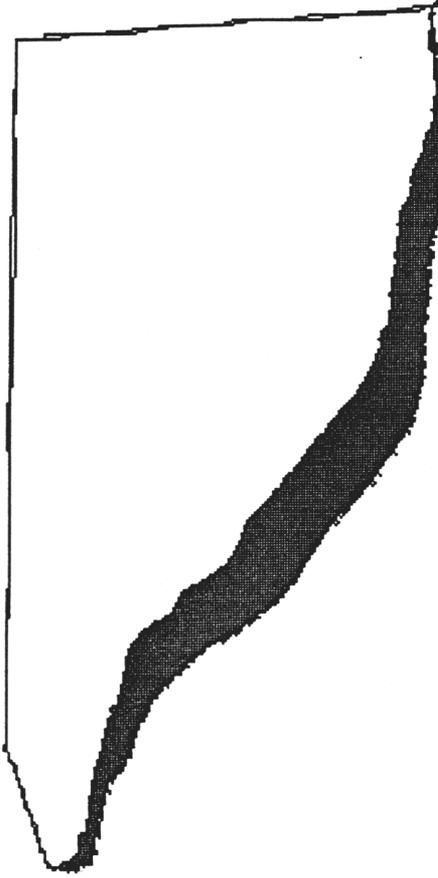
132.0R



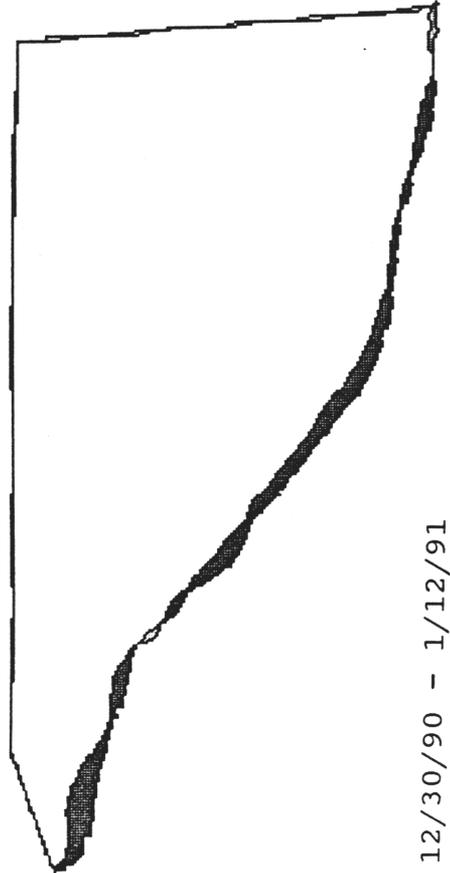
9/30/90



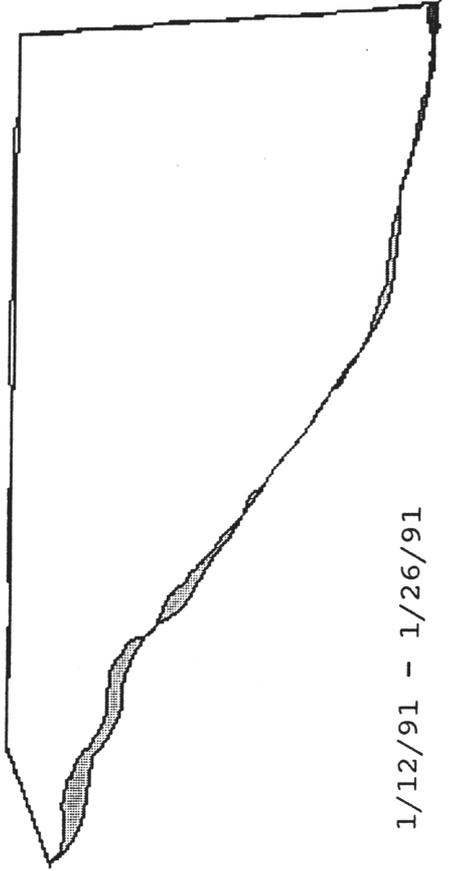
10/30/90 - 12/17/90



12/17/90 - 12/30/90



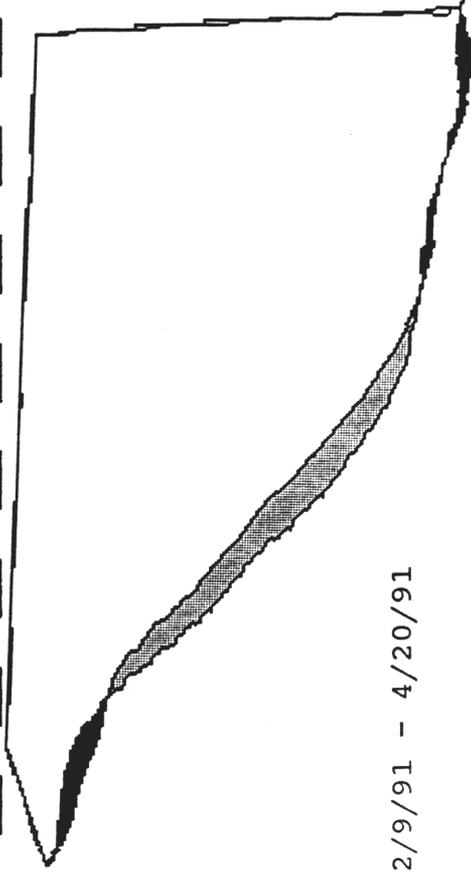
12/30/90 - 1/12/91



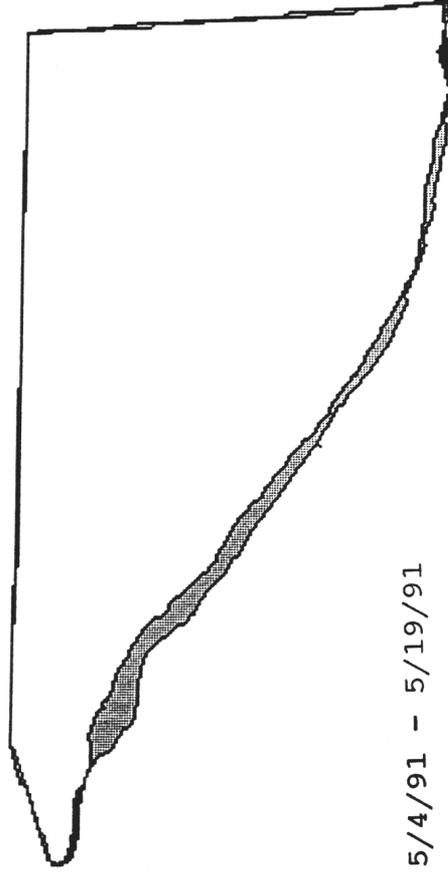
1/12/91 - 1/26/91

9/30/90 10/30/90

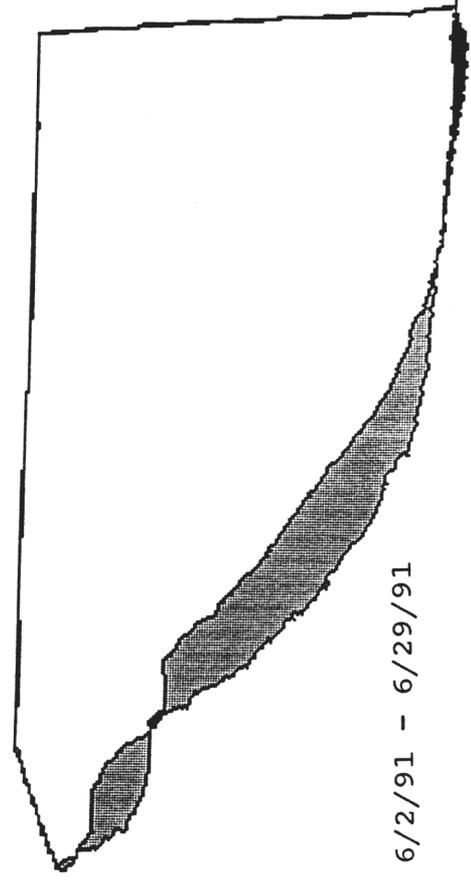




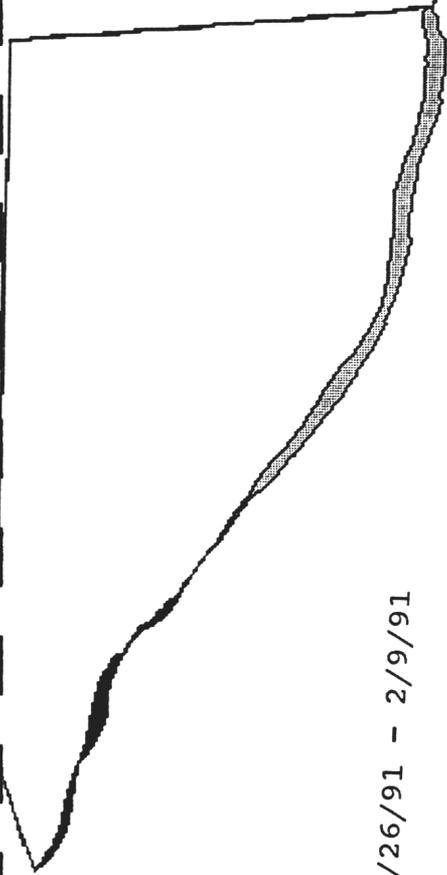
2/9/91 - 4/20/91



5/4/91 - 5/19/91



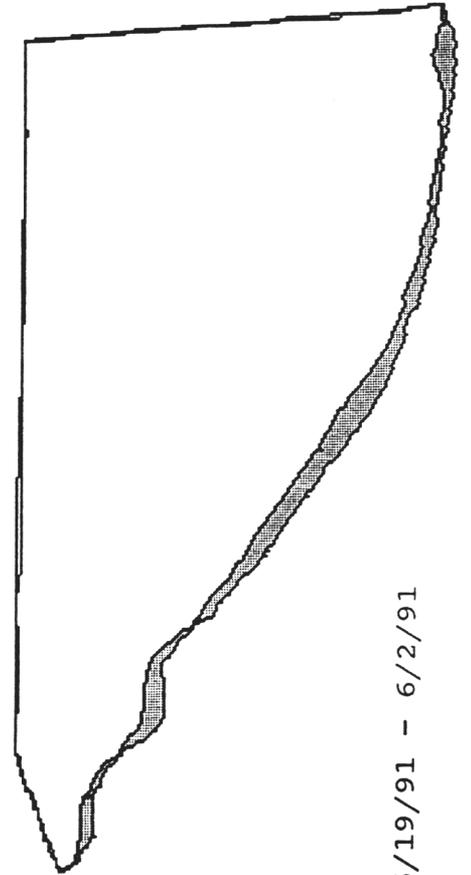
6/2/91 - 6/29/91



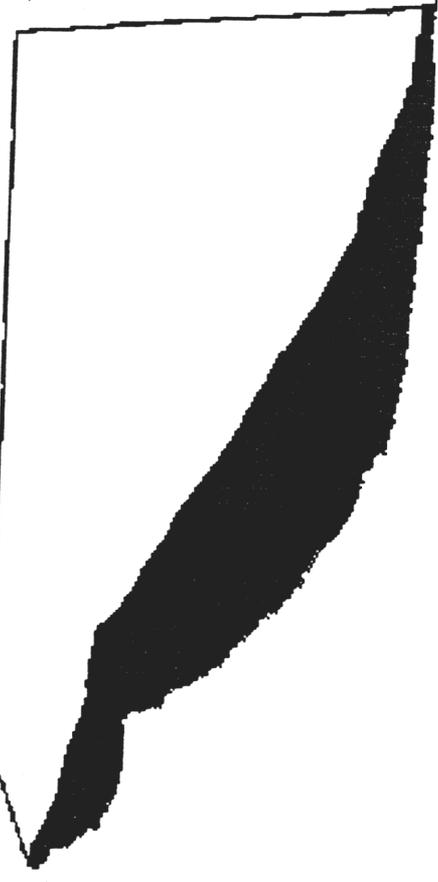
1/26/91 - 2/9/91



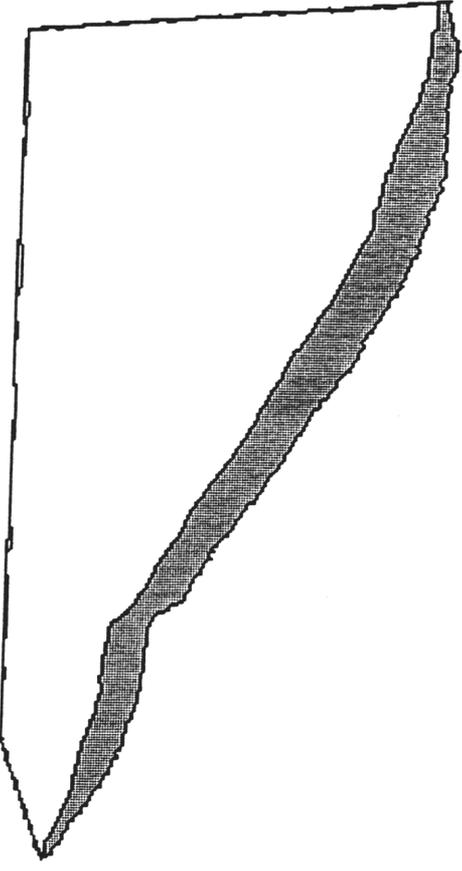
4/20/91 - 5/4/91



5/19/91 - 6/2/91



6/29/91 - 7/14/91



7/14/91 - 7/27/91

134.6L

10/30/90

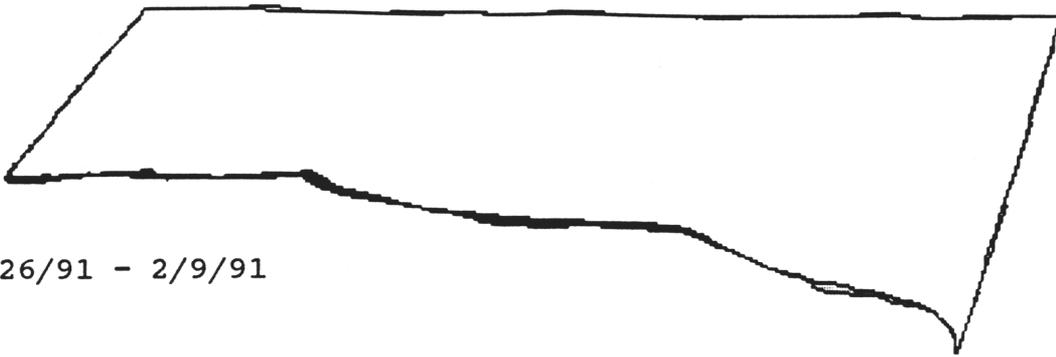


10/30/90 - 12/17/90

12/17/90 - 12/30/90

12/30/90 - 1/12/91

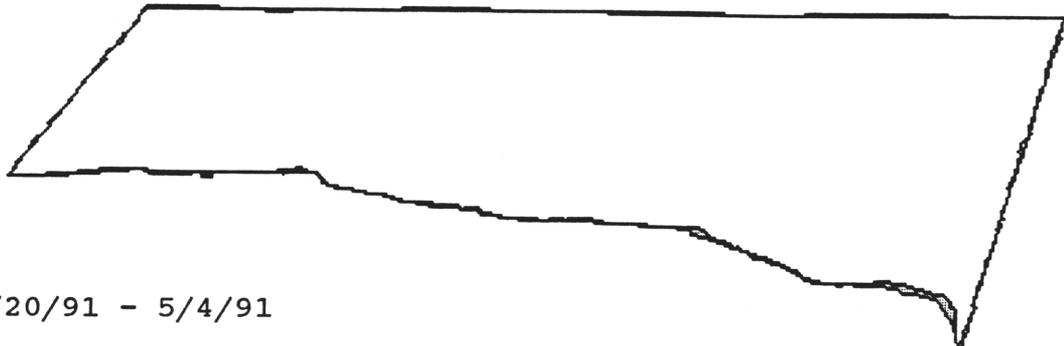
1/12/91 - 1/26/91



1/26/91 - 2/9/91



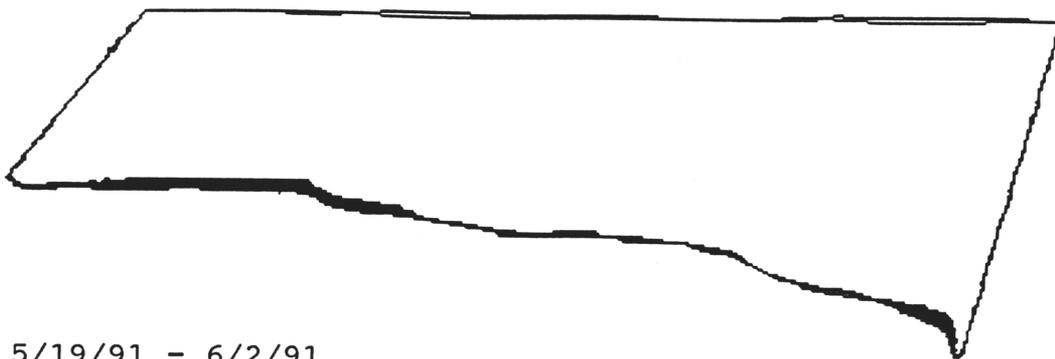
2/9/91 - 4/20/91



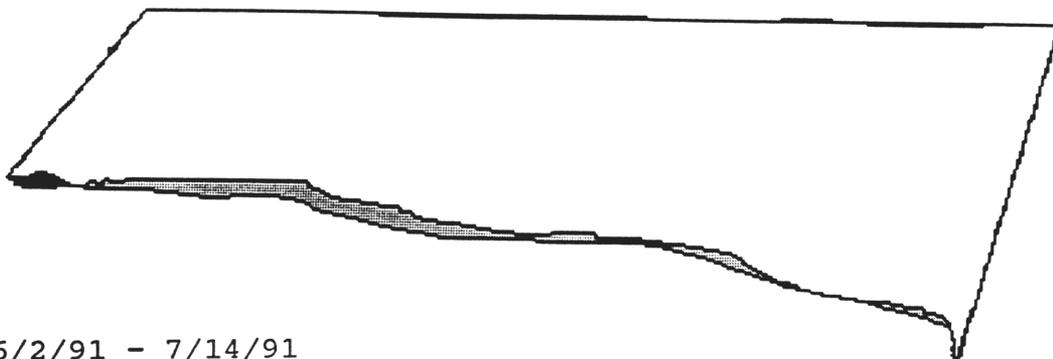
4/20/91 - 5/4/91



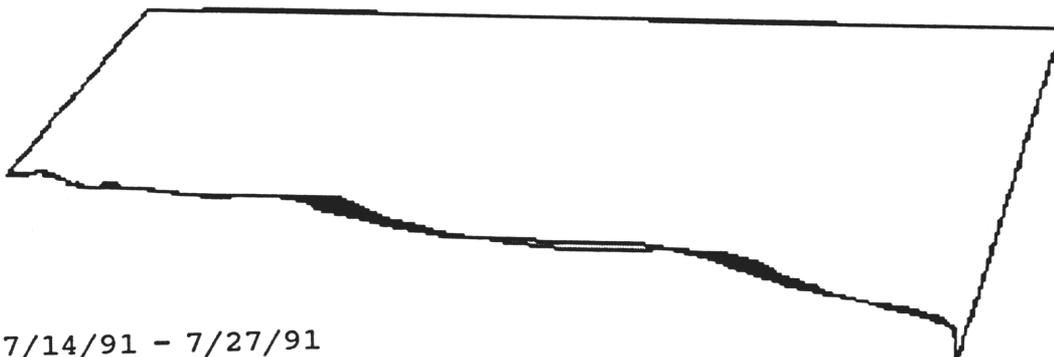
5/4/91 - 5/19/91



5/19/91 - 6/2/91

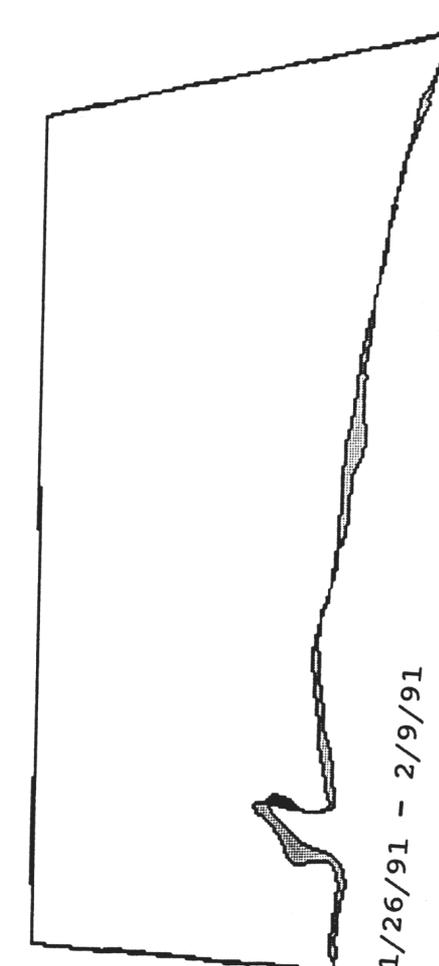
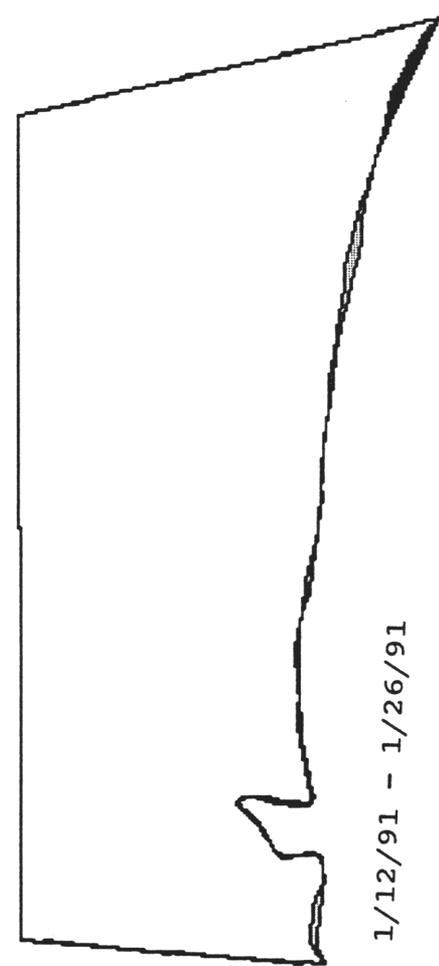
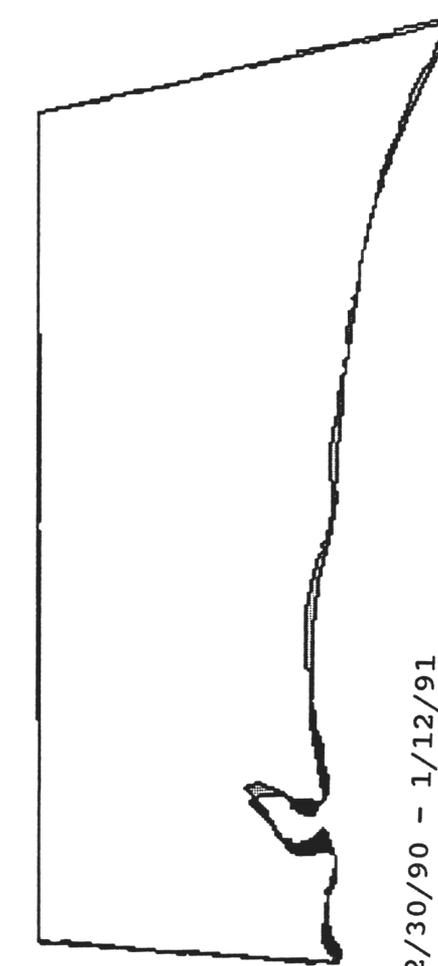
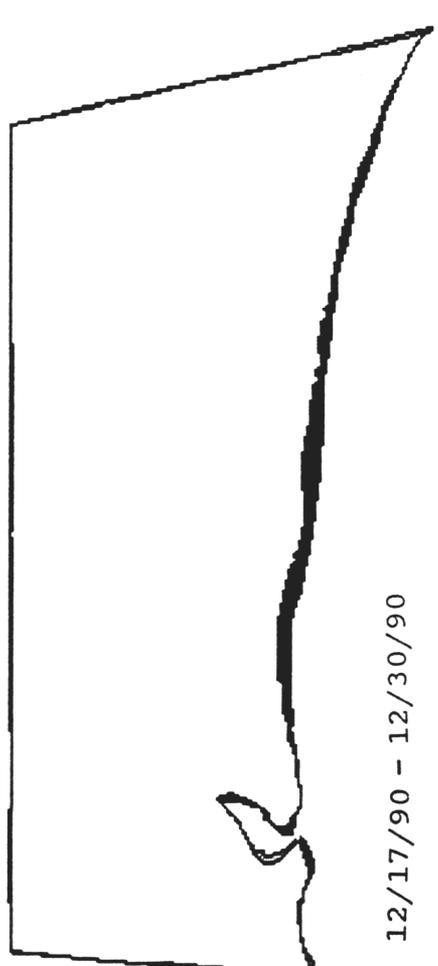
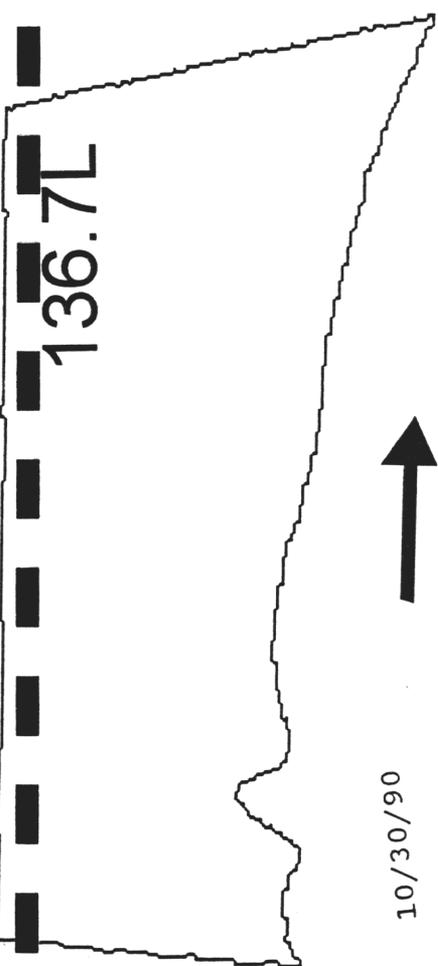


