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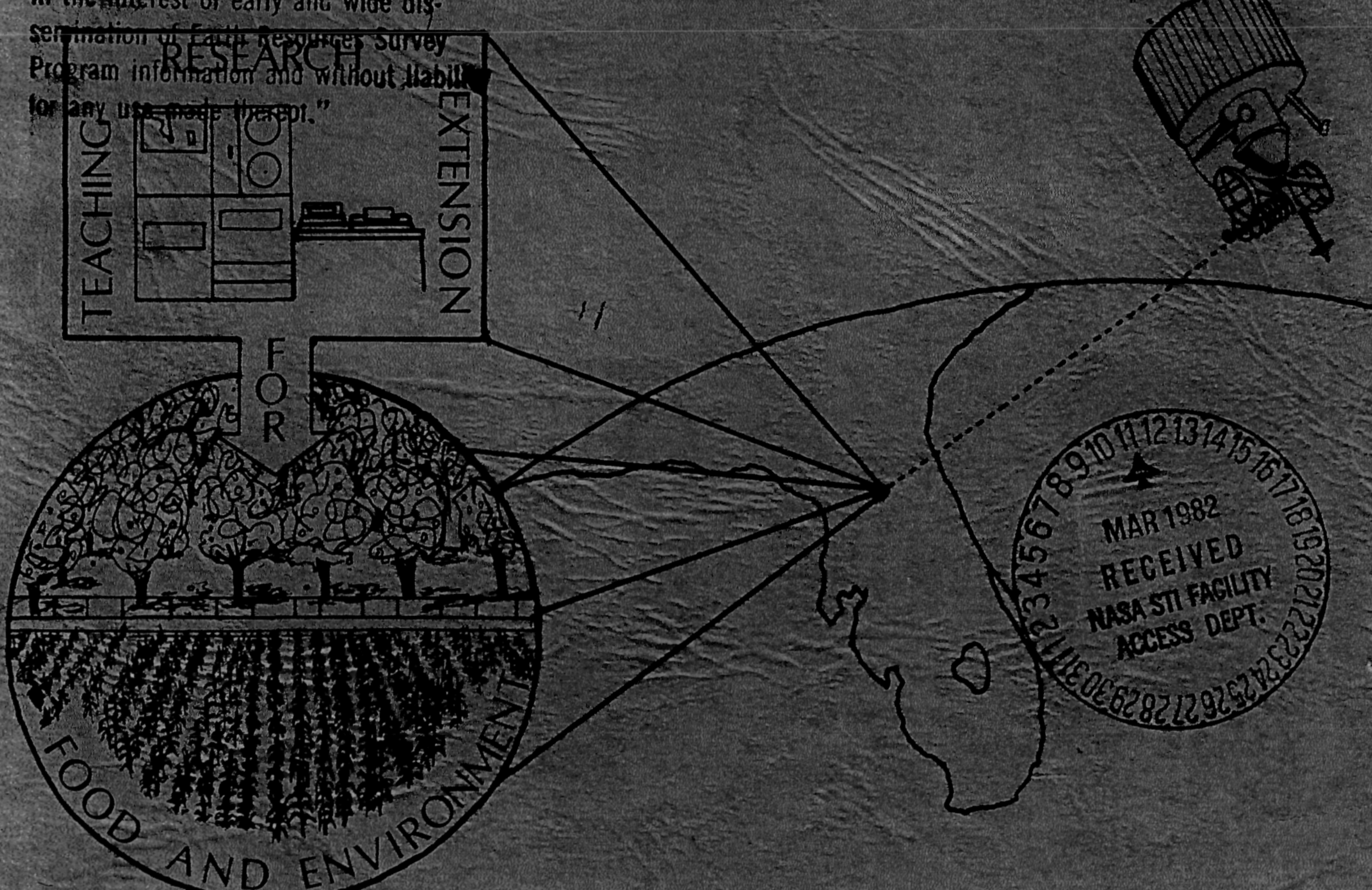
APPLICATION OF SATELLITE FROST FORECAST TECHNOLOGY TO OTHER PARTS OF THE UNITED STATES

PHASE II



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APPLICATION OF SATELLITE FROST FORECAST TECHNOLOGY TO OTHER PARTS OF THE UNITED STATES
PHASE II

FINAL REPORT

PRESENTED TO:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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15. Abstract

This is the final report of the second year's activities of a two-year effort to ascertain the application of satellite freeze forecast technology. The effort is periodically referred to as CCM II (Cold Climate Mapping Phase II). Input to this report was provided by Pennsylvania State University (C. T. Morrow) and Michigan State University (Dr. Stuart H. Gage and Dr. Jon F. Bartholic). Thermal infrared data is taken from the GOES satellite over a period of several hours and color enhanced by computer according to temperature. The varying temperatures can then be used to assist in frost forecasting.

16. Key Words

Remote Sensing, GOES, Freeze Forecasting

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CCM II

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INTRODUCTION

This is the final report of the second year of activity of a two-year effort to ascertain the application of satellite freeze forecast technology to other parts of the U.S. This effort has been periodically referred to as CCM II (Cold Climate Mapping Phase II); this acronym appears in the report occasionally.

The first year's activity was accomplished under NASA Contract NAS10-9611. The final report under that contract is dated October 1980 with the final revision dated March 1981. Although the second year of activity was clearly a continuation of the first year's work (notice "Phase II" used in title), a new contract number, NAS10-9876, was designated and a lapse in the funding occurred from 05/03/80 to 07/10/80. That funding lapse included the frost period in both Michigan and Pennsylvania. The lapse left Dr. Ellen Chen, a very productive post doctorate on the first year of the contract, to be funded by other contracts during the lapse, with the result that her full attention was never returned to this effort. Communications to get Michigan State University and Pennsylvania State University back on target were time consuming and met with varied success during the period of this contract.

The Phase II contract (NAS10-9876) includes a three month period of "forebearance". This period was granted in response to a request for a no-cost extension to aid in the development of the final report to include final reports from the two subcontractors (copy of letter dated March 26, 1981 from William R. Harris is included in the 3rd Quarterly report as Appendix 1). This extension changed the end date of the contract from July 9, 1981 to October 9, 1981.

This report covers the period from July 10, 1980 through October 9, 1981. In the case of Pennsylvania, the most productive data collection period was during the lapse in funding between the two phases of the contract, i.e. the spring of 1980. Three quarterly progress reports have been submitted (see Table 1).

TABLE 1. PREVIOUS REPORTS

Quarterly Report	Dated
First	December, 1980
Second	January, 1981
Third	April, 1981

TABLE 2. List of CCM II Subcontractors
Contract NAS10-9876

Shorthand designation	Institution	Investigator	Location
PSU	The Pennsylvania State University	Dr. C. Terry Morrow	University Park, PA
MSU	Michigan State University	Dr. Stuart Gage (Dr. Jon F. Bartholic)	E. Lansing, MI

As was the case with Phase I (NASA Contract NAS10-9611), the same two subcontractors (see Table 2) are involved in Phase II (NASA Contract NAS10-9876).

Throughout the report the subcontractor's contributions are referred to as the PSU and the MSU Reports, respectively. The PSU Report may be found in Appendix 1. All references to Appendices with Roman numerals that appear in this report are referring to appendices of the PSU Report and are all contained within Appendix 1. The next 4 paragraphs appear to contain exceptions to this rule but notice that the Roman numerals refer to appendices of previous reports to NASA. Reference to the table of contents will aid in clearing up any confusion that may result from this effort to retain the contributions from the subcontractors in as near to original format as possible. The MSU Report makes up Appendix 2b of this report.

A very elaborate proposal was submitted by Dr. Stuart H. Gage of MSU and is contained in the First Quarterly Report as Appendix I of that report. While it does not directly address the Tasks as outlined in the Statement of Work, it places the CCM II effort very convincingly in the midst of the development of a broad based remote sensing capabiity that is under development at MSU. MSU's contribution to the second Quarterly report was late (arrived January 20, 1981, a few days after our Second Quarterly Report had left for KSC) and was retained for the Third Quarterly Report, becoming Appendix V of that Report. After a series of phone calls and an attempt by Dr.

John Gerber to aid in the procurement of a draft of the final report while he visited MSU in September, the draft was received on October 7, 1981. This was in time to include the MSU draft in the draft of the CCM II final report (the latter report was in the process of being mailed when the MSU draft arrived). However, there were very few cross references in the CCM II final draft that concerned the MSU report. Most of these have been added since the MSU draft arrived in October. Some modifications to that MSU draft are still expected at the time of refinement of the CCM II report, i.e. mid-November, 1981. It might be added at this point that it is our understanding that both Dr. Jon F. Bartholic and Dr. Stuart Gage worked over a weekend to get the draft to us as soon as it arrived. It is included in this report as Appendix 2b.

A phone call from MSU on October 1, 1981, passed (verbally) the data that MSU had collected to test the P-model. Mr. Robert Dillon, a programmer I, received that data and prepared it for input into the P-model evaluation programs. The results of those runs make up Appendix 2a.

The proposal from the PSU subcontractor arrived too late to include in the First Quarterly Report even though that report was held for some time in anticipation of receiving that PSU proposal. Consequently, it became Appendix I of the Second Quarterly (Mid-term) Report. The PSU proposal followed the tasks in the Statement of Work closely and disclosed that data collected on 5 frost nights during the Spring of 1980 would be used to test P-model. Very productive communications resulted in the delivery of that data for P-model runs at UF/IFAS and the communication of the results back to PSU for evaluation. These results are covered in detail in the PSU Report that makes up Appendix 1 of this report. Note that there are nine (9) appendices to the PSU Report which are numbered in Roman numerals.

The following portion of this report entitled TASKS REPORTS is written in a format in which the individual task is first declared and then a discussion of progress toward that task follows. In the case of Task I there are four parts of the task denoted by a, b, c, and d.

TASK REPORTS

Task 1: From data bases collected, make sample runs of the P-model and/or concept and present observations/conclusions as to:

a. Can the P-model and/or concept work in that particular geographic setting;

Data from Michigan State University documenting the frost of May 6-7, 1981 were passed to IFAS/Climatology by telephone (verbally) on October 1, 1981. Mr. Robert Dillon copied the data and prepared it for input to the P-model. The results of that analysis make up Appendix 2a.

The average error made by P-model in 55 predictions made using the MSU data was $-0.024^{\circ}F$ with a standard deviation of 2.374 degrees. The worst prediction was a 6-hour forecast made at midnight that predicted a 6AM temperature $6.1^{\circ}F$ too low. The large positive errors were all made in the 9PM forecast for the remainder of the night, i.e up to 10 hours ahead. The 10-hour forecast for 6AM was slightly over 3 deg. F too high. The P-model's performance was judged quite acceptable.

Sample runs of the P-model were made on data from Pennsylvania (see Appendix VI of PSU report for detail). Numerous phone conversations, magnetic tape exchanges, and visits by the investigators (see Table 3) improved computer to computer communications between Dr. C.T. Morrow's Lab at PSU and the Climatology Lab at UF/Gainesville to the extent that such analyses can be quite effective in the future. The visits helped clarify communication problems and resulted in the depth of interpretation that characterizes the remainder of this report (see also Appendix 6).

A copy of PSU's proposal makes up PSU Appendix I, i.e. Appendix 1, Appendix I. While it suggests that 5 nights of data are available for the Spring of 1980 and more data would be collected for the Spring of 1981. The data was first received at Gainesville in the format indicated in Appendix II. While such graphs of temperature

Table 3. Exchange visits by CCM II investigators.

Visitor	Location	Dates (1981)
J.D. Martsolf	Pennsylvania State Univ. Univ. Park, PA. Ag. Engr. Lab, Environ. Measurements	August 26-27
C.T. Morrow	University of Florida Gainesville, FL Climatology Lab, HS-PP	September 28-29

data versus time served in the selection of particular nights that qualified as typical frost nights, they did not provide input appropriate to the P-model. Consequently, a procedure to go back to the original magnetic tape records and transfer appropriate records to a tape that was later sent from Pennsylvania to Florida was developed (see PSU Appendix III). The testing data base was reduced to the first 4 nights of the 1980 data (see page 9 of PSU report, Appendix 1). Dew point temperatures were located in a hand-written log and called down from Pennsylvania to Florida (see PSU Appendix IV) and incorporated in the P-model input files (shown in PSU Appendix V). The results of the P-model input runs of the Pennsylvania data comprise PSU Appendix VI. Dr. Morrow discusses these results on page 10 through 13 of the PSU report (Appendix 1). It is possible to add to his discussion that he was surprised that the model worked as well as it did for the particular site that was used. The main criteria for choosing the site was that it was available (a rather arbitrary choice).

