

Relation Between Prescribed Slash Burning
and Stream Temperatures on the Quinault
Indian Reservation ; a Preliminary Study.

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INTRODUCTION

Over the years a significant amount of time, effort, and money has been expended in an attempt to protect fish and their environment from potential impacts due to timber harvest on the Quinault Indian Reservation. In some cases valuable timber was left standing, machinery restricted from sensitive areas, and special logging procedures required to preserve streamside management zones (SMZ), buffer strips, and sensitive areas. For the past few years, forest managers have begun utilizing prescribed burning of slash as a viable technique to remove large amounts of slash and increase timber productivity. No assessment work has been done in the Quinault Indian Reservation to study the effects these prescribed burns may have on fish and their environment.

In view of the increased practice of prescribed burning, it was believed that a closer look at the effects on salmonid populations was in order. In cooperation with the Quinault Indian Nation and the Bureau of Indian Affairs, a study was initiated in three areas (Figure 1) to monitor stream temperature, as an indicator of detrimental effects on salmonids before, during, and after prescribed burns, in two areas and to monitor temperature in an old-growth forest before clearcutting.

STUDY SITES

JONES CREEK

Jones Creek, a previously unnamed tributary to the North Fork Raft River within the boundaries of the Quinault Indian Reservation, was selected for this study based on the following criteria:

- 1.) Clearcut within the last two years.
- 2.) Slash burning scheduled to take place in the near future.
- 3.) Relatively small stream size (potential effects would be more pronounced).
- 4.) Potential salmonid-bearing waters.

The study site (Figure 2) consisted of three sections of Jones Creek. Block 495 contains 4349 feet (1326 meters) of stream. This block was clearcut and subsequent logging operations were completed on October 15, 1985. Slash burning took place on July 30, 1986 and was completed in less than one hour. Block 376 contains 896 feet (273 meters) of stream upstream from block 495. This block was clearcut with logging operations completed on September 26, 1984. Slash burning took place on August 28, 1984. The third section of the study site is a second-growth (30-year old) patch of red alder which contains 670 feet (204 meters) of stream downstream of the two clearcuts.

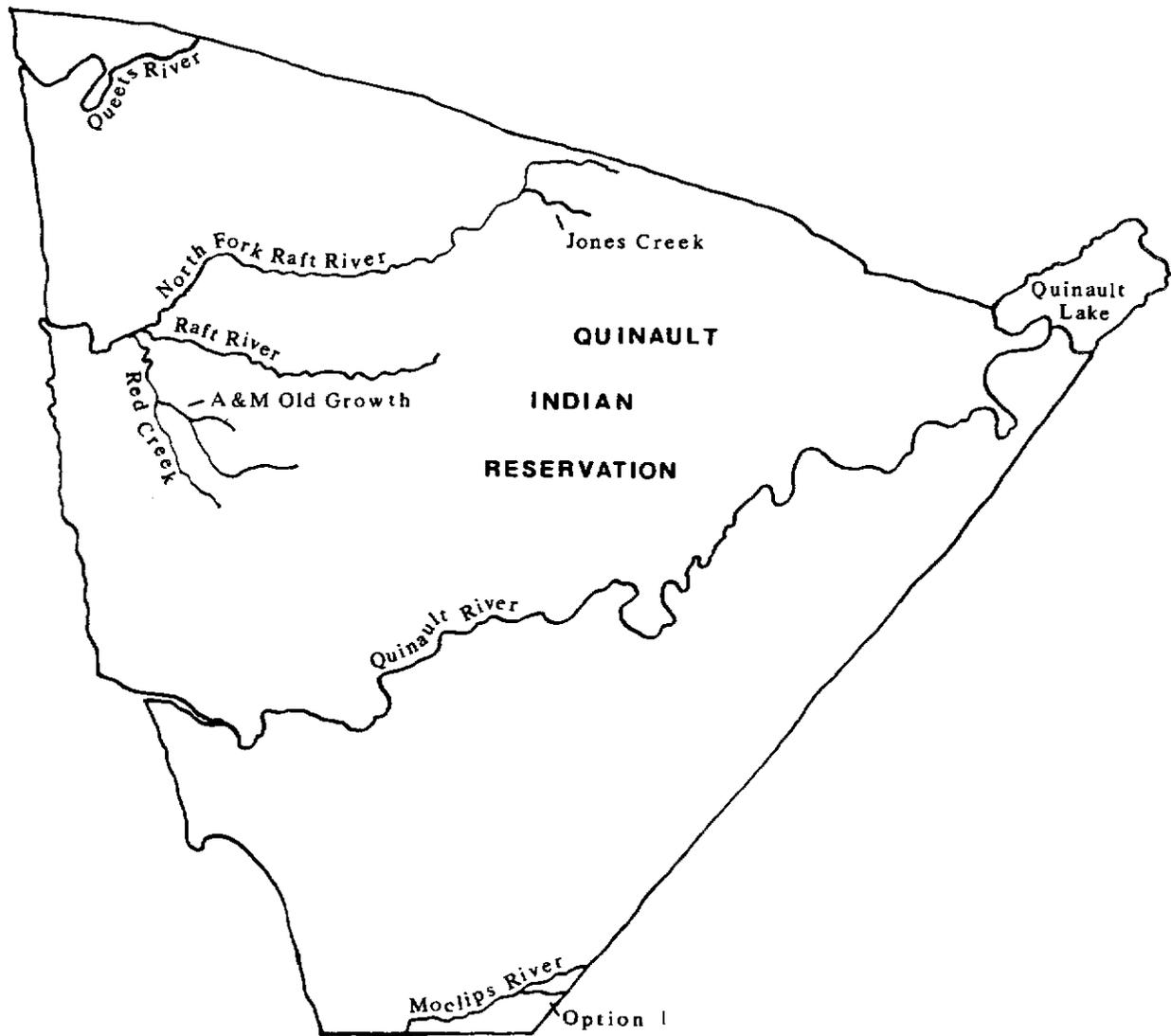


Figure 1.-Three temperature study areas located on the Quinault Indian Reservation.

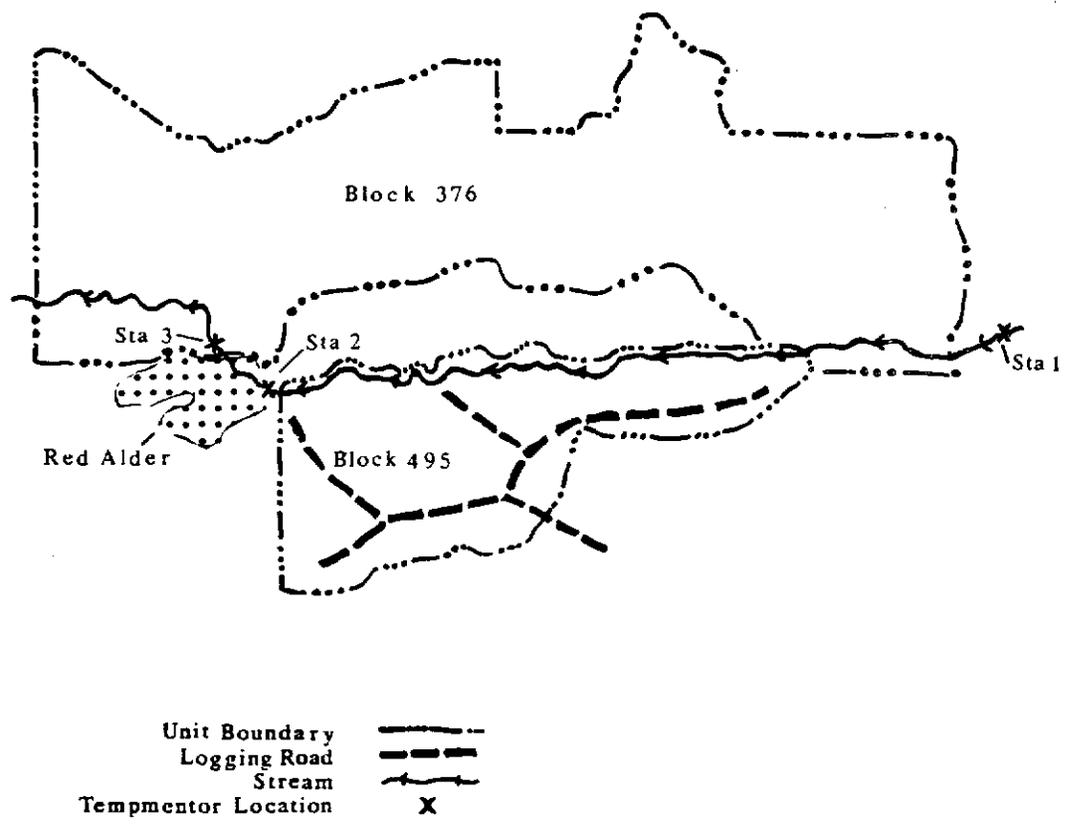


Figure 2.-Jones Creek study site on the Quinault Indian Reservation. Sta 1 is the upstream control, Sta 2 is the clearcut site, and Sta 3 is the downstream control.

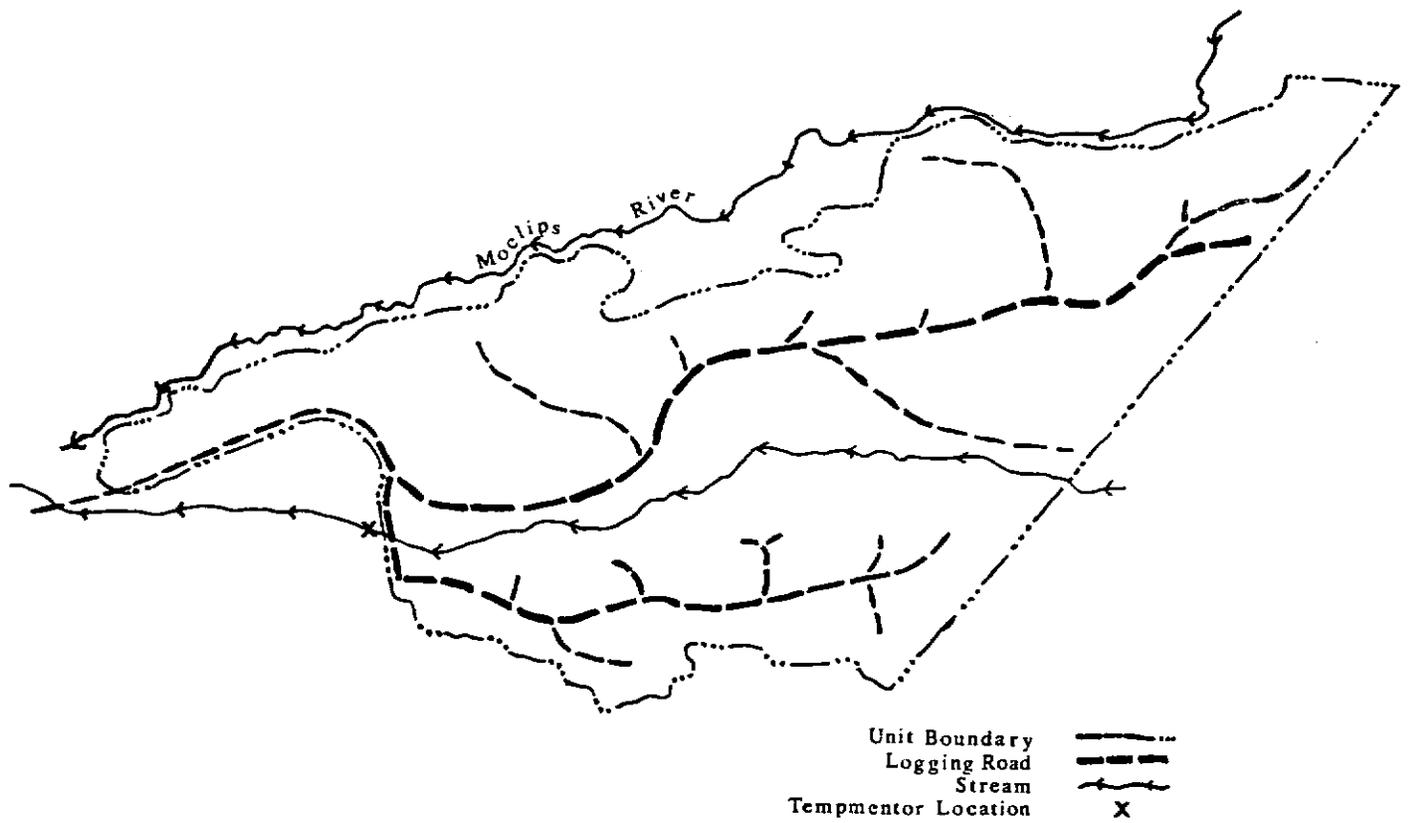
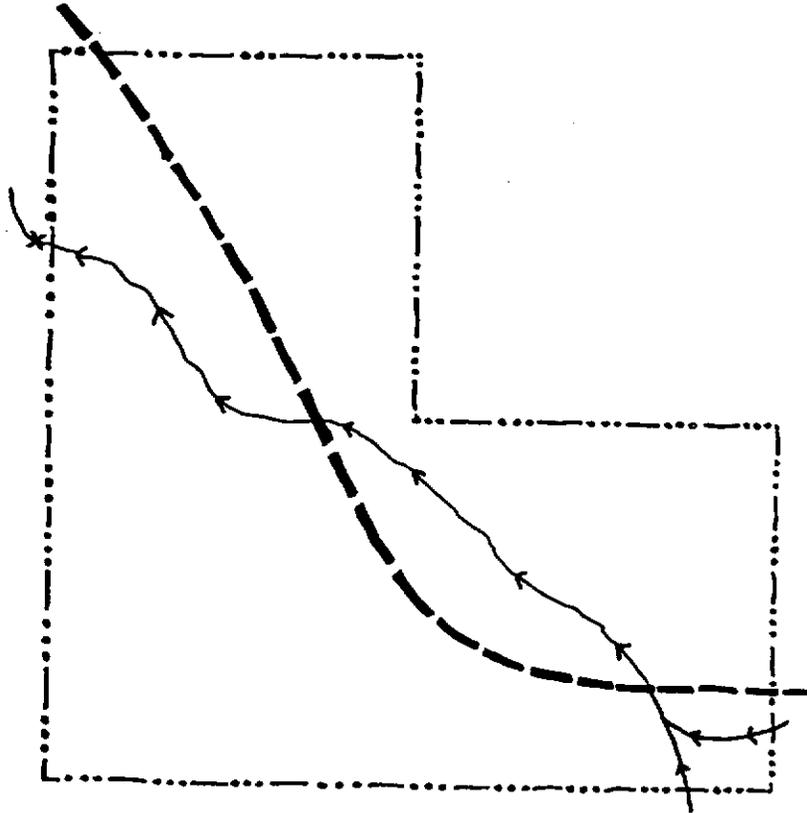


Figure 3.-Option 1 study site on the Quinault Indian Reservation.



Unit Boundary - - - - -
Logging Road - - - - -
Stream - - - - -
Tempmentor Location X

Figure 4.-A&M Old Growth study site on the Quinault Indian Reservation.

DATA COLLECTION

JONES CREEK

Stream temperatures were collected at three locations every 30-minutes from July 2, 1986 to July 28, 1986 prior to slash burning on block 495 (Figure 2). These temperatures were recorded by a programmable temperature sensing device (Tempmentor) which measured temperatures to the nearest 0.1 C. On July 28, 1986 the Tempmentors were retrieved and data downloaded onto a microcomputer for storage and analysis. The Tempmentors were then set to record temperatures every 5 minutes and deployed back to their respective locations on the morning of July 29, 1986. In addition, at the time of Tempmentor deployment, live cars containing 15 steelhead juveniles (about 50/lb.) were placed in the stream at each location. Slash was burned on block 495 the following morning, July 30, 1986. The Tempmentors and live cars were retrieved on July 31, 1986. The conditions of steelhead juveniles were recorded and the data from the Tempmentors downloaded for storage and analysis. The Tempmentors were again set to record temperatures every 30 minutes and deployed back to their respective locations on the same day. Monitoring of stream temperature has continued, and will continue into the future, to assess long-term effects.

OPTION 1

Baseline stream temperatures were collected at 30-minute intervals starting January 14, 1987 at one location (Figure 3) downstream from the clearcut using a Tempmentor. Temperature monitoring has continued to the present. Due to the unannounced weekend slash burning of this site, we were unable to reset the tempmentor to record temperatures at 5-minute intervals, deploy an additional Tempmentor upstream of the site as a control, or deploy live cars with fish as in the Jones Creek study.

A&M OLD GROWTH

Stream temperatures were collected at 30 minute intervals starting February 18, 1987 at one location (Figure 4) downstream from the old growth forest using a Tempmentor as in the above site. Temperature monitoring has continued to the present .