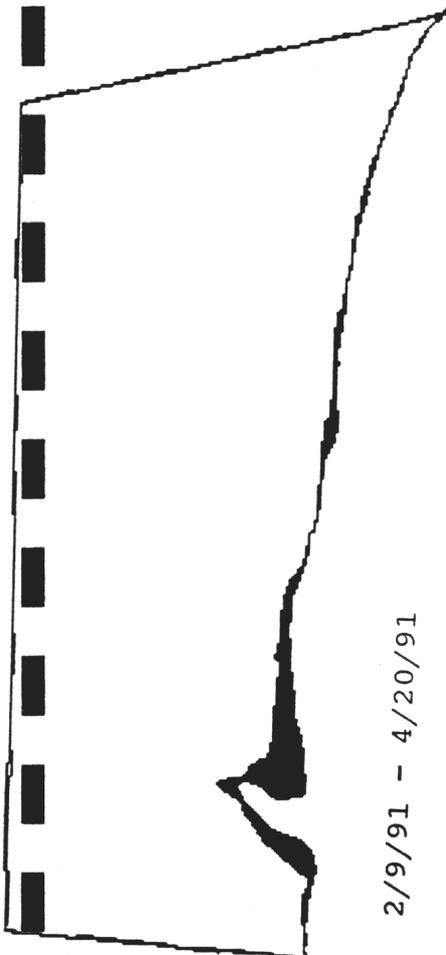
6/2/91 - 7/14/91



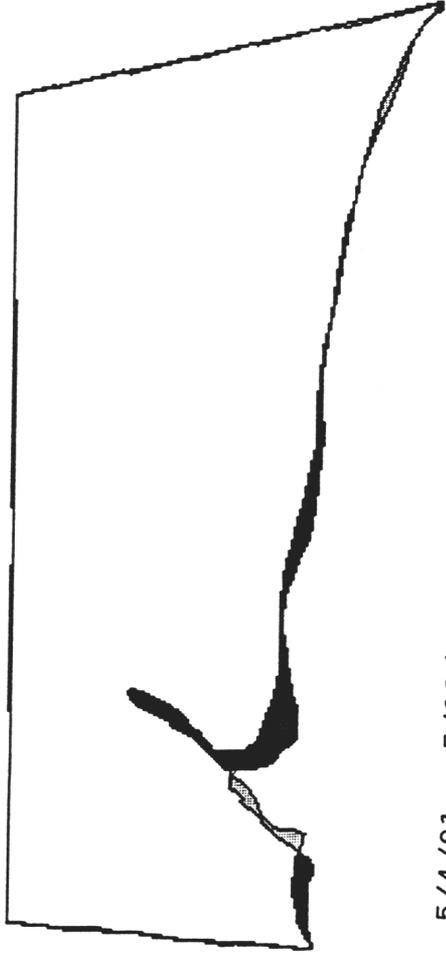
7/14/91 - 7/27/91

136.7L

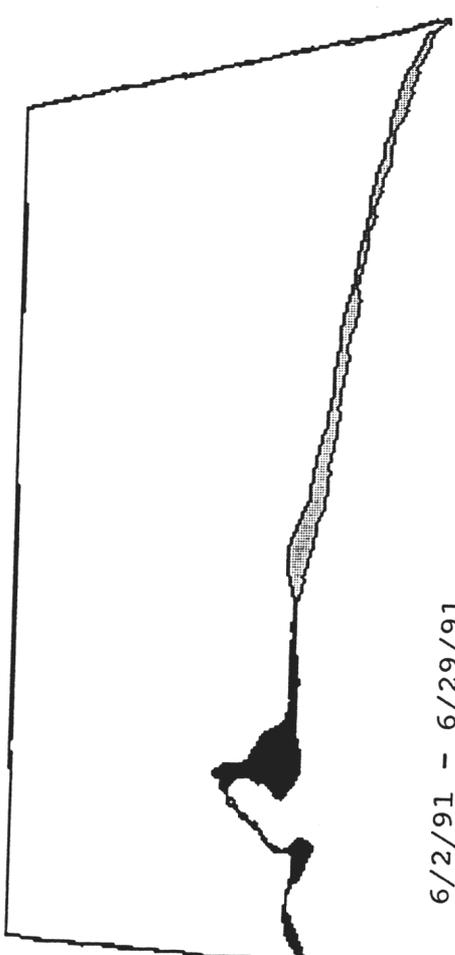




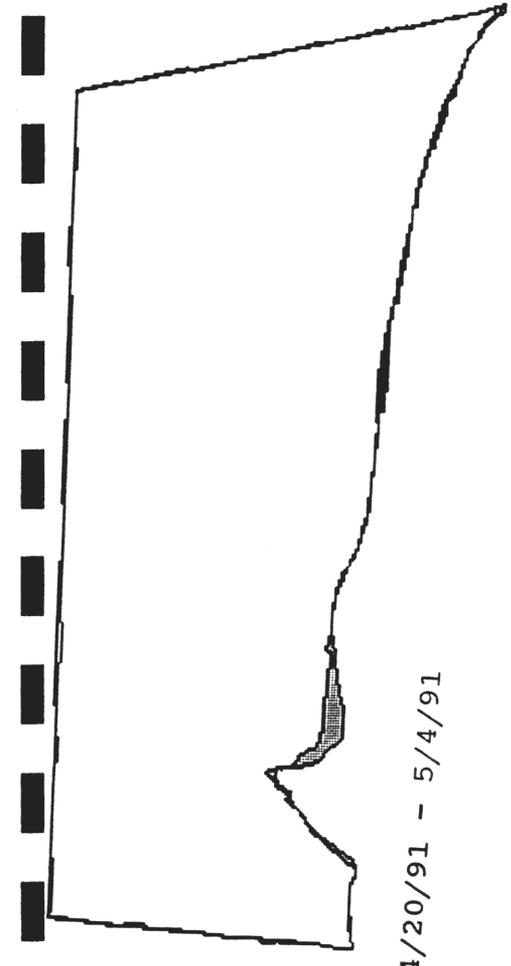
2/9/91 - 4/20/91



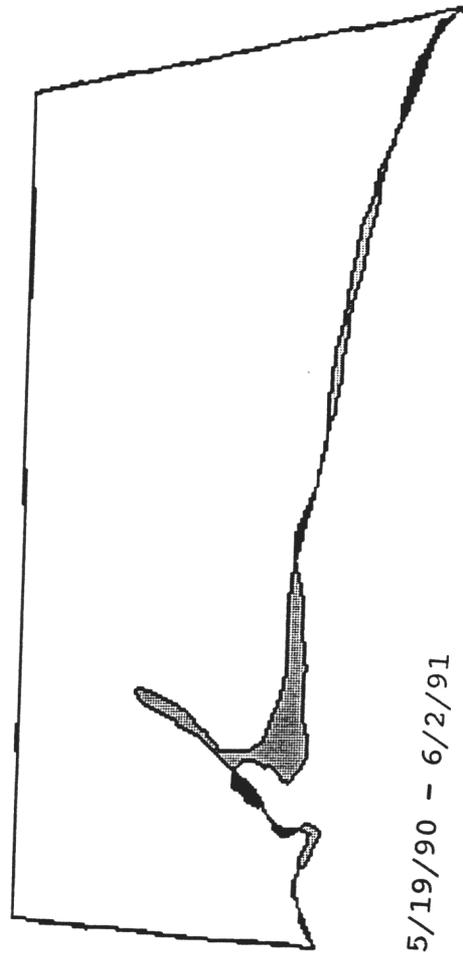
5/4/91 - 5/19/91



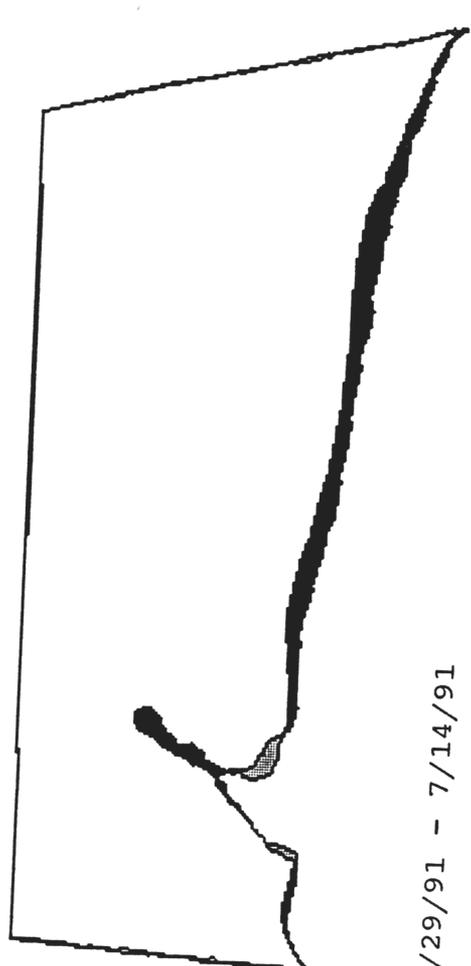
6/2/91 - 6/29/91



4/20/91 - 5/4/91

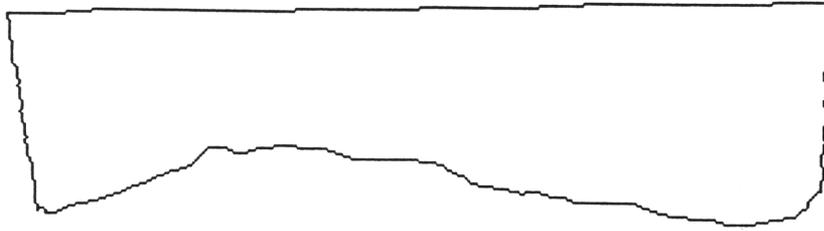


5/19/90 - 6/2/91

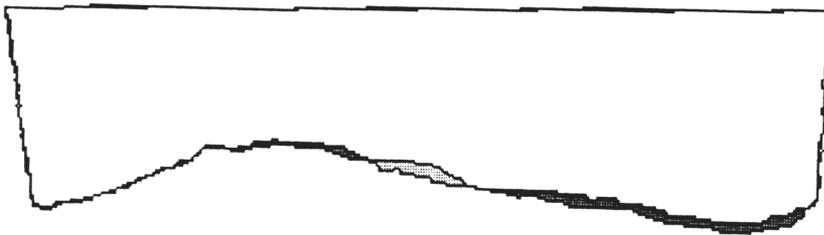


6/29/91 - 7/14/91

139.0R



9/30/90



9/30/90 - 10/30/90



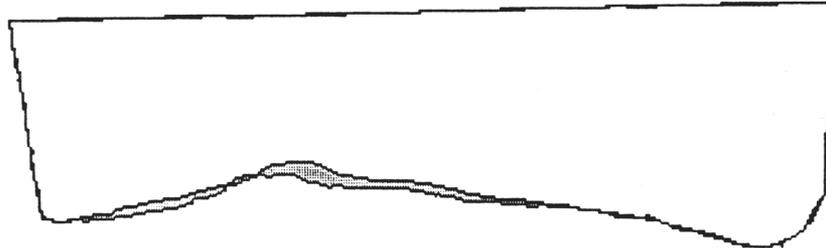
10/30/90 - 12/17/90



12/17/90 - 12/30/90



12/30/90 - 1/12/91



1/12/91 - 1/26/91



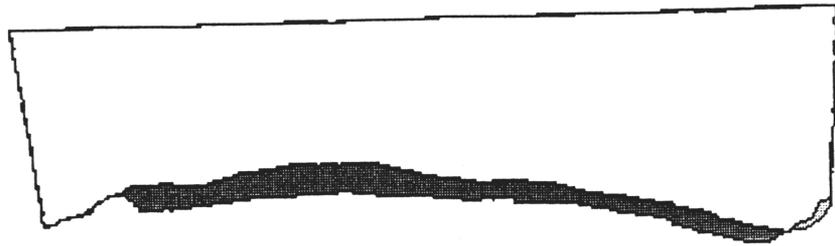
1/26/91 - 2/9/91



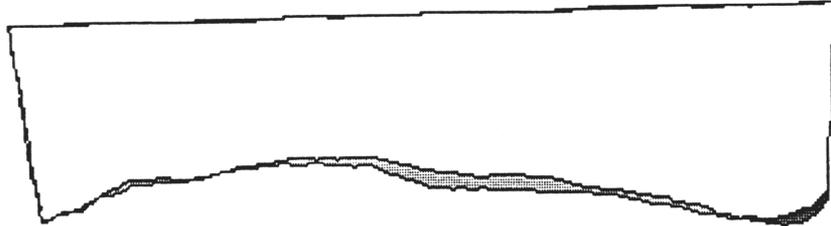
2/9/91 - 4/20/91



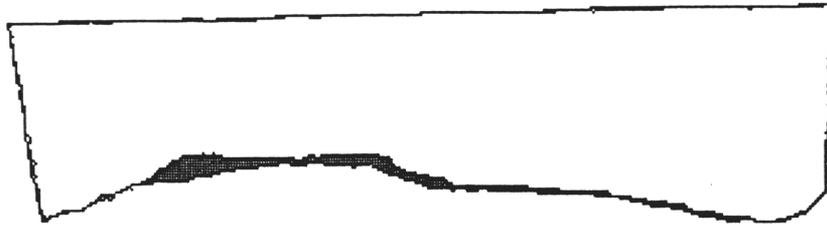
4/20/91 - 5/4/91



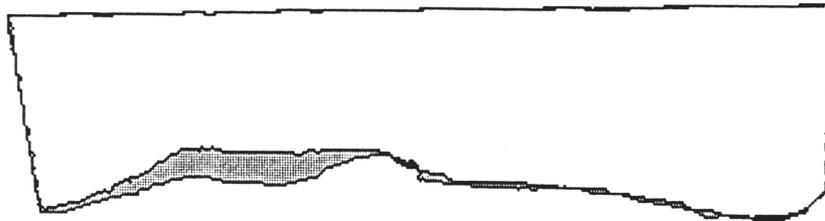
5/4/91 - 5/19/91



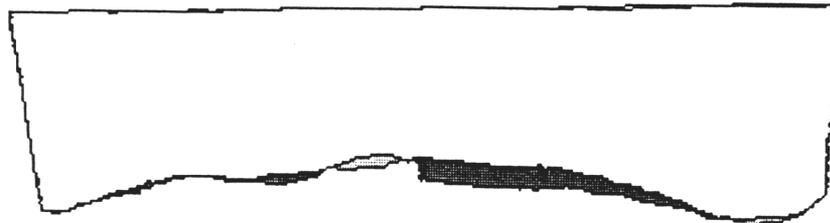
5/19/91 - 6/2/91



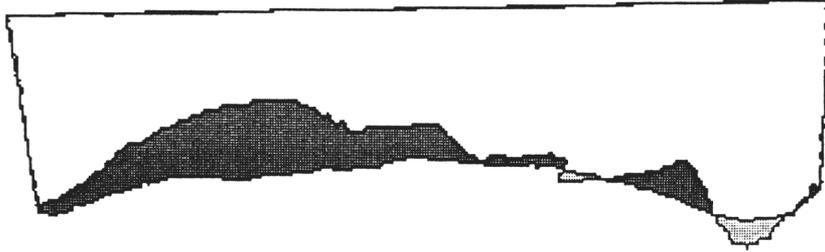
6/2/91 - 6/29/91



6/29/91 - 7/14/91



7/14/91 - 7/27/91



7/27/91 - 6/1/92

145.5L



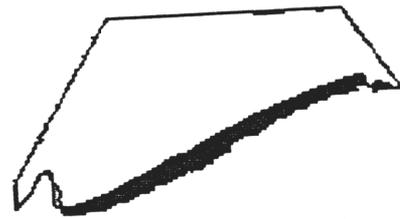
10/15/90



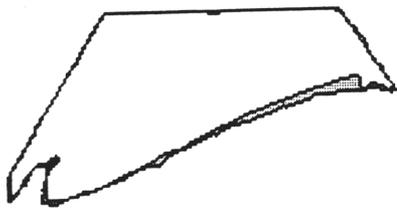
10/15/90 - 10/30/90



10/30/90 - 12/17/90



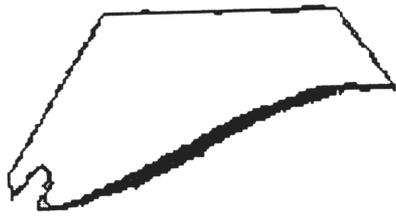
12/17/90 - 12/30/90



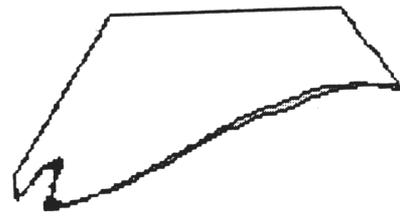
12/30/90 - 1/12/91



1/12/91 - 1/26/91



1/26/91 - 2/9/91



2/9/91 - 4/20/91



4/20/91 - 5/19/91



5/19/91 - 6/2/91



6/2/91 - 6/30/91

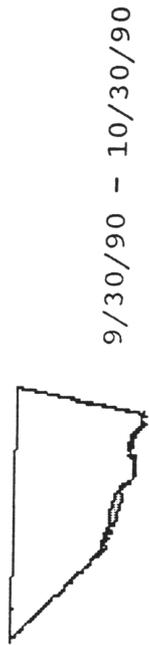


6/30/91 - 7/14/91



7/14/91 - 7/27/91

153.6R





5/4/91 - 6/2/91



7/27/91 - 10/12/91



6/2/91 - 6/29/91



10/12/91 - 6/1/92



6/29/91 - 7/14/91

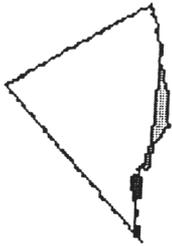


7/14/91 - 7/27/91

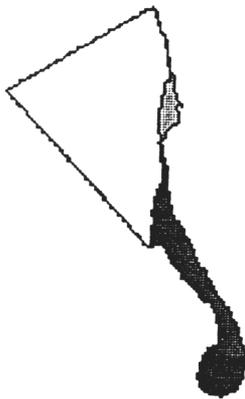
157.7R



9/30/90



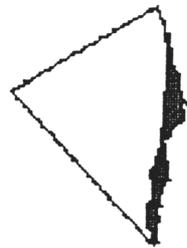
12/17/90 - 12/30/90



9/30/90 - 10/30/90



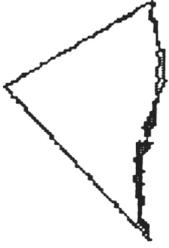
12/30/90 - 1/12/91



10/30/90 - 12/17/90



1/12/91



5/4/91 - 5/19/91



5/19/91 - 6/2/91



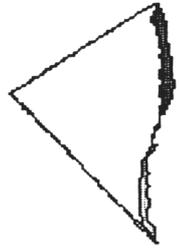
6/2/91 - 6/30/91



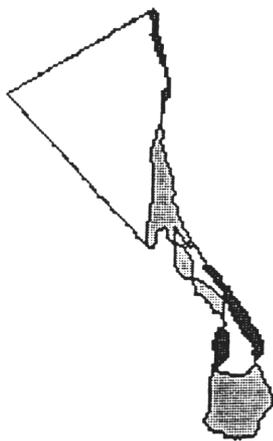