Conclusion: Comparisons of the PSU P-model runs with those on pages 36 through 42 of the SFFS V Mid-term report, i.e. runs on Florida Key Station data, with those of Michigan (Appendices 2, a & b) and with those of Pennsylvania (Appendix 4) indicate that the P-model seems to do as well in mountainous terrain as it does on the gentle rolling to flat Florida or Michigan terrain (c.f. pages 11 and 15 of Appendix 4). The P-model concept may be considered effectively independent of geographic setting. However, if P-model were determined by future analyses to show bias it is conceivable that such bias could be corrected by some minor modification to P-model. In other words, these studies revealed no reason to feel that the P-model will be a problem in the exportation of the SFFS concept.

b. Degree of correlation with ground truth data;

Table 3 of Appendix 2b summarizes the error analysis of the MSU data, i.e. the difference between the P-model predictions and the observations. There was a mean error by P-model of $-0.024^{\circ}F$ in 55 comparisons. This is very acceptable.

Table 6.3 of the PSU Appendix VI summarizes the error analysis performed on the PSU data. There was a mean error by P-model in 264 comparisons of only $0.6^{\circ}F$ (see Table 6.1, PSU Appendix VI) which is quite acceptable (page 11, PSU report, Appendix 1).

c. Appropriateness to agricultural/meteorological environment;

Pages 8 and 9 of the MSU Report (Appendix 2b) describes 5 reasons that the P-model seems appropriate to the Michigan environment. These point primarily to the similarity in the expected energy transport mechanisms, i.e. both radiative and convective, during freezes in both Florida and Michigan.

Page 13 of the PSU Report (Appendix 1) initiates a discussion by Dr. C.T. Morrow of the appropriateness of the P-model to the agricultural needs of Pennsylvania and by inference to the fruit growing areas of Northwestern U.S. He concludes that the model has quite a bit of applicability (see pages 15 and 16 of PSU Report, Appendix 1; and also Appendix 6).

It seems to this author (who feels somewhat qualified to speak to this question by virtue of 13 years of experience in frost protection research in Pennsylvania) that two characteristics of fruit production in temperature zones have permitted growers to register less concern about frost or cold damage in comparison to those who grow tropical plants in sub-tropical climates, e.g. citrus. One of these is that the production areas in the temperate zones are generally more scattered over the total area and consequently when frost damage occurs its localized effects define a minority of affected growers. Secondly, only the crop is in jeopardy; the trees live on to potentially bear another year. However, while producer pressures may not be as high in deciduous fruit areas for frost warning services the total extent of the damage is large. The consumer pays for the losses in higher fruit prices and some of the transportation and marketing mechanisms suffer greater fluctuations in their volume, leading to operations inefficiencies and finance problems.

Regarding the appropriateness of the P-model to the meteorological environment there are no apparent reasons that the large scale weather is significantly different from that in Florida, i.e. the frosts occur primarily in the presence of a large high pressure dome. On the micrometeorological scale there seems to be some reason for concern because the P-model is a one-dimensional model, i.e. the vertical components of the energy budget are primarily involved. Cold air drainage, horizontal flow of heat, would seem to be ignored except for the wind speed indicators that have the opportunity of tipping off the model that down slope flow is occurring. The resulting mixing is likely to forestall as rapid a temperature drop as would otherwise occur. This mechanism is apparently handled quite effectively because the model seems to have predicted the temperatures at the Rock Springs site in Pennsylvania rather well; That site is on the West slope of Mt. Tussey, i.e. very much in a cold air drainage pattern.

d. If feasible, discuss parameters important to the location of key weather stations, i.e. numbers, settings, etc.

The MSU Report (Appendix 2b) does not directly address this question but contains a statement on Page 9 that indicates there has been a persistence of temperature differences between stations in the MOSS product analysis. They interpreted this as an indication that there are good correlations between key (weather forecasting sites) locations and agricultural weather measuring locations. While it is not explicit in Appendix 2b it should be noted that Michigan already benefits from one of the largest and most effective network of agricultural weather stations in the nation.

Dr. C.T. Morrow discusses a computerized dissemination network that PSU is planning (see pages 16-18, PSU Report, Appendix 1). There are possibilities that the communication network may include automatic weather stations to support integrated pest management programs as well as to facilitate a warning system similar to the Satellite Frost Forecasting System. The Meteorology Department of PSU has had an automated weather station in operation for some time on top of the 5-story building in which their department is housed. There have been negotiations underway to move that station off the building roof and onto agricultural lands of the Agricultural Experiment Station that are likely to remain in similar service for years to come in order to make the observations more characteristic of the surrounding countryside. This has immediate implications in the feasibility of the acquisition of ground data for the Nittany Valley.

The National Weather Service has provided frost warning services from a station in Kearneysville, West Virginia, but under the manpower reductions this position has remained vacant in recent years. The previous weather service provides some tradition around which an automated station might be located since the University of West Virginia operates a branch station of their Agricultural Experiment Station there. The branch station at Biglerville is another possibility. Several possibilities exist to represent the concentration of fruit production in what is referred to as the Cumberland-Shenandoah production region. The region is well represented by a meeting of researchers and extension specialists serving the fruit industry in a group called the Cumberland- Shanandoah Fruit Worker's Conference. There is a good possibility that this group would play a very active part in the placement of automated stations in the event of the implementation of a SFFS-like program.

Task 2: Give observations/conclusions as to the applicability of the S-model and/or concept from the data base at the two areas. This portion of the study must be general as this subject cannot be covered comprehensively without substantial work in statistical evaluation of temperature correlations which is beyond the scope of this contract.

Recent developments with the S-model indicate that there are good possibilities that the coefficients for the model may be produced by the minicomputer system supporting a SFFS-like system. This certainly could be the case for areas like Pennsylvania and Michigan. However, this possibility was not sufficiently apparent at the time that the subcontracts were drawn up to attempt to test the concept through the subcontracts.

The S-model represents the possibility of developing a SFFS that can recall the distibution of temperatures during previous freezes in a particular area and bring that cold climate climatology to bear upon present forecasts. Since compouters have excellent memories, the concept of recalling such information from memory and influencing the forecasts with it is good climatology and very likely will be attracive to any who adapt SFFS to their locations. However, the S-model in its current configuration fails to live up to these expectations. It may not be a trivial matter to bring past freeze information to bear readily upon current freeze events until the navigational problems with the satellite data from one year to another are resolved. That problem is defined well enough to declare it nontrivial. This line of thought is discussed in more detail under Task 5.

Certainly, there will be pressure on SFFS developers and adapters to lengthen the period over which the system can be expected to successfully or usefully forecast. The possibility of using the excursion of temperatures above a common base during the day previous to the freeze as convincingly related to the amount that temperatures may be expected to drop below that base on the subsequent clear night gives hope of lengthening the forecast period. Drs. Hartwell Allen and Ellen Chen have been perfecting a method of determining the heat capacitance of soils by observing the temperature excursions through clear days using day and night IR image sequences after the fact. The moisture conditions in a particular locality have been found by Dr. Ellen Chen to be clearly involved in the amount that one may expect that locality to cool under radiant frost conditions. It is likely that the development of this heat capacitance mapping technology will spin-off into the SFFS development with the possibility of extending the points in time from whence the system will forecast into the previous day, i.e. develop forecasting periods approaching 20 hours, double the current capability. Without the present limitation on the range of temperatures that can be acquired via 1200 Baud link with Suitland, Maryland has prevented the acquisition of daytime IR maps in sequence with nighttime IR maps due to over or under ranging problems at NOAA/NWS. This program is discussed in more detail under Task 4.

Pages 10 and 11 of the MSU Report (Appendix 2b) describe in some detail the conviction that similar temperature patterns persist from one frost night to the next indicating a stong dependence on surface vegetation and soil characteristics. Figures 1 through 4 of Appendix 2b were submitted as evidence of such persistence.

Task 3: Identify and discuss any peculiarities of the Michigan and Pennsylvania sites which might limit conclusions from being applied elsewhere in the United States as a general case.

a. Michigan: A peculiarity of Michigan under frost conditions is that the wind speed seems to be less likely to go to zero during the event, making wind machines and other frost protection methodology difficult to adopt without some qualification. This peculiarity in the case of a SFFS-like system works in favor of the system when used in Michigan. The more the wind tends to mix up the air near the surface the more likely the pixel temperatures determined by the satellite are to very closely represent the temperature of the whole area. If other areas of the Midwest were thought to have greatly different frost conditions than Michigan has there would be a problem in extrapolating the experience from Michigan to Ohio, Indiana, Illinois, Kentucky, Missouri, Wisconsin, Minnesota, Iowa, Nebraska, etc. However, all of this area of the United States seems to have high pressure domes that continue to move with the westerlies across the country during the frost season (both spring and fall) so that the periods of dead calm under the center of the high are relatively short. The further south one goes, the more likely the high pressure domes are to become stalled between the westerlies and easterlies, resulting in longer periods of cold, clear and calm weather.

Since the paragraphs above were developed the MSU Report (Appendix 2b) arrived with an explicit statement concerning Task III (see pages 11 and 12 of that report). It declares the Florida and Michigan cases to be very similar but an earlier statement (item 3 on page 8) indicates that Ceel Van Den Brink had interpreted in earlier work that approximately 70% of Michigan's frosts were radiational and 30% were advective. Since this ratio would be more like 90:10 in Florida the author of this report has let the following conclusion stand.

Conclusion: The Michigan case provides a good example for the remainder of the Midwest. The Florida experience is more likely to be a good example for the southern U.S.

b. Pennsylvania: The PSU site is on the slope of one of the narrow ridges that separates the broad fertile valleys of the fruit growing portion of the Appalachian Mountains. The diagram that makes up Figure 2 in Appendix 3 demonstrates two points:

1) the variations in temperature under frost conditions in mountain-valley topography are very similar from

one frost to another.

2) these variations closely follow the topography and have distance scale very similar to the intervalley topographical features.

Figure 1 relates this situation to a typical pixel from GOES, i.e. approximately 25 square miles in area. If the pixel location is known, i.e. the pixel is oriented relative to the geography of the covered area there is an excellent possibility that the relationship between the pixel temperature and that of particular sites covered by the pixel will become known and used with reliability.

Conclusion: small scale (relative to pixel size) variations in topography and hence in temperature distribution may not pose a serious limitation to the usefulness of a SFFS-like system in mountainous terrain. However, in order for the products to be convincing it is likely that a period of time is necessary during which the product users become calibrated or convincing research must be accomplished for each area that relates individual site temperatures to pixel temperatures. Finally, it is assumed in this discussion that it will become possible in these systems to orient the pixels with respect to the location they actually cover.