RESULTS AND DISCUSSION

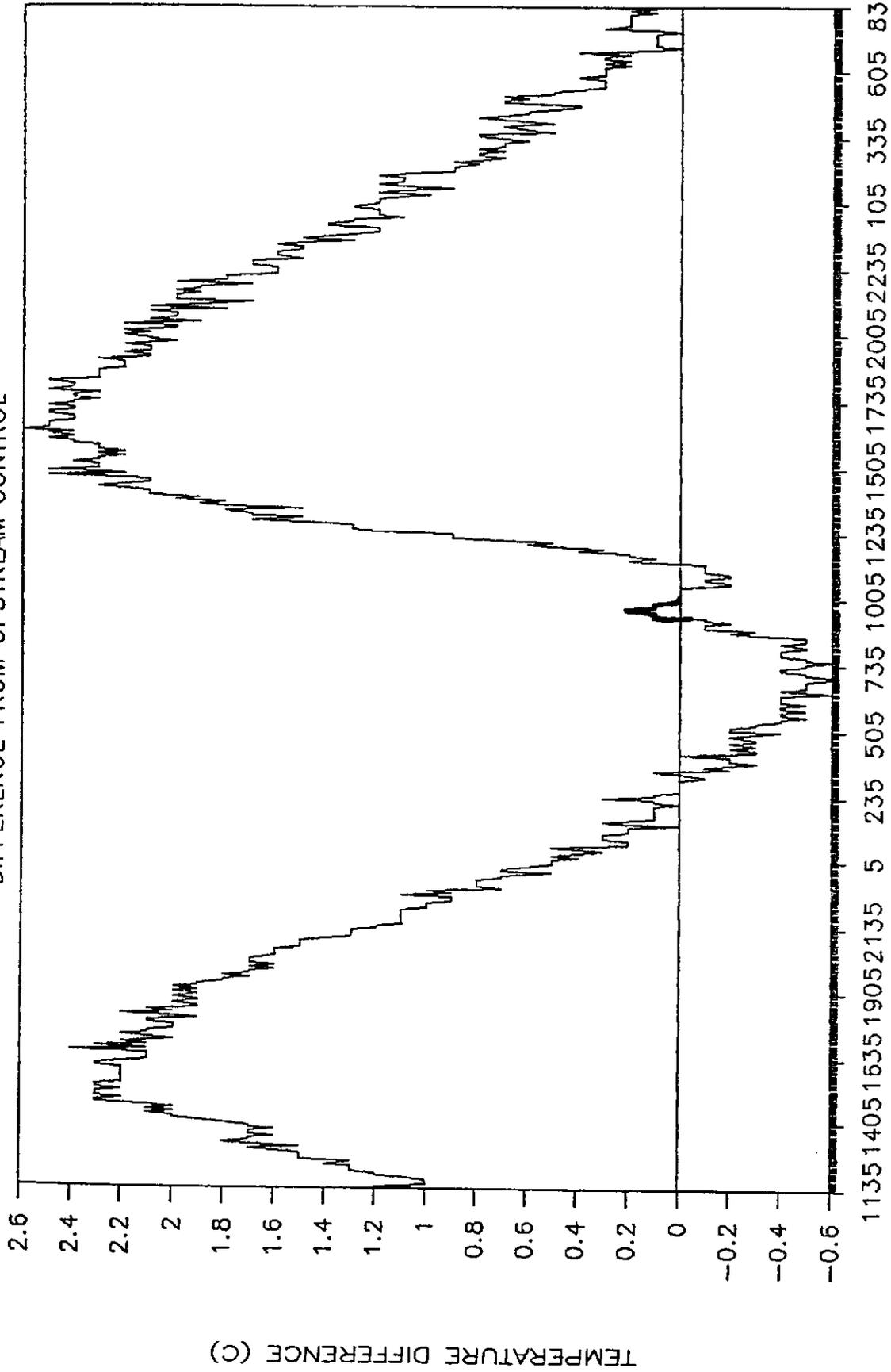
JONES CREEK

All steelhead juveniles survived during the three day test and appeared to be in good condition. This indicated that a lethal, short-term oxygen depletion or other water quality change did not occur due to the burn.

The results of the short-term temperature monitoring at 5-minute intervals are illustrated in Figure 5. No substantial

BURNING OF BLOCK 495 (JULY 29 - 31)

DIFFERENCE FROM UPSTREAM CONTROL



TIME IN 5 MIN. INTERVALS

Figure 5.-Temperature differences at the Jones Creek burn site compared to the upstream control taken during the burn at 5-minute intervals. Red area indicates time of burn.

change in the differences between temperatures in the clearcut and upstream control was observed in the several hours following the burn. There were significant temperature increases at the burn site compared to the upstream control at midday both before and after the burn (Figure 5). It is our opinion that this was primarily due to solar radiation and that the burn had no major effect on this pattern (Figure 5). This observed pattern of increased stream temperature in the clearcut was a typical pattern throughout the summer months (Figure 6). At first glance, Figure 6 indicates that daily high temperature differences between the burn site and control were greater for most days (an average of 1.1 C higher) after the burn than before the burn. This pattern could have been caused by either a reduction in streamside cover or more frequent sunshine after the burn. To determine whether the observed greater differences after the burn were due to more frequent sunshine, we compared daily high air temperatures, for the same time period, recorded by the Washington Department of Natural Resources at their Black Knob station approximately 7 miles from the project site, to daily water temperature differences between burn and control sites. This comparison, overlay Figure 7, indicates that the observed higher temperature differences in Jones Creek were probably due to increased air temperatures and/or sunshine and not necessarily to a reduction in streamside cover.

Unfortunately, data recorded for 1987 downstream of the burn site was rendered unusable because of a bank cave-in. This cave-in dropped a large amount of bank material on the temperature sensing probe and kept the device from measuring actual stream temperatures at that site. For general information, all daily high temperatures at all three sites for each month are shown in the Figures in Appendix A.

OPTION 1

The highest recorded temperature during the period from January 15, 1987 to September 24, 1987 occurred on August 10 and was 19.2 C. The lowest recorded temperature occurred on March 1 (4.4 C). The results of temperature monitoring at 30 minute intervals could not be used for evaluation of the burn on September 19, 1987 because we had no control temperatures for comparison. Daily high and low temperature at the Option 1 site for each month are shown in the Figures in Appendix B.

A&M OLD GROWTH

The highest recorded temperature during the period from February 19, 1987 to September 24, 1987 was on August 4 and 9, 16.2 C, while the lowest recorded temperature occurred on March 1 (4.4 C). Daily high and low temperature at the A&M Old Growth site for each month are shown in the Figures in Appendix C.

TEMP DIFFERENCES FROM UPSTREAM CONTROL

JONES CREEK (JULY-SEPT. 1986)

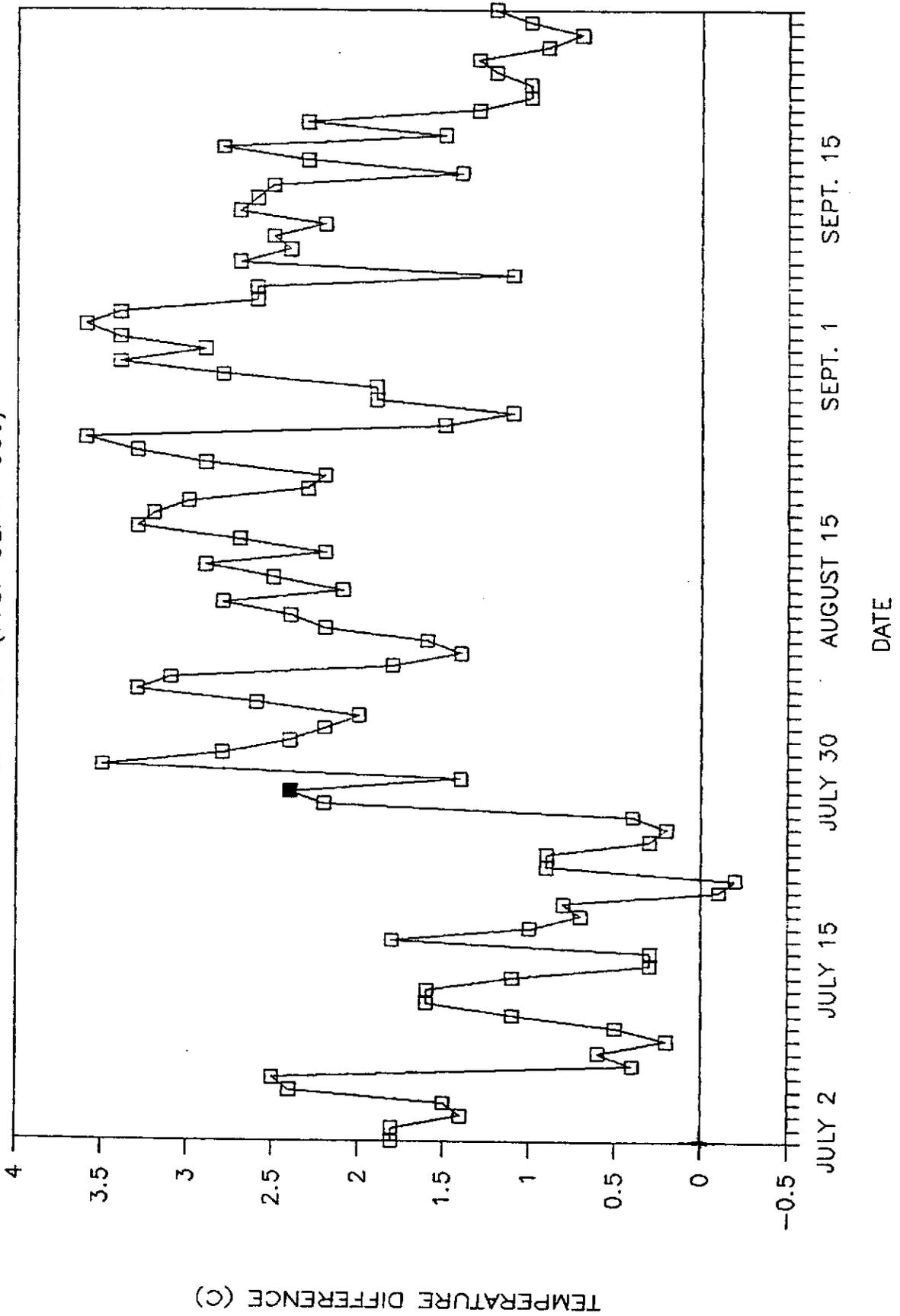


Figure 6.-Daily high temperature differences of the burn site on Jones Creek compared to the upstream control during the summer months. Dark square indicates day of the burn.

TEMP DIFFERENCES FROM UPSTREAM CONTROL

JONES CREEK (JULY-SEPT. 1986)

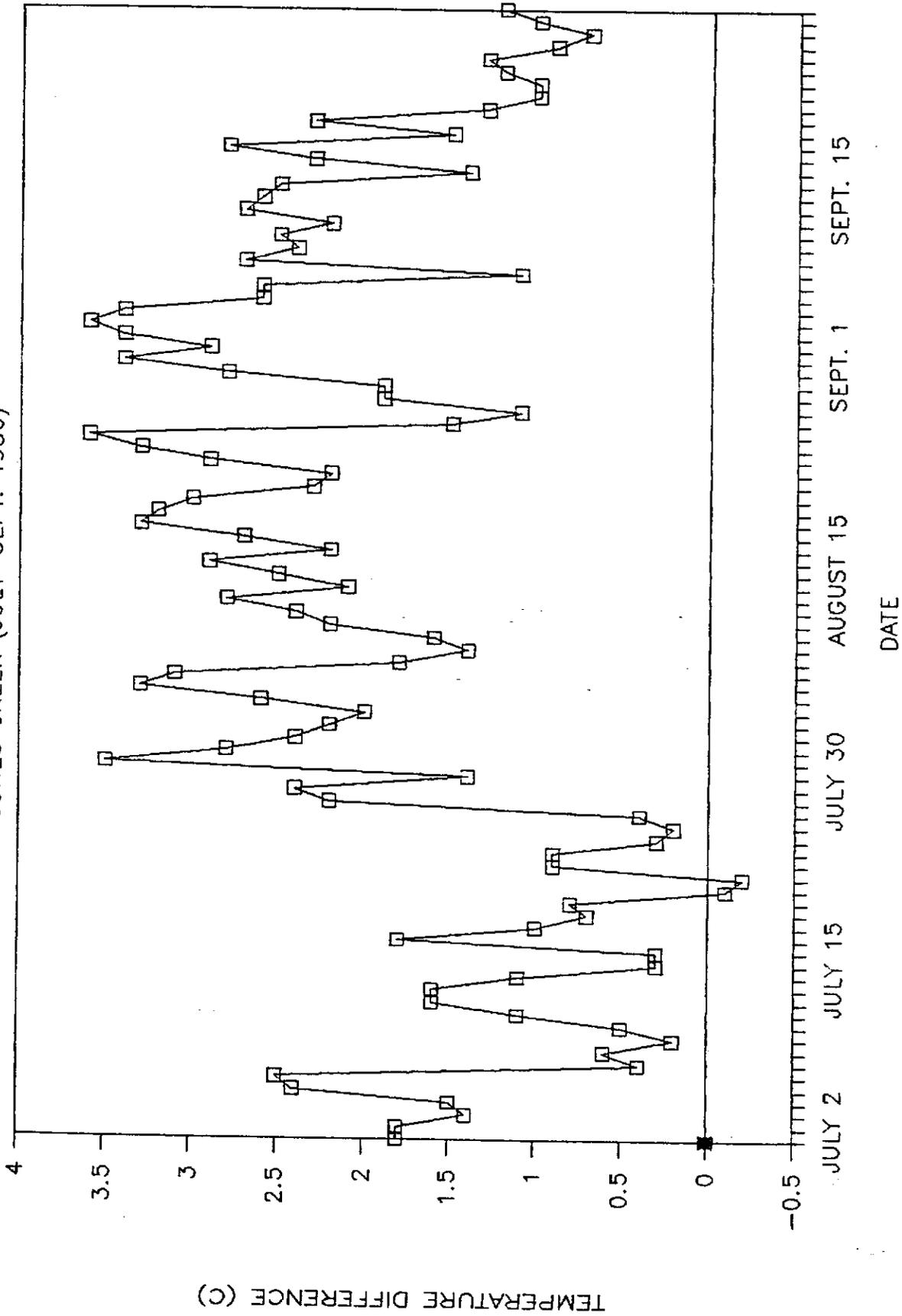


Figure 7.-Overlay of daily high temperatures recorded at the Black Knob weather station during the summer months.

In the logged areas, Jones Creek is characterized by steep-sided unstable, banks, up to 6 feet high, with an average stream width of 16 feet at mean high water. During summer low flows the discharge was just barely observable at times although water was always present in the channel. During winter storms this creek has overflowed its banks and spread far into the surrounding clearcut. The stream bottom was sandy, with the exception of a few gravel pockets. Numerous logging-associated debris jams were present (this debris washed into the stream after logging).

The patch of red alder located downstream of the logged area provided a stark contrast to the logged area. This portion of the stream was characterized by relatively low, stable banks and gravel bottom.

Coho subyearlings were found within block 495 and the patch of red alder by means of electrofishing. No sampling was done in block 376.

OPTION 1

The unnamed stream located in this site (Figure 3) is a tributary to the Moclips River located within the Quinault Indian Reservation. This site was selected based on the same four criteria used for the Jones Creek site described above. This site contains 4707 feet (1434 meters) of stream with an average stream width, at mean high water mark, of 12 feet. Clearcut harvesting of this site started in July, 1985 and subsequent logging operations were finished in March, 1987. Slash burning of this site took place on September 19, 1987 and was completed in approximately two hours. Visual observations of adult coho, subyearlings, and fry have been made in this stream in past years so electrofishing was not necessary to verify these observations.

A&M OLD GROWTH

The unnamed stream located in this site (Figure 4) is a tributary to Red Creek which flows into the Raft River within the Quinault Indian Reservation. The timber surrounding this stream is old-growth and has never been harvested. The site was selected because of its value for baseline data pertaining to a natural situation as compared to a replanted site or naturally regenerated second-growth forest. This area may be clearcut within the next several years. This site contains 4300 feet (1311 meters) of stream with an average stream width, at mean high water, of 32 feet.

No visual observations of salmonids in this stream have been documented. Electrofishing is planned for a later date.

CONCLUSIONS AND RECOMMENDATIONS

JONES CREEK

The burning at this site had no apparent short-term impacts on the salmonid population of this stream. This result was not unexpected because 1) the streambed was six feet below surrounding ground level, 2) the burn occurred on only one side of the stream, and 3) there was a management decision to wait until the prevailing wind was blowing away from the stream before igniting the burn site.

The Tempmentors will be checked more frequently in the future to insure that the sensing probes are in the stream and are not obstructed. We recommend that the Jones Creek study continue for one more year, to obtain baseline data, with a follow-up study every 4 to 5 years to assess long-term recovery of stream temperature as streamside vegetation grows.

Other future studies should focus on a site where the stream in question flows through the burn site rather than along its boundary and/or is less recessed from ground level. It is our opinion that such a stream could be subjected to extreme temperature shifts and should be monitored. In addition, we recommend that air temperature in the immediate vicinity be used to determine the effects of solar radiation.

OPTION 1

This study was begun in an effort to satisfy the above recommendation on future site selection where a stream flows through the burn site. However, this site was burned on a weekend and we were not notified so were unable to deploy the needed upstream control temperature monitor to make any temperature comparisons.

The stream in this site had been protected by a good-quality buffer strip but the slash burning killed a substantial portion of the vegetation in that strip. We recommend a field assessment of the damage by collecting temperature data at the existing site (Figure 2) and at an upstream control through next summer. This would require the use of two additional Tempmentors; one for the upstream control and the other as an air temperature control.

A&M OLD GROWTH

The continued monitoring of this site for baseline stream temperature data is important to gain insight into the normal range of temperature buffering provided by old-growth forest. This data could be used to compare to temperature buffering in second generation forests. We recommend that an additional Tempmentor be deployed as an upstream control to provide a complete picture of the temperature buffering capability of an old-growth forest.

Acknowledgments

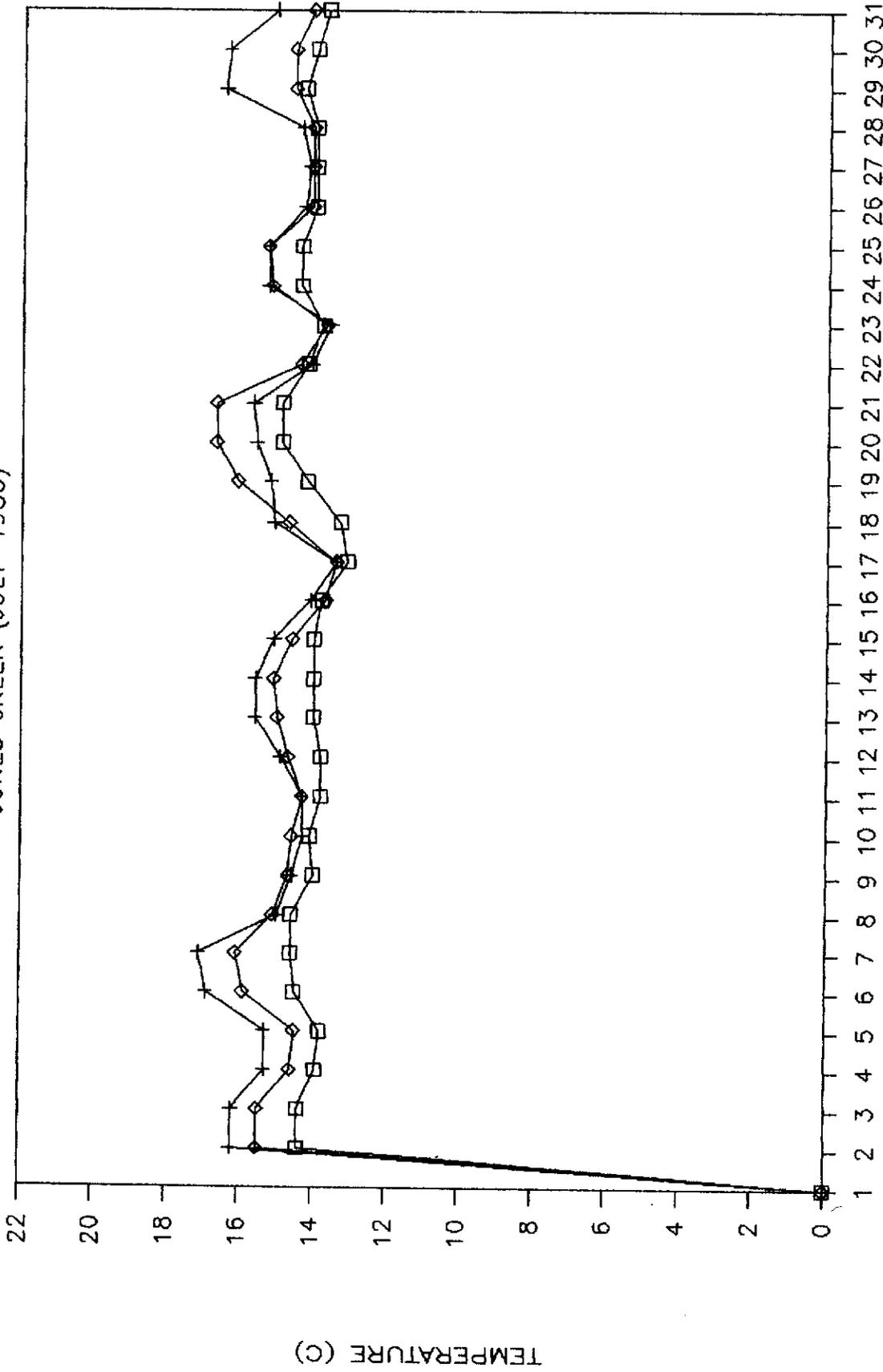
The author gratefully acknowledges the assistance of Bruce Jones in site selection, background information, and data collection, and Eric Knudsen for review of this report.