1/26/91 - 2/9/91



2/9/91 - 4/20/91



4/20/91 - 5/4/91



6/30/91 - 7/14/91



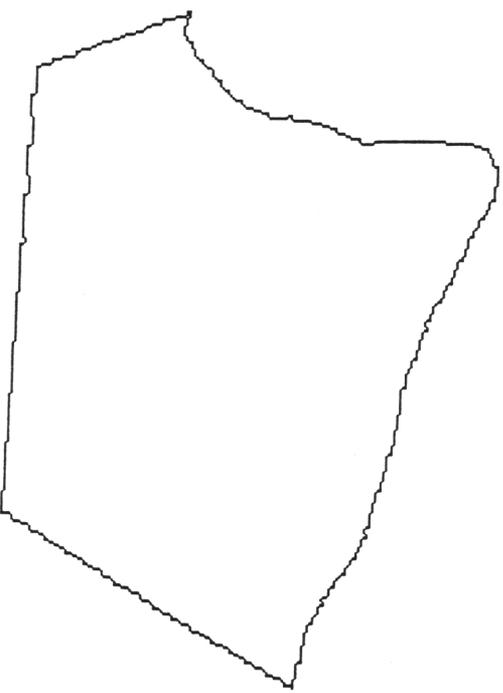
7/14/91 - 7/27/91



7/27/91 - 6/1/92



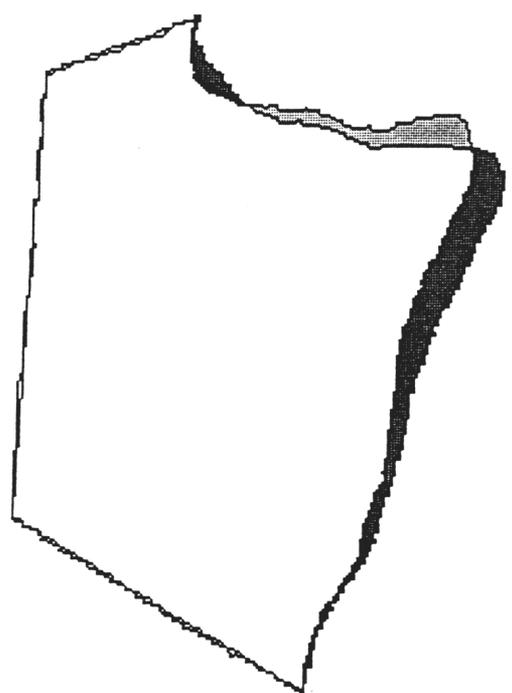
166.5L



9/30/90



10/30/90 - 12/17/90



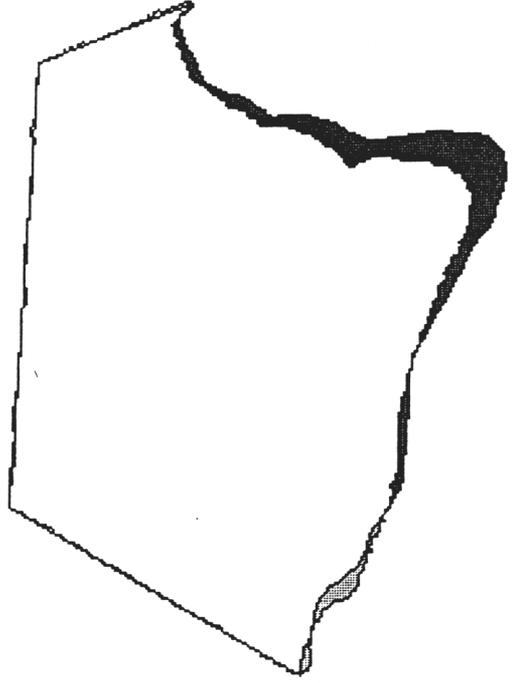
9/30/90 - 10/30/90



12/17/90 - 12/30/90



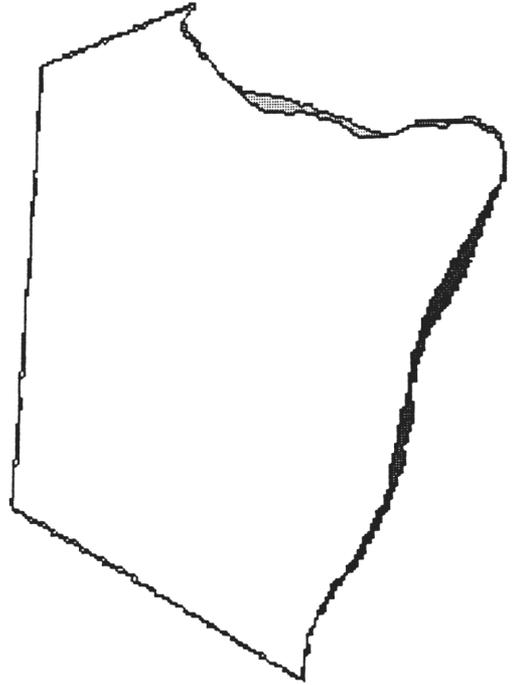
1/26/91 - 2/9/91



2/9/91 - 4/20/91



12/30/90 - 1/12/91



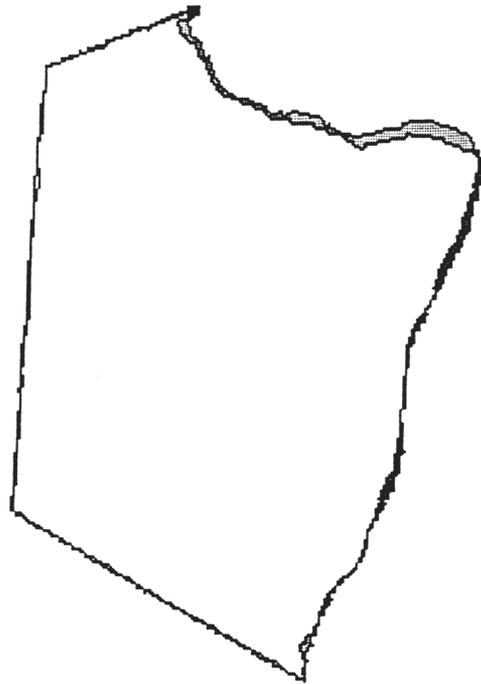
1/12/91 - 1/26/91



4/20/91 - 5/4/91



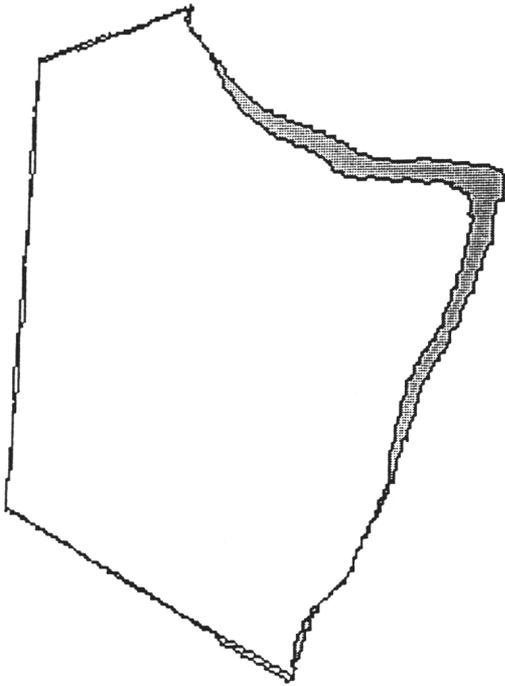
5/19/91 - 6/2/91



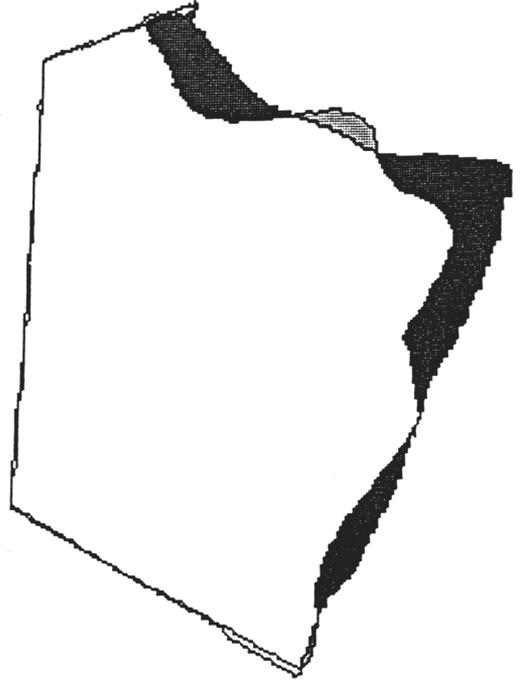
5/4/91 - 5/19/91



6/2/91 - 6/30/91



6/30/91 - 7/14/91

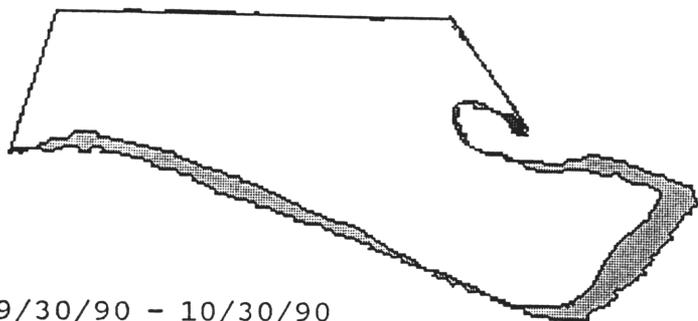


7/14/91 - 10/12/91

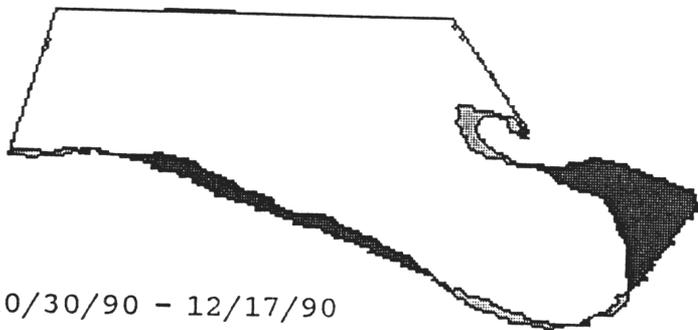
168.0R



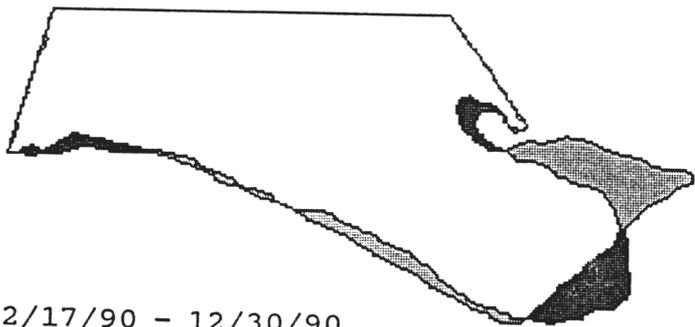
9/30/90



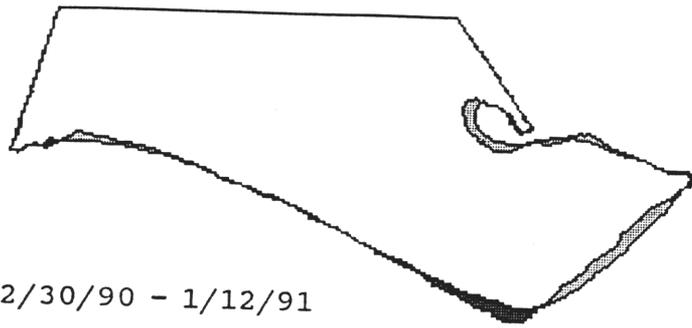
9/30/90 - 10/30/90



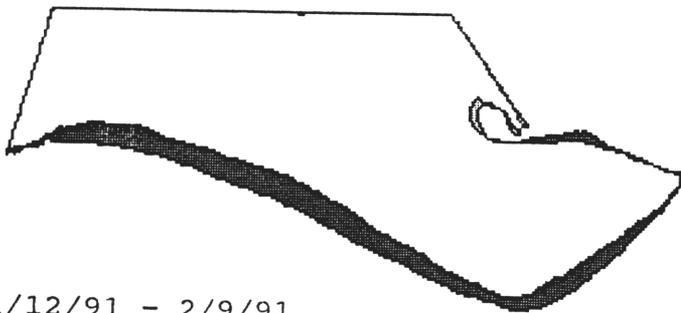
10/30/90 - 12/17/90



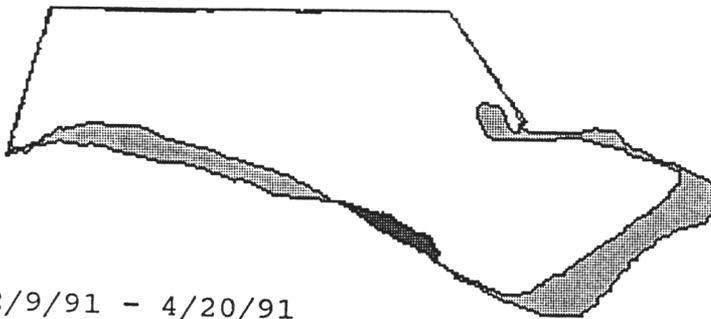
12/17/90 - 12/30/90



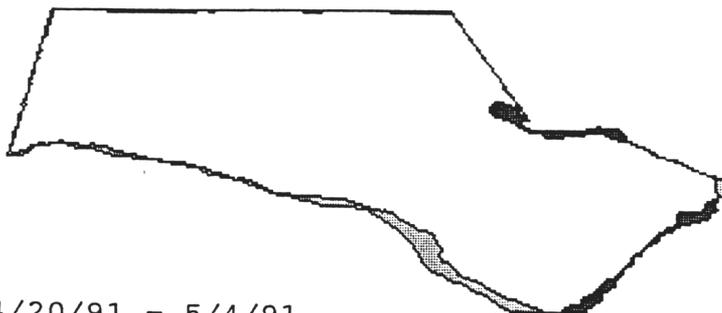
12/30/90 - 1/12/91



1/12/91 - 2/9/91



2/9/91 - 4/20/91



4/20/91 - 5/4/91



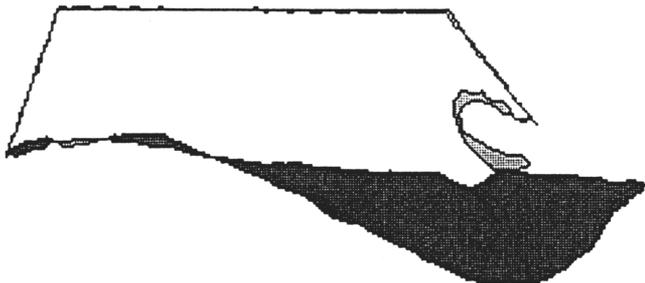
5/4/91 - 6/2/91



6/2/91 - 6/30/91

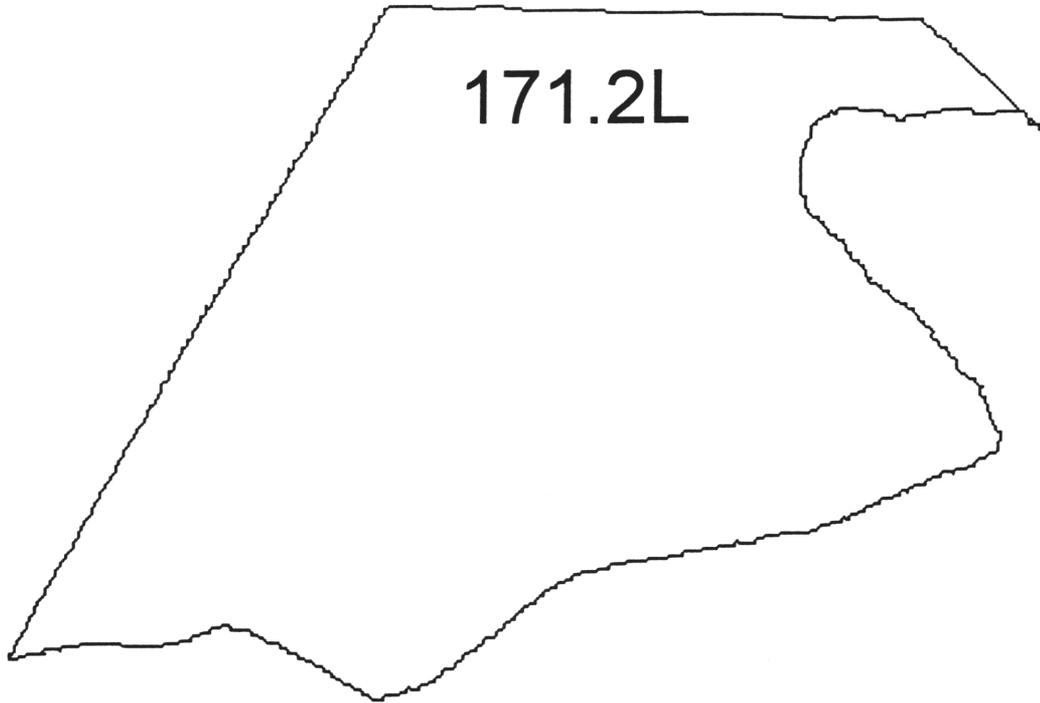


6/30/91 - 7/27/91



7/27/91 - 10/12/91

171.2L

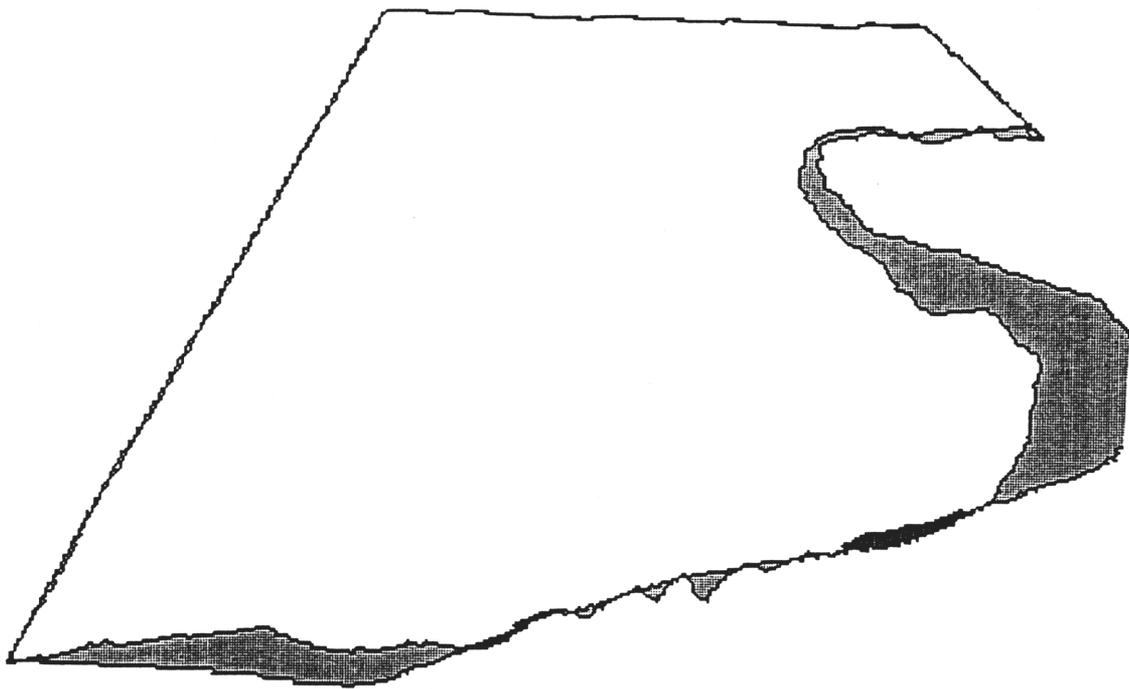


12/17/90

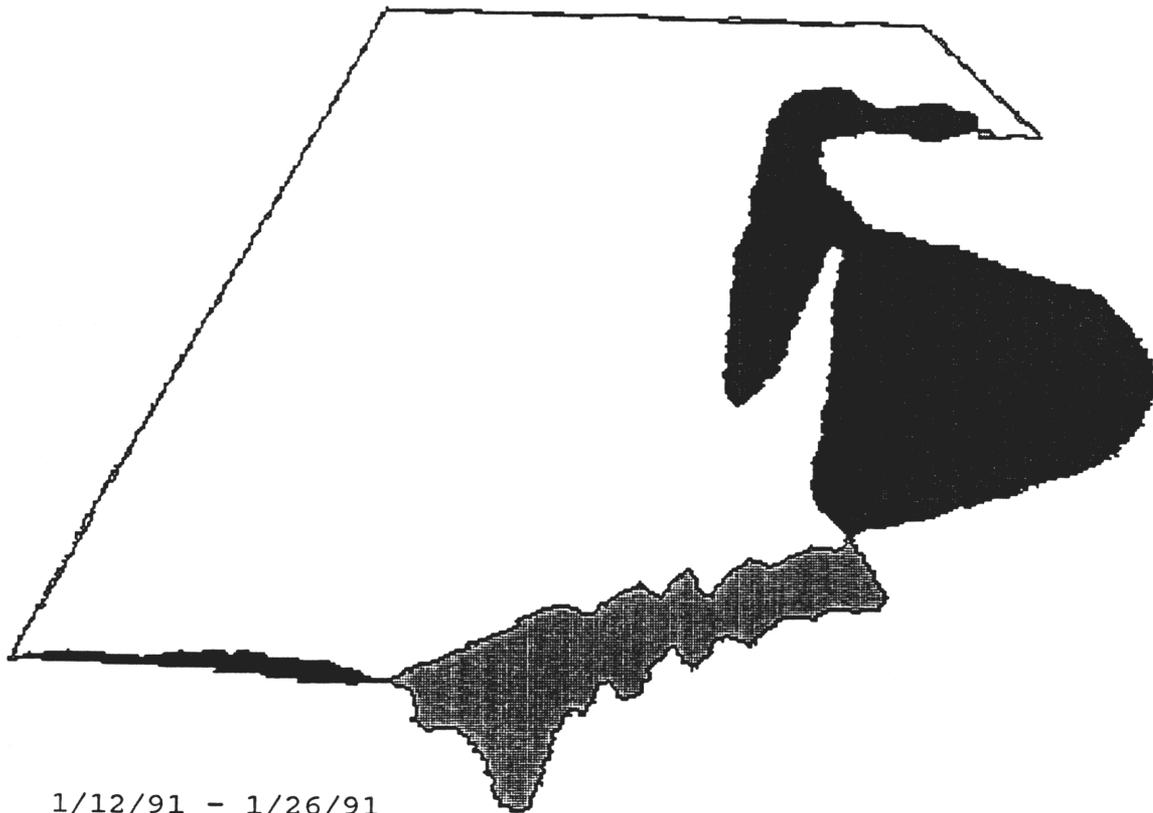


12/17/90 - 12/30/90

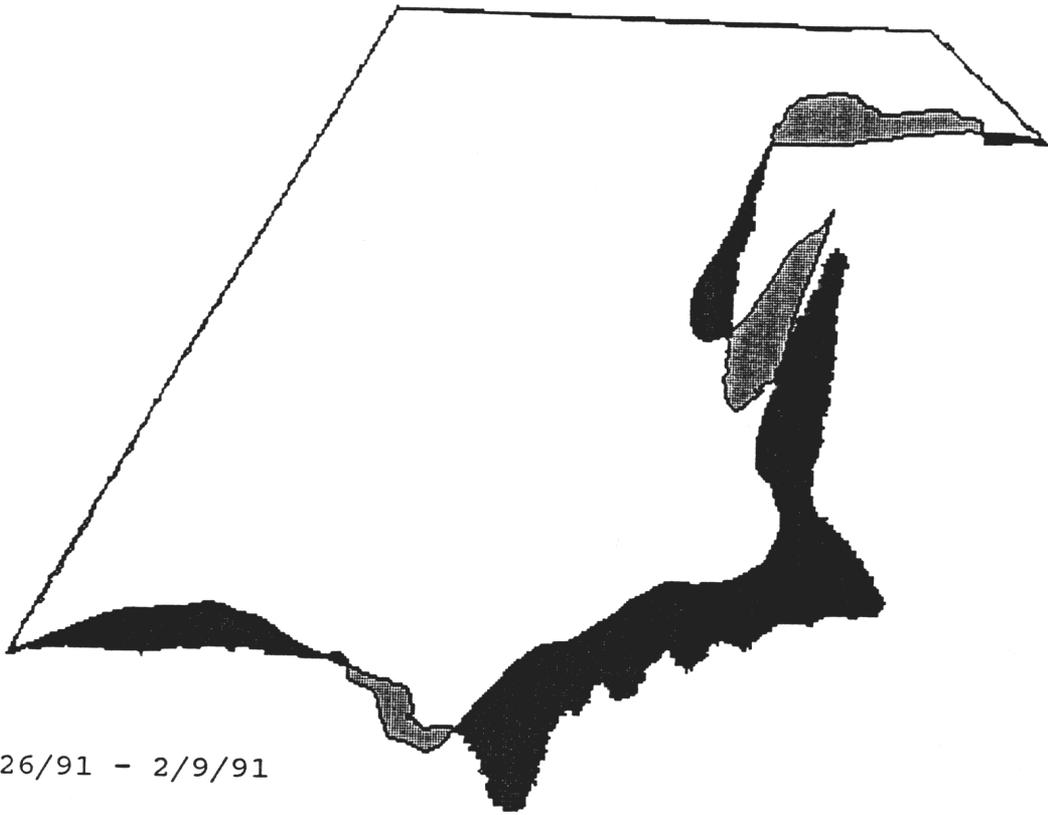




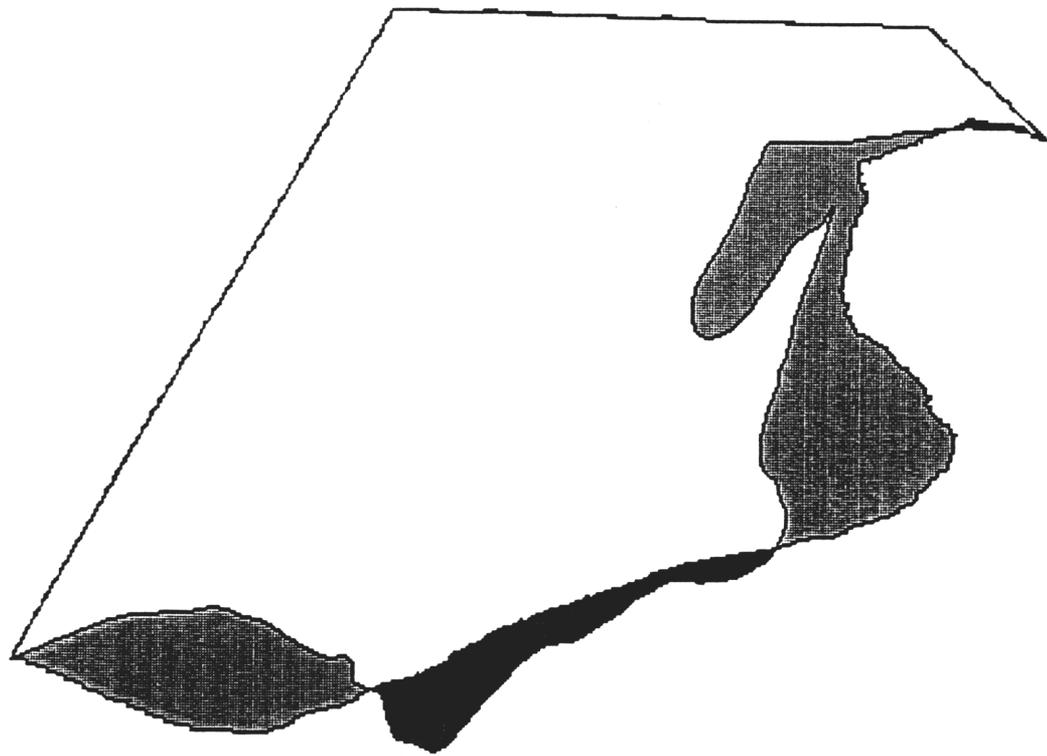
12/30/90 - 1/12/91



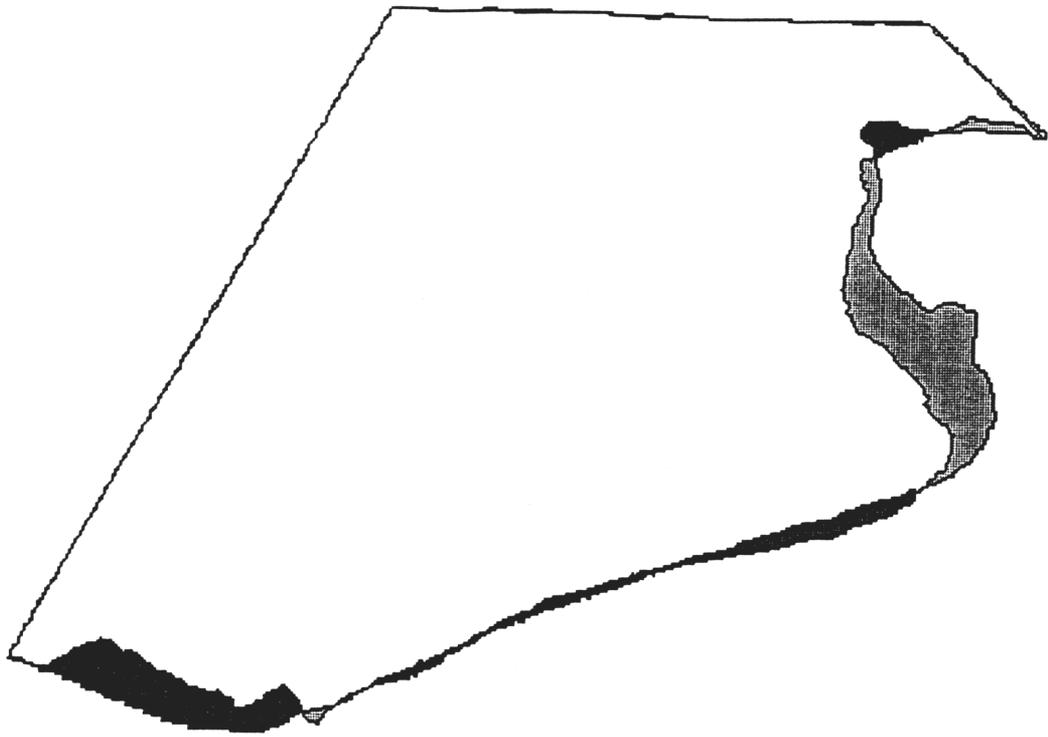
1/12/91 - 1/26/91



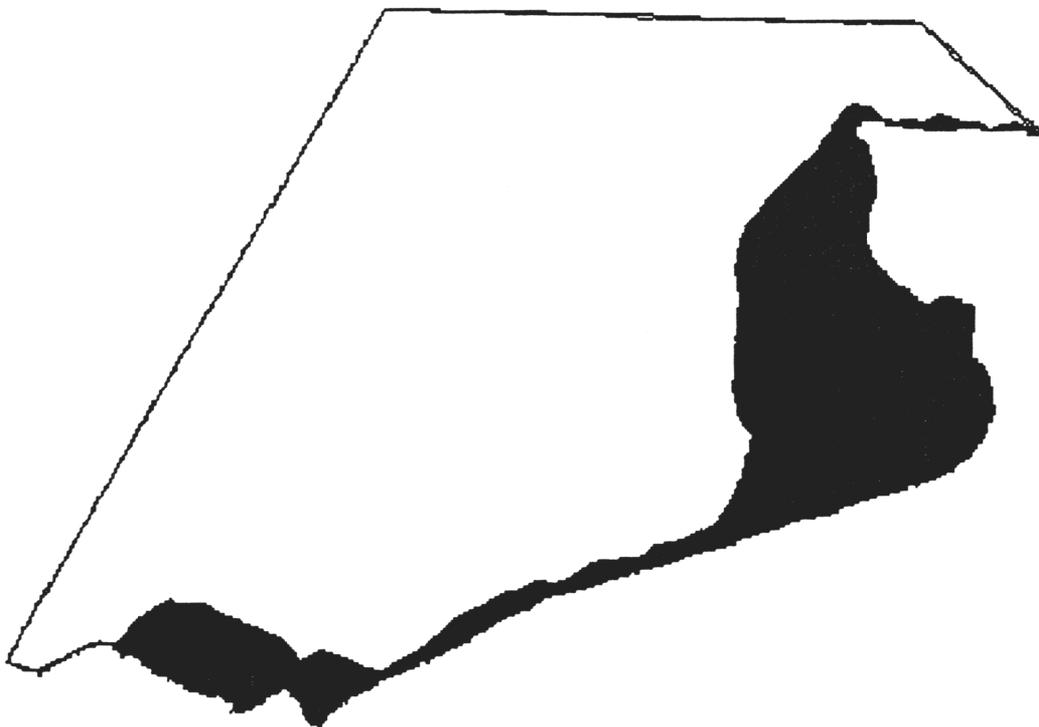
1/26/91 - 2/9/91



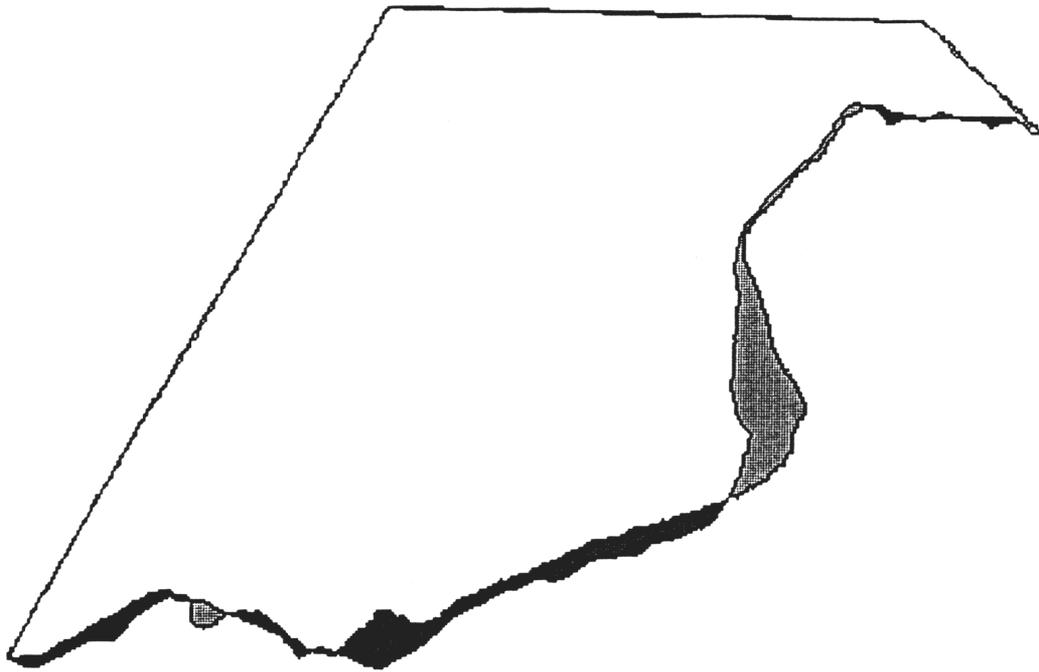
2/9/91 - 4/20/91



4/20/91 - 5/4/91



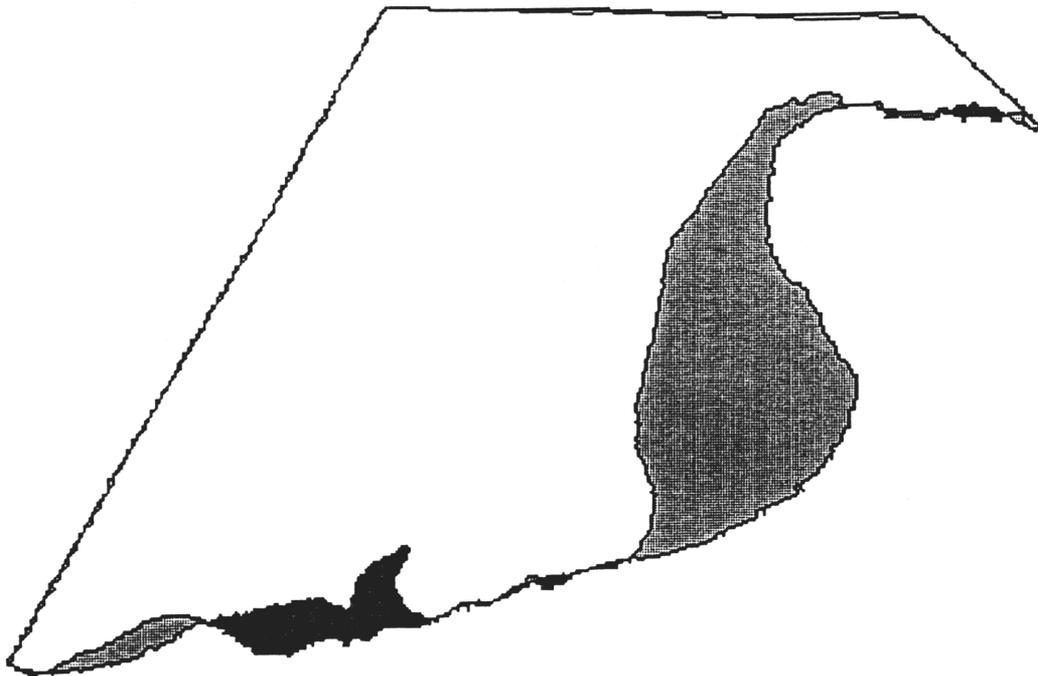
5/4/91 - 5/19/91



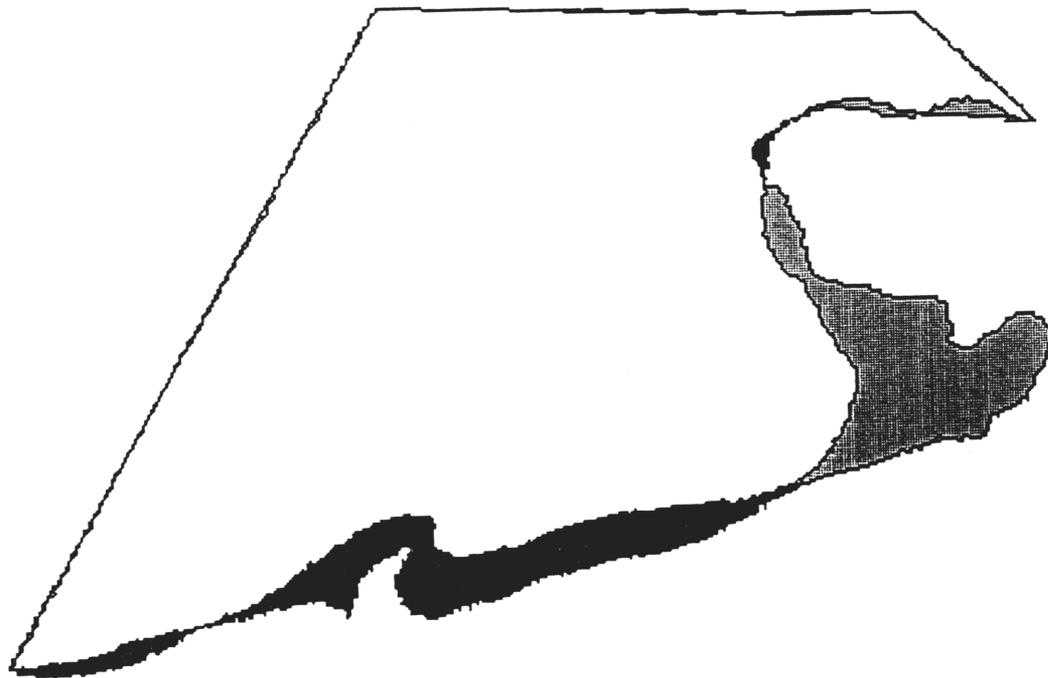
5/19/91 - 6/2/91



6/2/91 - 6/30/91



6/30/91 - 7/14/91



7/14/91 - 7/27/91

172.3L

09/30/90

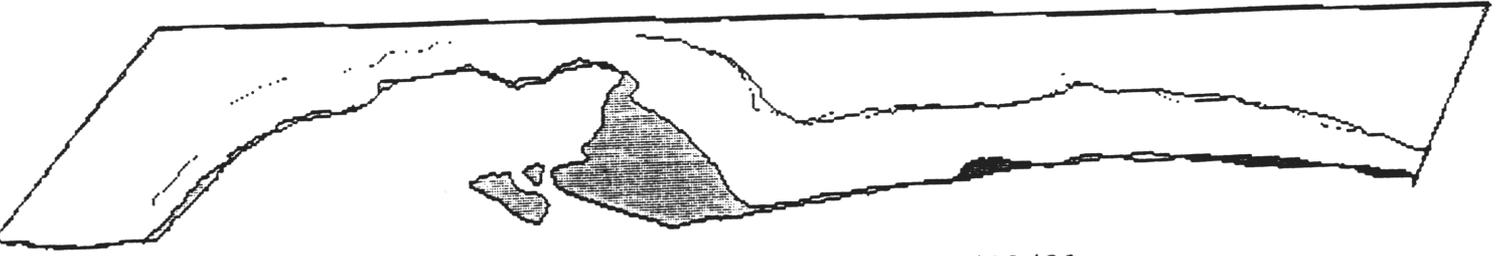
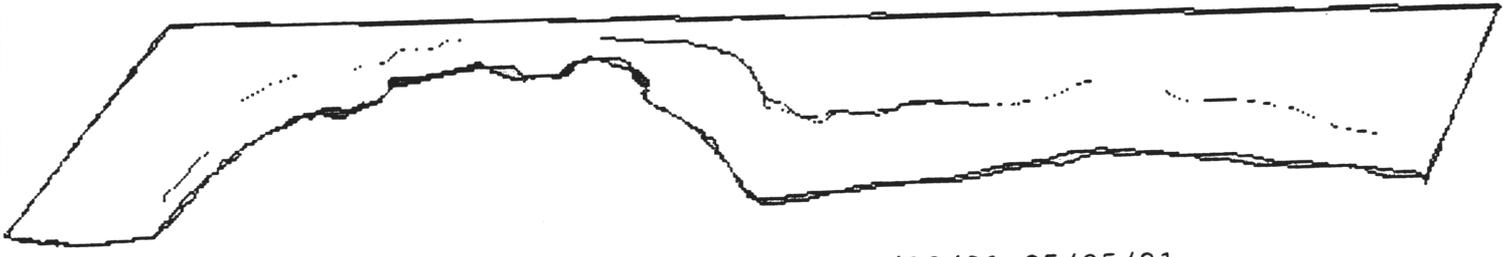
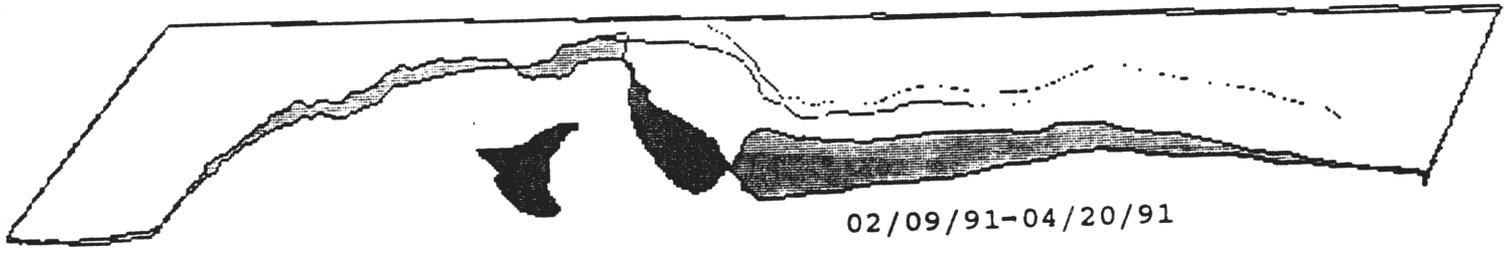
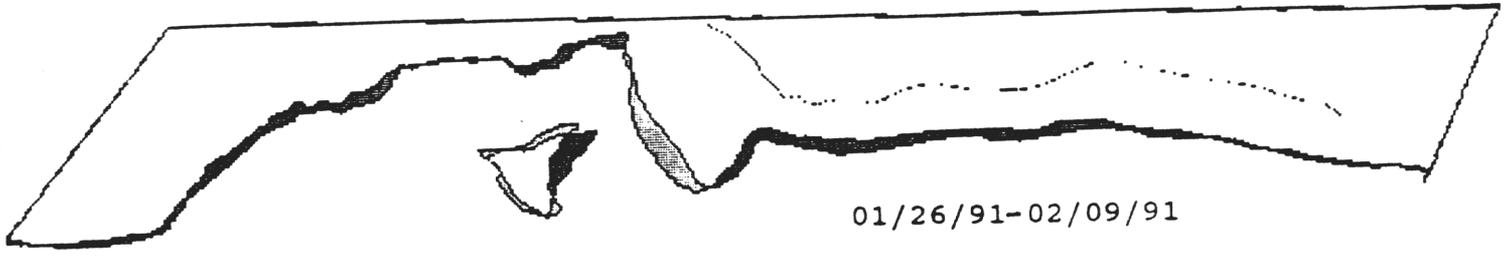