Task 4: Give recommendations as to whether the concept should

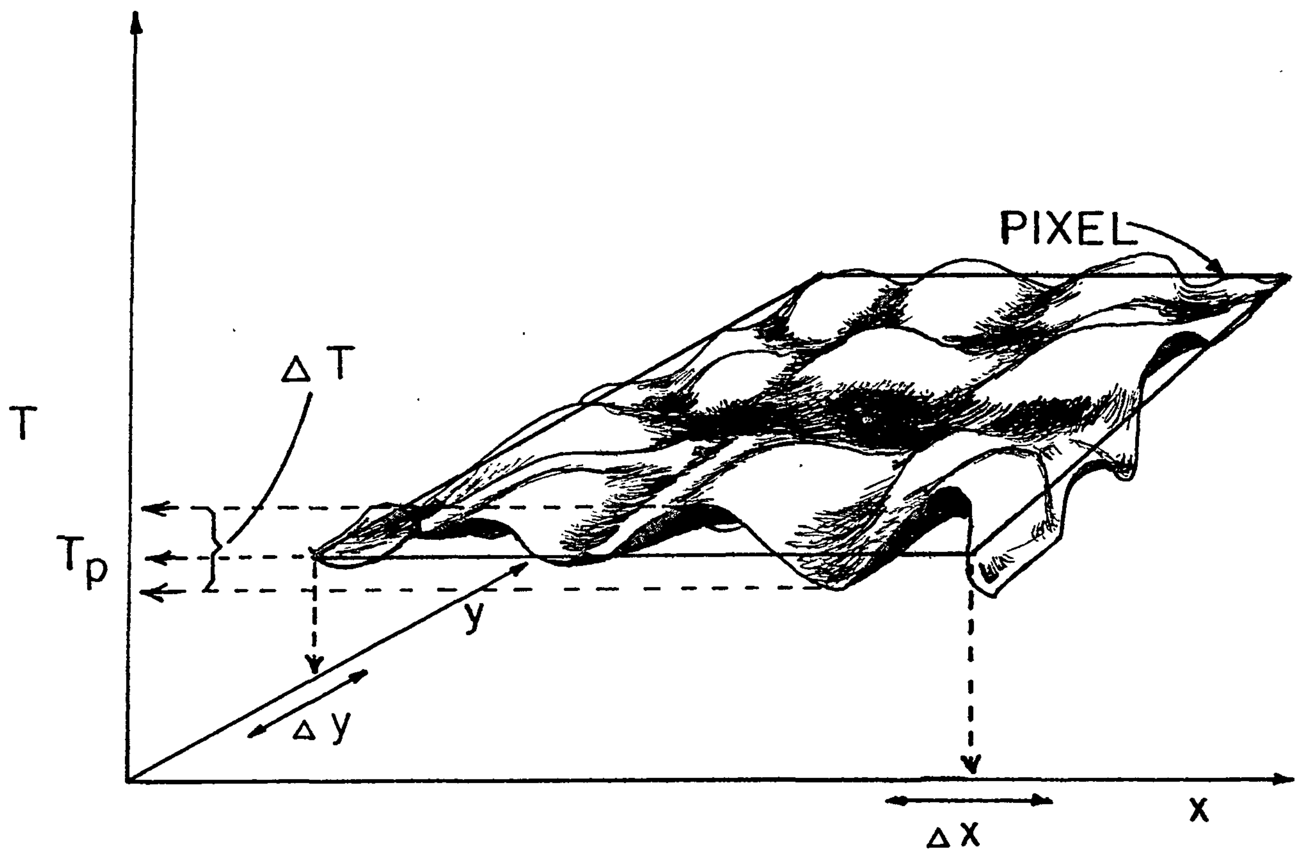

Fig. 1. Sketch of pixel with dimensions larger than elements of temperature fluctuation implying that if the pixel remains constant relative to the topography ($\Delta Y = \Delta X = 0$) and the temperature distribution remains constant relative to the topography for post events (a well documented horticultural observation) then given locations will have predictable ΔT with respect to the pixel temperature (Tp).

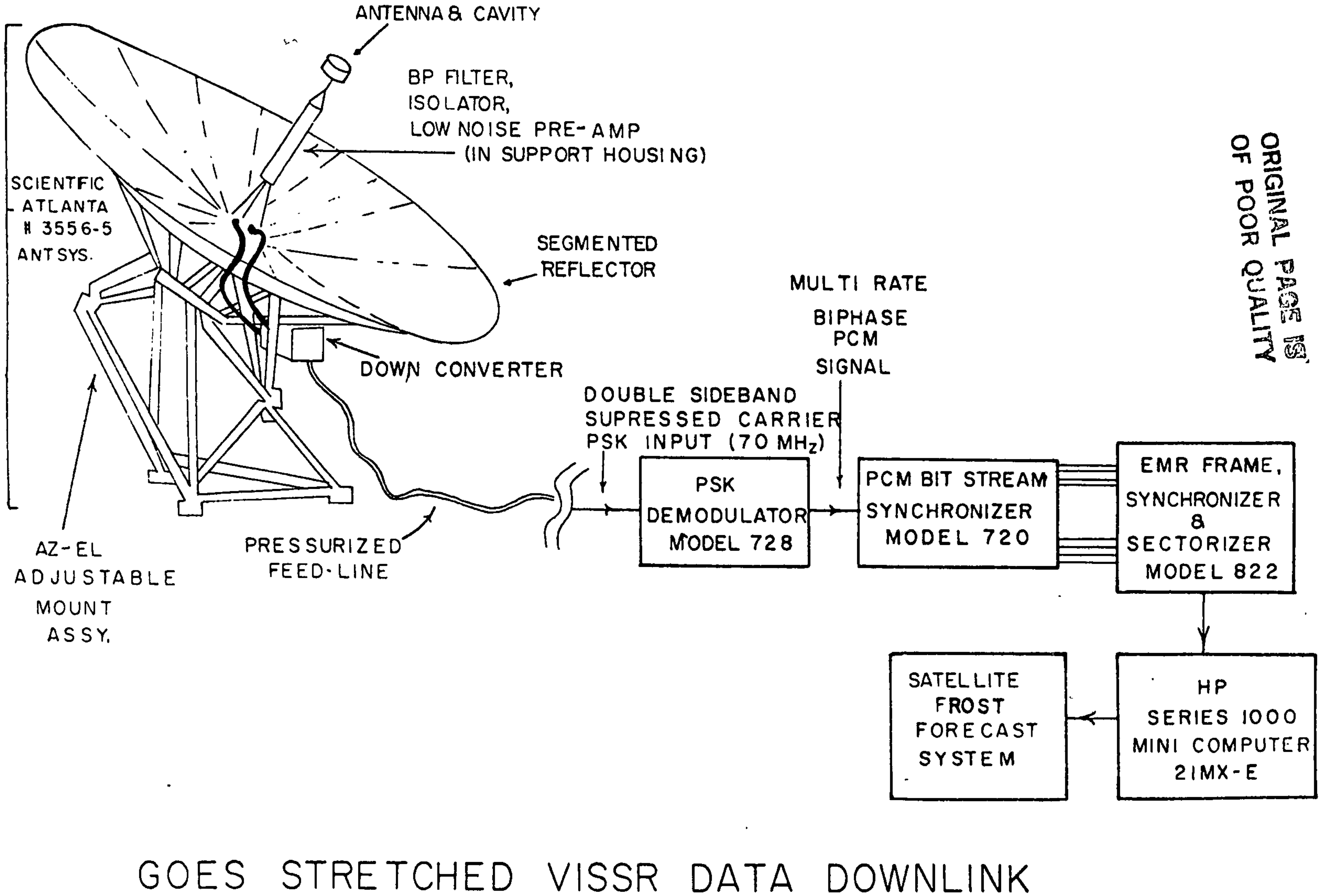

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Figure 2. Diagram of the GOES Satelite downlink system that has been proposed to capture and sectorize the satellite data necessary to operate SFFS in Florida. This system is expected to become operational about December 1, 1981, in Gainesville, Florida, near the IFAS Climatology Lab in the Fruit Crops Department.

be pursued further and if so, what specific studies should be performed.

On pages 20 and 21 of the PSU Report (Appendix 1), Dr. Morrow makes six recommendations regarding the future of this type of study. These might be summarized to have indicated that while there is additional work that is identifiable, the concept is useful and is likely to be pursued (see Appendix 6). Communications with Dr. Morrow along these lines permits this author to indicate that a joint effort between the Pennsylvania State University and some private company is the likely future developer of this sort of service in the Northeastern U.S.

The Department of Meteorology of INPE, Brazil, is down linking GOES-East IR data to document the location and intensity of freezing temperatures during very cold nights in the coffee and citrus producing areas of Brazil. Mr. Michael Allan Fortune made contact with IFAS/Climatology when he was visiting NOAA/NESS in Suitland, MD on Oct. 5, 1981, to describe the Brazilian acquisition system and request information about SFFS. At our suggestion he also made contact with NASA/KSC and NASA/HQ (Mr. James M. Dodge, in the latter case). We have exchanged some information and it is apparent that both parties would probably benefit from closer communications concerning the nature of the efforts.

Appendix 2b contains MSU's recommendations for additional work in the following areas: P-model performance when Michigan soils are frozen in the early Spring; collection of GOES data from NOAA/NESS on a real time basis; correlation of temperature patterns with general surface conditions during freeze events. On page 12 of Appendix 2b indicates that, "Clearly, the conceptual theme of using GOES data to aid in characterizing the thermal regimes in a state both in non-real and real time, need to be further prusued. The data proves to be very accurate, particularly during freeze events and correlations of temperarture patterns with general surface conditions would indicate more information could be obtained."

Appendices 4 and 5 contain manuscripts that describe the SFFS system as reported to a group of scientists having responsibilities for the communication of agricultural weather data and to an international symposium on citriculture in Japan. Both manuscripts describe SFFS as a rapidly developing methodology that has potential application in horticulture when the industry experiences frost hazard. Most horticultural industries are climatically temperate or subtropical and consequently experience frost hazards.

The following are specific studies that it would seem from our experience to be necessary to the utilization of a SFFS-like thermal map display and forecasting system:

1) Navigation of the Satellite Data

The user of the information in real-time must know where his fruit is located in relation to the thermal map or the value of the information is greatly reduced in his decision-making process. While survey results published in NAS10-8920 Reports indicate that Florida growers can find their location within a couple of pixels on thermal maps of the entire peninsula, the growers are quick to expect geographic references that have some reliability. It should be noted at this point that if the information is to be valuable to the real-time user it must be available to him within a matter of minutes after it becomes available from the satellite.

The use of the data in the assessment of damage and subsequent planning of transportation and marketing scenarios is a near real-time operation and seems even more dependent on good geographical orientation of the data in order to couple the data with densities of crops for which the critical temperatures are known. The Jan. 13, 1981 freeze in Florida demonstrated this use of SFFS products convincingly. At this point the need for some standardized pixel location becomes apparent. The data bases upon which assessment programs will depend will undoubtedly be fixed in space and require that some interpolation of the satellite data be made to line up the temperature fields directly on top of the areas for which the crop densities have been determined.

Finally, the long-term user of the temperatures for climatological studies which we have been terming, "cold climate mapping," or CCM, must be able to relate thermal maps one with another over extended periods of time, i.e. years. Consequently, not only do the navigational studies need to deal with orientation on the face of the globe but with the software that seems necessary to develop time series of data that have acceptable space orientation. It is becoming apparent that this includes stretching and rotation as well as the simple x and y offsets of the rectangular coordinate system.

The navigation or orientation of the satellite data was indicated under Task 2 to be critical to the successful operation of S-model as it currently exists. But fairly sophisticated tools to study this problem are becoming available in the SFFS software. Consequently, there is hope that the goal of developing a system that will have a recollection of past freezes and be able to bring such information not only into display to remind the forecaster of the scenario but also to incorporate the patterns into the forecasted product through the S-model is realistic. The effort would seem to be dependent upon the ability of the system to stack the pixels in time over a particular geographical location. The changes in temperatures of these pixels (even during the previous day) become the principal ingredient upon which the model forms its predicted product. The memory of past events comes into play by the development of software that can relate the current happening with a similar one of the past, either automatically or with aid from the user. In its present configuration, the potential power of SFFS is far from its zenith.

This is an emphatic recommendation that the effort with S-model development continue.

2) The Dissemination of SFFS products

This is viewed as a continual process that is necessary to achieve the maximum value from the observed and forecasted products. We appear to be on the threshold of an era of the home computer controlled communication device that brings in all manner of information from which the user can make decisions in finance, purchasing, services such as transportation, lodging, etc. Opportunities to interface with these various private, quasi-public and public service communication networks should be investigated and capitalized upon where appropriate. Funding from the USDA/SEA-Extension has been requested and some obtained (Agreement 12-05-300-535, Amendment 1) for this purpose. Further efforts along this line are anticipated by UF/IFAS. These include the pursuit of contacts with television firms. So far there have been two promising contacts in this latter area, one from Ft. Myers, and the second from St. Petersburg.