APPENDIX A

Daily high temperature by month for Jones Creek (July 1986 - September 1987). Station locations are indicted on Figure 2.

DAILY HIGH TEMPERATURES

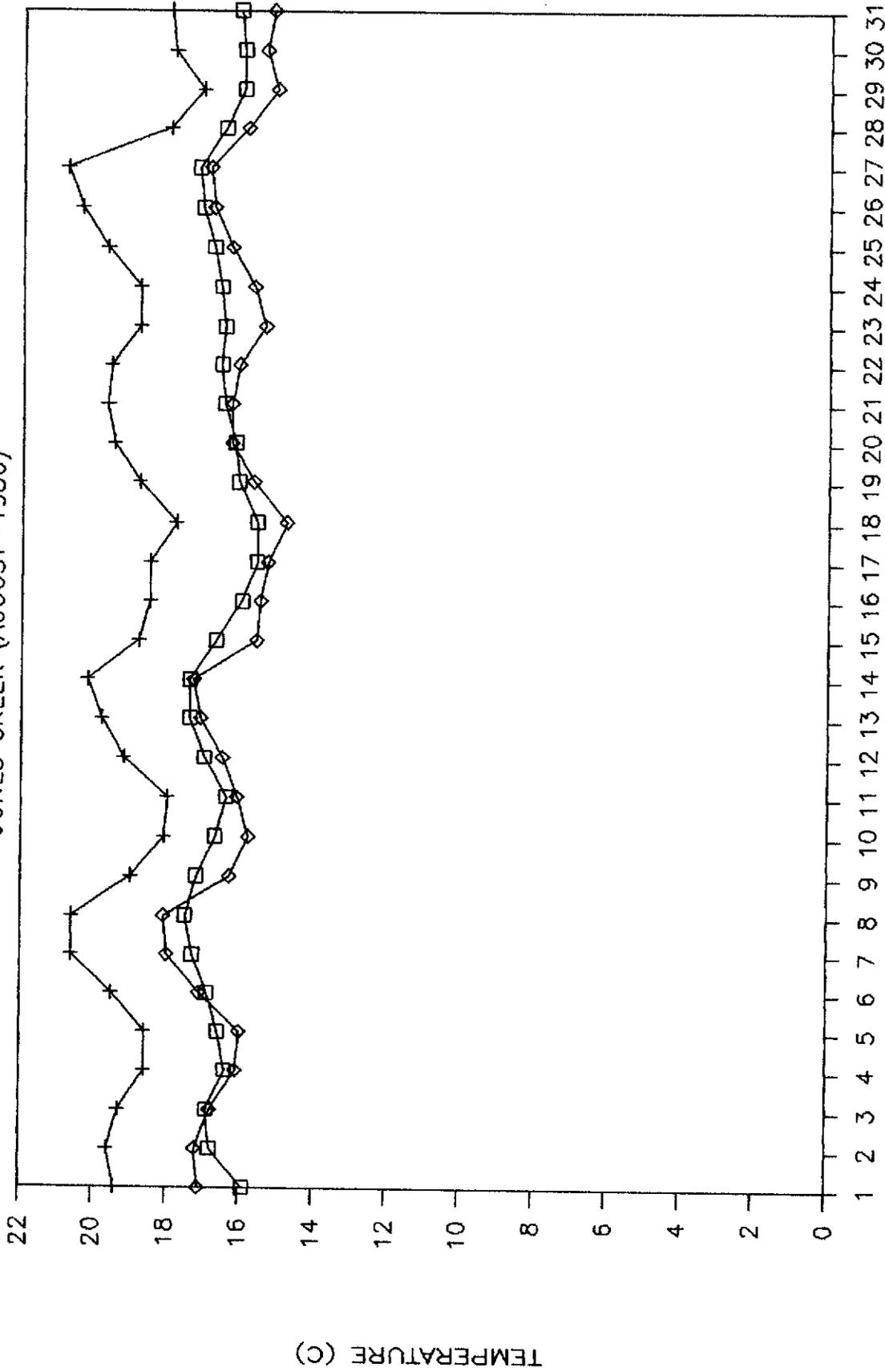
JONES CREEK (JULY-1986)



□ STA #1 + DATE ◇ STA #3

DAILY HIGH TEMPERATURES

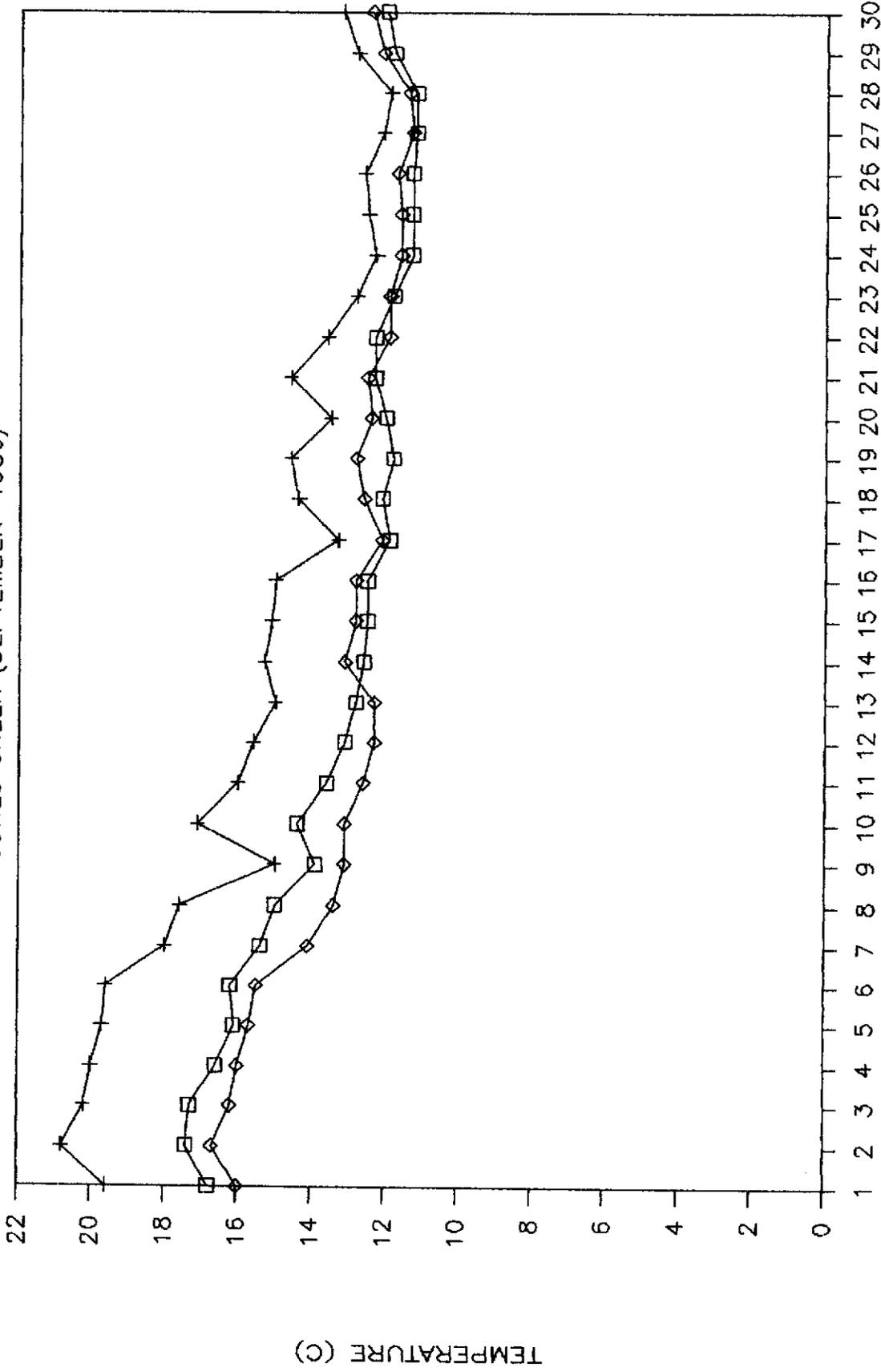
JONES CREEK (AUGUST-1986)



□ STA #1 + DATE ◇ STA #3

DAILY HIGH TEMPERATURES

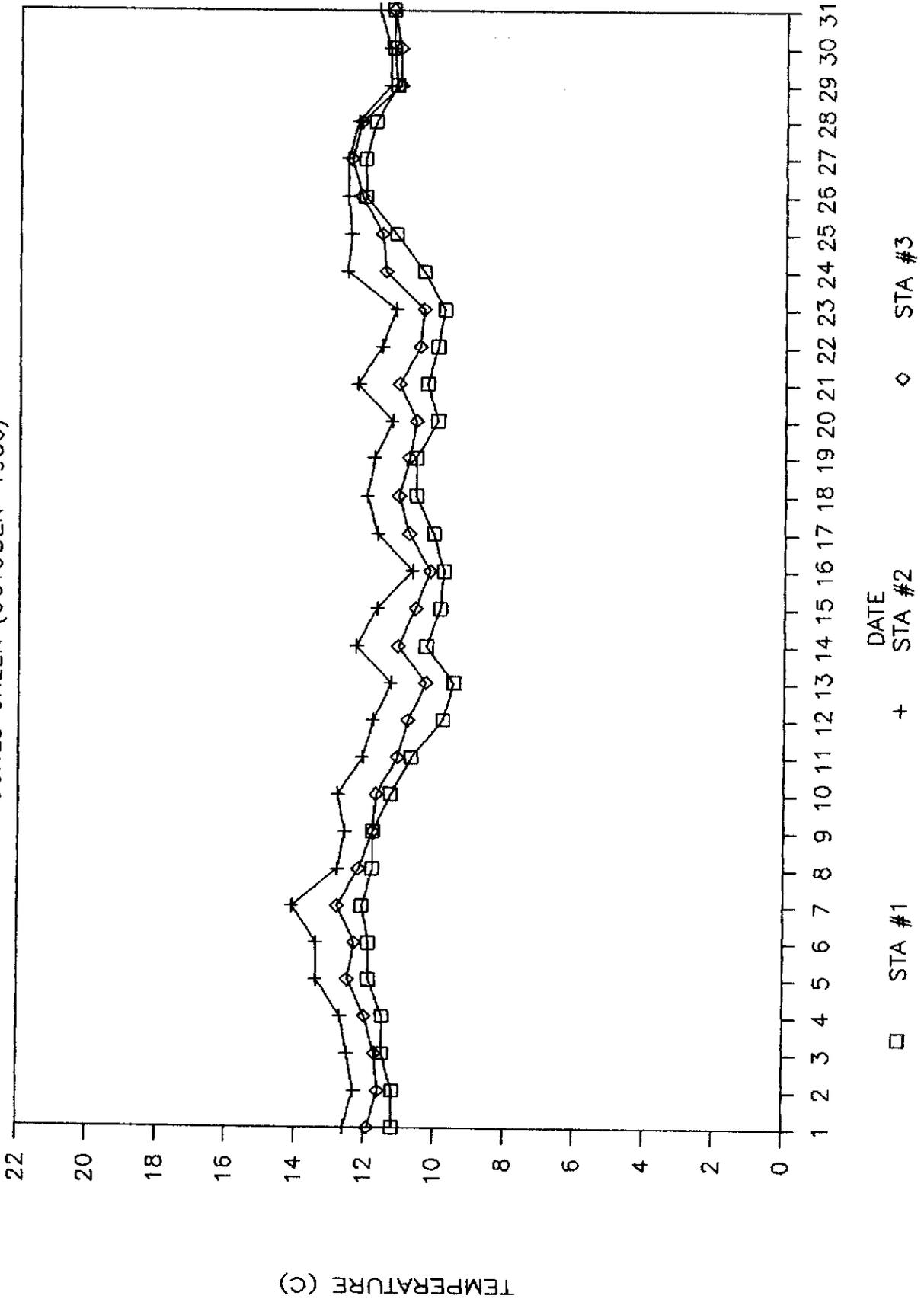
JONES CREEK (SEPTEMBER-1986)



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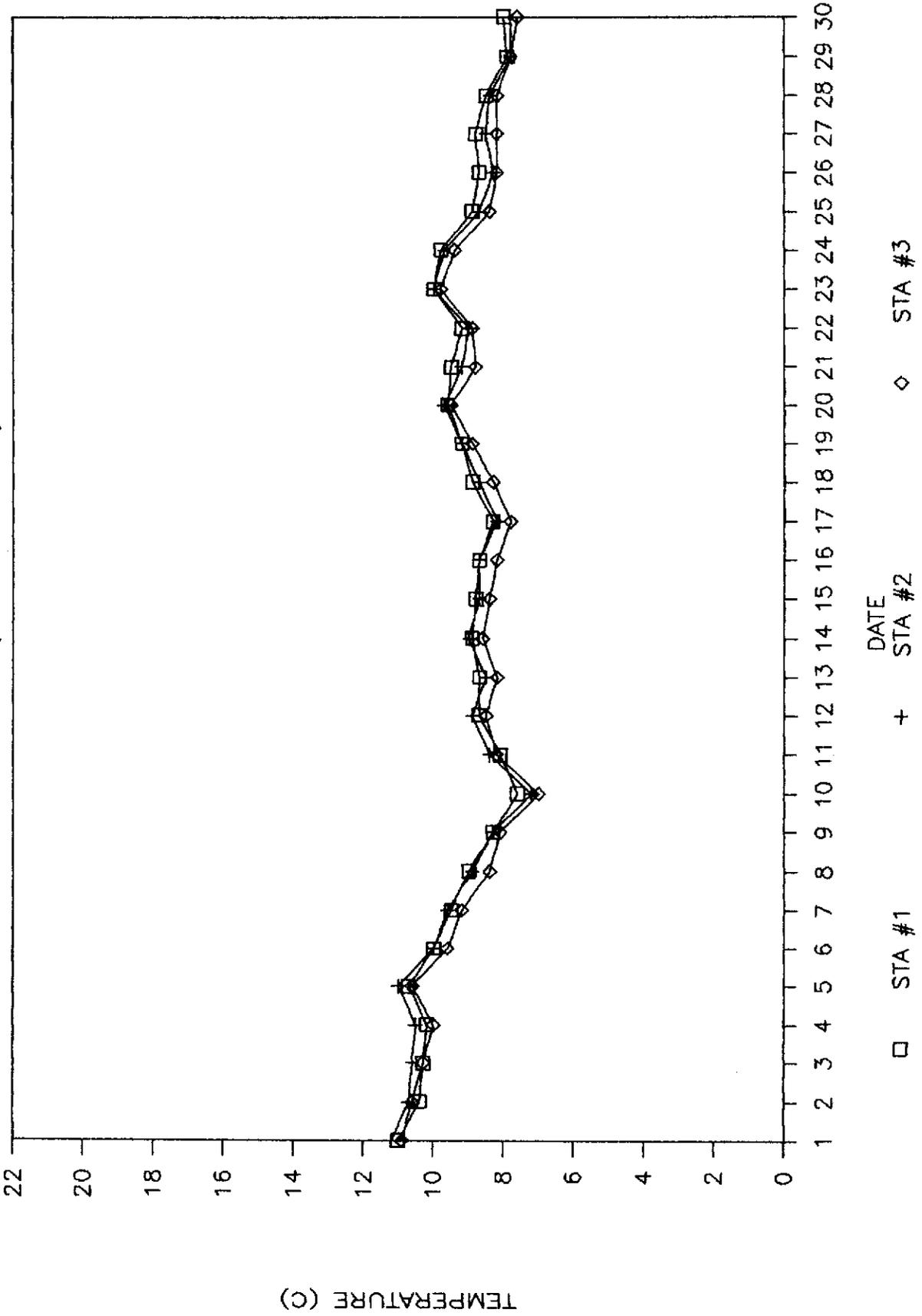
DAILY HIGH TEMPERATURES

JONES CREEK (OCTOBER-1986)