09/30/90-10/30/90

10/30/90-11/11/90

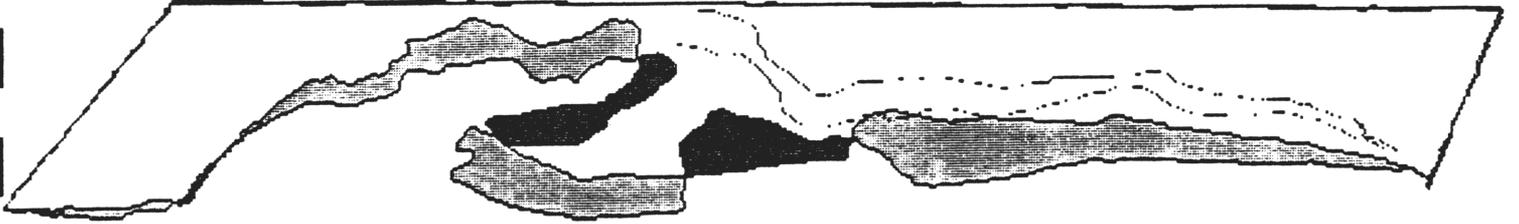
12/17/90-12/30/90

12/30/90-01/12/91

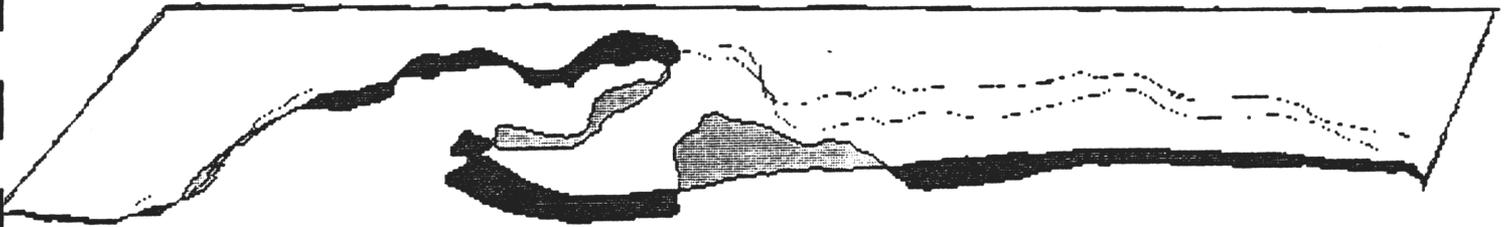




06/02/91-06/30/91



06/30/91-07/14/91

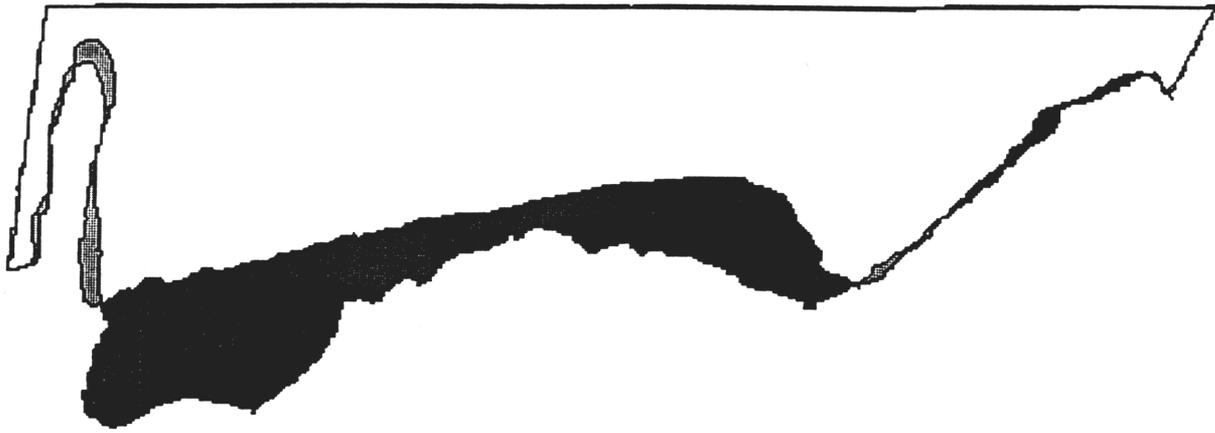


07/14/91-07/27/91

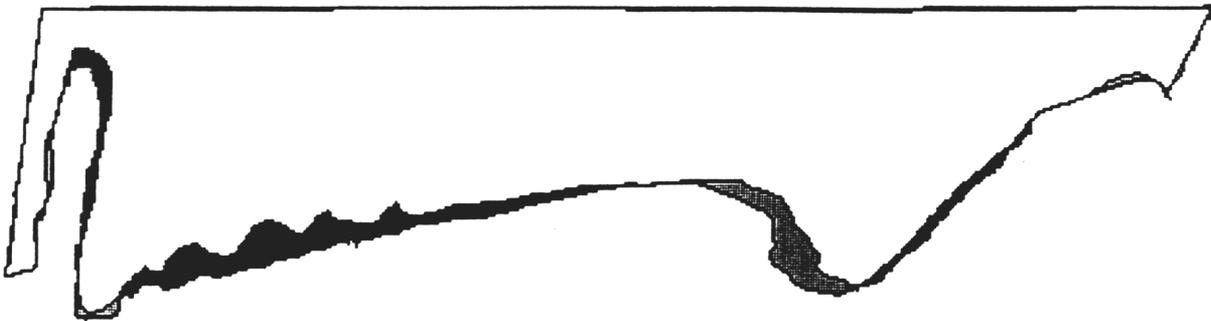
182.4R



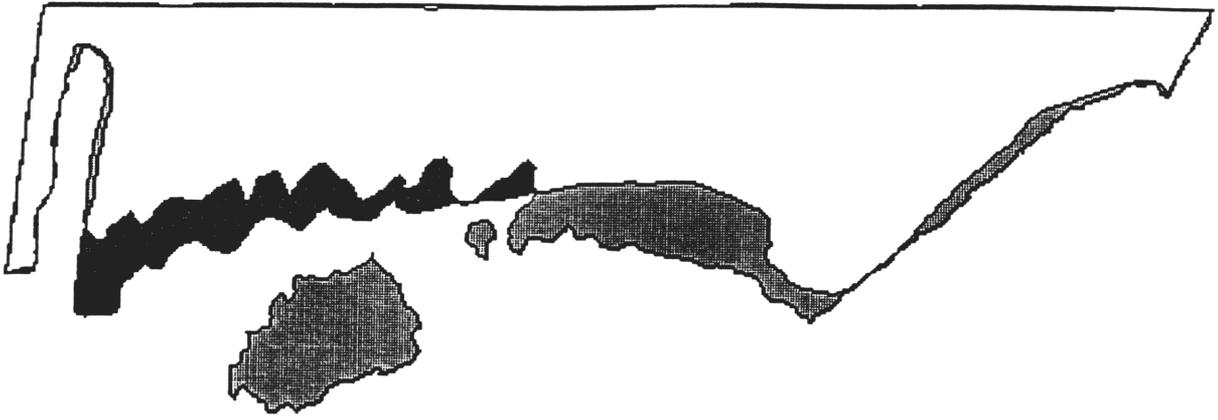
9/30/90



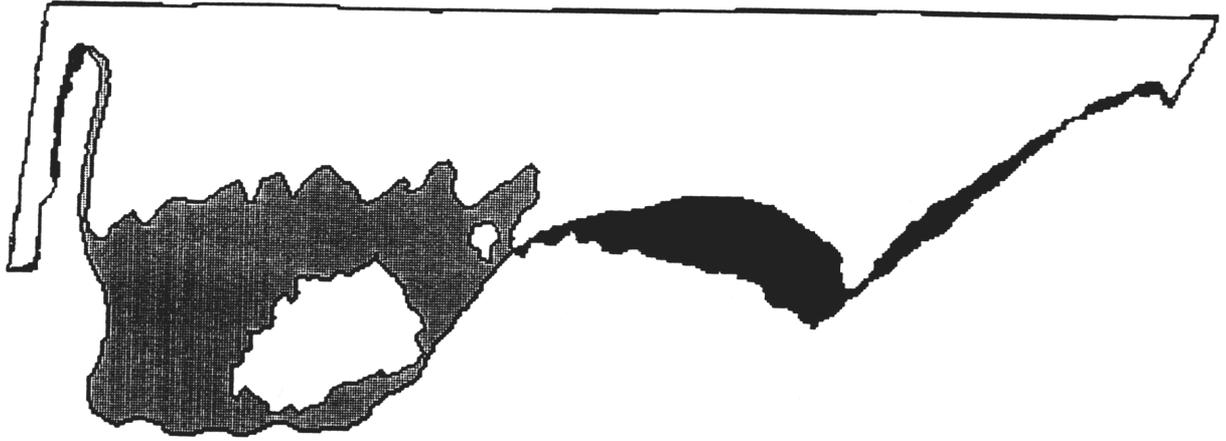
9/30/90 - 12/17/90



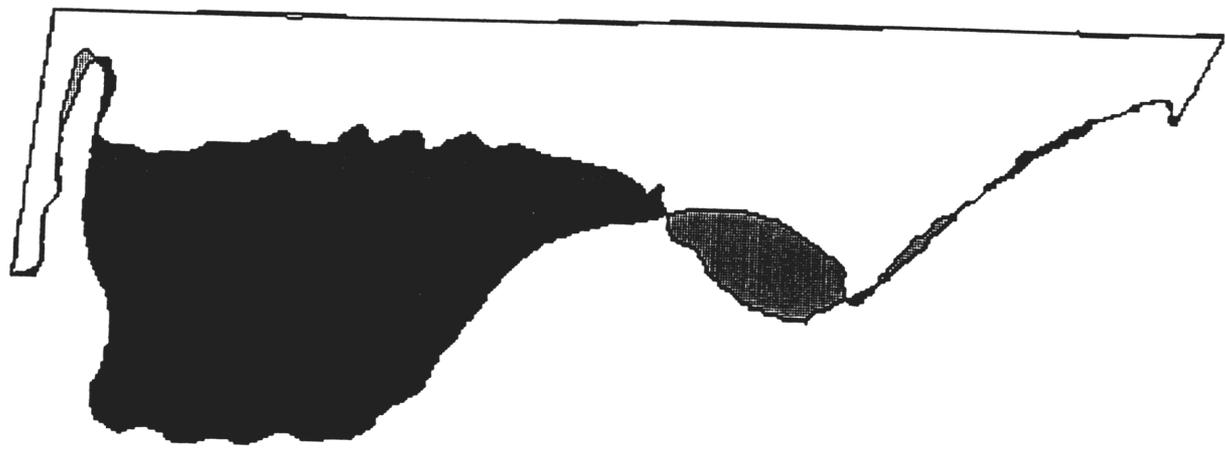
12/17/90 - 12/30/90



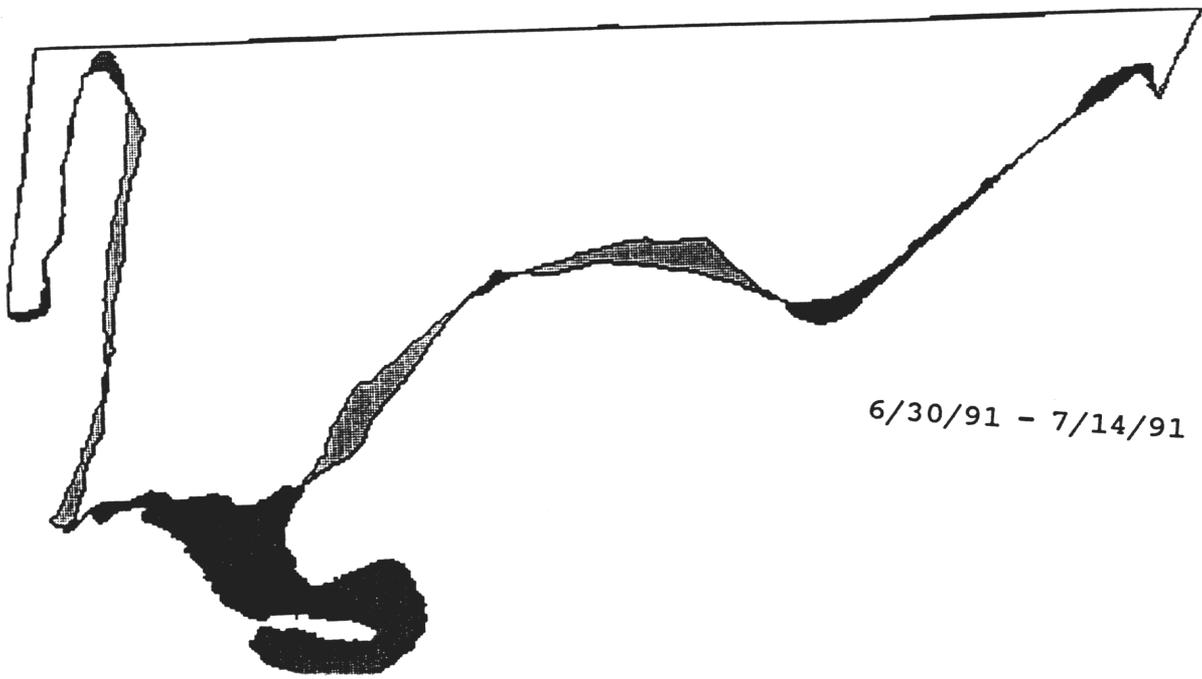
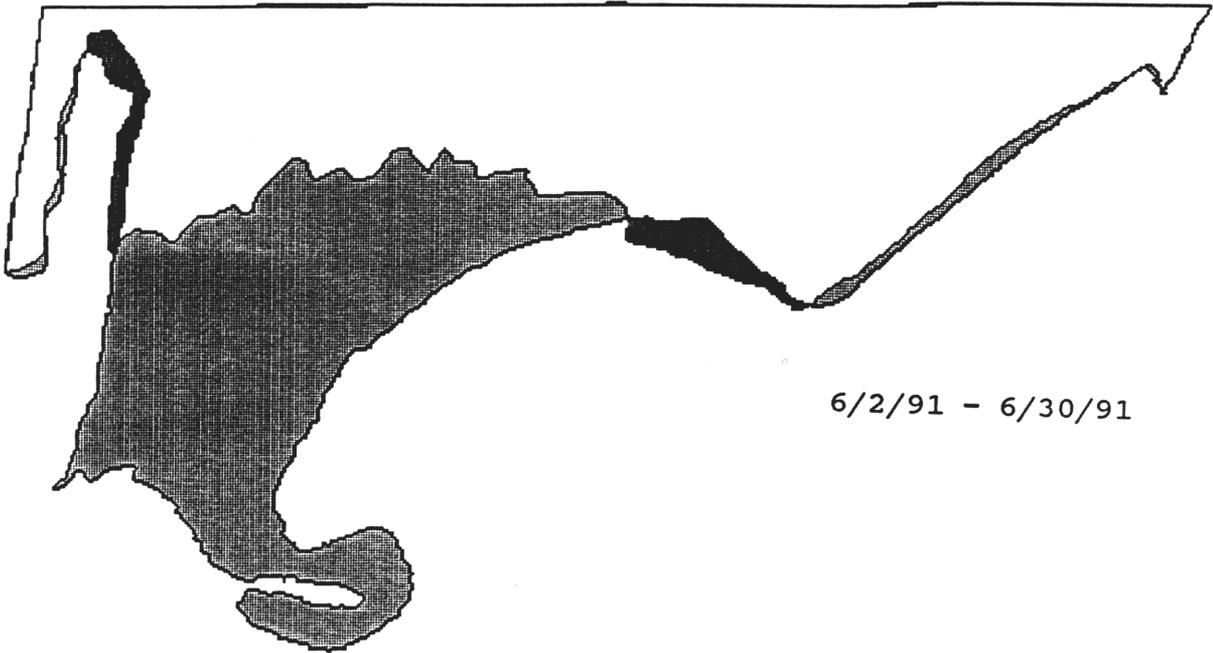
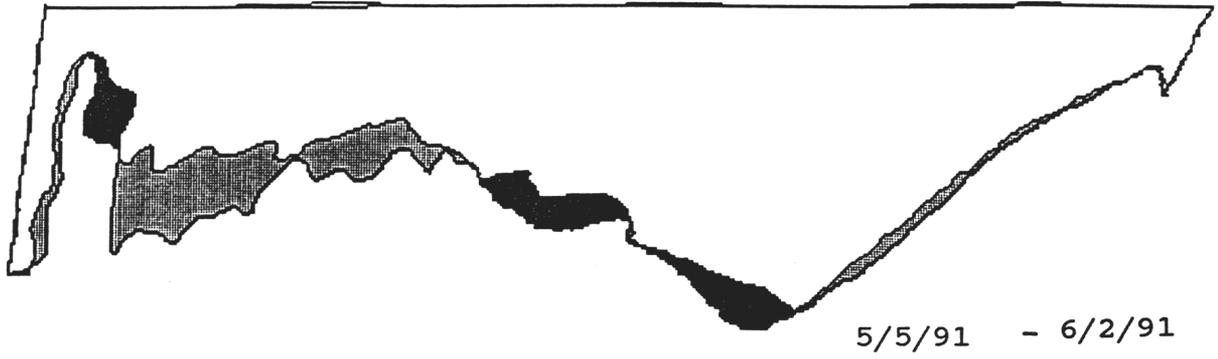
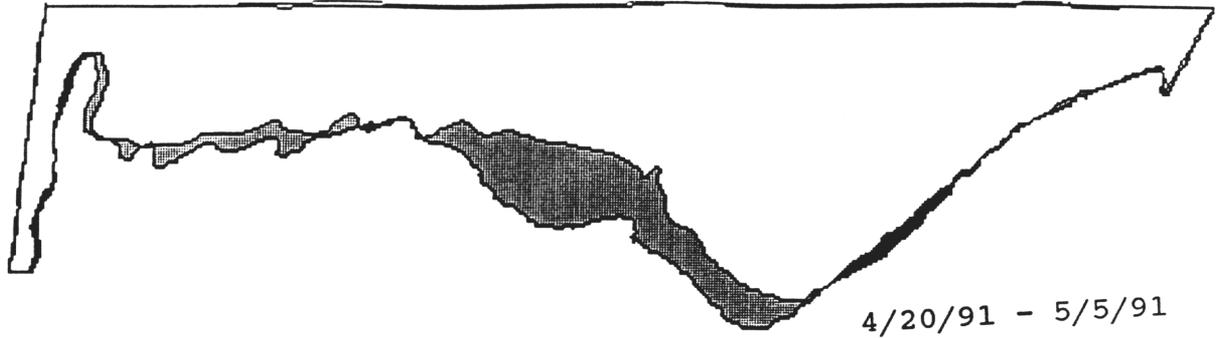
12/30/90 - 1/12/91