3) Satellite Data Acquisition

Currently, the satellite freeze forecast system (SFFS) is dependent on a 1200 Baud link to a NOAA/NWS queue in Suitland, Maryland, that in turn is dependent upon the successful operation of at least two batch programming operations to transfer the data from the antenna to a data base from which it is sectorized for the Florida queue. While this experimental link worked rather well in the 79-80 frost season, it was quite unsatisfactory during the 80-81 season and little hope has been provided by NOAA/NESS, or for that matter NOAA/NWS, that much better performance can be expected from an experimental link on a system that has as much operational pressure as theirs. The MSU Report (Appendix 2b) indicates on Page 7 that the method of obtaining GOES data from NESS in Suitland was no longer operative and that they should use the historical archiving system at Wisconsin. MSU on pages 13 and 14 of Appendix 2b describes difficulties and frustration in acquiring satellite data due to a rapid change in NESS policy. IFAS attempts to acquire the data on MSU's behalf were disrupted by the declaration of center of sector being within the NOAA/NESS program at Suitland and not under IFAS control.

The direct downlink described in Figure 2 has been proposed and largely funded by IFAS to be operational during the 81-82 season. Since there is no redundancy in the system, it will serve simply as a back-up to the current method of satellite data acquisition described earlier in the paragraph.

Initially, SFFS acquired satellite data from the GOES-TAP link, an analog linkage through the NOAA/NESS field station in Miami. The analog data was digitized at the SFFS site in Ruskin, Florida, for use in the SFFS display and forecast software. Presently, the digital data in the NOAA/NWS queue in Suitland, Maryland, is in the form of ASCII characters.

The number of characters in the ASCII set is 95, restricting the temperature range over which data can be transmitted to 95/2 or 47.5°C (85.5°F) since the infrared temperature resolution of GOES is 0.5°C. Actually the data is downlinked in binary and the complete range 000 through 255 (256 temperature divisions from -110.2°C to 56.8°C or -165.3°F to 134.3°F). If the data could be passed from NOAA/NWS to SFFS in binary instead of translation to ASCII, it is much more likely that most of the full scale would be available (some combinations become illegal due to control character assignment through the various software interfaces involved). Mr. Art Bedient at NOAA/NWS is presently trying to develop the binary data transfer possibility. IFAS/Climatology is trying to ready SFFS to accept binary data input since the antenna link will transmit in binary format.

SFFS's acquisition of digital satellite data from GOES has been taking place in parallel with an effort connected with with a much more sophisticated (and consequently expensive) acquisition system known as McIDAS. The development of McIDAS has reached a stage in which a private company, Control Data Corporation, appears to be in the process of producing systems that used to be available in limited numbers through the University of Wisconsin. Both SFFS and, we understand, McIDAS are NASA developments. There may be some mutually beneficial exchanges of information between the developers. Certainly SFFS would benefit from increased reliability in satellite data acquisition and aid in the navigational aspects of the data orientation. Contact has been made with Control Data Corporation (CDC) to identify several possibilities that SFFS may benefit from the presence of a McIDAS in Florida and that CDC may benefit from the incorporation of an additional application, i.e. the frost warning products, into McIDAS.

4) Development of Alternative Forecasting Models

There is every reason to believe that with time the forecasting models, i.e. the P-model and the S-model, will be improved. Certainly there is a need to develop simpler models that will operate on less expensive computer systems, e.g. the APPLE II+ system that is being used by 6 counties currently interfacing to the SFFS/Florida system. One much simplified S-model uses coefficients that simply relate the pixels to changes in key station temperature as weighted by the distance of the pixel being forecasted from the particular key station.

With increased use of the SFFS systems there is little doubt that various research efforts will find it both convenient and advisable to experiment with new models and test their performance against the present models. As the users of the system become more sophisticated in their demands for options on the system, there will be continued pressure to develop additional features as justified by need.

5) SFFS's potential role in rapid communication of weather data

Currently, SFFS products are communicated to users in the following manner: first the NWS forecasters at Ruskin see the products displayed on the color monitor and, in the case of the key station data, on a clip board on their data board. They make their forecasts and communicate them to radio stations and other media by the same procedures that they have used before having SFFS. SFFS may be mentioned in this process but it is more likely that the users of the NWS frost warnings will not be aware that such a tool exists and is influencing the forecasts.

Secondly, SFFS products are beginning to be linked to other display systems from both the Ruskin and the Gainesville components of SFFS. Last winter, APPLE II computers at the Lake County and the Polk County Agriculture Extension Centers received satellite maps from a third APPLE in Gainesville, and built displays for the agents, John Jackson and Tom Oswalt. The impressions they gained from viewing the thermal maps were relayed through the tapes they played to subscribers of phone links to electronic secretaries. These agents carry out very effective educational programs in frost protection on freeze nights through these verbal telephone links with growers. Largely because of the popularity of the concept, this APPLE II+ network has been increased to six county offices this year. Four are in counties with citrus and two in peaches (see Table 4).

The rate at which the ASCII character string can be communicated from queues in the Hewlett-Packard minicomputers that service them has been increased this year to 1200 Baud. It requires about 3 minutes to transmit a thermal map to a user by the new network.

In addition to serving the new APPLE II+ network from Ruskin the HP mini is expected to acquire the dew point information it needs to make its P-model forecast through a port in the NWS/AFOS mainframe. Once this link is established it seems possible and quite likely that other weather data available in the AFOS system will become available to SFFS and be transmitted by the APPLE II+ Network to users. Digitized radar maps are likely to be targets for this link as well as many of the text formated weather summaries that are not communicated by AFOS.

Finally, SFFS in Florida, may have additional opportunities to support similar efforts in other states. For example, PSU outlines an attractive possibility in a letter dated October 6, 1981, which

Table 4. Listing of members of the 81-82 APPLE II+ Network using products from SFFS.

Location	Agent	County	Crops	Connection
Homestead	Seymour Goldweber	Dade	Avocados, limes, vegetables, etc.	Ruskin
Ft. Pierce	Pete Spyke	St. Lucie	Citrus ornamentals	Ruskin
Bartow	Tom Oswalt	Polk	Citrus	Ruskin
Tavares	John Jackson (Francis Ferguson)	Lake & Orange	Citrus	Gainesville
Madison	Jacque Breman	Madison	Peaches	Gainesville
Quitman	Henry Carr	Brooks	Peaches	Gainesville

is attached to this report as Appendix 6. The letter proposes to explore the possibility of submitting a proposal to help fund the goals of the proposal. Another example is the Brazilian Frost Warning System described earlier.

In summary, there are possibilities that the SFFS computer equipment will be called upon in the future to support a much larger menu of products than simply the SFFS products. To accomplish this there is a need to develop some very flexible software to handle the link between SFFS and AFOS. Secondly, the link into AFOS may permit other areas of the United States to capitalize on SFFS products by picking up summaries or renditions of them off the AFOS schedule. However, this possibility is clearly in the domain of NOAA/NWS and will be explored at their instigation.

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APPENDIX 1

P S U

Pennsylvania State University

Report

Author: Dr. C. Terry Morrow

APPLICATION OF SATELLITE FROST FORECAST TECHNOLOGY TO OTHER PARTS OF THE UNITED STATES
PHASE II
FINAL REPORT
PENNSYLVANIA SUBCONTRACTOR

Submitted to: University of Florida
Institute of Food and Agricultural Science
2121 HS/PF
Gainesville, Florida 32611

Submitted by: C. T. Morrow, Principal Investigator
Department of Agricultural Engineering
The Pennsylvania State University
University Park, Pennsylvania 16802

Submitted on: September 21, 1981

Signature

C. T. Morrow, Principal Investigator

Table of Contents

Introduction

This final report of work performed under a grant for application of satellite frost forecast technology to other parts of the United States, Phase II is being submitted by The Pennsylvania State University to the University of Florida for inclusion in a final report to the National Aeronautics and Space Administration. The work being described in this report is the result of the second year of support from NASA relating to this topic.

The work performed by The Pennsylvania State University is in accordance with a proposal which had been submitted from The Pennsylvania State University to the University of Florida on December 1, 1980. A copy of this proposal is included as Appendix I of this final report. The findings at The Pennsylvania State University will be described in terms of the objectives of that proposal. In order to make the task easier for the University of Florida to prepare a consolidated final report, however, the findings and conclusions will also be reported in terms of tasks which had been requested by NASA for Phase II of this project.

There was a large amount of data collected at The Pennsylvania State University experimental sites for the purposes of this study. Much of the raw data has been included as an appendix to this final report and will be discussed where appropriate. In order to make the most concise conclusions relative to the objectives of this project isolated portions of that data have been analyzed in detail. Many findings which will be presented during the course of this report are results of interpretation of selected data as opposed to an overall evaluation of all data collected for the project.

This approach was believed to be very desirable in view of the time required for data analyses. There is, however, believed to a sufficient quantity of data fully analyzed to enable some clear indication of the merits of the techniques being evaluated as a part of this contract.

Task 1. Collection of Data for P-Model

A. Description of Test Site

The data which was collected for use in running the freeze prediction model, P-Model, as described by Sutherland (1980) was obtained at the Rock Springs Agricultural Research Center. This facility is the location of the primary agricultural research station for The Pennsylvania State University. For the past several years extensive frost protection research has been conducted at this location. There are two primary orchard facilities available at this station. One of these orchards is equipped for heaters for studying the use of heating as a frost protection technique. An adjacent orchard has the facilities for providing overhead sprinklers as an alternate method of frost protection. The sprinkled orchard was the location of the test instrumentation for obtaining the measurements reported for this study.

i. Topography

The Rock Springs Agricultural Research Center is located about nine miles west of State College, PA, latitude 40°42'23" north, longitude 77°57'20" west. The orchard elevation is 1240 feet above sea level. The site is located at the base of "Gobbler's Knob", a mountain ridge with an average top elevation of 1840 feet (peak 1860 feet). The orchard is 3500 feet NNW of the peak directly downslope.

The general slope of the orchard area is a 1 foot drop in elevation to 50 feet horizontal. The slope of the orchard itself is about 1.5 foot drop to 100 fee horizontal sloping down towards NNW.

ii. Physical Description

The orchard is made up of two blocks, 209 trees per block. Each block consists of 19 rows, 11 tree per row, 10 foot spacing between each tree. The site size is 324 x 230 feet, each block 324 x 100 feet with a 30 foot space between the blocks. The rows are oriented NNW-SSE.

A stream 300 feet to West of the orchard provides water for a large and thick stand of conifers. This sets up a year- round wind break for the prevalent west wind. A stand of pines 50 feet to the NE provides a wind break for the Easterly winds. The NNW and SSE directions are exposed. To the SSE between the mountain and the orchard there is a large open field and there are some small orchards with short trees to the NNW.

iii. Climatological Figures

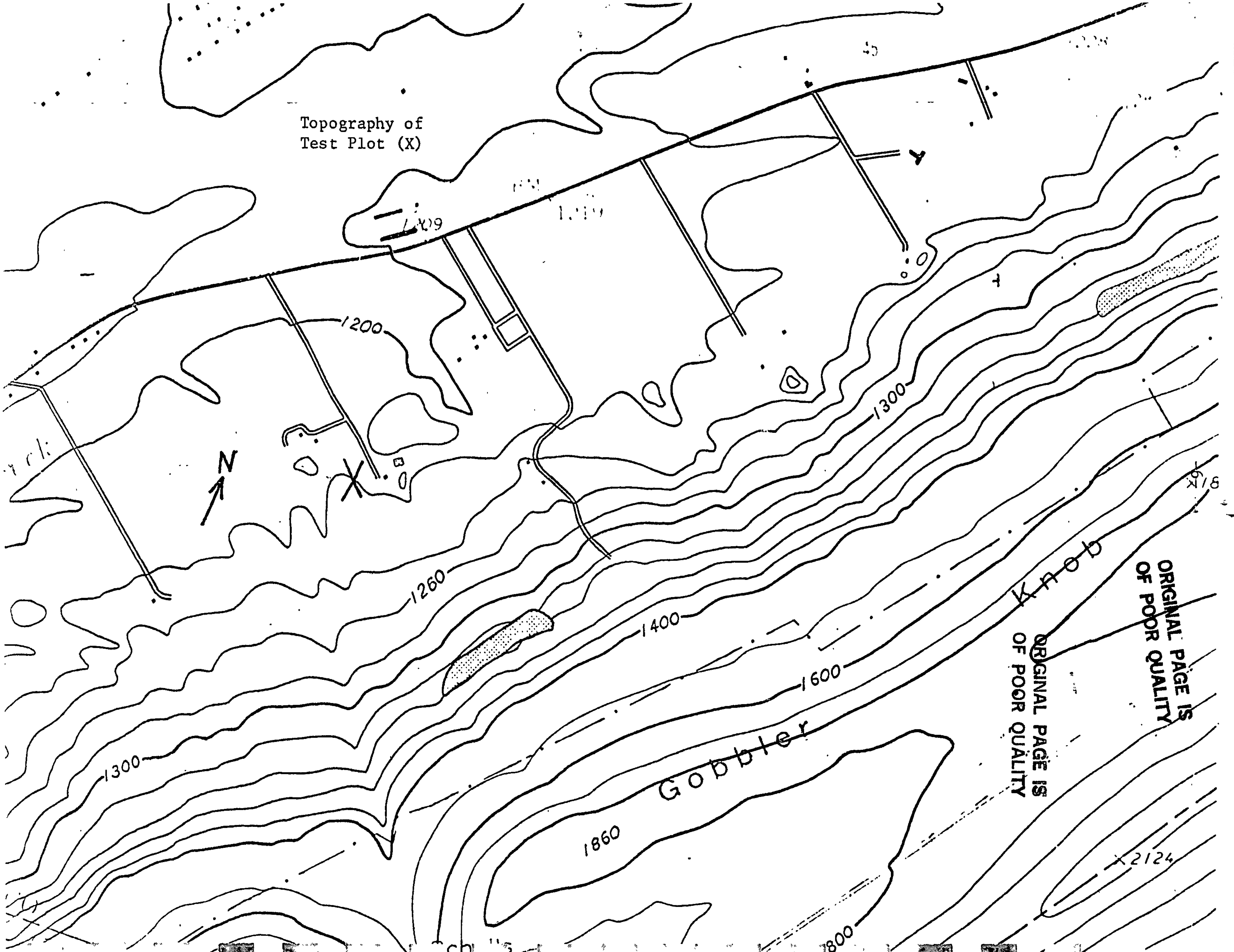
The following table shows average monthly climatological information for the State College area (Spring months):