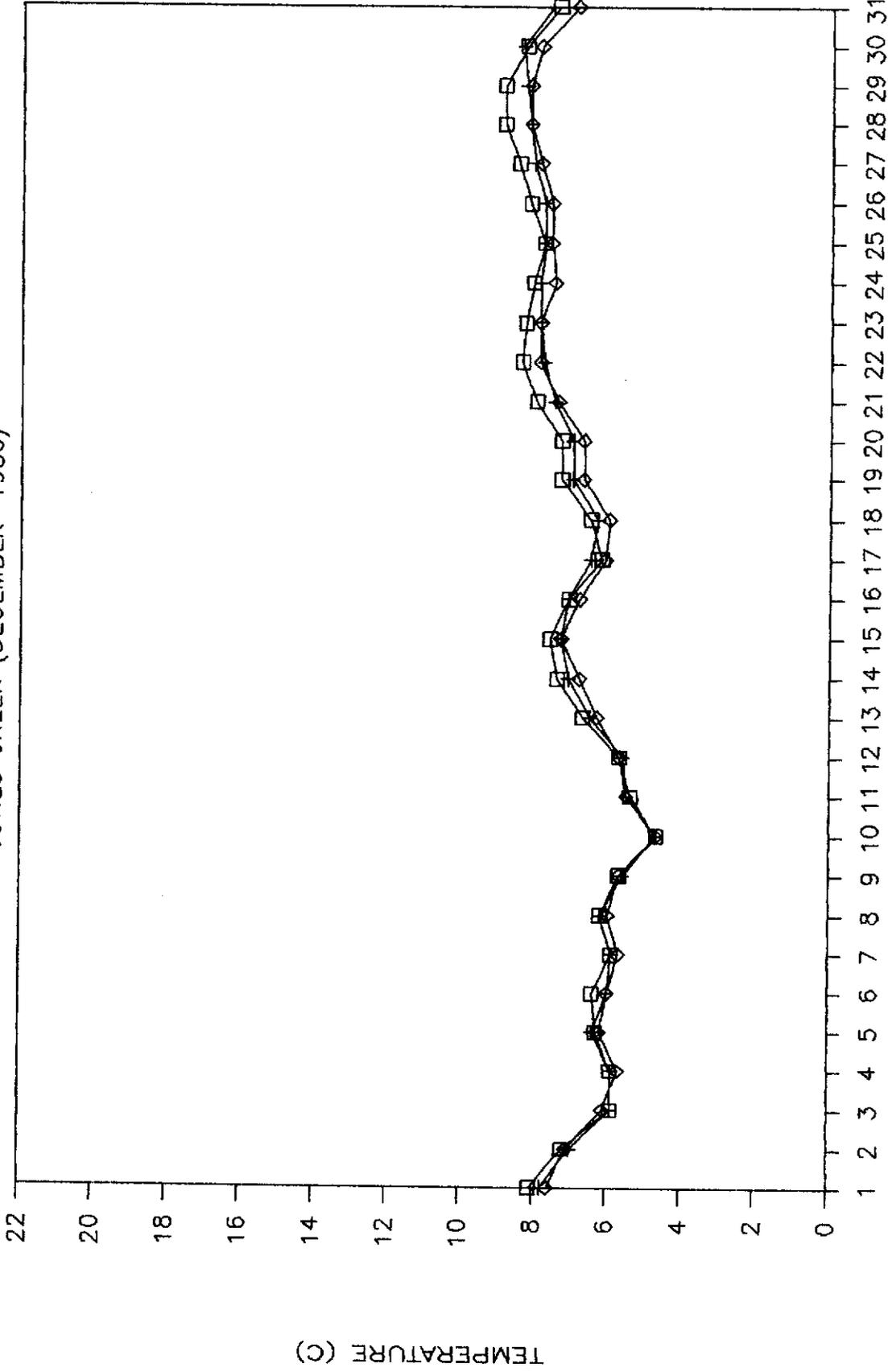
DAILY HIGH TEMPERATURES

JONES CREEK (NOVEMBER-1986)



DAILY HIGH TEMPERATURES

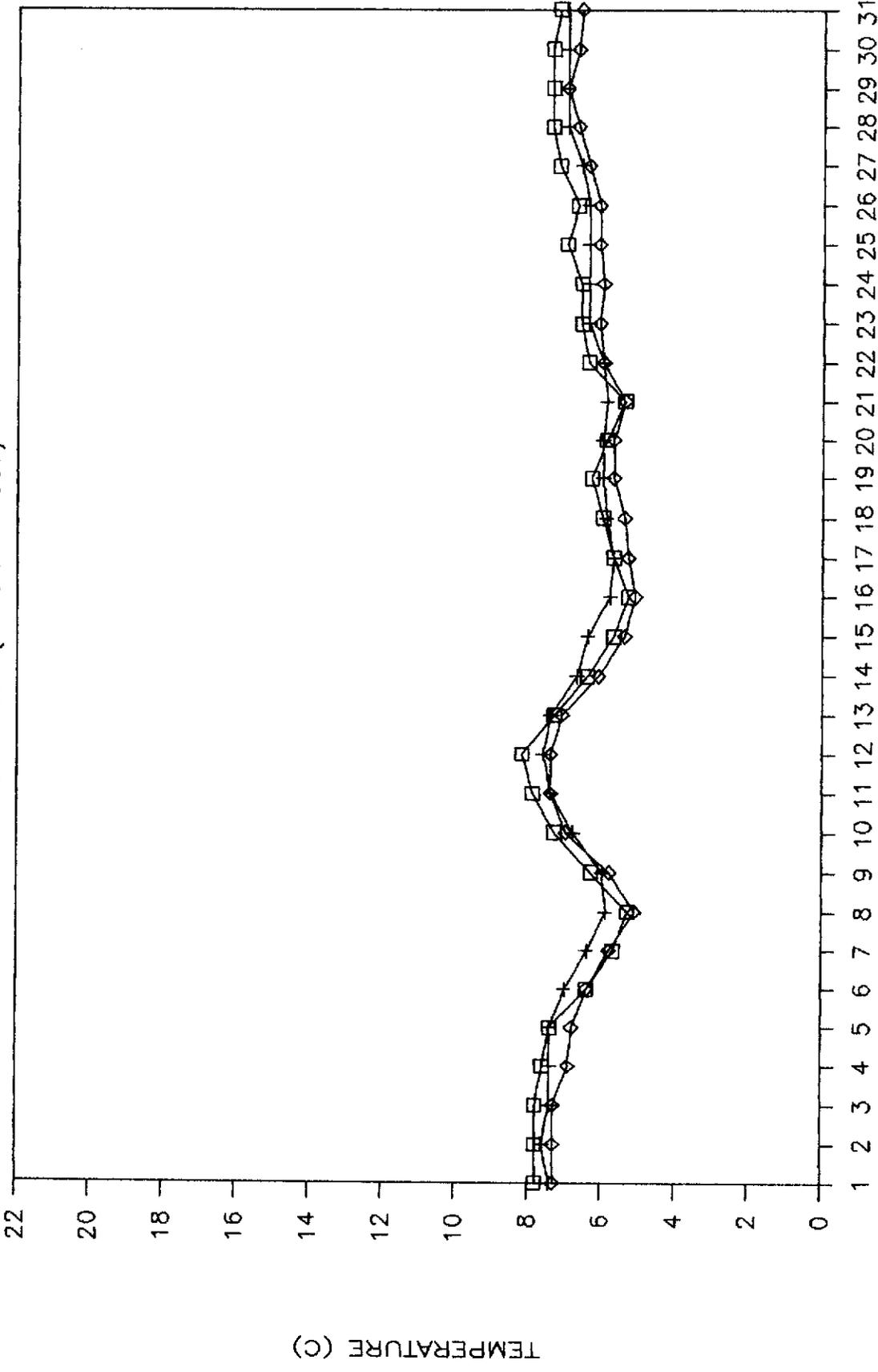
JONES CREEK (DECEMBER-1986)



□ STA #1 + STA #2 ◇ STA #3

DAILY HIGH TEMPERATURES

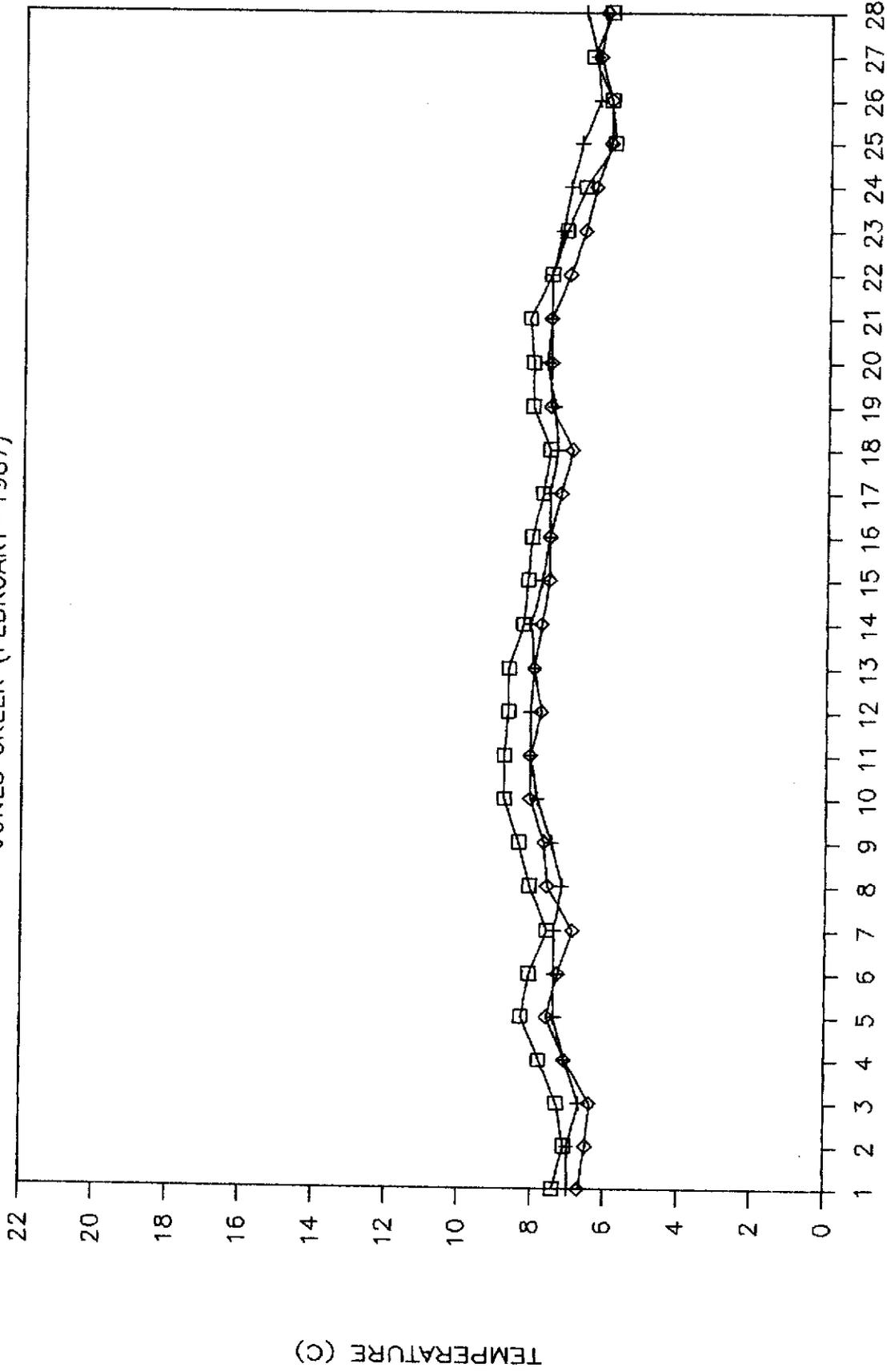
JONES CREEK (JANUARY-1987)



□ STA#1 + DATE ◇ STA#3

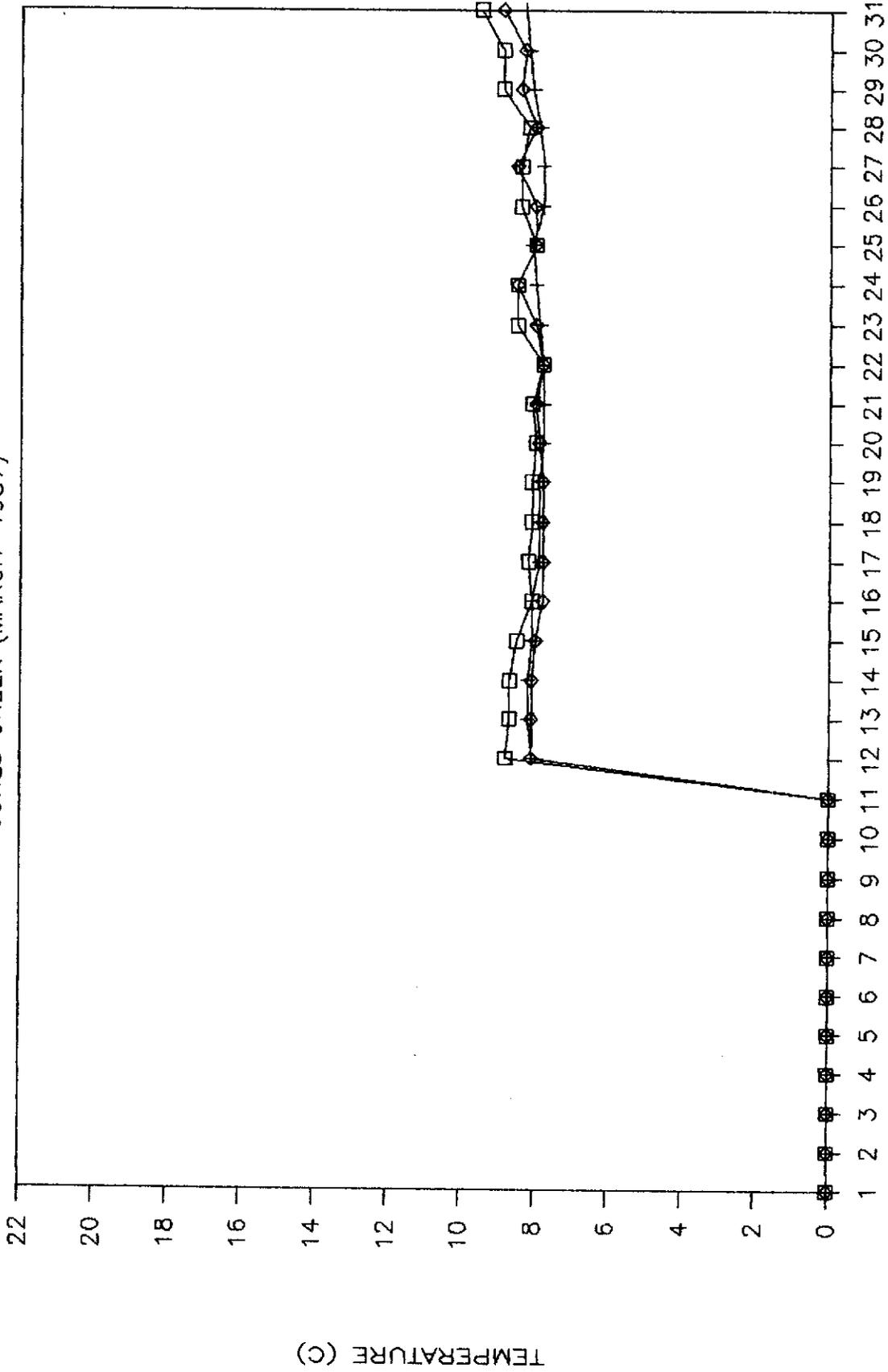
DAILY HIGH TEMPERATURES

JONES CREEK (FEBRUARY-1987)



DAILY HIGH TEMPERATURE

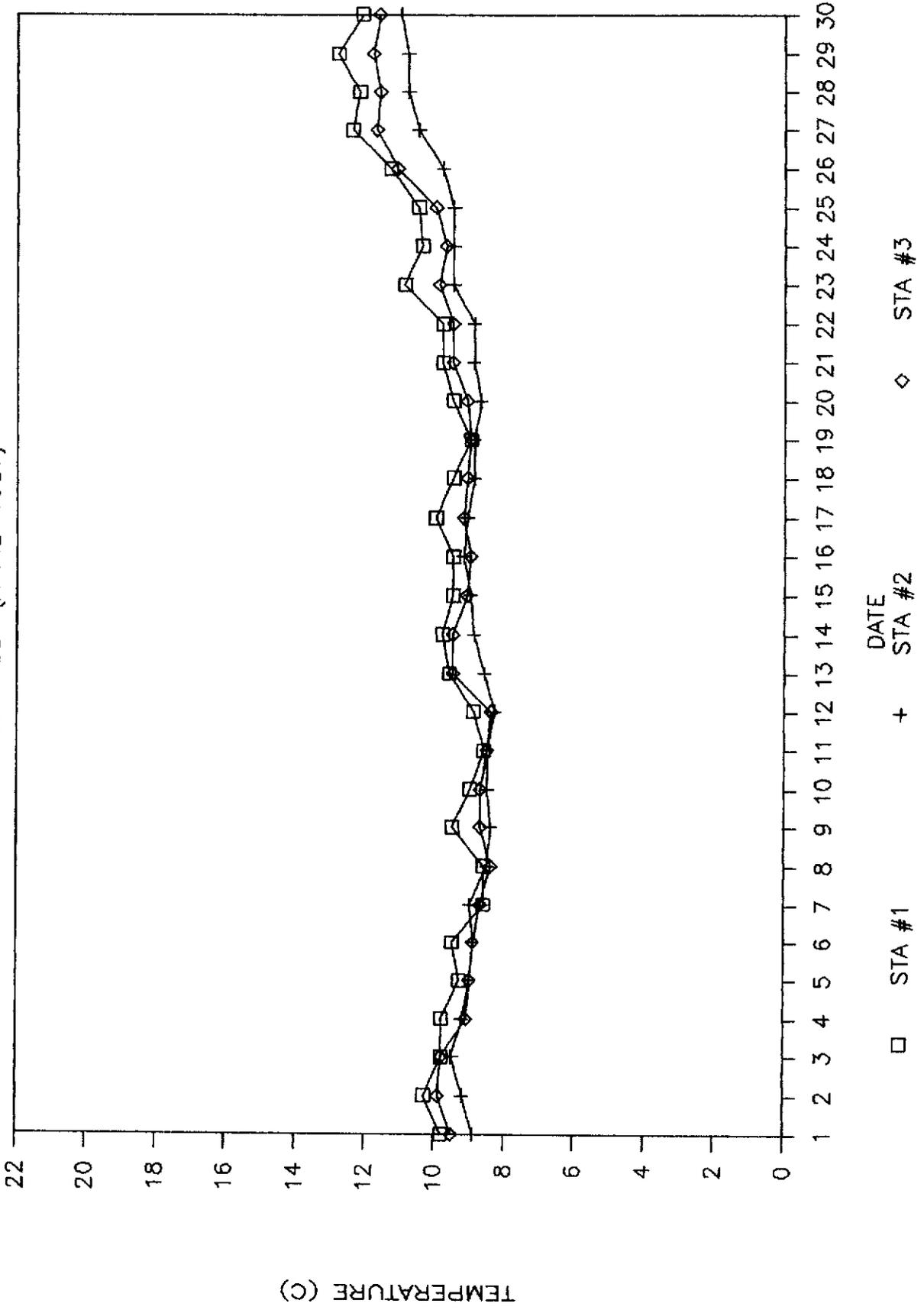
JONES CREEK (MARCH--1987)