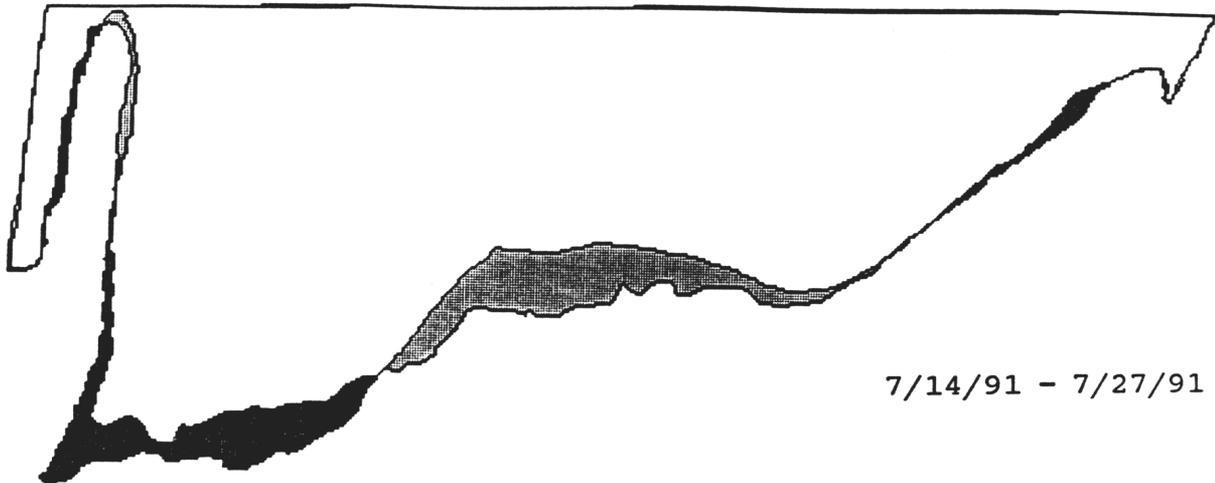


1/12/91 - 1/26/91



1/26/91 - 4/20/91





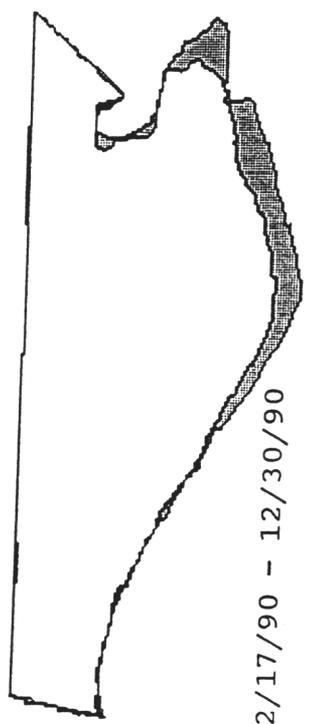
7/14/91 - 7/27/91



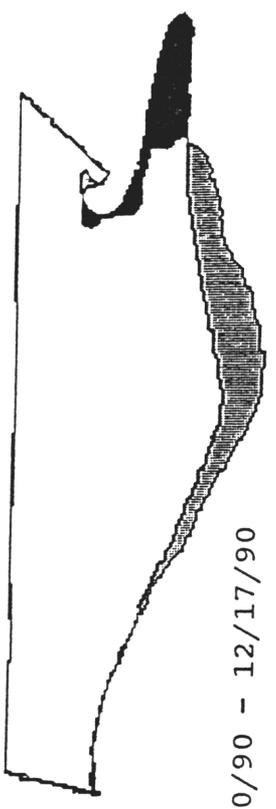
182.8R



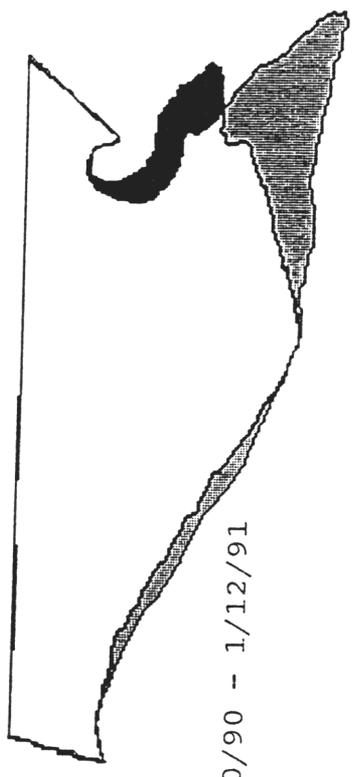
10/30/90



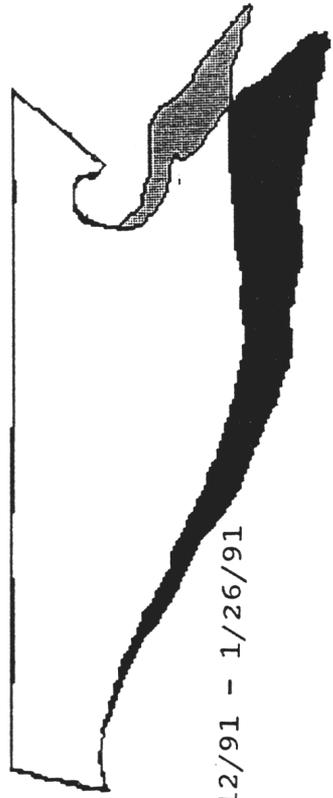
12/17/90 - 12/30/90



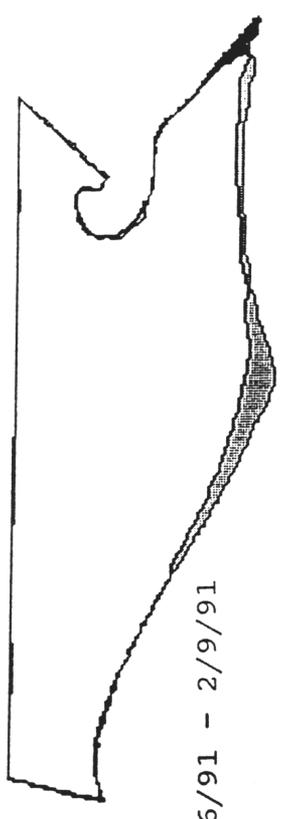
10/30/90 - 12/17/90



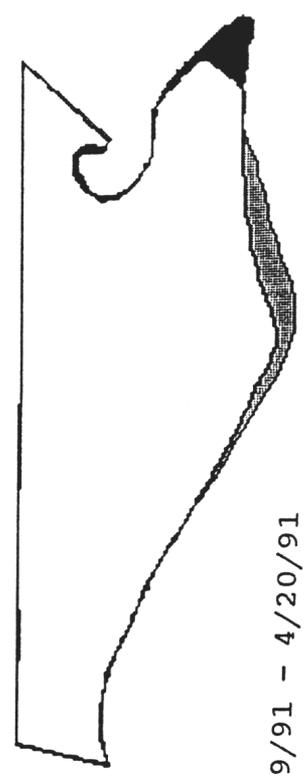
12/30/90 - 1/12/91



1/12/91 - 1/26/91



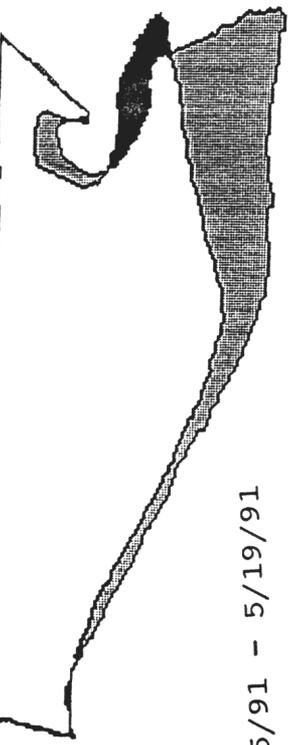
1/26/91 - 2/9/91



2/9/91 - 4/20/91



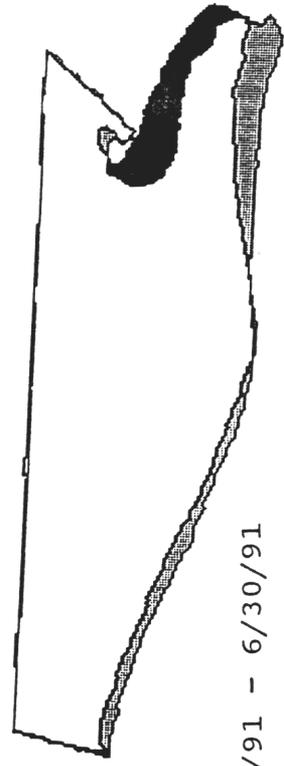
4/20/91 - 5/5/91



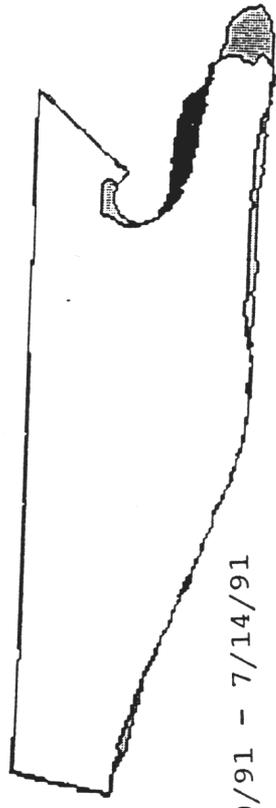
5/5/91 - 5/19/91



5/19/91 - 6/2/91



6/2/91 - 6/30/91



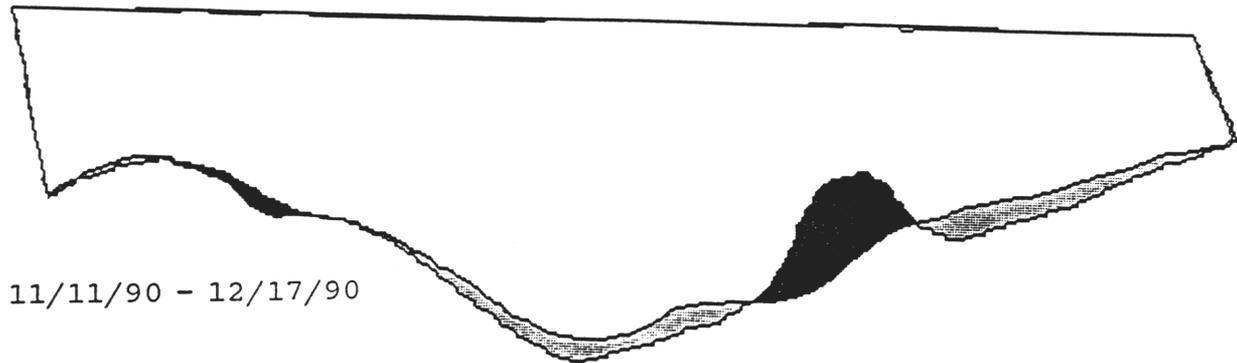
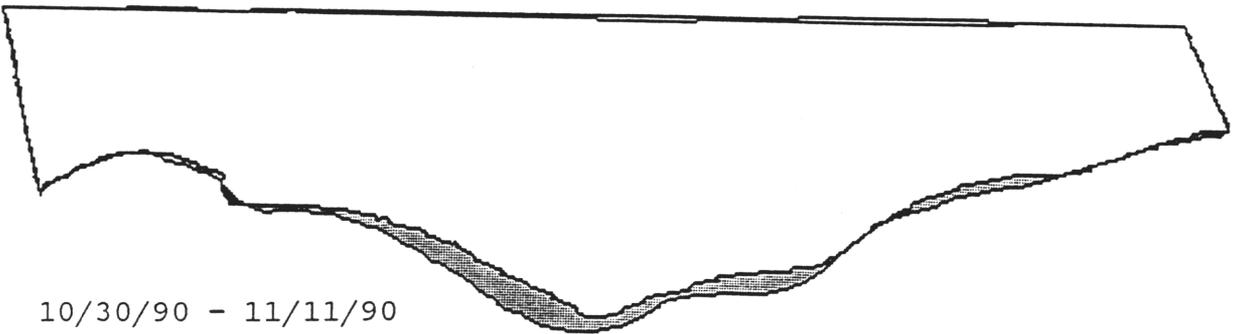
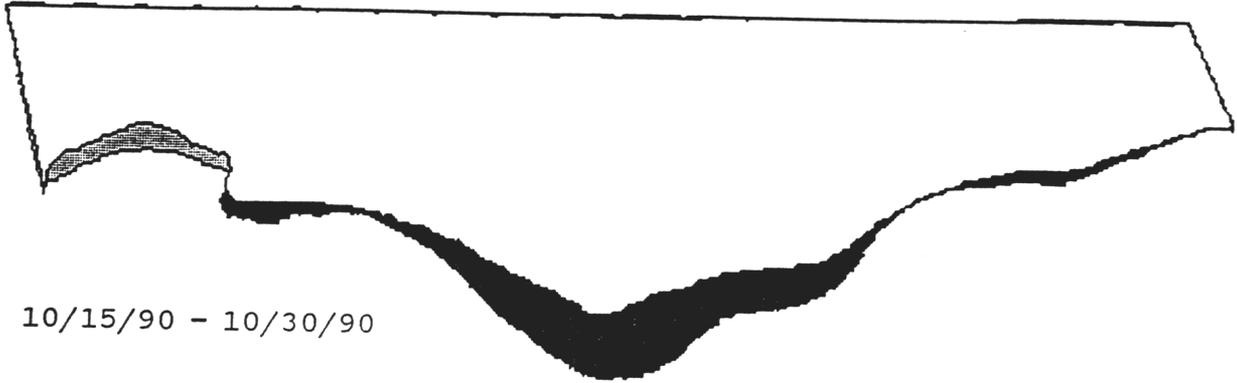
6/30/91 - 7/14/91

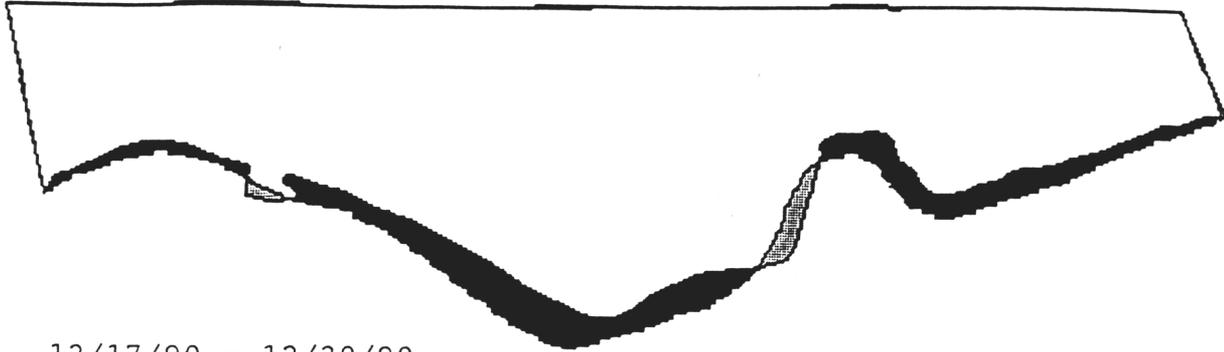


7/14/91 - 7/27/91

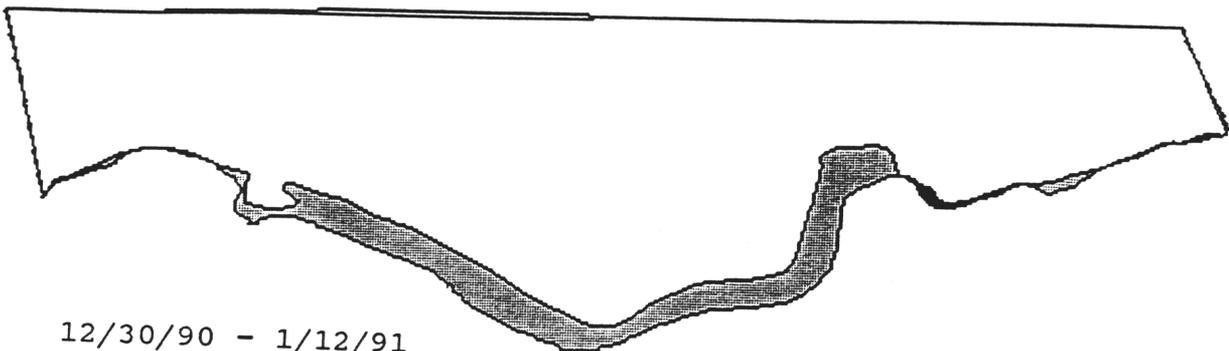
183.9L

10/15/90

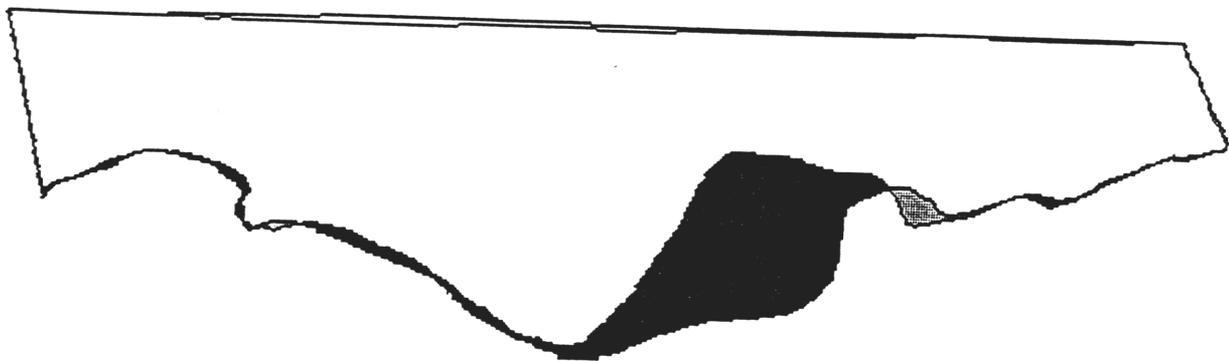




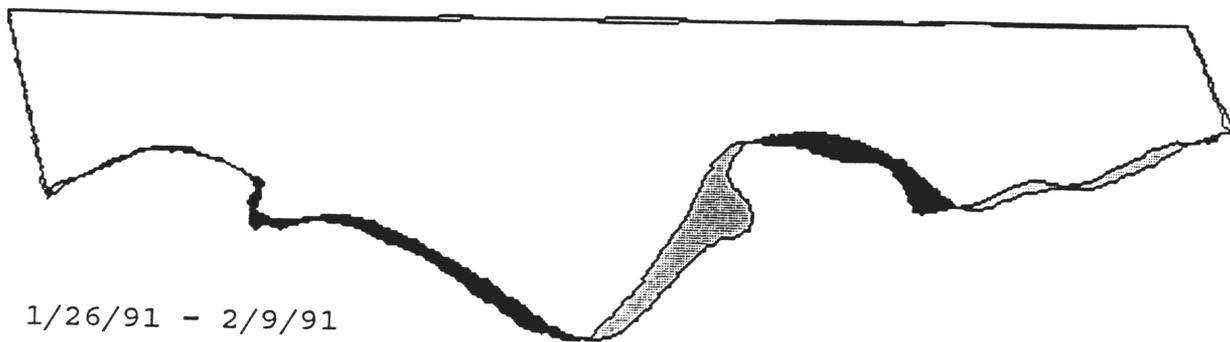
12/17/90 - 12/30/90



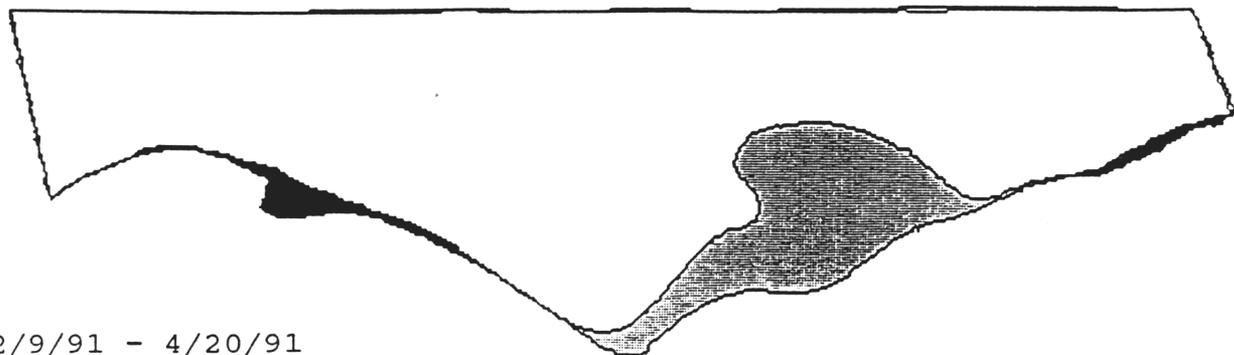
12/30/90 - 1/12/91



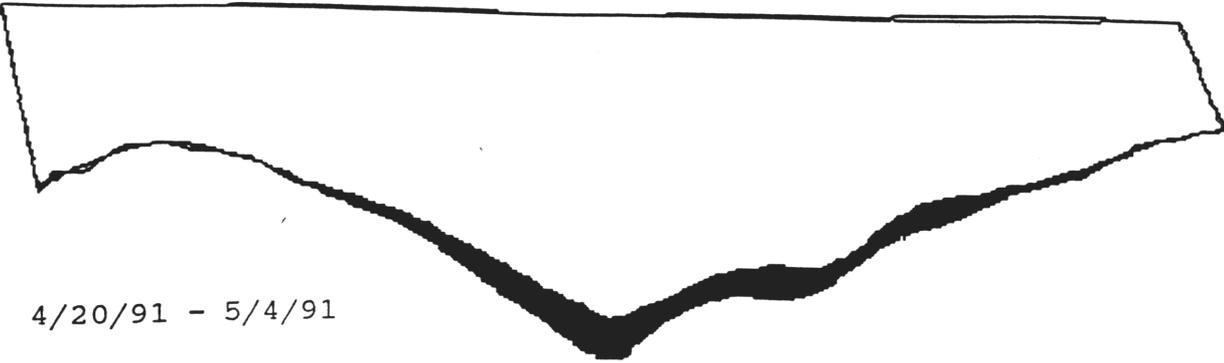
1/12/91 - 1/26/91



1/26/91 - 2/9/91

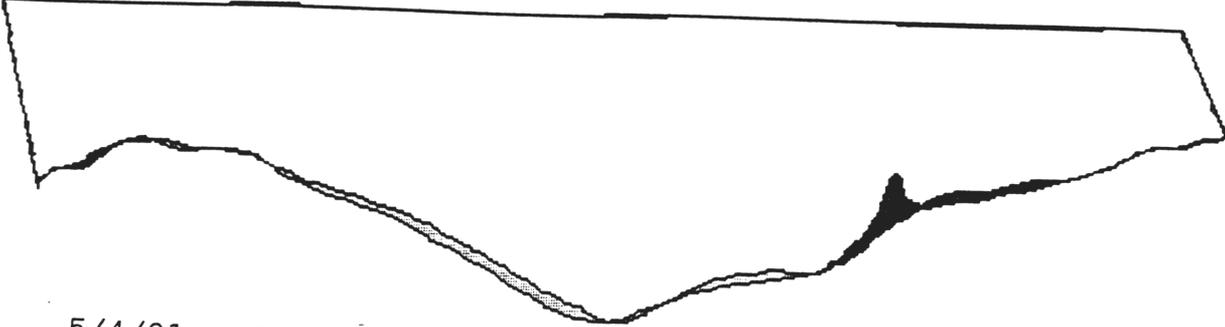


2/9/91 - 4/20/91



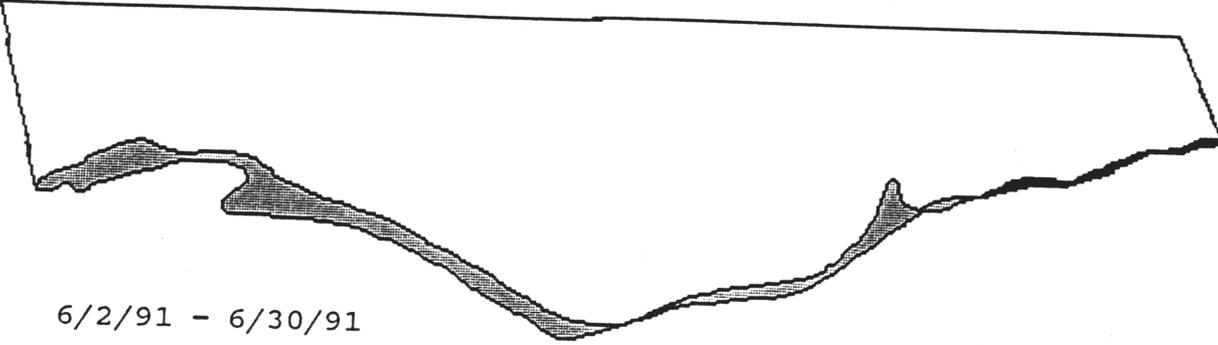
4/20/91 - 5/4/91

This diagram shows a cross-section of a channel with a central depression. The area within the channel is filled with a solid black color. The channel boundaries are irregular, with a small peak on the right side.



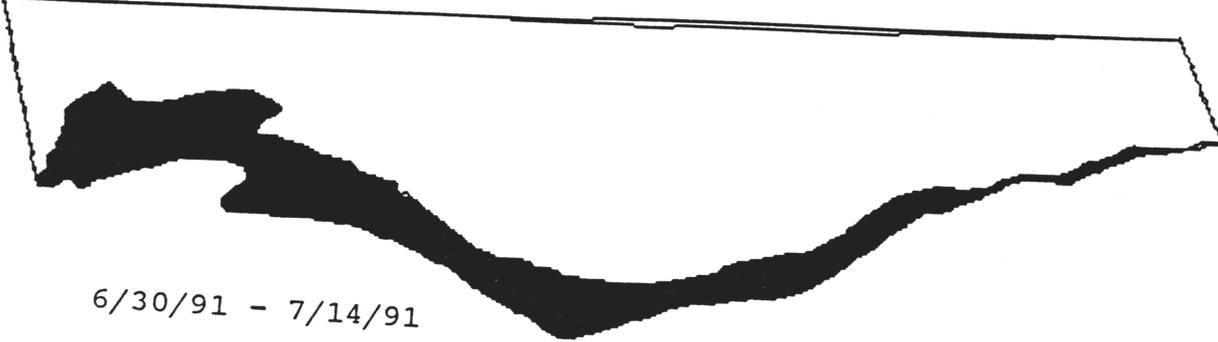
5/4/91 - 6/2/91

This diagram shows a cross-section of a channel with a central depression. The area within the channel is filled with a light gray stippled pattern. The channel boundaries are irregular, with a small peak on the right side.