	March	April	May	June
Dry bulb temp. °F	36.6	49.0	59.9	68.1
Max. dry bulb °F	46.0	59.0	71.0	79.0
Dew point temp. °F	27.0	38.0	48.0	58.0
Precipitation inches	3.43	3.34	4.03	3.34
Wind MPH	10.0	9.0	9.0	6.0
Solar insolation BTU's	1090	1404	1685	1914
Solar fraction	.466	.472	.494	.530

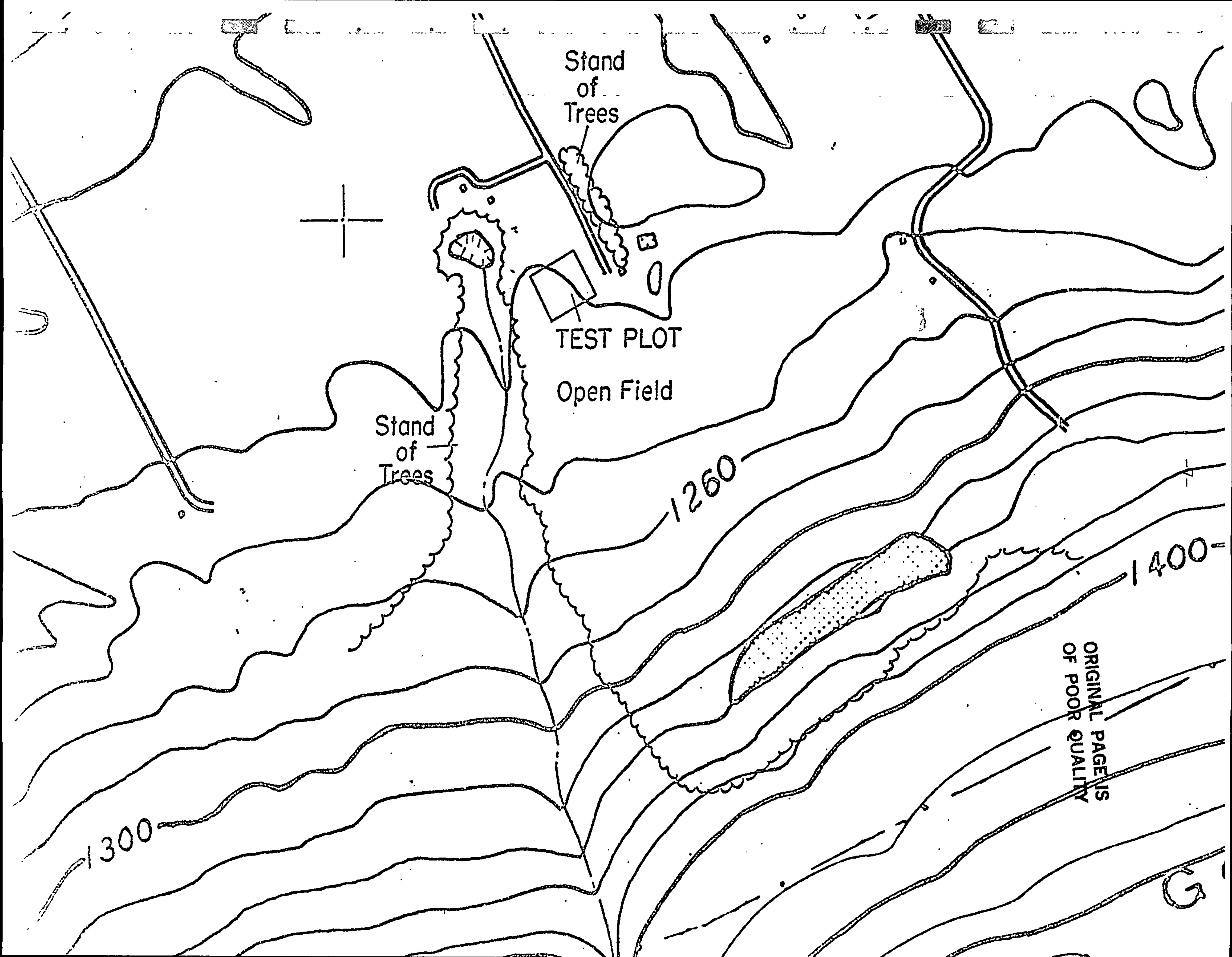
iv. Aerial Photographs and Topography Maps

The location of the Rock Springs Agricultural Research Center and the test plot is shown on the enclosed copies of an aerial photograph and a portion of the reproduction of a topological map. As may be seen from the aerial photograph the test site, denoted by an X on the photograph, is located in an open field at the base of a large stand of mountaineous forest. The location is further documented on a portion of the topological map. As may be seen from the enlarged topological map, the test plot is at an elevation of about 12,020 feet above sea level. The terrain to the south of the test

Aerial Photograph Showing Test Plot
(Test Plot Denoted by X)



ORIGINAL PAGE IS
OF POOR QUALITY


Stand
of
Trees
TEST PLOT
Open Field
Stand
of
Trees
1260
1400
1300

site increases rather rapidly as shown by the enclosed contour line depictions. A full description of the topography in the vicinity of the test site may be obtained from a U.S. geological survey map for the Pine Grove Mills quadrangle in the Pennsylvania series. The map currently available was produced in 1973 and is a part of the 7.5 minute series. Copies of this map are available either through the U.S. geological survey or from the principal investigator at The Pennsylvania State University.

B. Data Collected

Data were collected for use in this project at the previously described Rock Springs Agricultural Research Center site. Much of the analyses which have been made in Phase II of the satellite freeze forecast project are based on data which were collected during the spring of 1980. Data were also obtained for nights in the spring of 1981, but it is believed that the most definitive results are based on the analyses of the 1980 data.

Data which were collected include the following:

a. Air temperature at 9.3 and 1.5 meters.

b. Soil temperature at the surface, 10, and 50 centimeters deep.

c. Wind speed at a height of 1.5 meters.

d. Dew point temperature.

e. Net radiation.

The air temperature data were collected by means of mechanically aspirated and shielded type T thermocouples. The soil temperatures were measured with type T thermocouples. The dew point temperature was obtained with a lithium/chloride type of sensing element. The wind speed was evaluated with a climatronics anemometer. All of these data were collected on an Esterline-Angus data logger. The collection was in the form of a printed paper tape and for part of the time the data were also accumulated on a seven track magnetic tape. After appropriate processing and reduction of the data, a nine track ASCII formated tape was produced and sent to the University of Florida for use in the P-Model analysis program.

Many nights of data were available for inclusion in this study. As may be indicated by the plots of frost data given in Appendix II, it was decided that primary concentration should occur for the nights of May 7-8, May 8-9, May 9-10, and May 15-16, 1980. Several additional nights of data are available at the University of Florida or at The Pennsylvania State University if additional questions occur. As may be seen from the plots shown in Appendix II, there is significant variation in the parameters being studied for the afore mentioned nights.

A log describing the various channels and the format of the tape which was provided to the University of Florida is included as Appendix III of this report.

Upon analysis of the data which had been collected it was discovered that on occasion the dew point sensor which had been used was apparently giving erroneous results. It was, therefore, believed appropriate to use manually recorded dew point temperatures which had been collected for the nights under question. These dew point temperatures were provided to the University of Florida in a format as shown in Appendix IV. The device which was used for the collection of these dew point temperatures was an Ortemp dew point indicator.

A summary of the final resultant data which was used in P-Model predictions by the University of Florida is shown in Appendix V. It will be noted that the radiation data was believed to be insufficient to include in the model at the preliminary stage. Radiation has, therefore, been assumed to be zero for the purposes of P-Model computation.

C. P-Model Analysis

The data which had been supplied to the University of Florida by The Pennsylvania State University in the form of a nine track magnetic tape was used in the analysis of P-Model prediction. The results for this analysis are given in Appendix VI. As may be noted from the data in that appendix, the technique that is used with the P-Model analysis is to make predictions of temperature at a later point in a night using baseline temperatures for a three-hour period. For the present study the initial prediction hours that were used were 1800, 1900, and 2000. This prediction was then increased by one hour in hourly increments until the final predicting time of 0100, 0200, and 0300. The model predicted the temperature for hourly scan times until 0700 the following morning.

A complete summary of the P-Model analysis is given in Appendix VI. It is not very surprising to note that the best predictions normally occur during the time when a minimum number of hours occur from the baseline until the predicted point in time. It will be noted that the overall error analysis as also shown in Appendix VI is believed to be quite acceptable. The cumulative P-Model error analysis for all four nights and all prediction times was found to have a mean error of only 0.588. This error was based upon a population count of 264 data points.

The P-Model error analysis by nights was also found to be quite good as shown in Table 6.3 in Appendix VI. It will be noted that the error analysis by prediction time also tends to be much better for minimum prediction cycles. As may be seen from Table 4 in Appendix VI, the mean error ranges from a value of 3.123 when predicting ten hour temperatures to a value of minus 0.3 when only predicting one hour temperatures. A careful perusal of the predictions over the entire set of data indicates that this model does appear to have applicability to terrain such as was found in Pennsylvania for the purposes of this study. It must be realized that a great amount of additional data would probably need to be included to use this model in fruit growing operations, but the preliminary indications are that the technique is very applicable to predicting potential frost conditions in fruit growing regions such as are found in Pennsylvania.

The figures which are also shown in Appendix VI once again indicate a deviation between the predicted and observed temperature. As may be seen from those figures, the predictions are much better for a minimum number of hours deviation from the baseline temperatures. The heavy line which is shown on those figures indicates the observed temperatures. The lighter colored lines indicate predicted temperatures starting at various baseline times. Figure 6.1 shows P-Model prediction using the raw baseline as provided by The Pennsylvania State University. In Figure 6.2 this raw data for baselines was adjusted to provide a smooth function during the three hour baseline period. As may be seen by comparing Figure 6.1 and Figure 6.2 for any given night, there does not appear to be any significant benefit to using the error correction term in the P-Model. Examination of Figures 6.1 and/or 6.2 indicates the prediction as shown by P-Model for the nights of May 8-9 and May 15-16 was particularly good. The prediction of the other nights was not quite as accurate, but was still believed to be sufficiently useful to warrant further exploration of the application of this technique to Pennsylvania conditions. As previously stated, the P-Model certainly predicts temperatures much better during a time when a minimum number of hours occurs from the baseline. For example, in Figure 6.2.1, the predictive results are quite good for baseline times ending after 2200 hours. For predictions prior to that time there are significant deviations between the predicted and the observed temperatures. It is anticipated that additional inputs such as more radiation and additional inversion temperature data may help to enhance the ability of the P-Model to predict conditions over a longer period of time. It should be realized, however, that even if the P-Model is only able to make predictions two hours in advance it still would have a very useful benefit to growers who are attempting to provide frost production in a commercial orchard or grove.