□ STA #1 + DATE ◇ STA #3

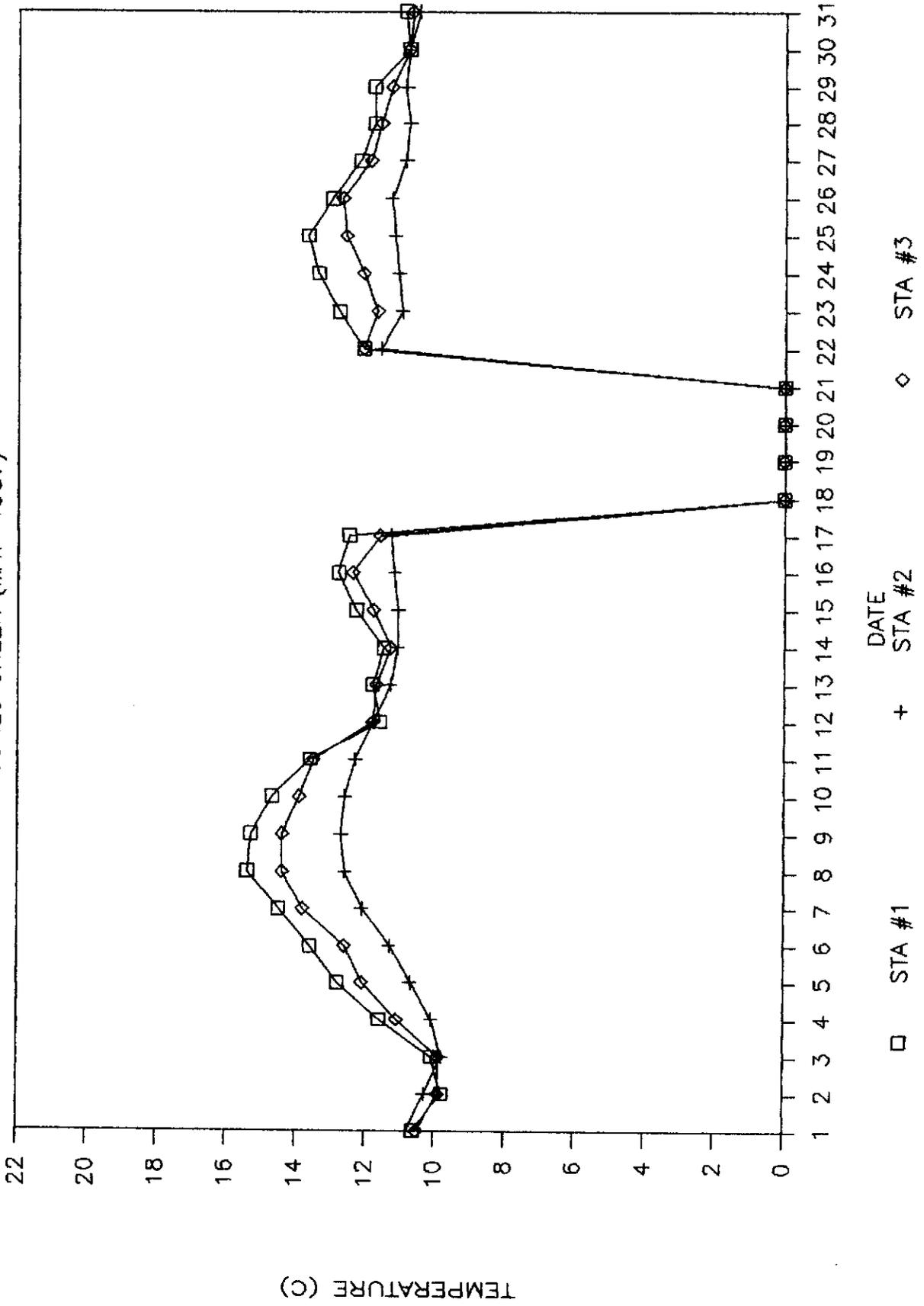
DAILY HIGH TEMPERATURE

JONES CREEK (APRIL-1987)



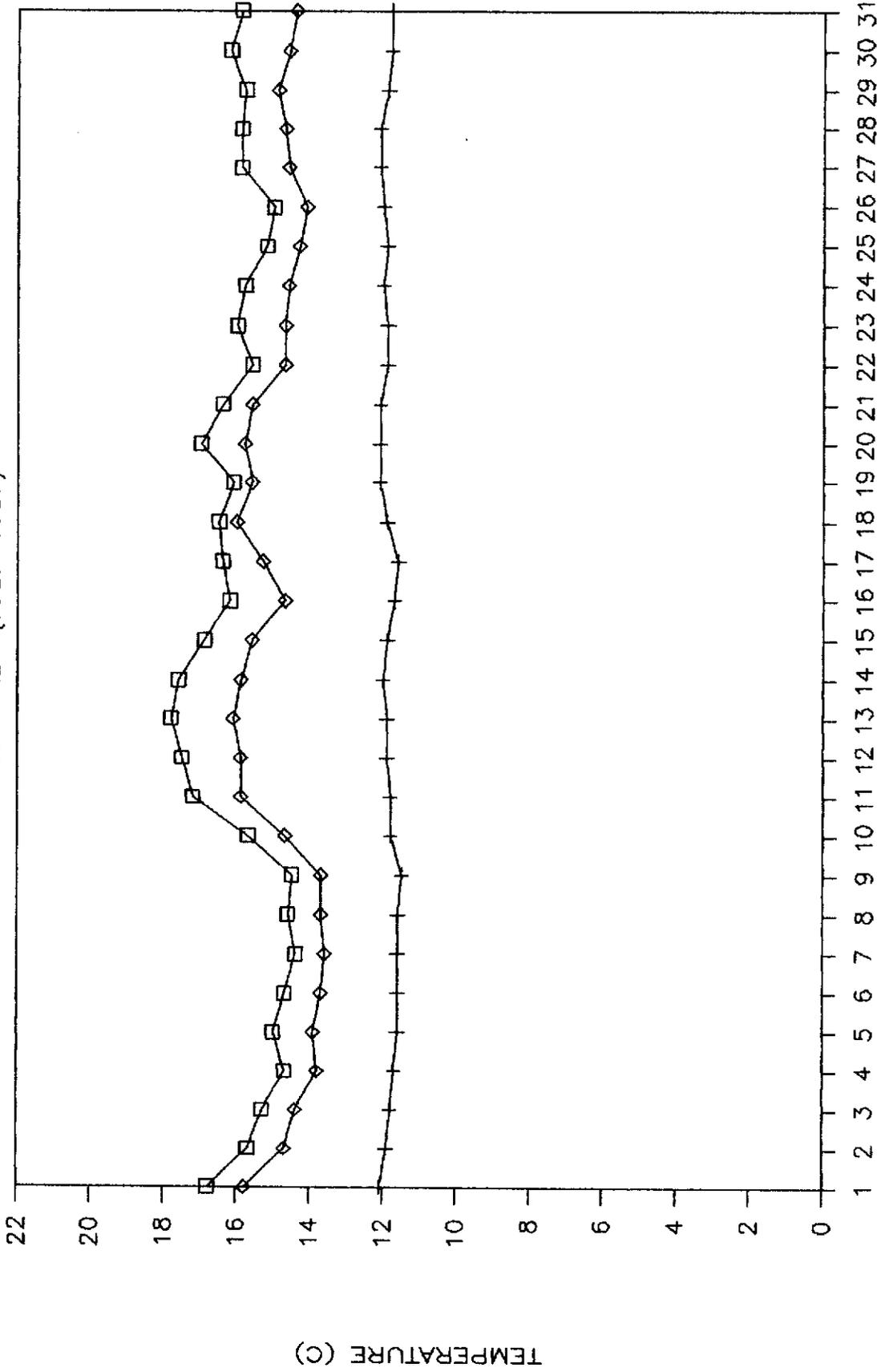
DAILY HIGH TEMPERATURES

JONES CREEK (MAY-1987)



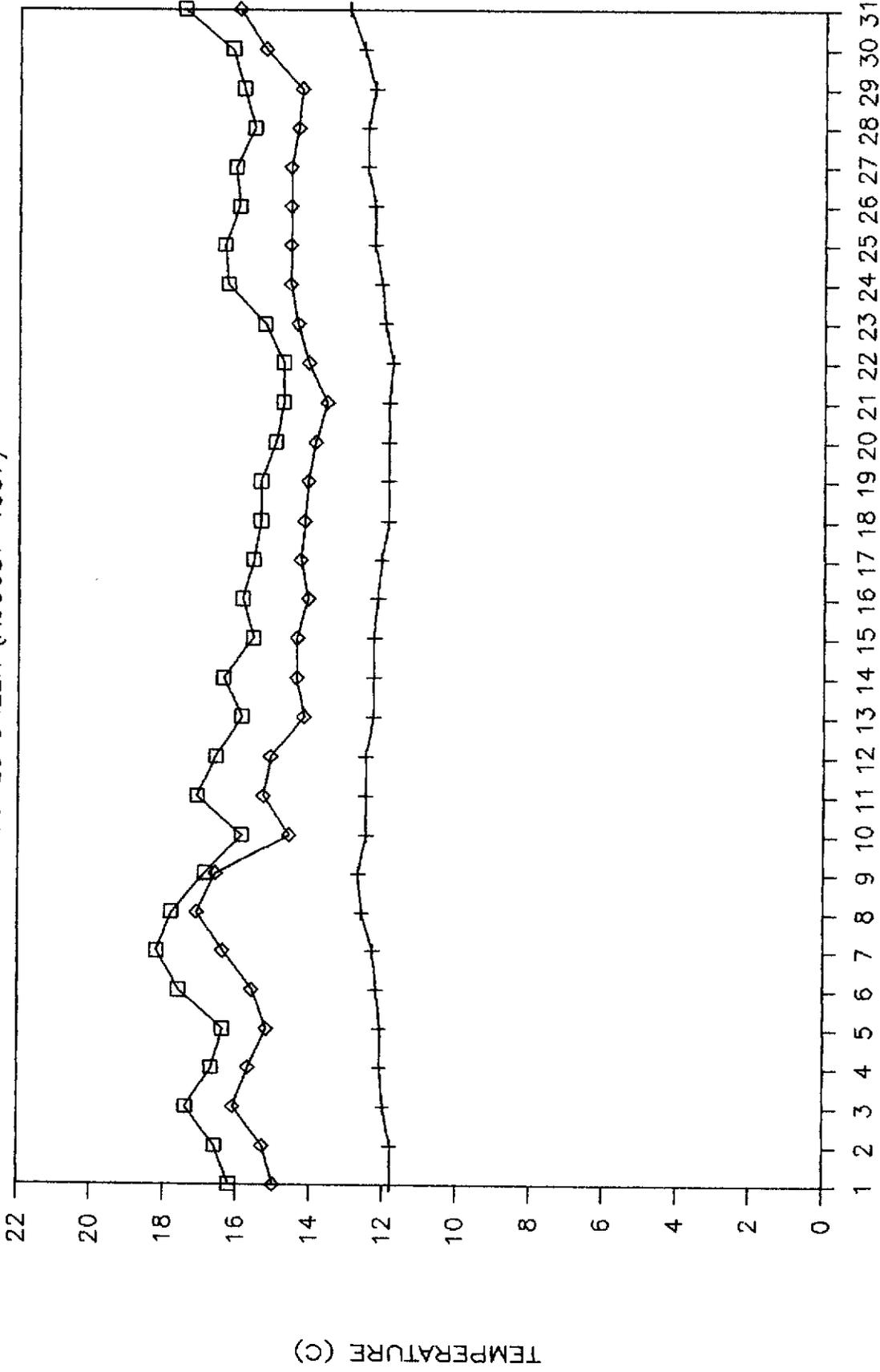
DAILY HIGH TEMPERATURES

JONES CREEK (JULY-1987)



DAILY HIGH TEMPERATURES

JONES CREEK (AUGUST-1987)



□ STA #1 + DATE ◇ STA #3

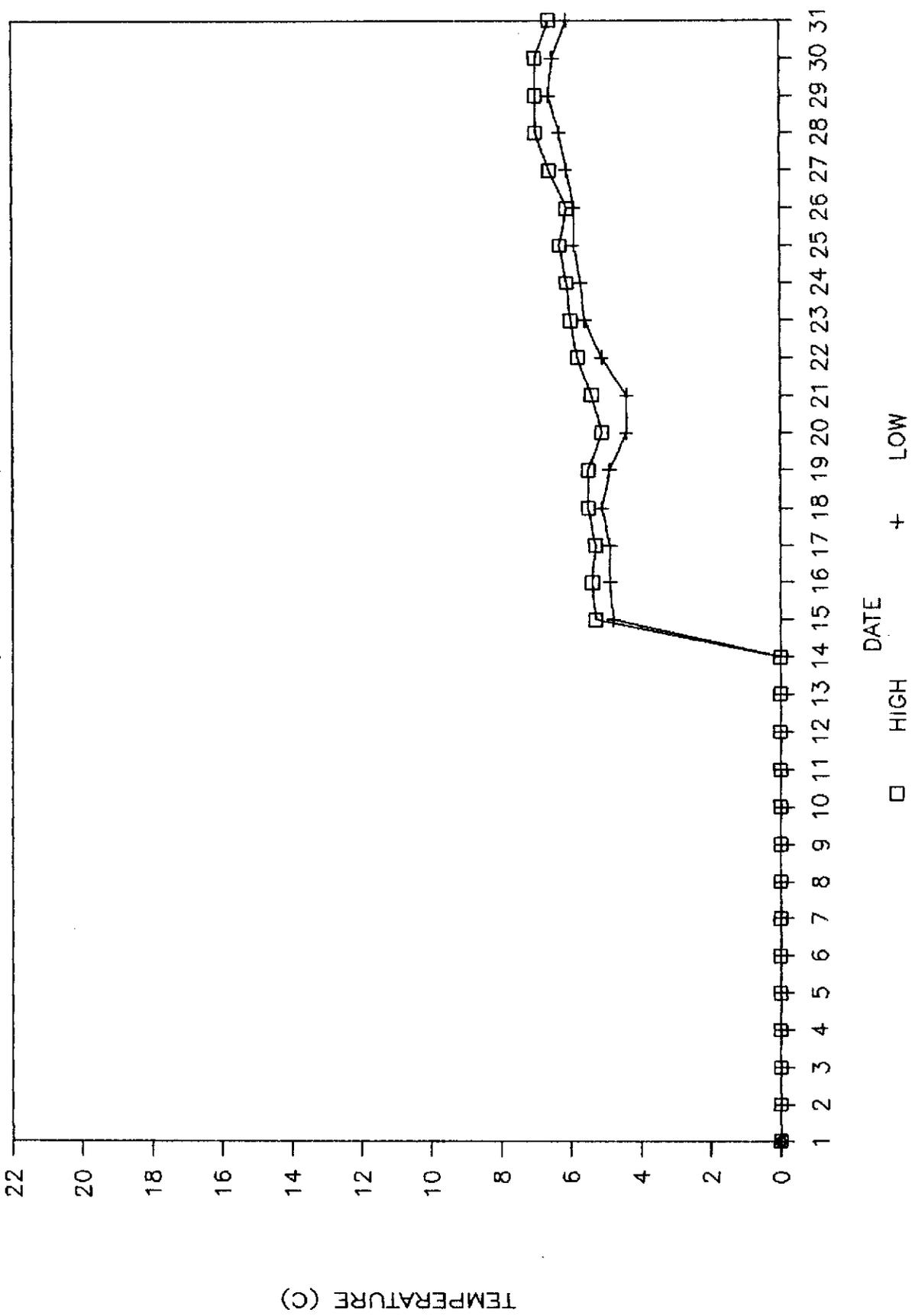
APPENDIX B

Daily high and low temperatures by month for Option 1

(January 1987 - September 1987).

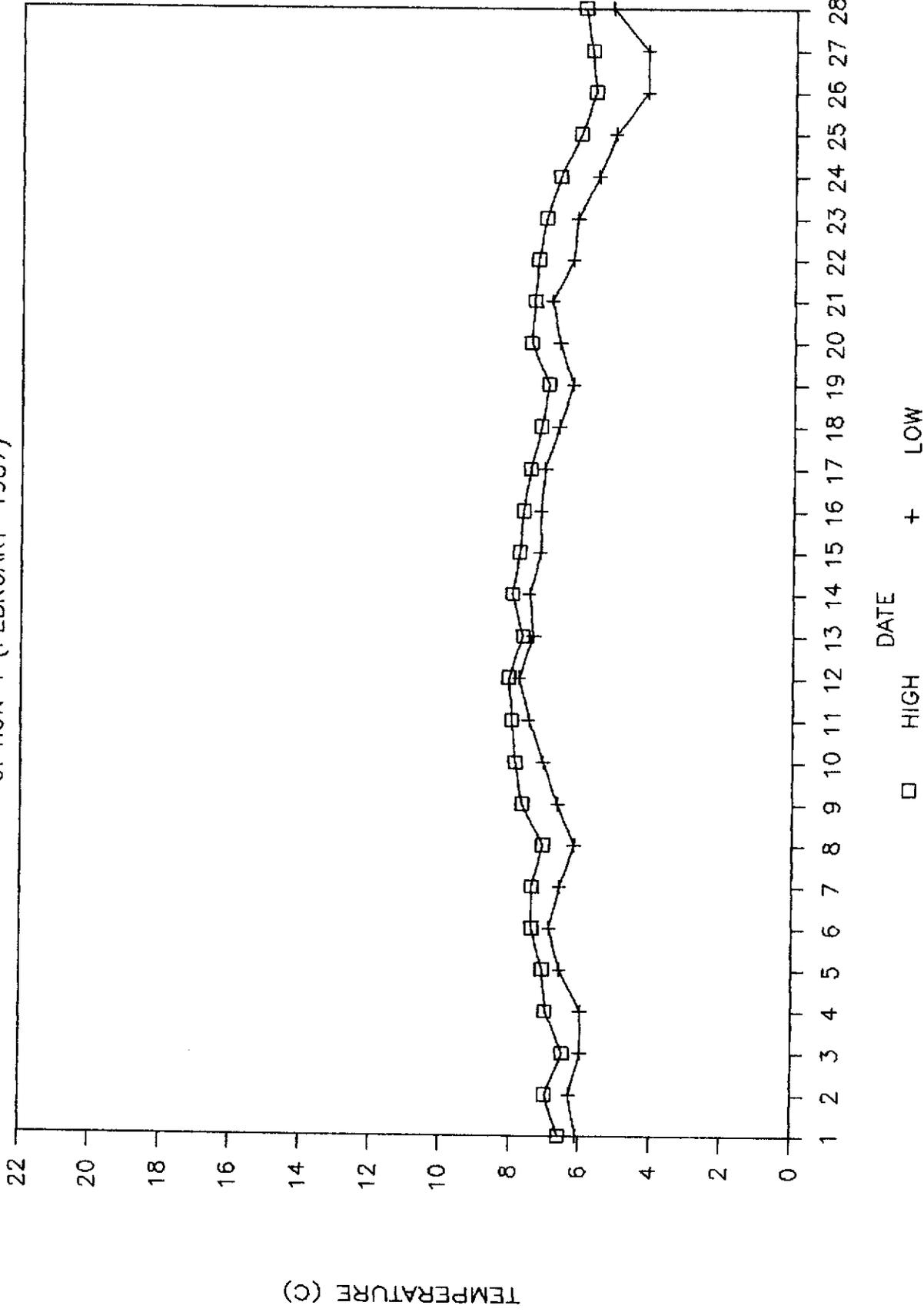
DAILY HIGH & LOW TEMPERATURES

OPTION 1 (JANUARY-1987)