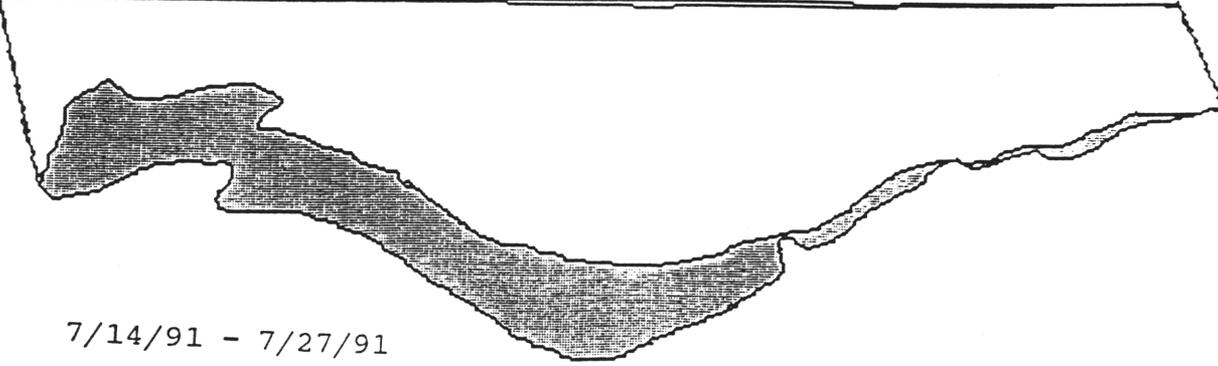
6/2/91 - 6/30/91

This diagram shows a cross-section of a channel with a central depression. The area within the channel is filled with a light gray stippled pattern. The channel boundaries are irregular, with a small peak on the right side.



6/30/91 - 7/14/91

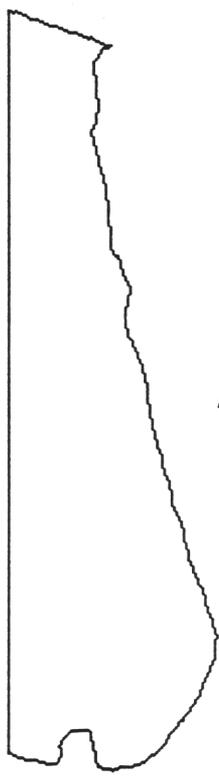
This diagram shows a cross-section of a channel with a central depression. The area within the channel is filled with a solid black color. The channel boundaries are irregular, with a small peak on the right side.



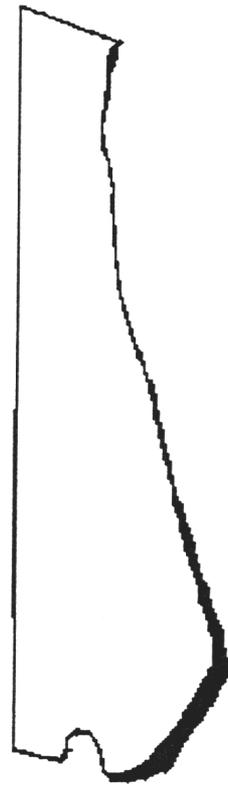
7/14/91 - 7/27/91

This diagram shows a cross-section of a channel with a central depression. The area within the channel is filled with a light gray stippled pattern. The channel boundaries are irregular, with a small peak on the right side.