Task 2. Description of the Major Apple Growing Regions of Pennsylvania

The primary apple growing region of Pennsylvania is located in the South Central area, between a 77 longitude and 78°W and at at 40°N latitude. The region covers two counties; Adams and Franklin, which have a total of almost 20,000 acres of apple orchards. The area has mountains with peak ridges 1500-2000 ft above sea level, generally running NE-SW, and valleys averaging 500-600 ft above sea level and several miles wide. Most of the orchards are located on the lower slopes of the mountains and on the gentler slopes in the valleys.

The following climatological information was taken from the centrally located point in each county; Gettysburg in Adams and Chambersburg in Franklin:

	Mean Elevation (ft)	Latitude	Longitude
Chambersburg	640	39°56'	77°38'
Gettysburg	540	39°50'	77°14'

Mean Temperature (°F)	March	April	May	June
Chambersburg	40.1	51.4	62.1	70.8
Gettysburg	41.2	52.6	63.0	71.5
Mean Maximum Temperature (°F)				
Chambersburg	51.3	62.7	73.6	81.2
Gettysburg	52.8	64.6	75.2	82.8
Mean Minimum Temperature (°F)				
Chambersburg	29.8	38.2	47.6	56.7
Gettysburg	30.5	39.3	49.0	59.7
Average Precipitation (inches) Both Locations				
	3.71	3.47	4.13	3.83

A full description of the Pennsylvania orchard fruit production areas by country and growers is included as Appendix VII to this report. This publication was compiled by the Pennsylvania Crop Reporting Service during 1978. As may be noted from the enclosed publication, there was a total acreage of 61,382 acreas of fruit production in Pennsylvania in 1978. Of that acreage 32,791 acreas were in apples. This survey included 893 apple growers of whom 825 qualified as commercial. As may be seen from Page 3 of the publication, 14,417 acreas of apples are present in Adams County and 4,266 acres in Franklin County as of 1978. These values should have not changed significantly since that time. The Pennsylvania orchard and vineyard survey will be updated approximately every five years.

Climatology data for the state of Pennsylvania is most easily obtained from a NOAA (National Oceanic and Atmospheric Administration) publication entitled Climatography of the United States No. 60, Climate of Pennsylvania. A copy of the material included on a microfilm of this publication has been attached as Appendix VIII to this report. Since this material was obtained from a microfilm it was very difficult to read in the presented form. If the user of this report needs to obtain more complete data he/she is referred to either the original publication or a microfilm. The Pennsylvania State University personnel involved in this project can also provide additional data upon request.

A careful examination of the principal fruit growing regions for Pennsylvania indicates that topography information can most easily be obtained from U.S. Geological Survey maps. These maps are available from USGS, Reston, Virginia 22092. The following quadrangles in the 7.5 minute series have significant acreage of orchards shown on them. All of these quadrangle maps were photo revised in 1973.

1. Arendtsville, PA
2. Biglerville, PA
3. Iron Spring, PA
4. Mont Holly Springs, PA
5. St. Thomas, PA
6. Scotland, PA
7. Waynesboro, PA

A number of other topological maps in Adams and Franklin County are also applicable, but the above mentioned ones upon examination have the highest percentage of orchards shown. If required The Pennsylvania State University can supply copies of these maps to any interested persons. As was previously stated, they are also available from USGS.

Task III P-Model Limitations

As was previously was discussed under Task I, the P-Model appears to have quite a bit of applicability to Pennsylvania conditions. It is believed that modifications may need to be made in this model in order to be suitably used for many of the fruit growing regions, but even in its present state the model does appear to offer some very definite advantages to a grower who is concerned with frost protection of his fruit crop.

A more detailed discussion of the manner in which the P-model may be applied to Pennsylvania growing conditions will be provided under Task IV of this report. The important concept that is being spelled out at this time, however, is that it is firmly believed that the model does appear to offer a benefit to Pennsylvania growers. This statement is supported by the error analysis and prediction charts that were presented in Appendix VI of this report.

Task IV Future Projections and Recommendations

Considerable time has been devoted to discussing the application of the P-model and satellite forecasting technology to Pennsylvania fruit growers needs. Many of the projections which are being made are, of course, speculative in nature but these projections are based upon present plans and predictions for Pennsylvania.

One of the necessities for Pennsylvania growers to make fullest use of satellite forecast technology is for a computerized information dissemination network. Discussions with Dr. G. A. Hussey, a computer specialist with the College of Agriculture at The Pennsylvania State University, indicates that present plans call for a microcomputer network to be made available in county offices under the control of the Pennsylvania Agricultural Extension Service. These microcomputers will probably be connected to a main frame computation system at University Park, Pennsylvania. Individual counties will then have the capability of accessing large data files by microwave and telephone links to the central computer complex. In addition to being able to provide many management type programs for Pennsylvania farmers and fruit growers, it will be possible to conceivably also provide forecasting capabilities for individual fruit growers.

Many farmers conceivably will also link to either the county extension offices or the central computer complex in order to obtain up-to-date forecast information for their own needs. It is anticipated that the P-model approach may be very conveniently used on individual large farms in Pennsylvania by making a series of adjustments to the prediction equations used in the P-model. These adjustments would take into account individual climatological histories and topographical features for a particular fruit growing region or farm. By making the fine adjustments indicated, it should be possible for a grower to obtain a very reliable forecast for his particular operation. It is anticipated that he may well decide to obtain forecast technology through the Agricultural Extension Service. Alternately he may wish to link to a commercially available service which could have available forecasting capability.

Dr. Hussey, who is previously cited, indicates that The Pennsylvania State University has negotiated with at least one commercial communication service for including agricultural data in their communication network. This type of communication service is of a format similar to that used by Source or Compuserve computer services currently available throughout the United States. Addresses for these commercial services are given in the cited references to this report. It is anticipated that it might be possible for individual states such as Pennsylvania to use commercial computer networks for information dissemination. By so doing material could more easily be upgraded and made available to growers throughout the United States without requiring an extensive computer network maintained specifically for a given state. Such a projection will need to be refined before it becomes practical, but it is the belief of this investigator that such a system is certainly feasible.

Other inputs which will be needed in order for a satellite forecast program to be useful to Pennsylvania fruit growers includes much better defined climatological data for Pennsylvania. This data will need to be calibrated and adjusted for individual fruit growing regions. The Office for Remote Sensing of Earth Resources at The Pennsylvania State University has for many years been involved in processing, analysis, and interpretation of remotely sensed data, most of which has been supplied by NASA in both imagery and digital format. Appendix IX to this report includes a discussion of the capability of that office. It is anticipated that one of the future continuations of the work described in this report would be to collect and define climatological data for a more wider portion of Pennsylvania than was included in this study. It is conceivable that the Office for Remote Sensing would be involved in such a collection and reduction of data. Having reduced temperature data for various portions of Pennsylvania, it then should be possible to refine the P-model in order to take into account climatological and topological variations throughout the fruit growing regions. This series of refined models would then be applied to individual fruit growers and/or areas in order to provide optimal predictions for frost potential.

Having developed individual calibrated models for various parts of Pennsylvania the grower would then need to have available a system for rapid access of the data such as had been previously described in this section. It is believed that growers may not all chose the same system, but in fact some growers might prefer to use a commercial service while others might tie into an agricultural extension service run by the state of Pennsylvania. Regardless of which route the individual grower should chose to take, it is believed quite probable that he or she should have access to timely data and projections for their individual farms. In order to get such projections, it is probably very desirable to have an ability to access satellite data quite rapidly. In order to do this efficiently one possibility may be to utilize down-link capability currently being developed at the University of Florida for obtaining directly satellite data. This data could be segmented and provided to Pennsylvania within a very short period of time after it was obtained from the satellite. By so doing, it would be possible to provide the grower with a very current projection of freeze forecast conditions. Such an operation would be somewhat expensive but is probably justified in view of the increasing costs for oil and the rapidly depleting water resources available to many fruit growers. It is anticipated that the satellite data would be provided by an institution similar to the University of Florida directly to Pennsylvania. The data would then be incorporated into either a single P-type model or a series of P-models which had been individually calibrated to fruit growers.

The fruit grower would call for the data via a personal computer available on their farm. Several modes of operation would be possible. The farmer could call at various time intervals and determine the probability of a frost. Alternately, an automatic dialing system and alarm network could be used to alert a grower to probable frost conditions on his or her individual operation. This technology would be the most effective, but would also be the most expensive for an individual grower to implement.

An alternate method of utilizing satellite projection in Pennsylvania would be to make P-model projections available to cable television networks in fruit growing regions. Many such cable television networks at the present time have channels which are devoted to news and similar materials. It is possible that the frost forecast could be incorporated as a part of these services

Of course, the National Weather Service is also providing in some areas of the United States, an agricultural forecasting service. It would be very desirable to use satellite forecast technology similar to that employed in this study for improving frost forecasting by the National Weather Service. A number of commercial forecasting services such as Accu-weather also could conceivably make use of the technology being described at this time. In conclusion several useful findings have resulted from this study. These findings can be enumerated as follows:

1. The P-model in its present form appears to give quite reasonable predictions for night-time temperatures over a short time interval under Pennsylvania conditions.
2. It appears feasible to modify the P-model in order to take into account topographical variations for individual fruit growing regions.
3. Present microcomputer technology appears to be very appropriate to enable individual fruit growers to use results from satellite freeze forecast technology.
4. In a continuation of this study it is suggested that a more detailed collection of climatological data is needed. This data would then be incorporated into the P-model in order to statistically evaluate the effectiveness of this model over a wide range of climatological conditions.

5. It is believed that in the next few years growers will have the capability and desire to quickly access results from forecast technology such as was used in this study. It would be desirable, therefore, to continue to work on an information dissemination network which will rapidly make satellite-based forecasts available to the grower. This information dissemination may well be offered by both commercial and public institutions.

6. A minimum of two additional years of data are needed in order to accurately evaluate the suitability of P-model to Pennsylvania growing conditions. It is hoped that some mechanism will be developed by which additional studies of the suitability of this model may be achieved.

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Appendix I

Proposal from The Pennsylvania State University

to

The University of Florida

OMIT TO APPENDIX 70

Application of Satellite Freeze Forecast
Technology to Other Parts of the U.S.
Phase II

Proposal for Continuing Support

Submitted to: University of Florida
Institute of Food and Agricultural Science
2121 HS/PP
Gainesville, Florida 32611

Submitted by: C. T. Morrow, Principal Investigator
Department of Agricultural Engineering
The Pennsylvania State University
University Park, Pennsylvania 16802

Submitted on: December 1, 1980

Note: This proposal is submitted from The Pennsylvania State University as a sub-contractor to the University of Florida. The University of Florida is designated as the prime contractor to John F. Kennedy Space Center, NASA.

Signatures

C. T. Morrow ______________ C. T. Morrow, Principal Investigator

______________ H. V. Walton, Head, Dept. of Ag. Engineering

______________ R. G. Cunningham, Vice President for Research

Application of Satellite Freeze Forecast Technology to Other Parts of the U.S. Phase II

Introduction

Improved methods of freeze forecasting would greatly benefit agricultural interests throughout the contiguous United States. NASA has entered into a joint effort with the National Oceanic and Atmospheric Administration (NOAA) to demonstrate the technology necessary to accomplish more accurate freeze forecasting in the state of Florida. To this end NASA has engaged the University of Florida, Institute of Food and Agricultural Sciences (IFAS), to develop and demonstrate a satellite freeze forecast system under NASA contract NAS10-9168.

During the past year, NASA also has had IFAS investigate the "Application of Satellite Freeze Forecast Technology to Other Parts of the United States" under NASA contract NAS10-9611. The first year's work concentrated in gathering key weather station data bases and comparing this data with the NOAA GOES-2 satellite or any other available satellite gathering temperature data and evaluating the usefulness of such satellite data in two selected test areas, which are located in Michigan and Pennsylvania. The collected data would be evaluated and conclusions/observations presented as follows:

The ability to correlate GOES data with surface data and its applicability to cold climate mapping considering such factors as:

a. Accuracy, resolution, and reliability of the satellite data;
b. Geometric distortions;
c. Terrain variables;
d. Atmospheric effects; and
e. Other.