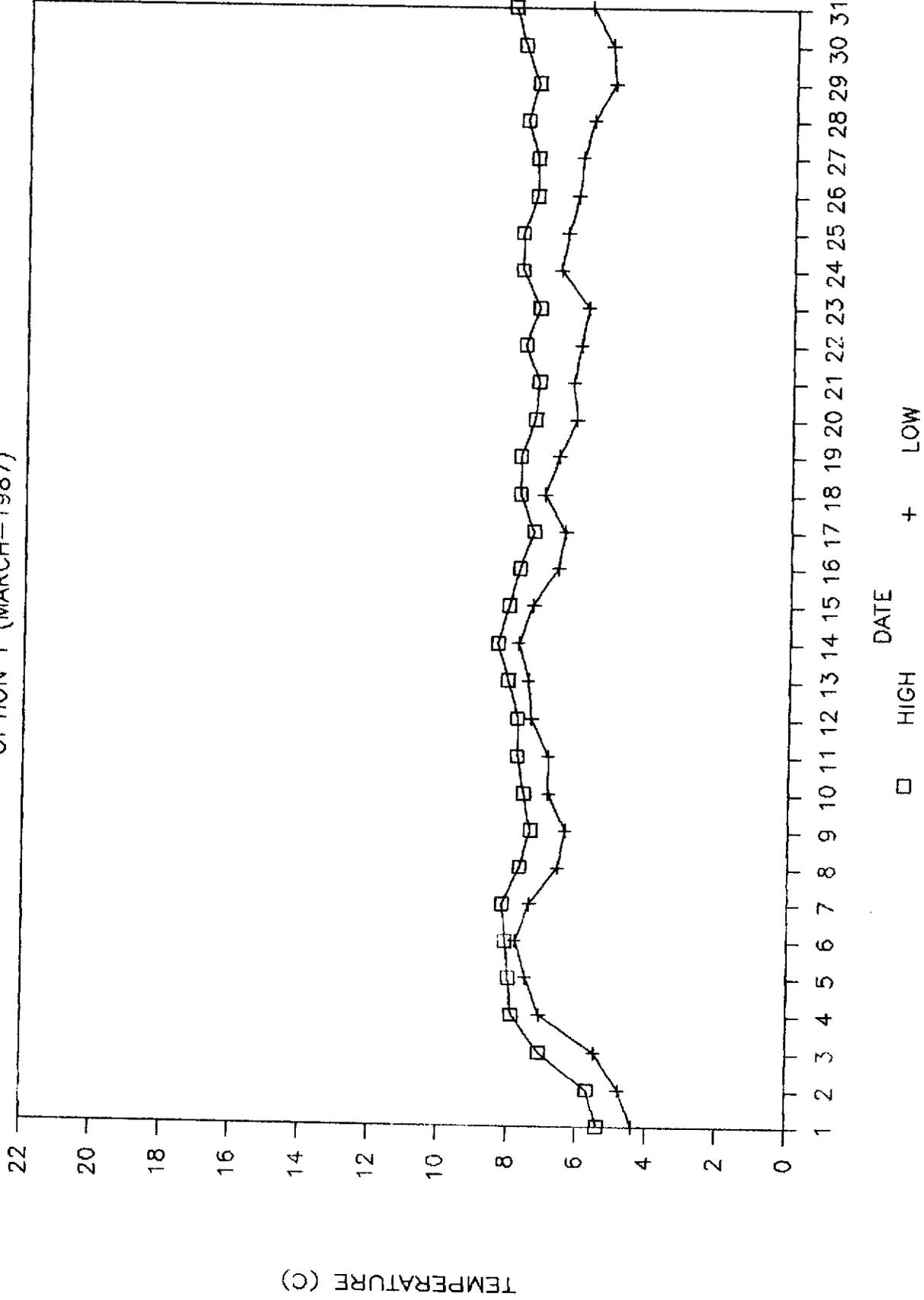
DAILY HIGH & LOW TEMPERATURES

OPTION 1 (FEBRUARY-1987)



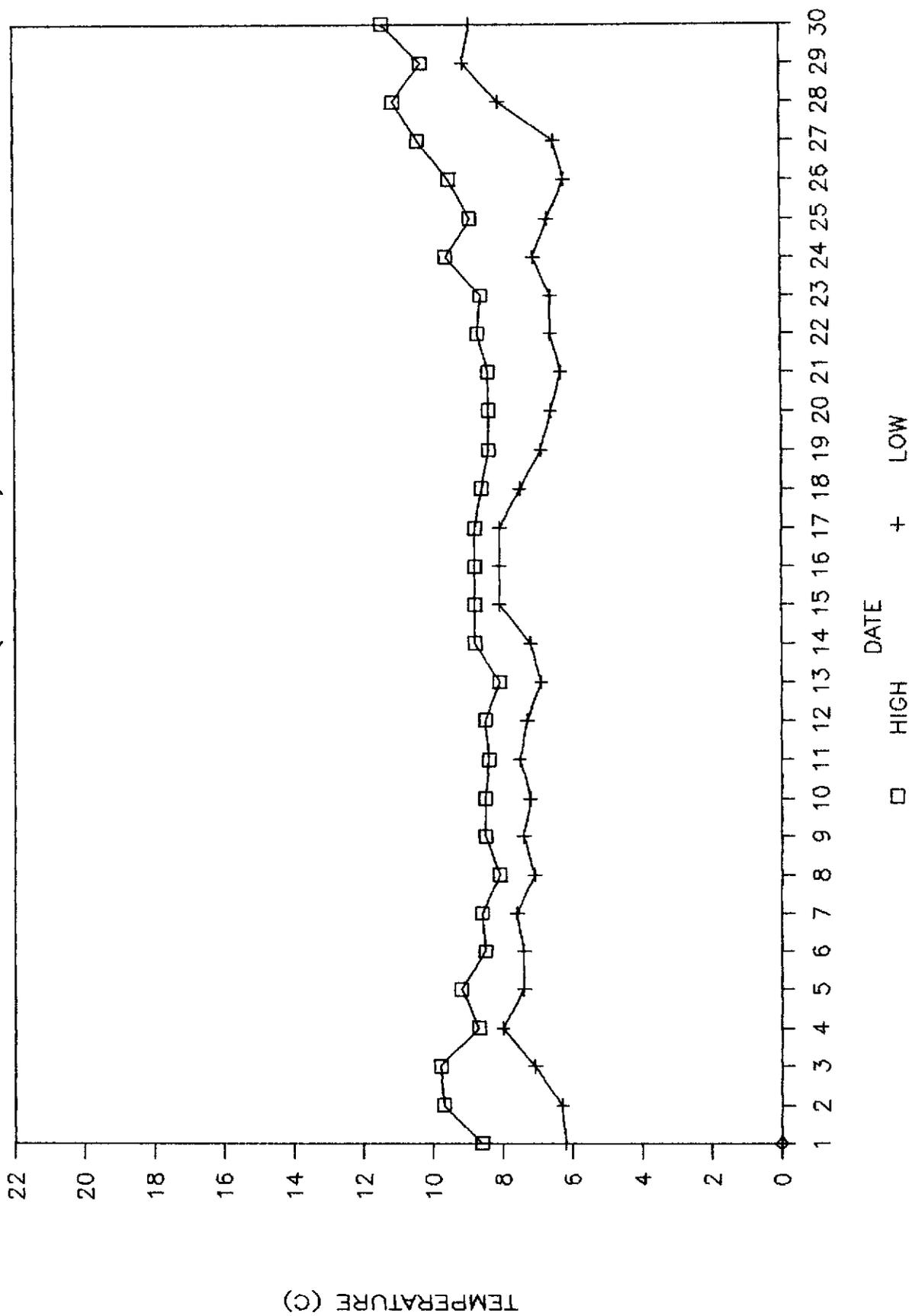
DAILY HIGH & LOW TEMPERATURE

OPTION 1 (MARCH-1987)



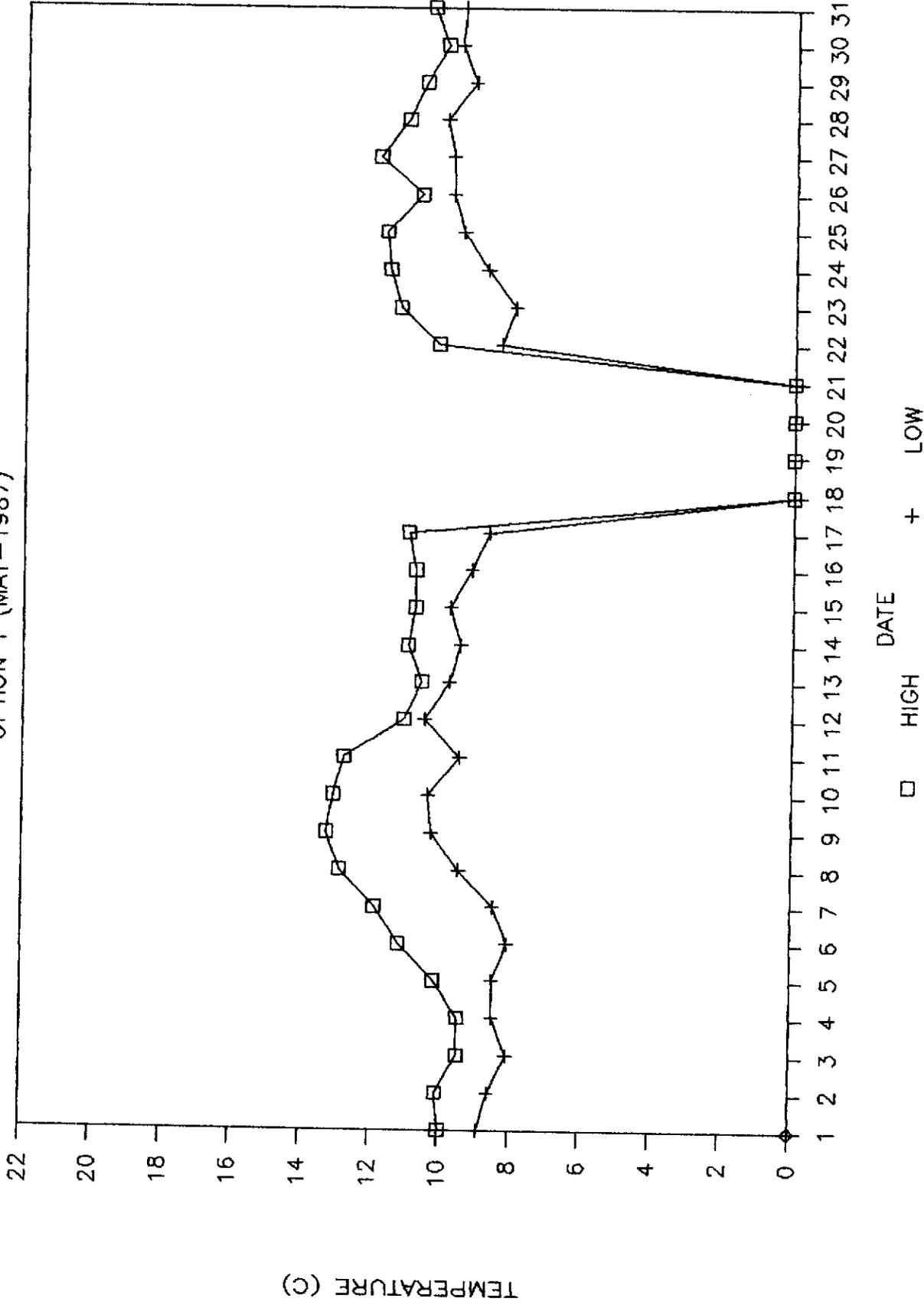
DAILY HIGH & LOW TEMPERATURE

OPTION 1 (APRIL-1987)



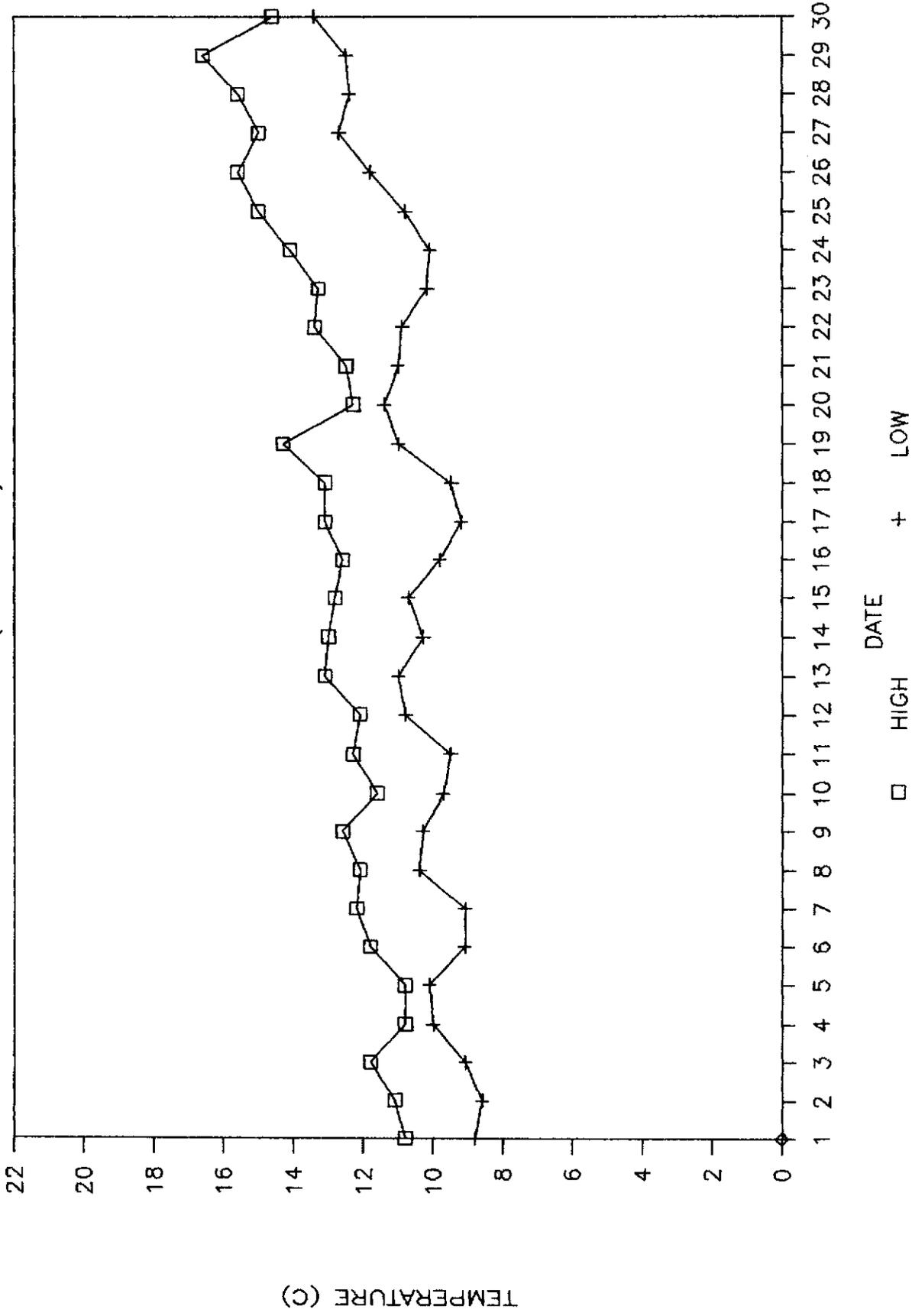
DAILY HIGH & LOW TEMPERATURES

OPTION 1 (MAY-1987)



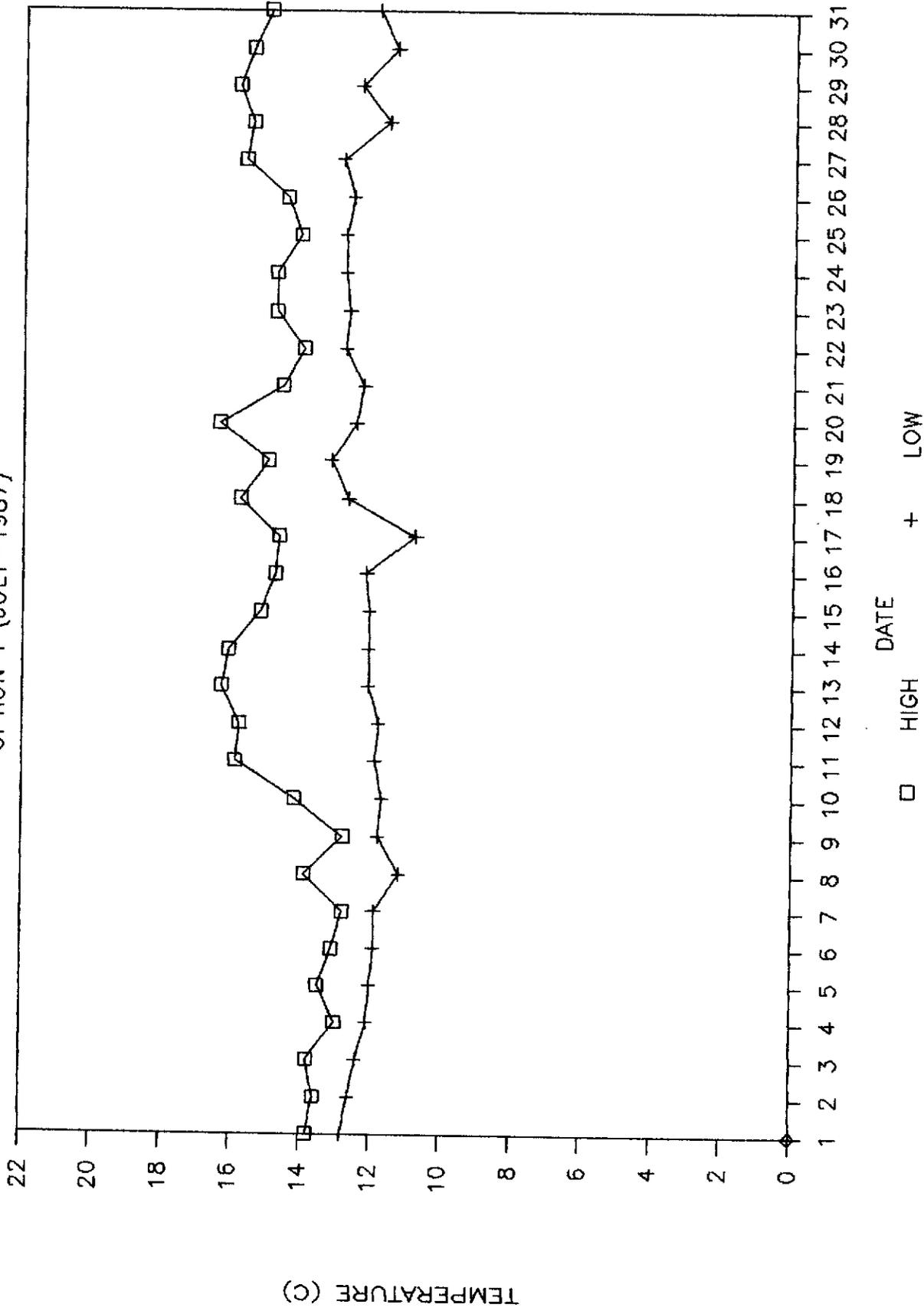
DAILY HIGH & LOW TEMPERATURES

OPTION 1 (JUNE-1987)