194.1L



9/30/90



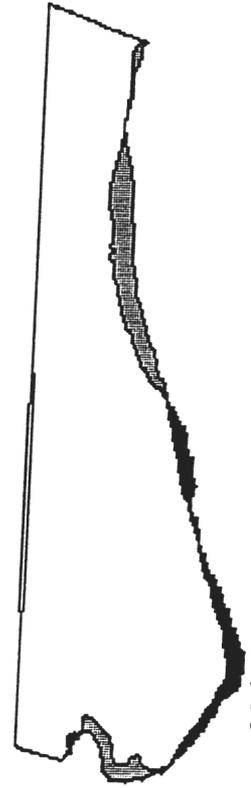
10/30/90 - 11/11/90



9/30/90 - 10/15/90



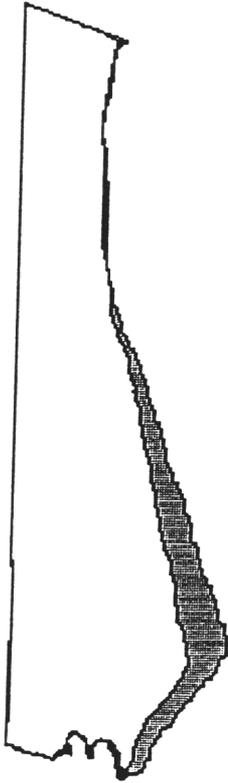
11/11/90 - 12/17/90



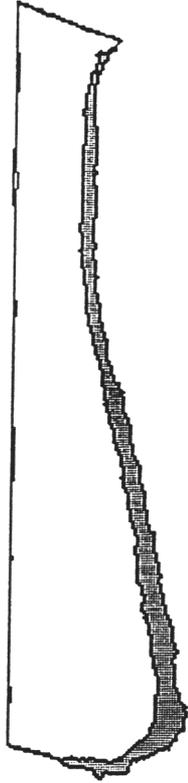
10/15/90 - 10/30/90



12/17/90 - 12/30/90



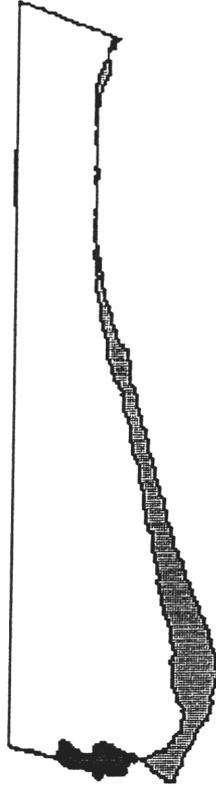
12/30/90 - 1/12/91



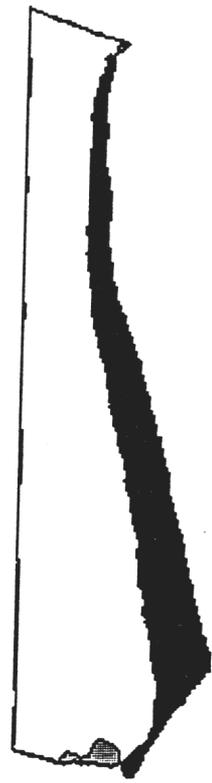
4/20/91 - 5/4/91



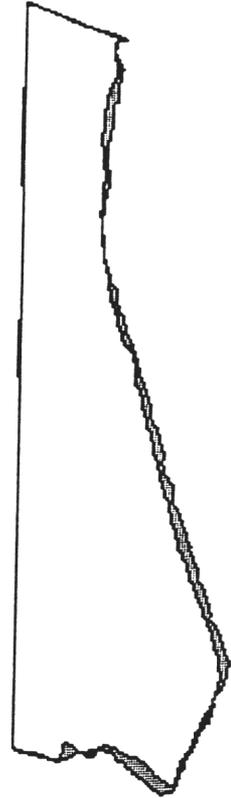
1/12/91 - 1/26/91



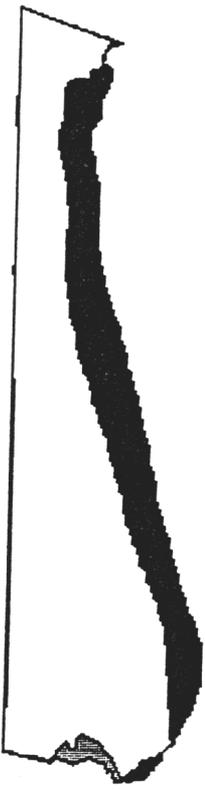
5/4/91 - 5/19/91



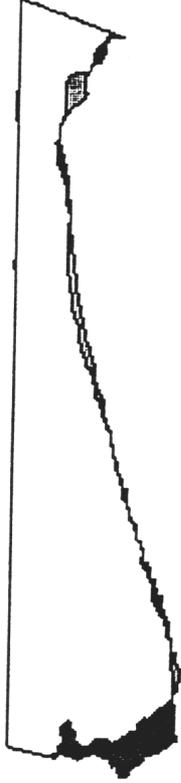
1/26/91 - 4/20/91



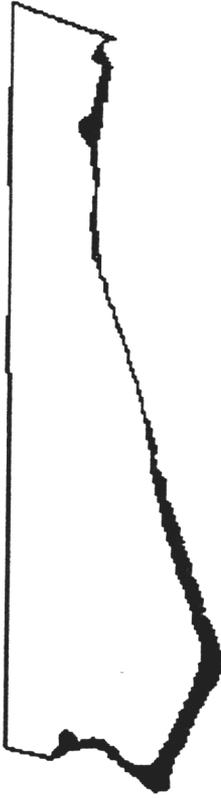
5/19/91 - 6/2/91



7/27/91 - 10/12/91



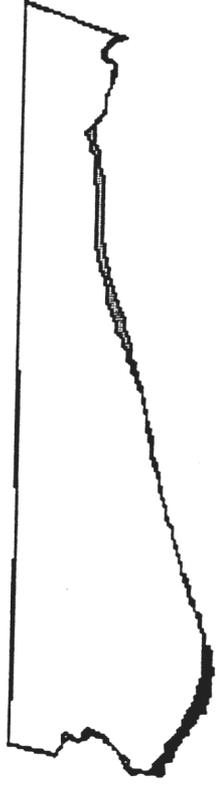
10/12/91 - 6/1/92



6/2/91 - 6/30/91



6/30/91 - 7/14/91

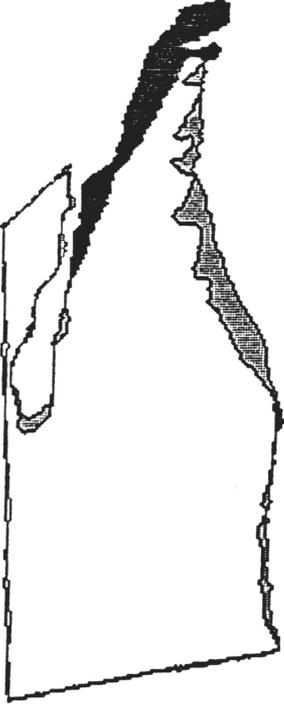


7/14/91 - 7/27/91

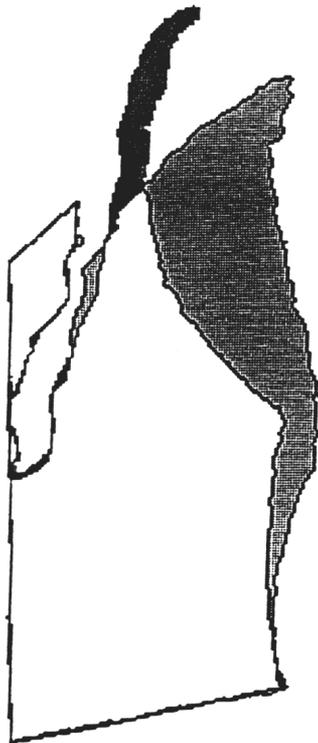
201.5R



11/11/90



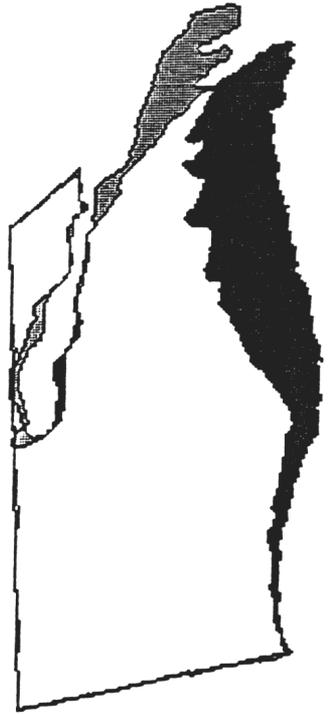
12/30/90 - 1/12/91



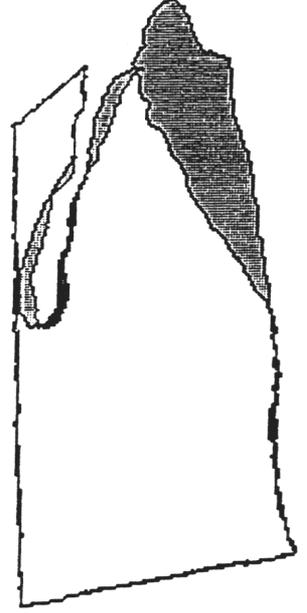
11/11/90 - 12/17/90



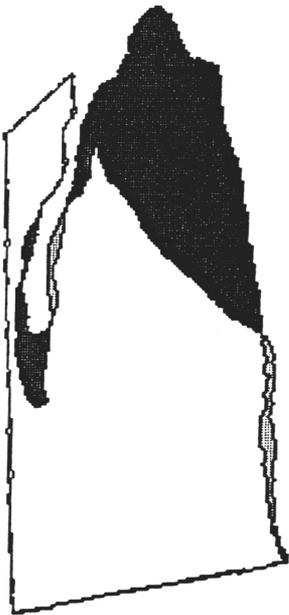
1/12/91 - 1/26/91



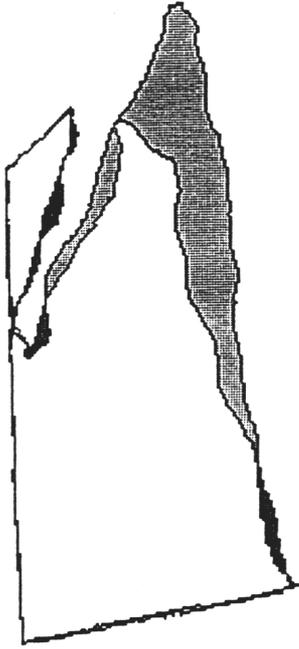
12/17/90 - 12/30/90



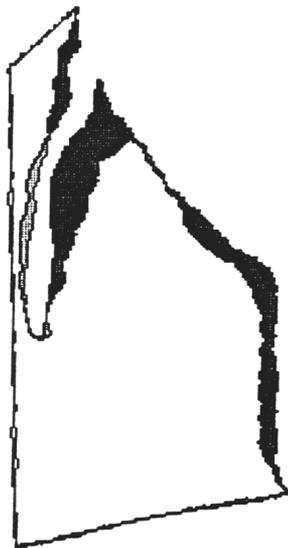
1/26/91 - 2/9/91



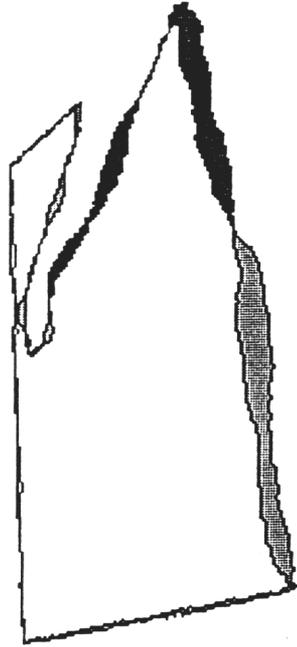
2/9/91 - 4/20/91



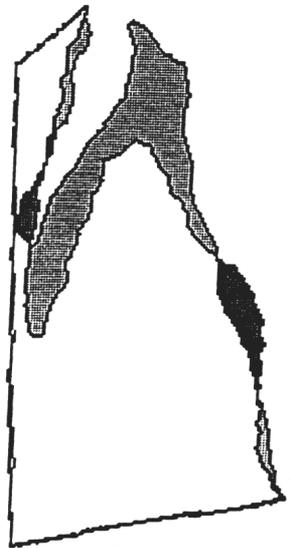
5/19/91 - 6/2/91



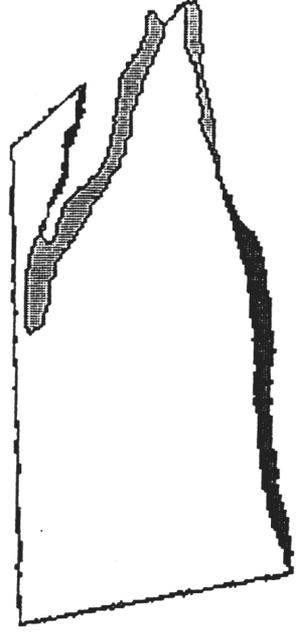
4/20/91 - 5/4/91



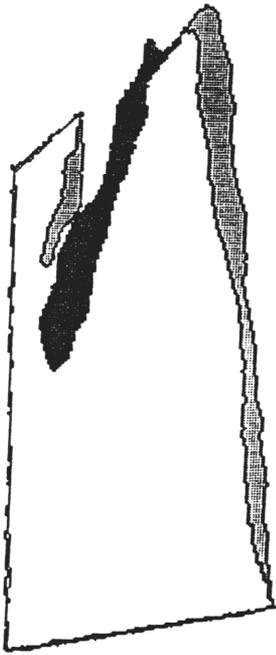
6/2/91 - 6/30/91



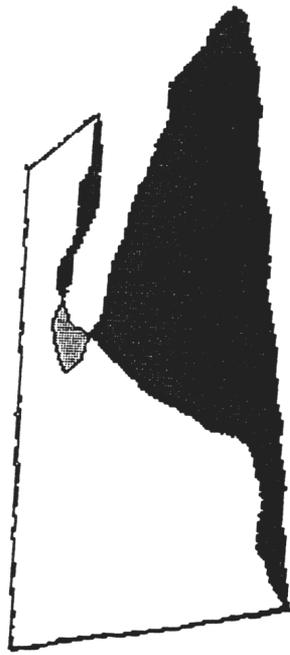
5/4/91 - 5/19/91



6/30/91 - 7/14/91



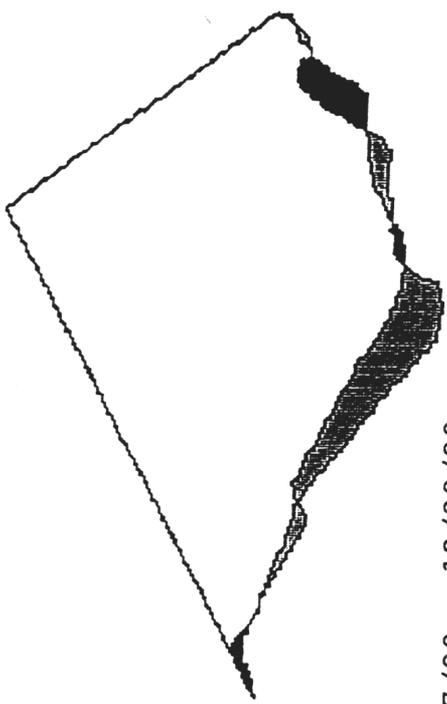
7/14/91 - 7/27/91



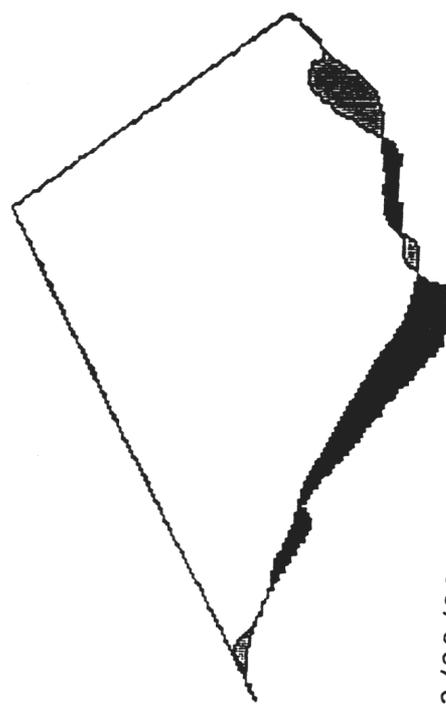
7/27/91 - 10/12/91



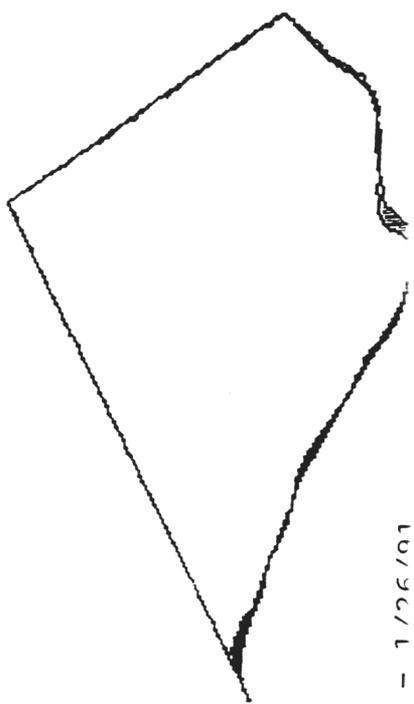
202.0R



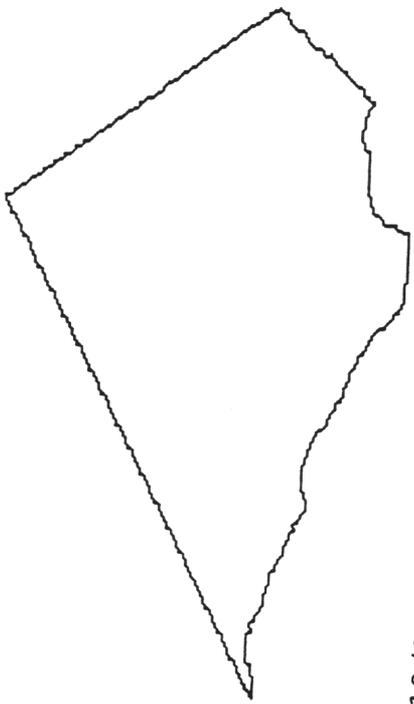
12/17/90 - 12/30/90



12/30/90 - 1/12/91



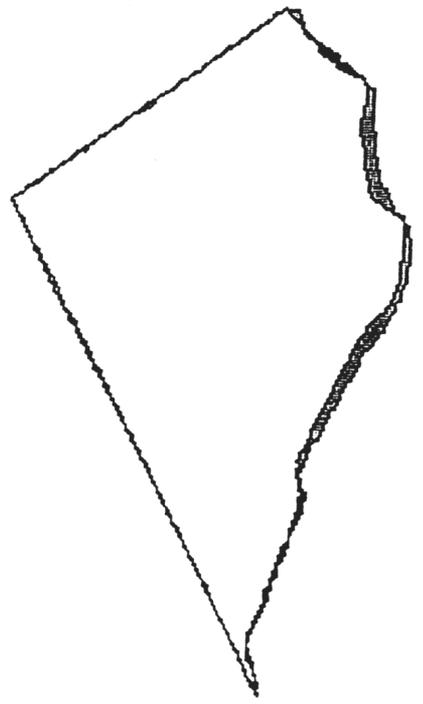
1/12/91 - 1/26/91



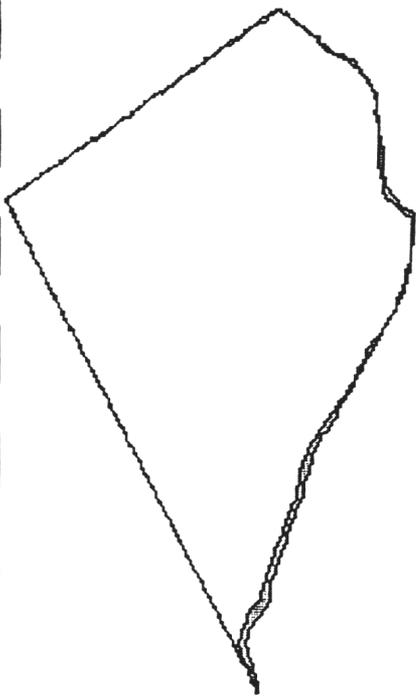
10/30/90



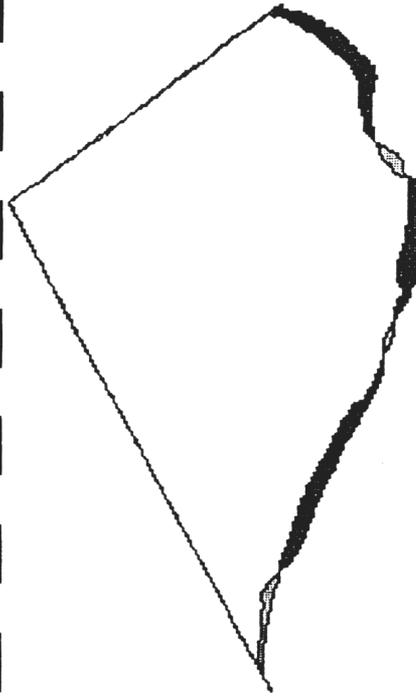
10/30/90 - 11/11/90