Scope

Under the proposed extension of the project, the Pennsylvania State University shall be responsible for accomplishing the following tasks:

Task 1. Collect data to be used in running a freeze prediction model (P-Model) by the University of Florida. This model was described by Sutherland, 1980. Data will be collected at a site located at the Rock Springs Agricultural Research Center. The site chosen for the data collection provides a uniform and level agricultural terrain. The following data will be collected at the site:

a. Air temperature at 9.3, and 1.5 meters
b. Soil temperature at the surface, 10, and 50 centimeters
c. Windspeed at 1.5 meters
d. Dewpoint temperature
e. Net radiation

In anticipation of continuing funding for the project data were collected during the Spring of 1980 for the following nights:

May 8, 1980
May 9, 1980
May 10, 1980
May 15, 1980
June 11, 1980

Additional data will be collected for nights in early Spring, 1981.

The above data will be supplied to the University of Florida for running the P-Model on their computer.

Archived GOES satellite data will be procured by the University of Florida for use in evaluating the applicability of the P-Model to Pennsylvania conditions.

Task 2. The Pennsylvania State University will supply terrain, surface and topographic information to the University of Florida concerning fruit growing regions in Pennsylvania. This information will be used to develop preliminary specifications for a statistics model such as the one previously developed at the University of Florida and described by Chen, 1980.

Task 3. The Pennsylvania State University will study the P-Model (Sutherland, 1980) and discuss limitations and pecularities of the Pennsylvania test site which might limit generalization of the P-Model to other areas of the United States.

Task 4. The Pennsylvania State University will make recommendations to the University of Florida relative to specific concepts and studies that could be pursued for further application.

Cited References

Chen, Ellen. 1980. Personal Correspondence. University of Florida, Gainesville, Florida.

Sutherland, R. A. 1980. A Short-Range Objective Nocturnal Temperature Forecasting Model. Journal of Applied Meteorology. March, 1980. pp. 247-255

Sub-Contact Budget, 1980-81

The Pennsylvania State University

Salaries		
C. T. Morrow, Principal Investigator		$1,000
M. A. Wittman, Electronics Technician		300
P. A. Mark, Technician		300
	Salaries Sub-Total	1,600
Wages		
Part-Time Hourly Help	400 hours @ ave. $3.40	1,360
	Wages Sub-Total	1,360
	Total-Salaries and Wages	2,960
Fringe Benefits		
22.10% of Salaries		354
6.60% of Wages		90
	Fringe Benefits Sub-Total	444
Travel		
Mileage to Rock Springs Agricultural Research Center		100
Travel to University of Florida and KSC		500
	Travel Sub-Total	600
Other		
Computer - IBM 370/3033 @ $252/hr		504
Expendable Supplies and Materials		700
	Other Sub-Total	1,204
	Total-Direct Costs	5,208
Indirect Costs		
64.30% of Total Salaries and Wages		1,903
	Total Estimated Costs	7,111

Appendix II

Frost Data for Pennsylvania Test Site

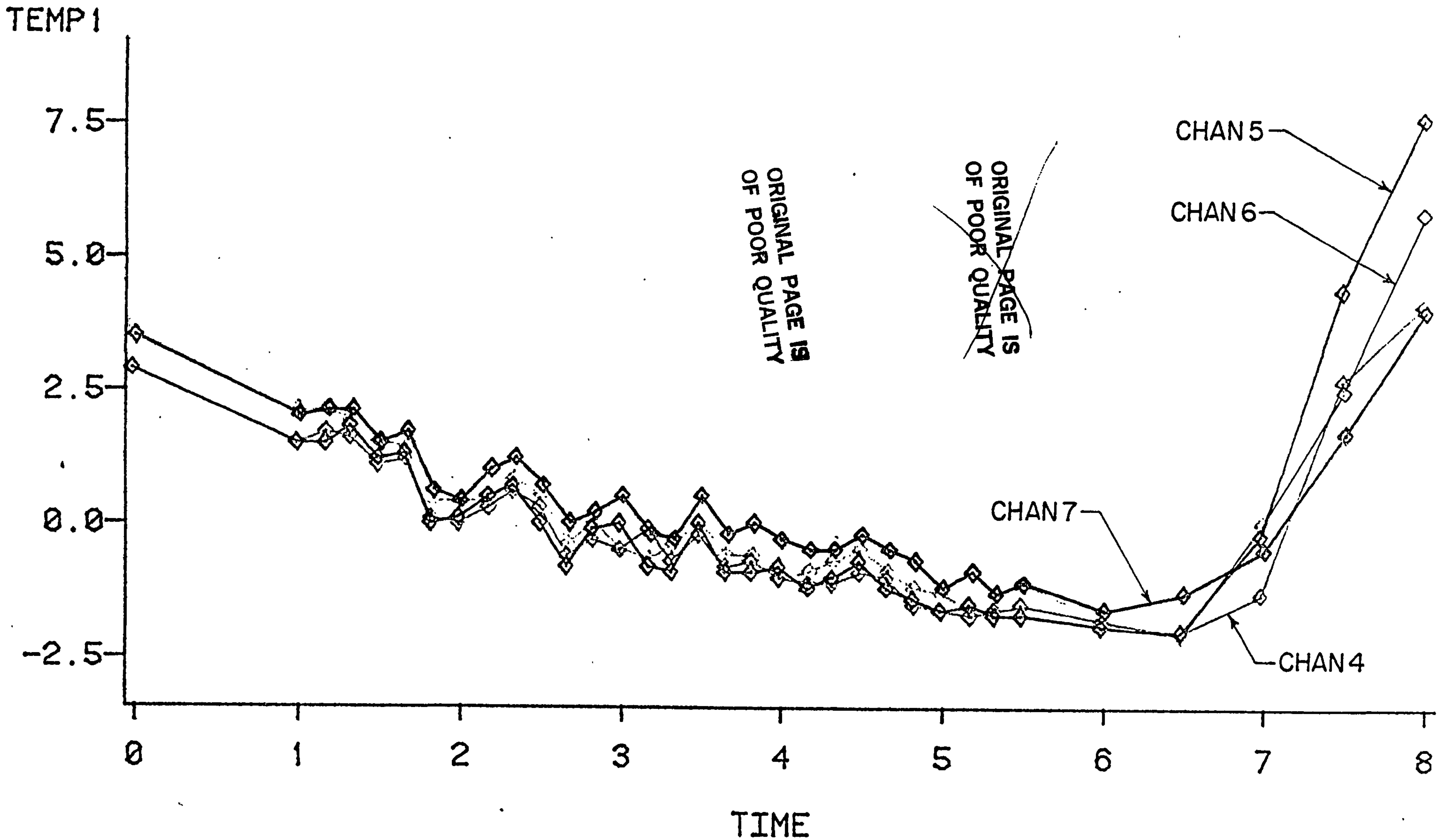
Channel Descriptions for Pennsylvania Data

May 8-9, 9-10, 10-11, and 15-16, 1980

Channel	Description	Units
4	Bud thermocouple, North block	Deg. C
5	Bud thermocouple, North block	Deg. C
6	Bud thermocouple, North block	Deg. C
7	Aspirator chamber, North block	Deg. C
8	Aspirator Chamber, South block	Deg. C
9	Bud thermocouple, South block	Deg. C
10	Bud thermocouple, North block	Deg. C
11	Bud thermocouple, South block	Deg. C
12	Bud thermocouple, South block	Deg. C
13	Bud thermocouple, South block	Deg. C
14	Surface temperature	Deg. C
15	Tower ground level thermocouple	Deg. C
16	Tower 1.5 meter aspirator	Deg. C
17	Tower 15 meter aspirator	Deg. C
18	Tower 5 meter thermocouple	Deg. C
19	Tower 3 meter thermocouple	Deg. C
20	Tower 3 meter aspirator	Deg. C
21	Tower 9 meter aspirator	Deg. C
22	Trench 10 cm thermocouple	Deg. C
23	Trench 10 cm thermocouple	Deg. C
24	Trench 50 cm thermocouple	Deg. C
25	Trench 50 cm thermocouple	Deg. C
26	Wind speed	Meters per second
27	Wind peak	Meters per second
28	Wind average	Meters per second