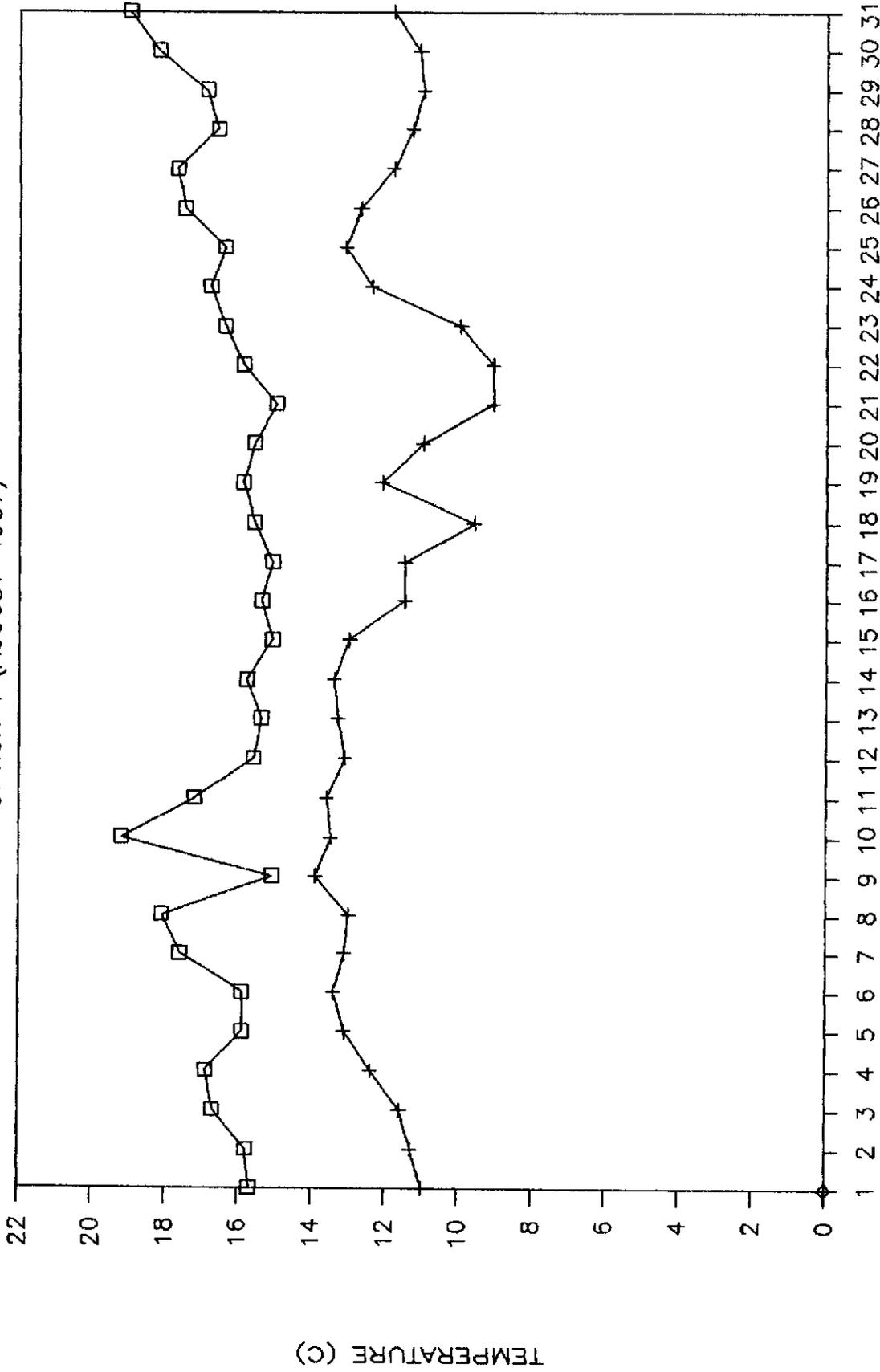
DAILY HIGH & LOW TEMPERATURES

OPTION 1 (JULY-1987)



DAILY HIGH & LOW TEMPERATURES

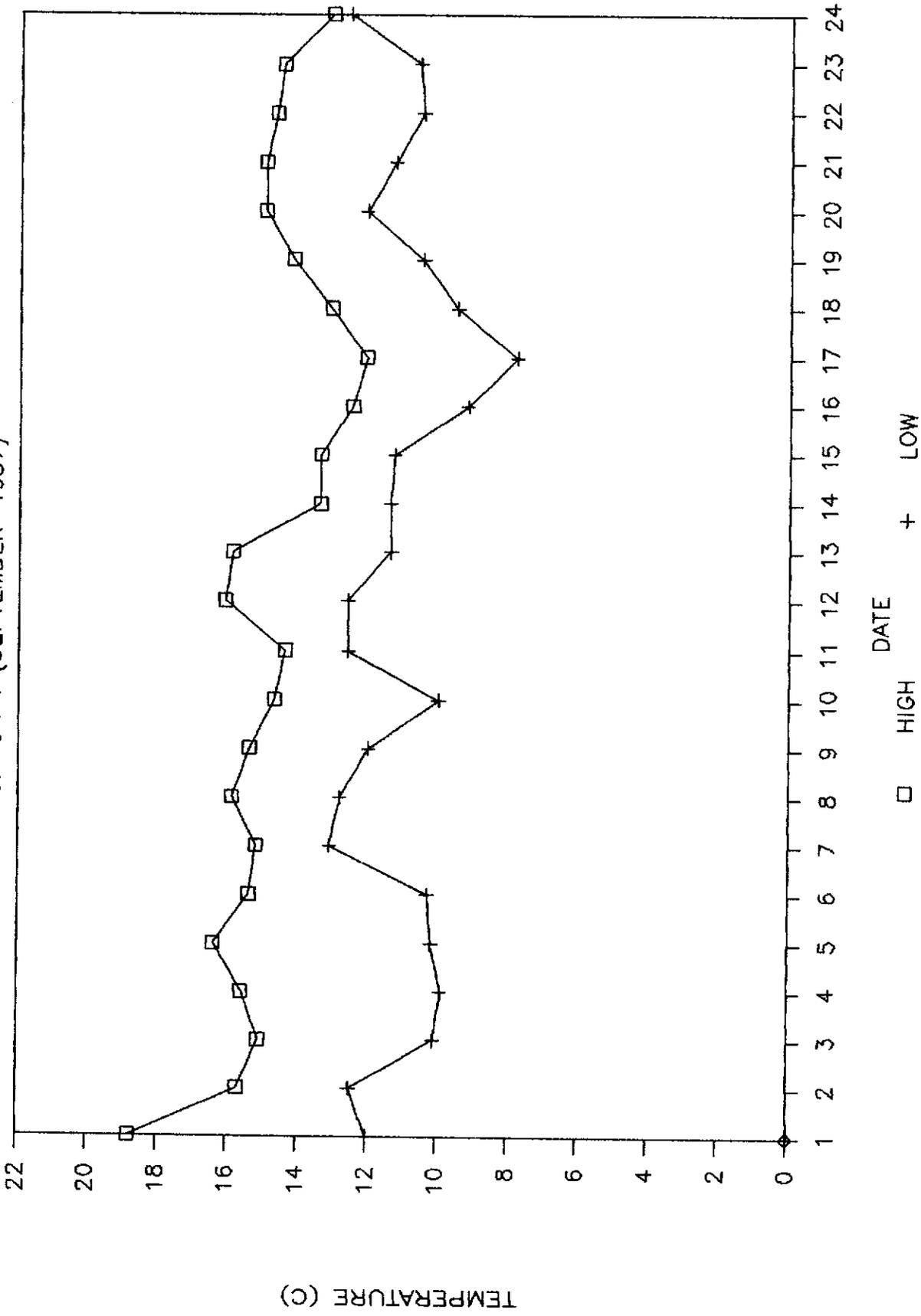
OPTION 1 (AUGUST-1987)



DATE □ HIGH + LOW

DAILY HIGH & LOW TEMPERATURES

OPTION 1 (SEPTEMBER-1987)

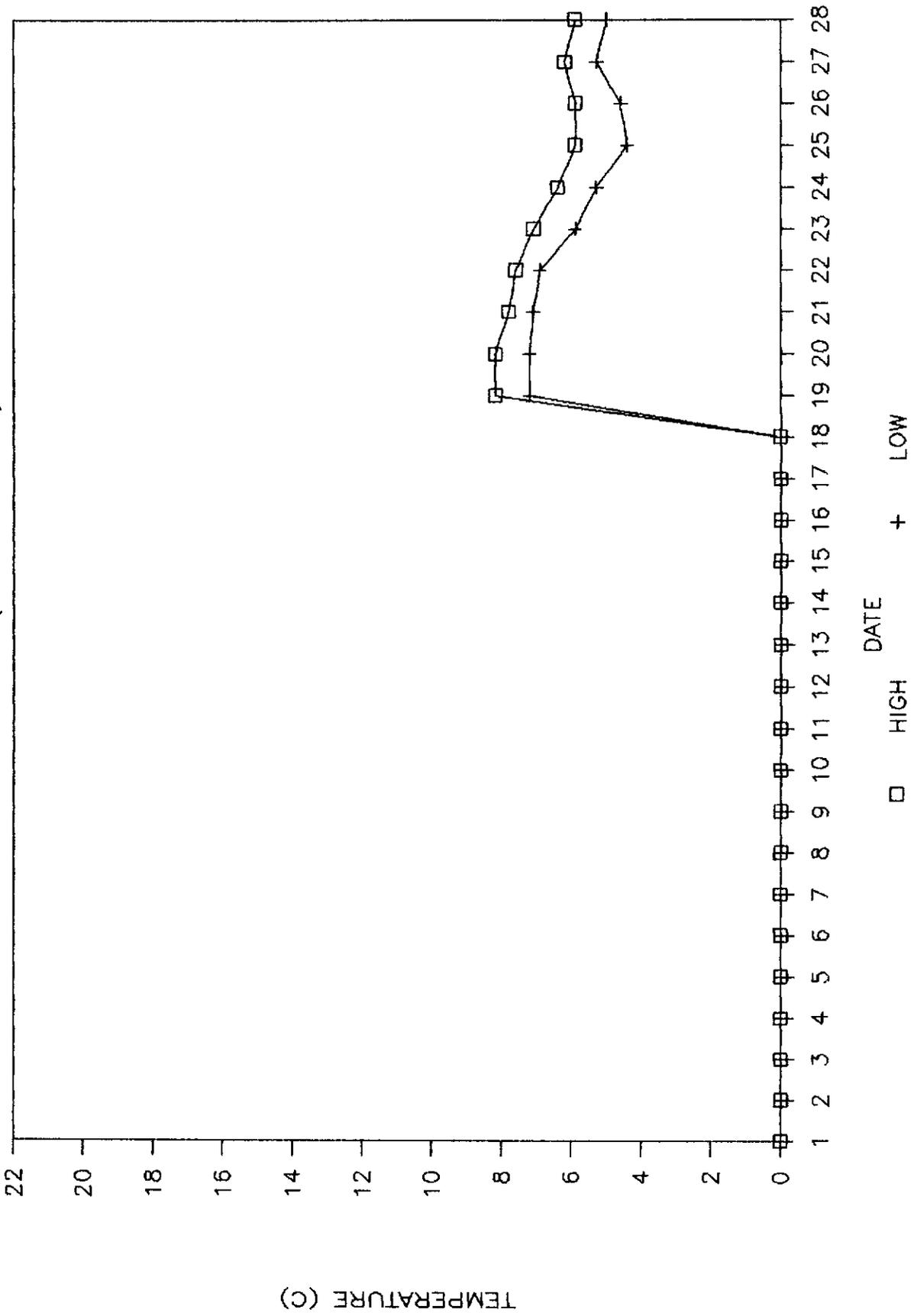


Daily high and low temperatures by month for A&M Old Growth
(February 1987 - September 1987).

APPENDIX C

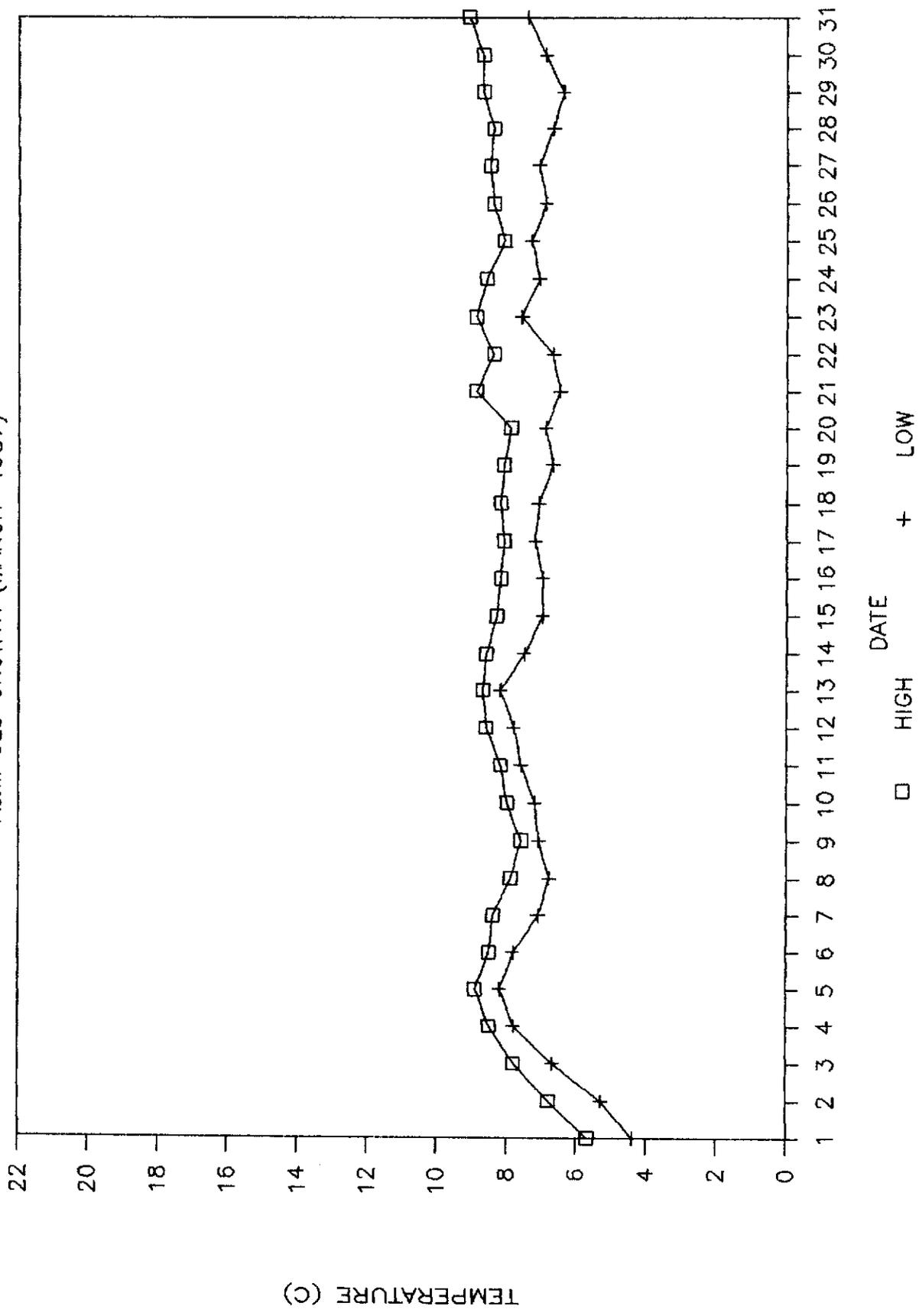
DAILY HIGH & LOW TEMPERATURES

A&M OLD GROWTH (FEBRUARY-1987)