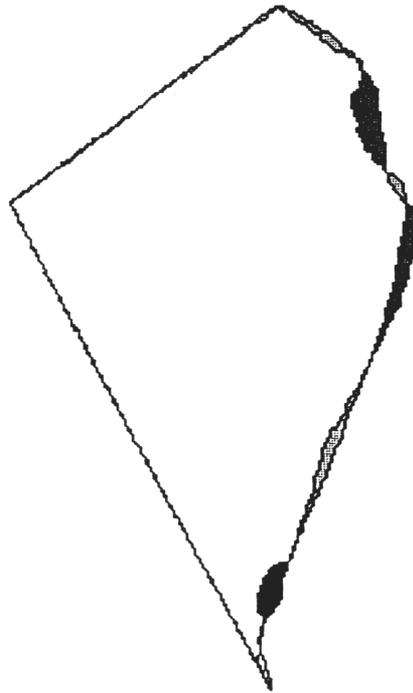
11/11/90 - 12/17/90



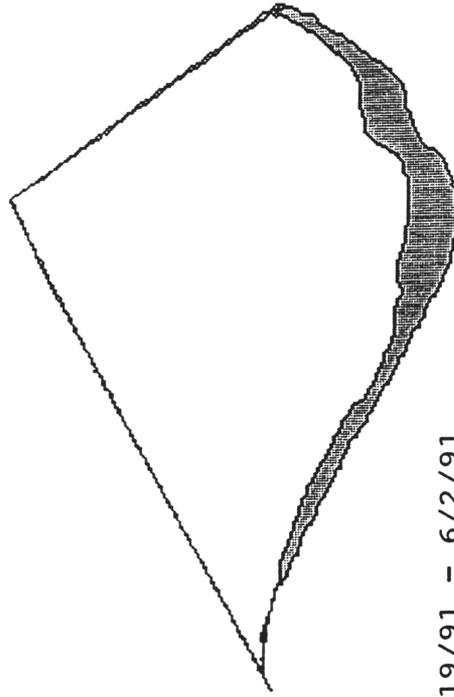
1/26/91 - 2/9/91



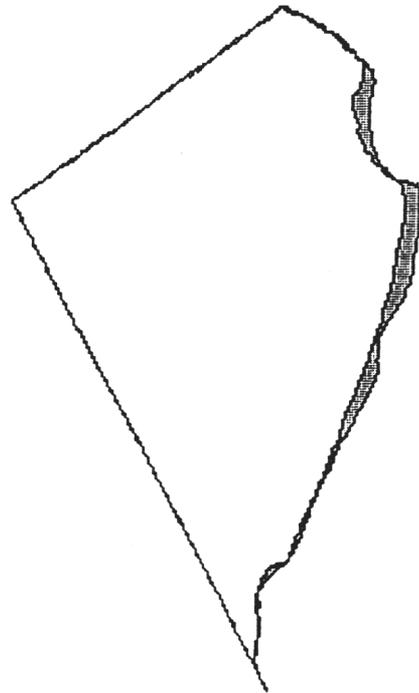
5/4/91 - 5/19/91



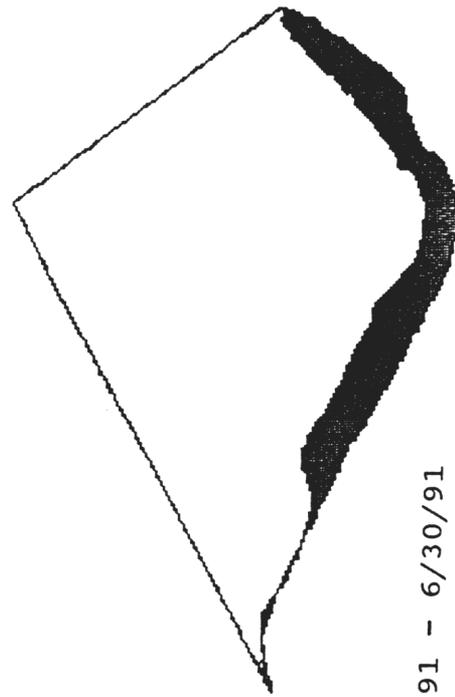
2/9/91 - 4/20/90



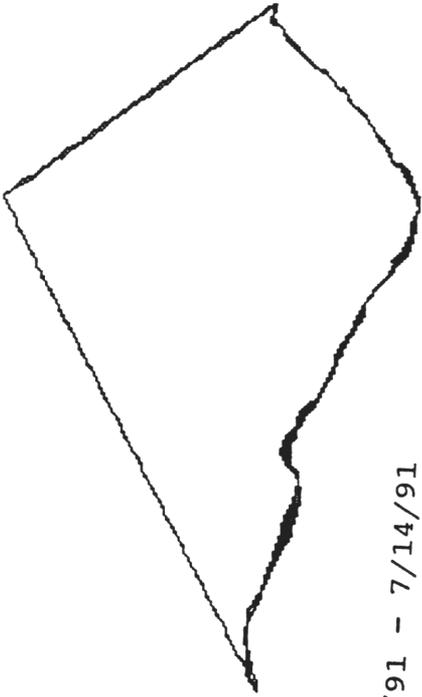
5/19/91 - 6/2/91



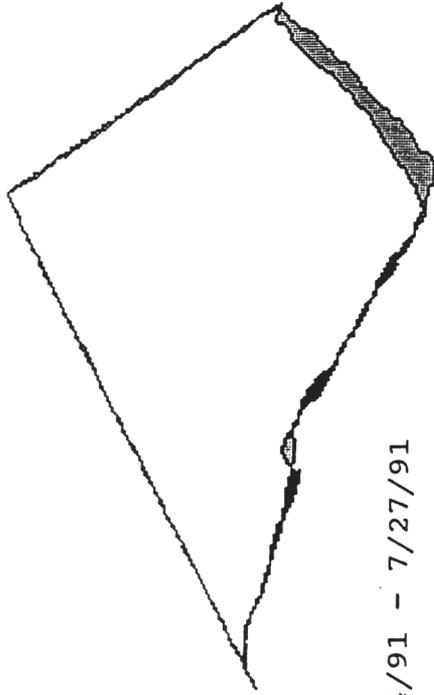
4/20/91 - 5/4/91



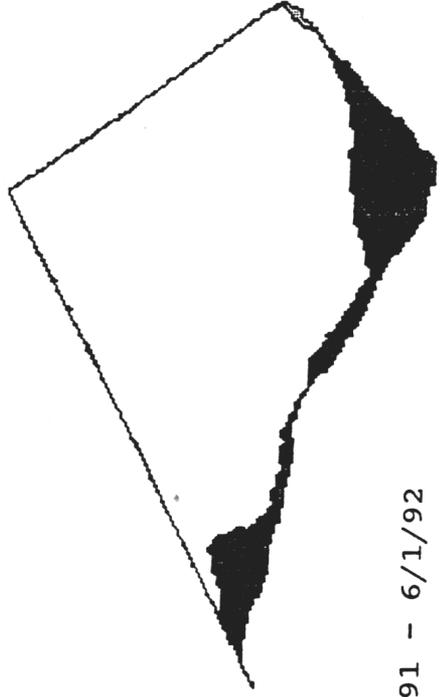
6/2/91 - 6/30/91



6/30/91 - 7/14/91



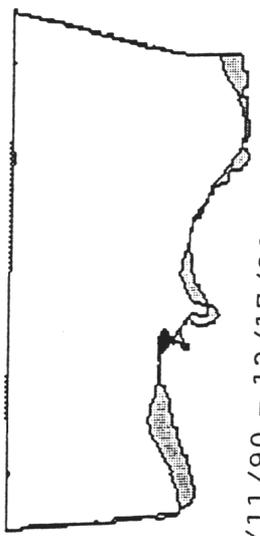
7/14/91 - 7/27/91



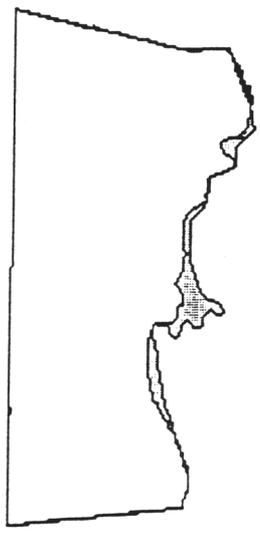
7/27/91 - 6/1/92

Z11.6R

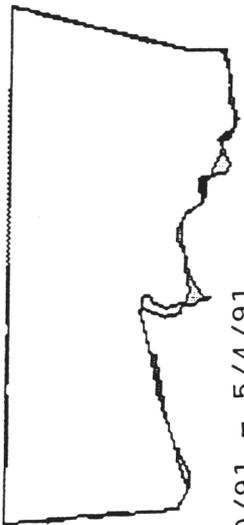
9/30/90



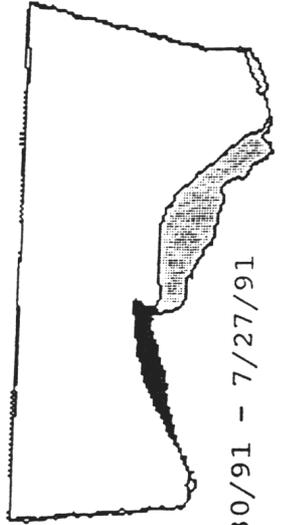
11/11/90 - 12/17/90



1/12/91 - 1/26/91



/20/91 - 5/4/91

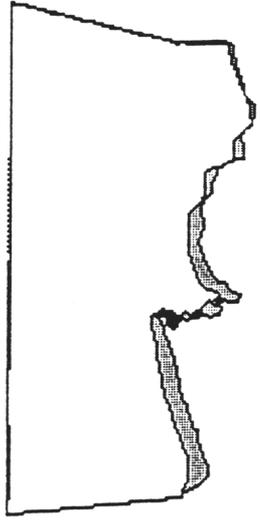


6/30/91 - 7/27/91

9/30/90 - 10/30/90



12/17/90 - 12/30/90

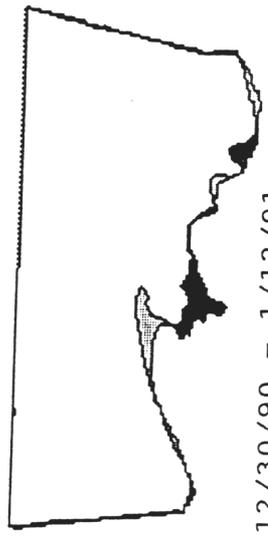


1/26/91 - 2/9/91



5/4/91 - 6/2/91

10/30/90 - 11/11/90



12/30/90 - 1/12/91



2/9/91 - 4/20/91



6/2/91 - 6/30/91

212.9L

9/30/90



9/30/90 - 10/15/90

10/15/90 - 10/30/90

10/30/90 - 11/11/90

11/11/90 - 12/17/90

12/17/90 - 12/30/90

12/30/90 - 1/12/91

1/12/91 - 2/9/91

2/9/91 - 4/20/91

4/20/91 - 5/4/91

5/4/91 - 5/19/91

5/19/90 - 6/2/91

6/2/91 - 7/14/91

7/14/91 - 7/27/91

219.9R

9/30/90



9/30/90 - 11/11/90

11/11/90 - 12/17/90

12/17/90 - 12/30/90

12/30/90 - 1/12/91

1/12/91 - 1/26/91

1/26/91 - 2/9/91

2/9/91 - 4/20/91

4/20/91 - 5/4/91

5/4/91 - 5/19/91

5/19/91 - 6/30/91

6/30/91 - 7/14/91

7/14/91 - 7/27/91

225.2R

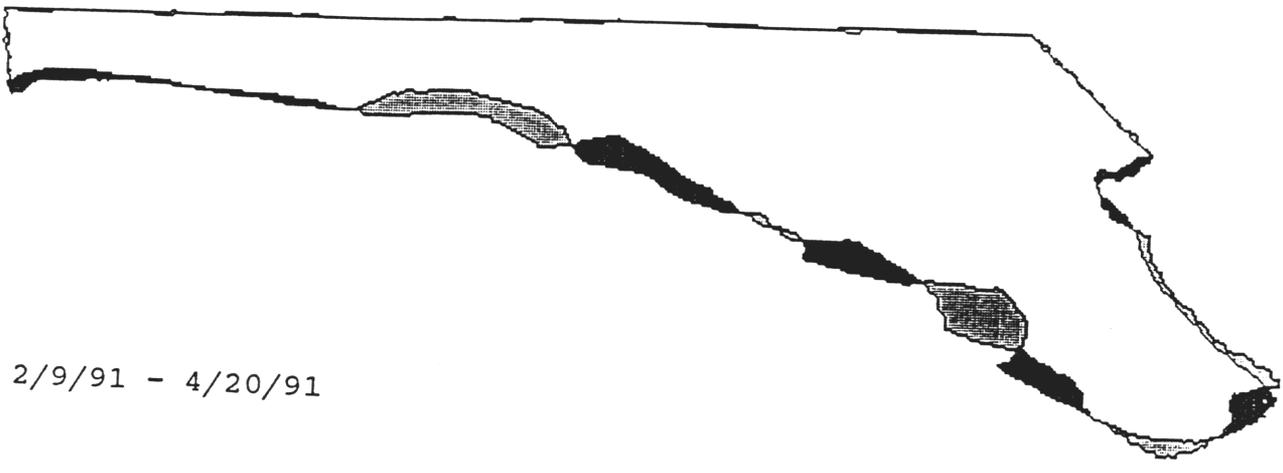
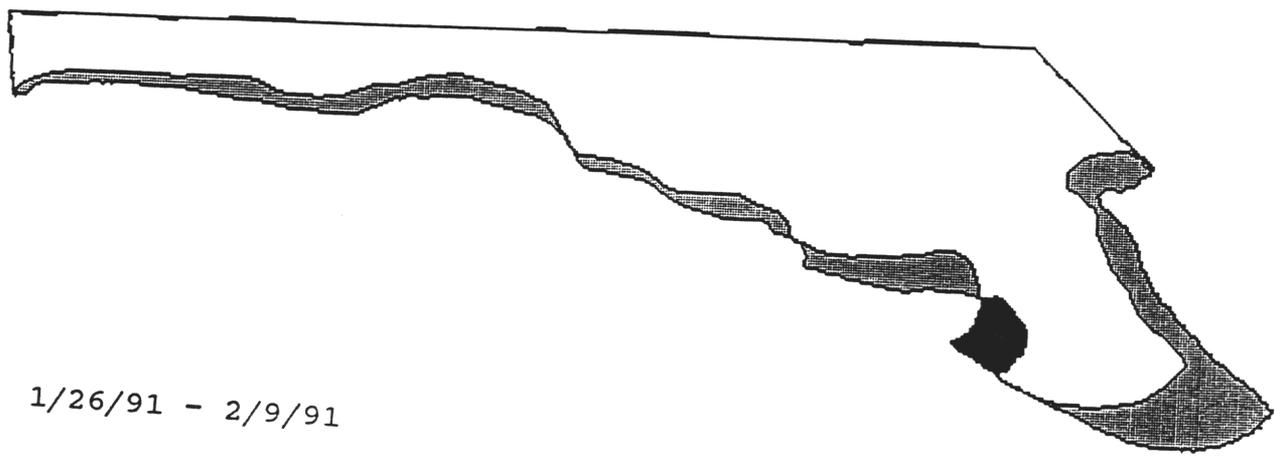
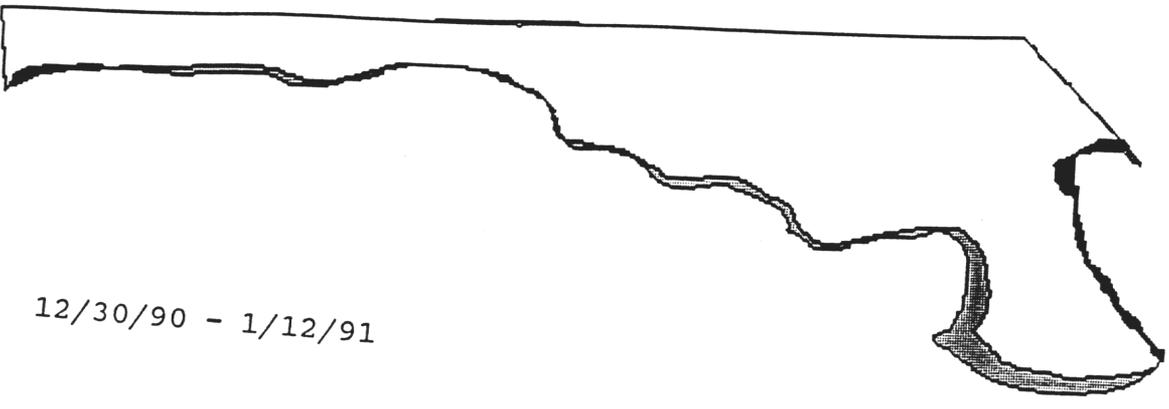
10/30/90



10/30/90 - 11/11/90

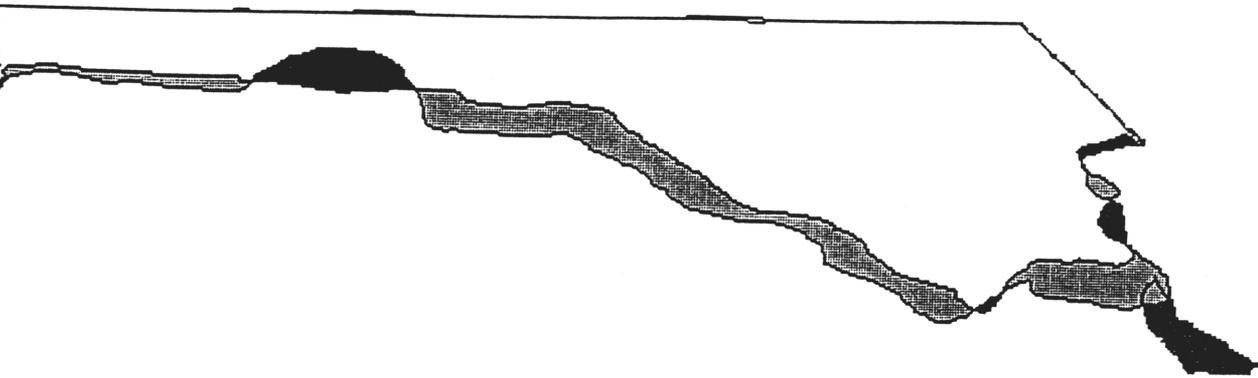
11/11/90 - 12/17/90

12/17/90 - 12/30/90

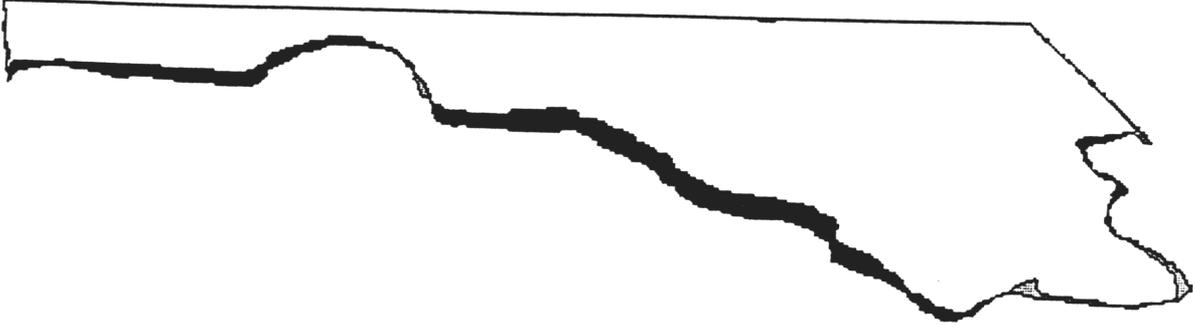




4/20/91 - 5/4/91



5/4/91 - 5/19/91



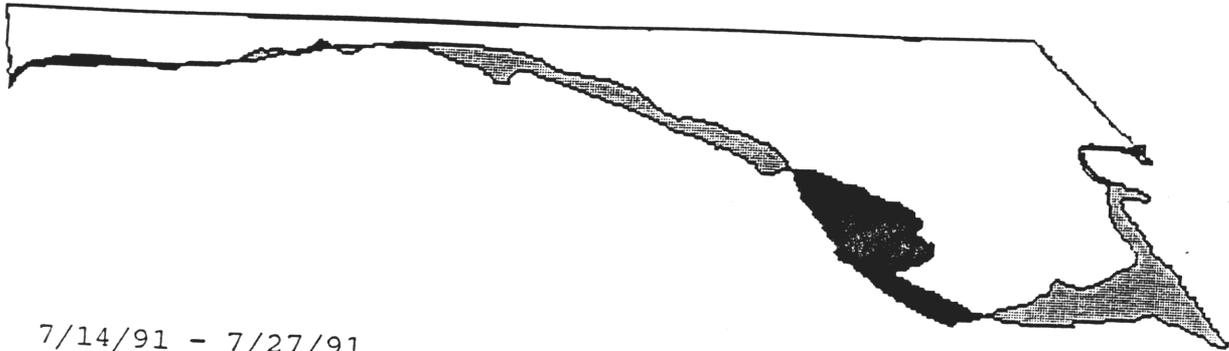
5/19/91 - 6/2/91



6/2/91 - 6/30/91



6/30/91 - 7/14/91



7/14/91 - 7/27/91