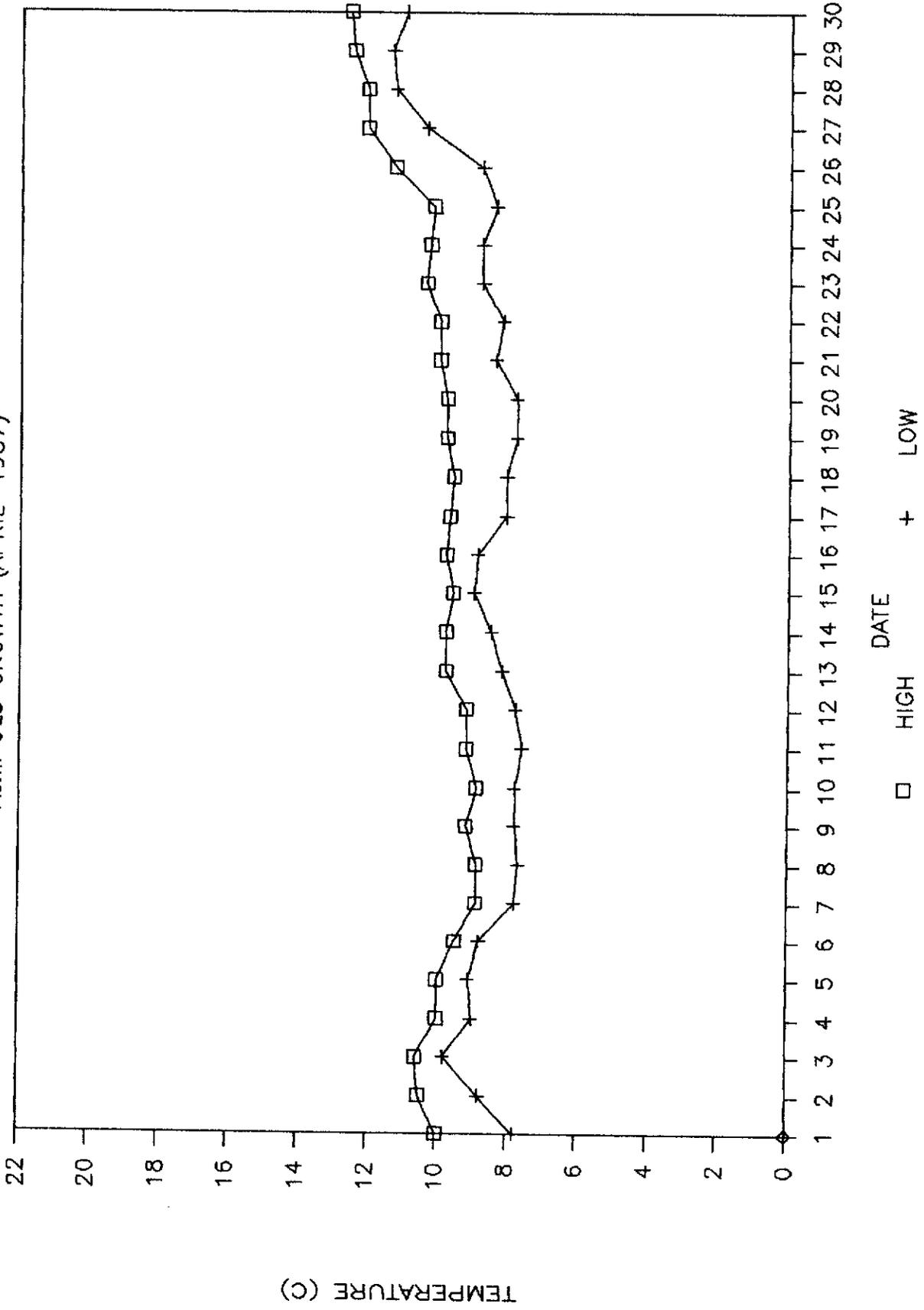
DAILY HIGH & LOW TEMPERATURE

A&M OLD GROWTH (MARCH--1987)



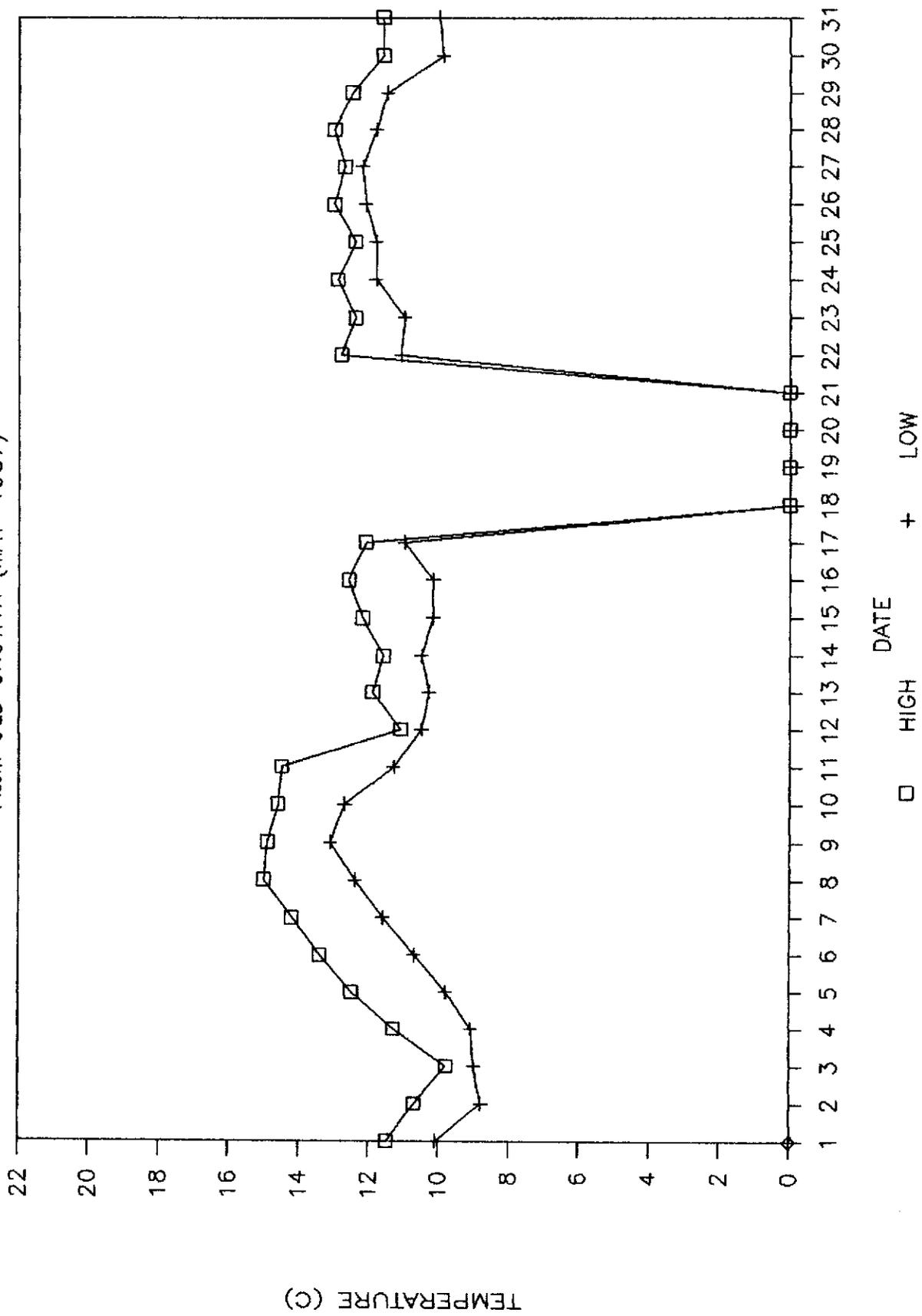
DAILY HIGH & LOW TEMPERATURE

A&M OLD GROWTH (APRIL--1987)



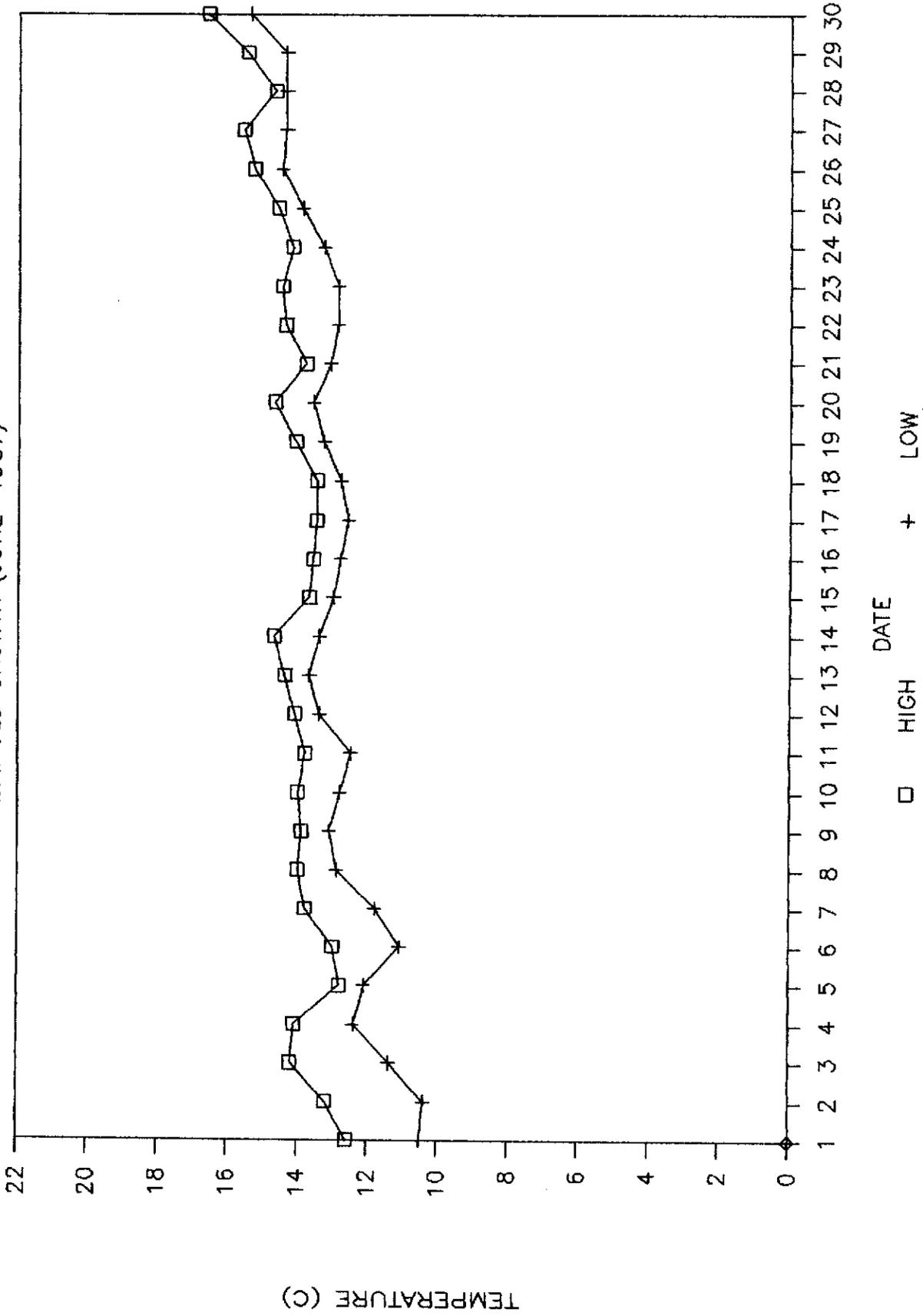
DAILY HIGH & LOW TEMPERATURES

A&M OLD GROWTH (MAY-1987)



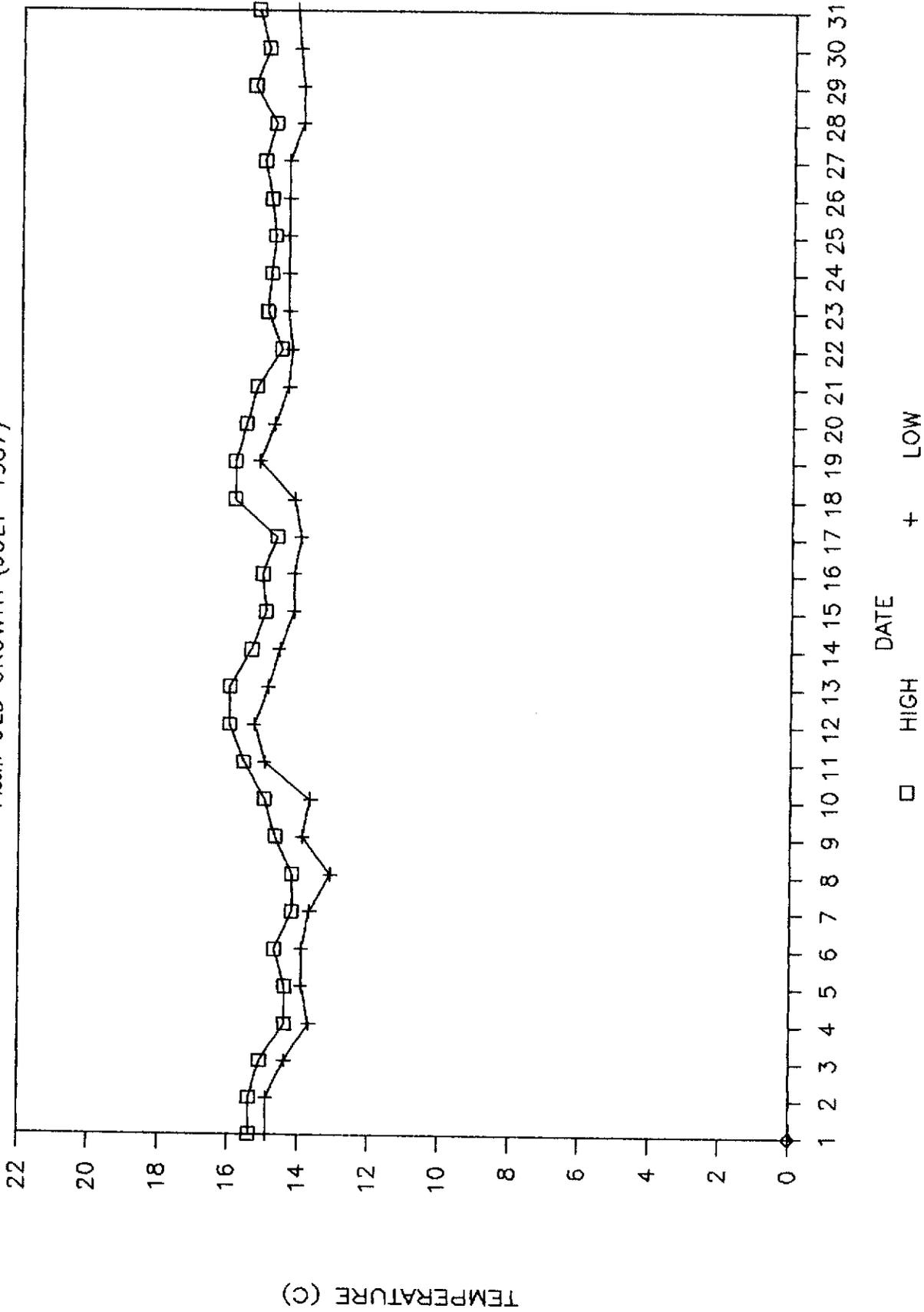
DAILY HIGH & LOW TEMPERATURES

A&M OLD GROWTH (JUNE-1987)



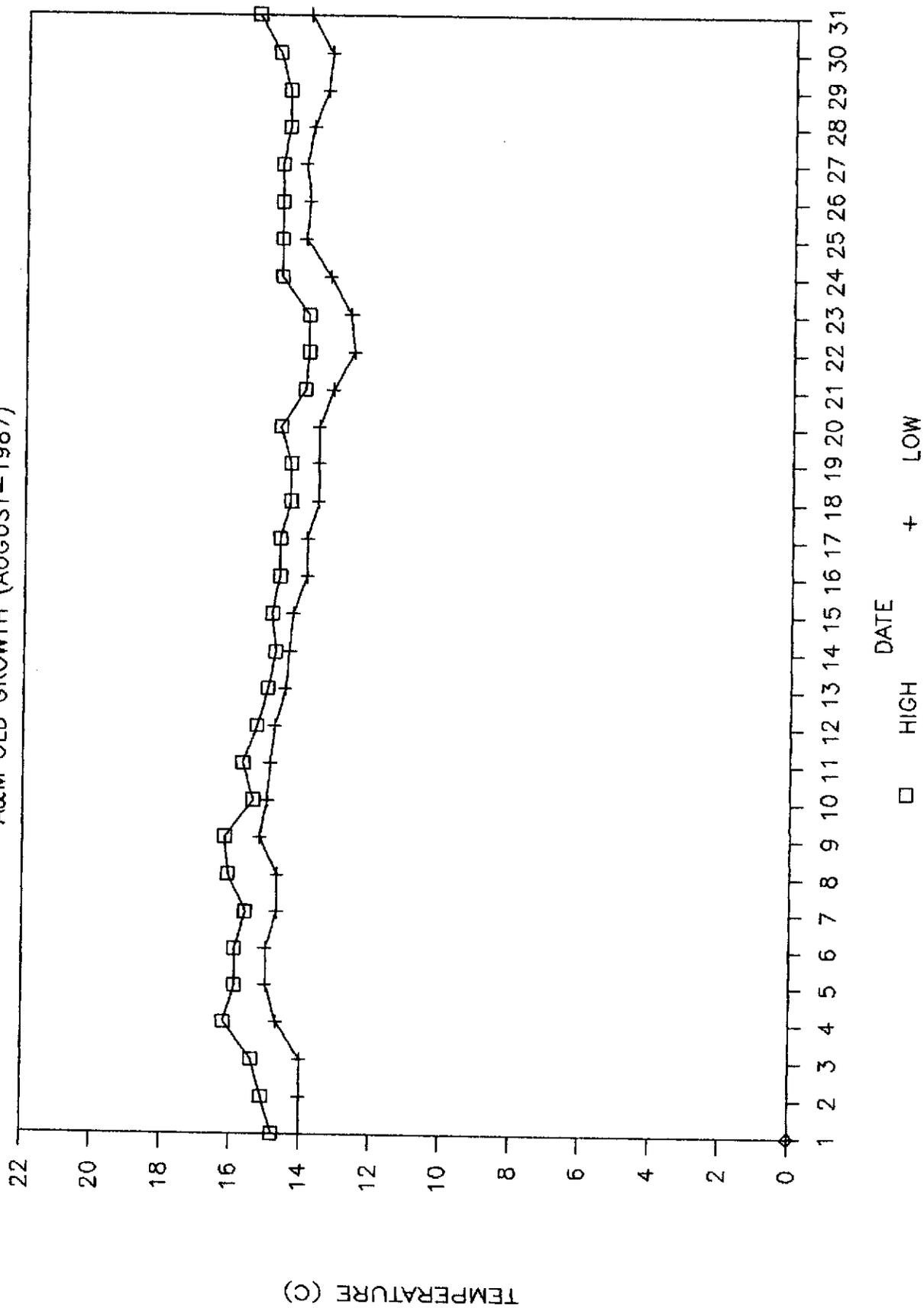
DAILY HIGH & LOW TEMPERATURES

A&M OLD GROWTH (JULY-1987)



DAILY HIGH & LOW TEMPERATURES

A&M OLD GROWTH (AUGUST-1987)



DAILY HIGH & LOW TEMPERATURES

A&M OLD GROWTH (SEPTEMBER-1987)