FROST DATA

MAY 8, 1980



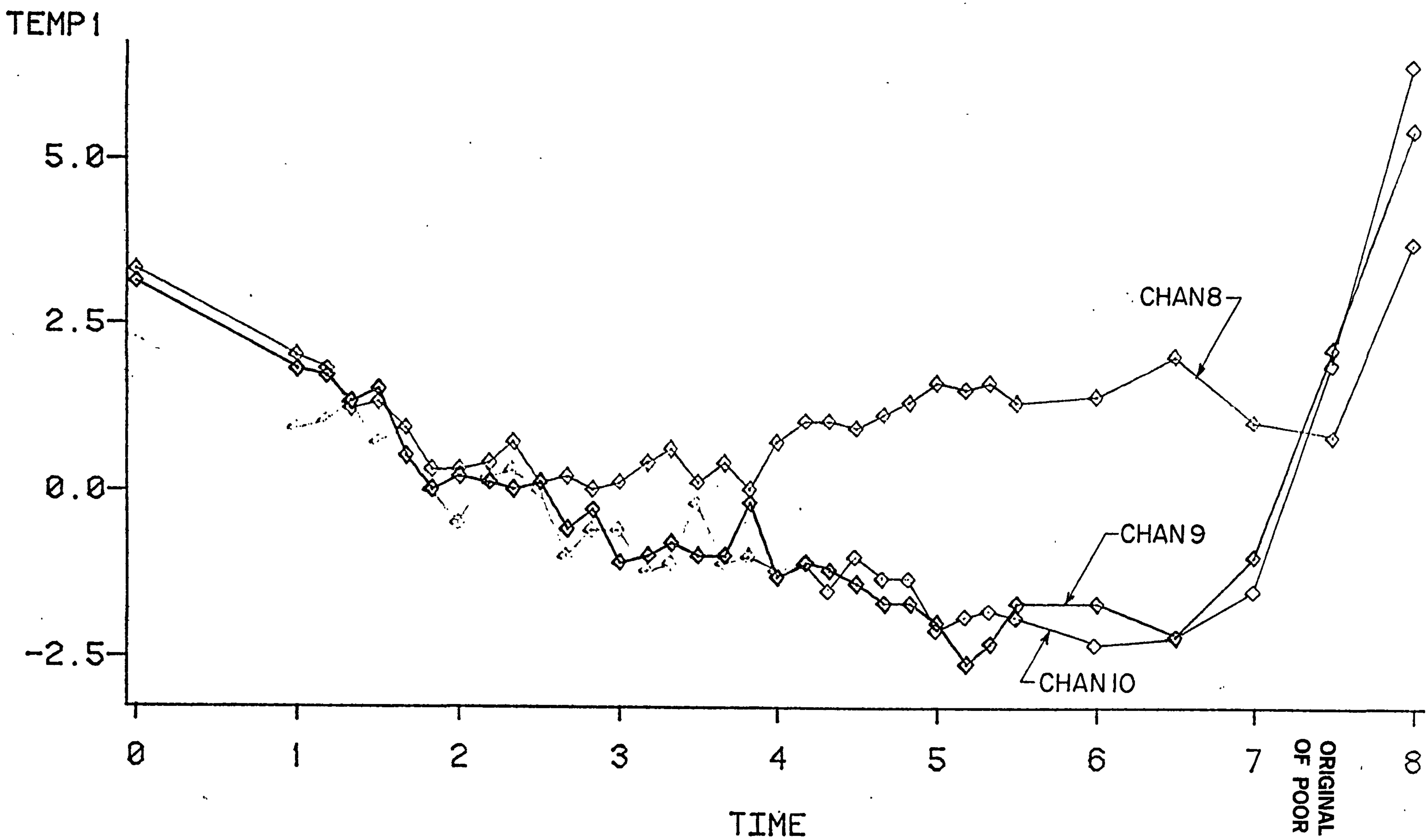
CHAN4=BLUE CHAN5=RED

CHAN6=GREEN CHAN7=BLACK

TIME IS IN HOURS, TEMP. IN DEG C

FROST DATA

MAY 8, 1980



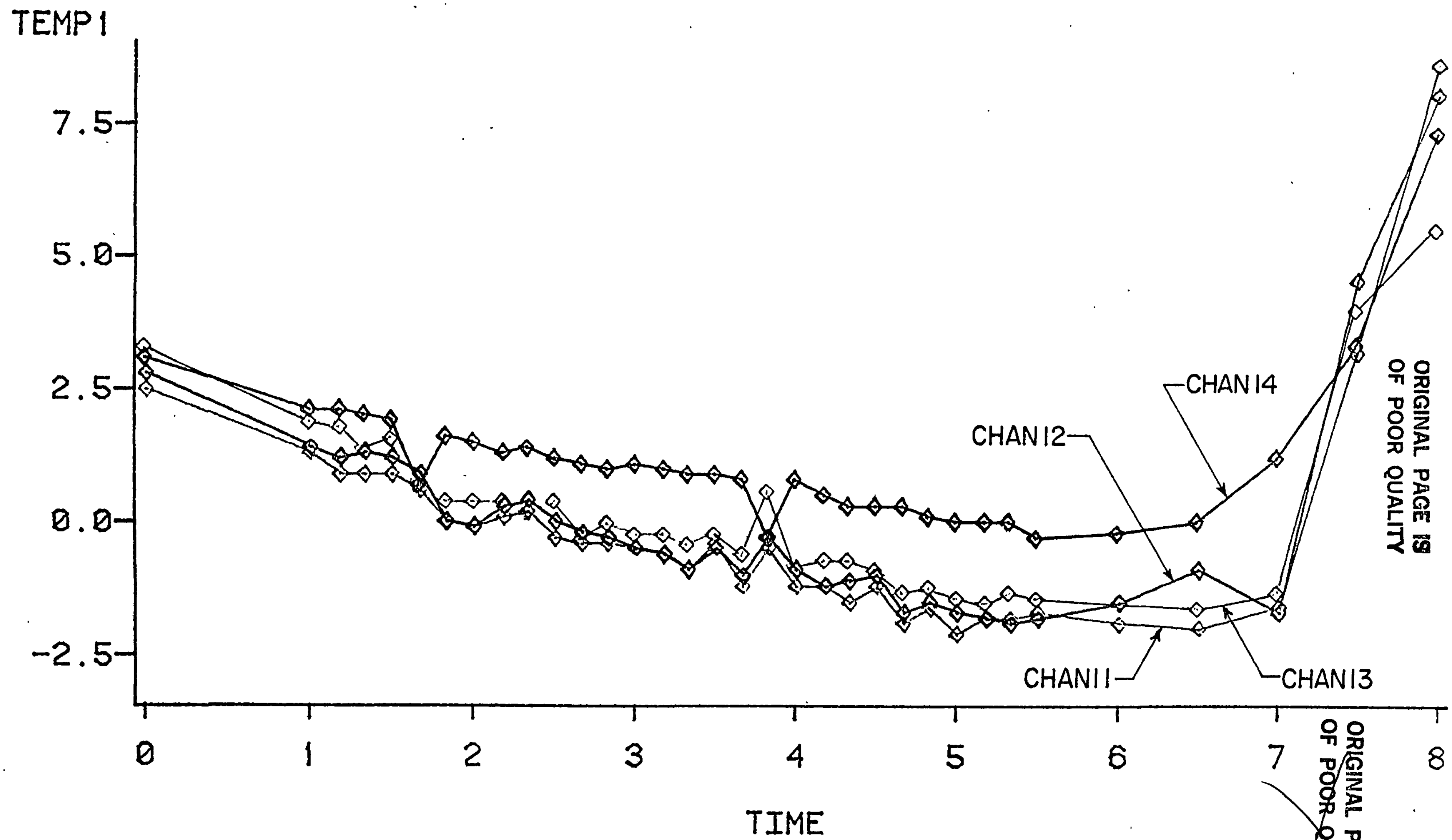
CHAN8=BLUE CHAN9=RED

CHAN10=GREEN

TIME IS IN HOURS, TEMP. IN DEG C

FROST DATA

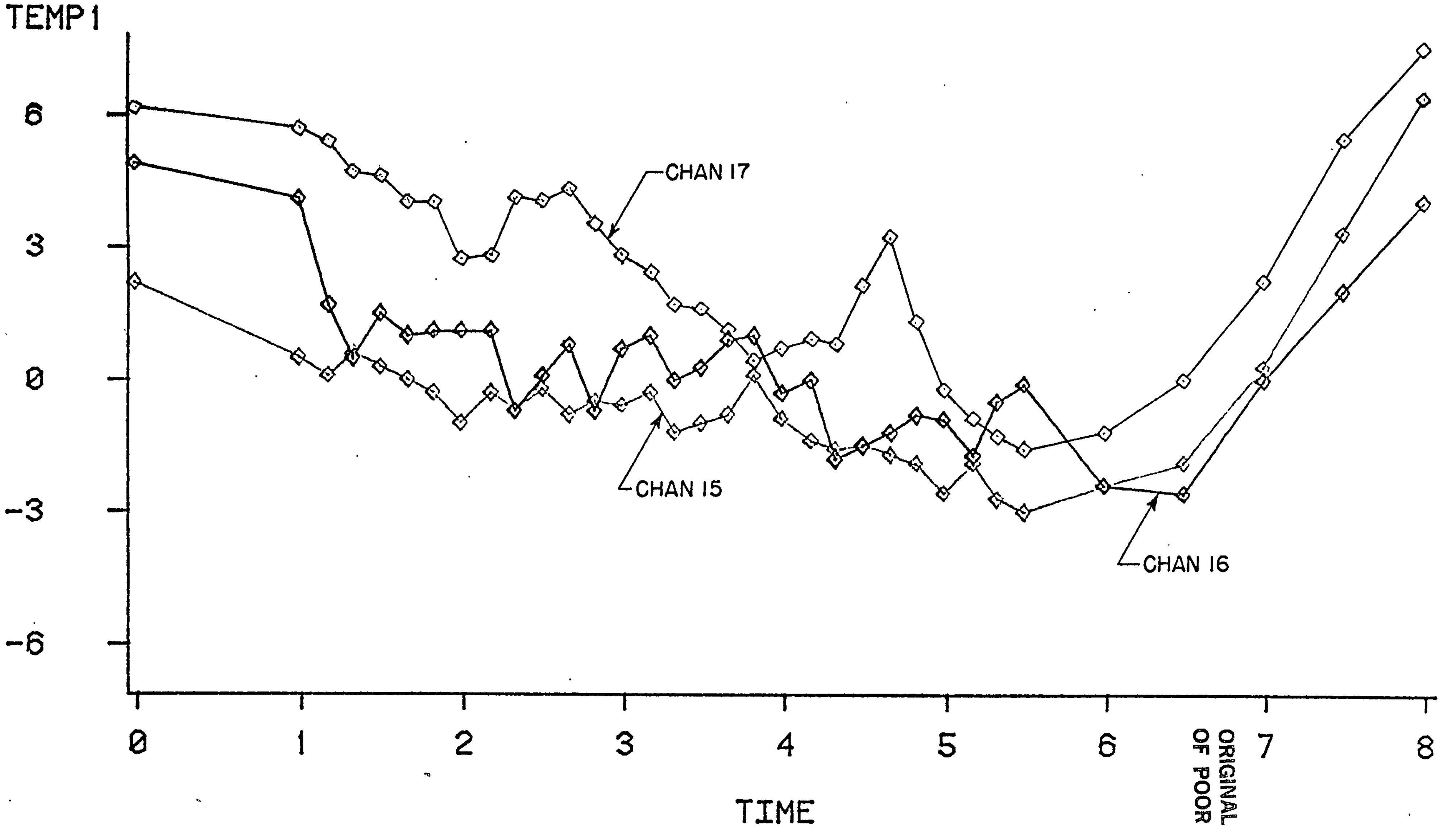
MAY 8, 1980



CHAN11=BLUE CHAN12=RED
CHAN13=GREEN CHAN14=BLACK
TIME IS IN HOURS, TEMP. IN DEG C

FROST DATA

MAY 8, 1980



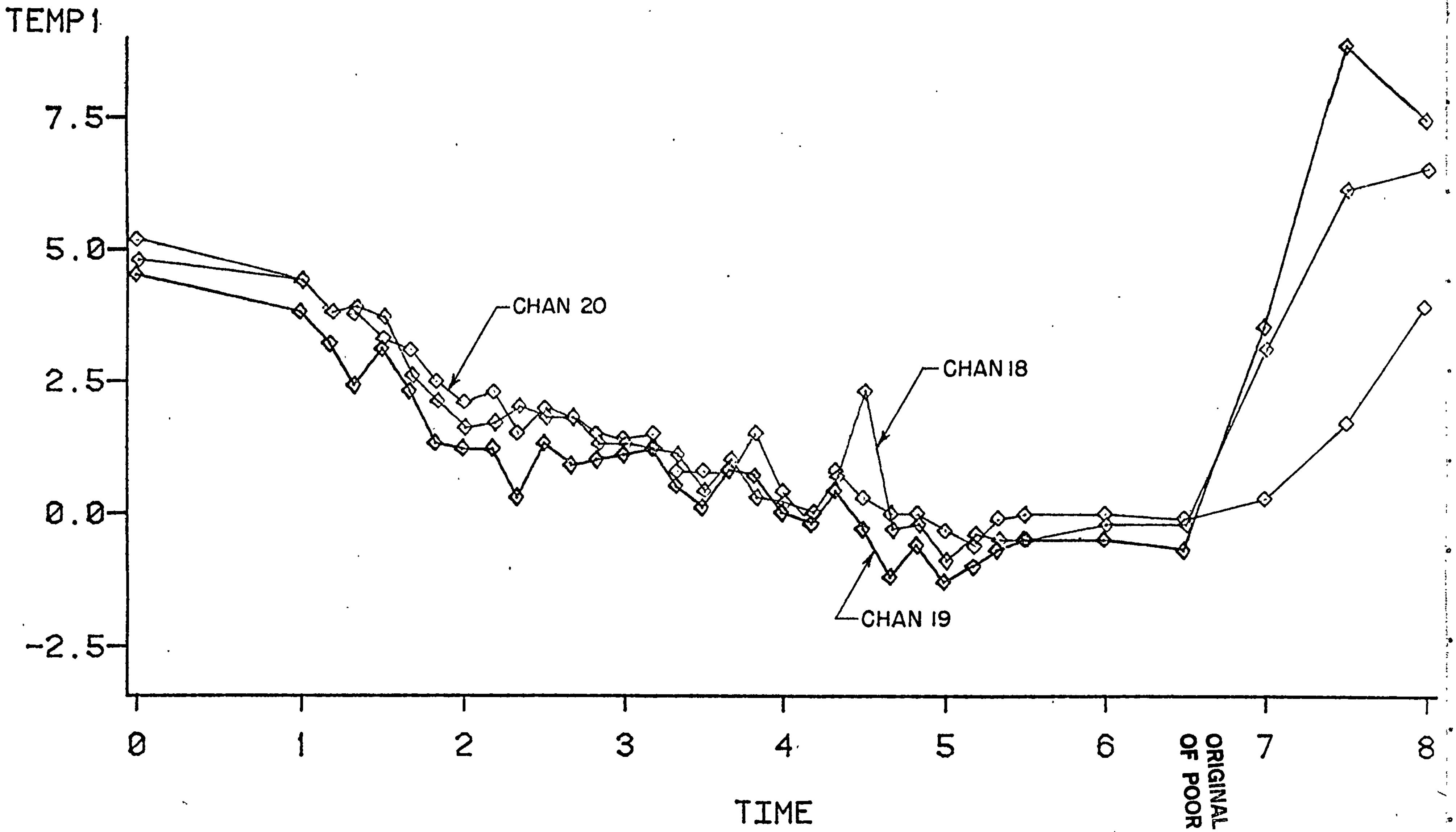
CHAN15=BLUE CHAN16=RED

CHAN17=GREEN

TIME IS IN HOURS, TEMP. IN DEG C

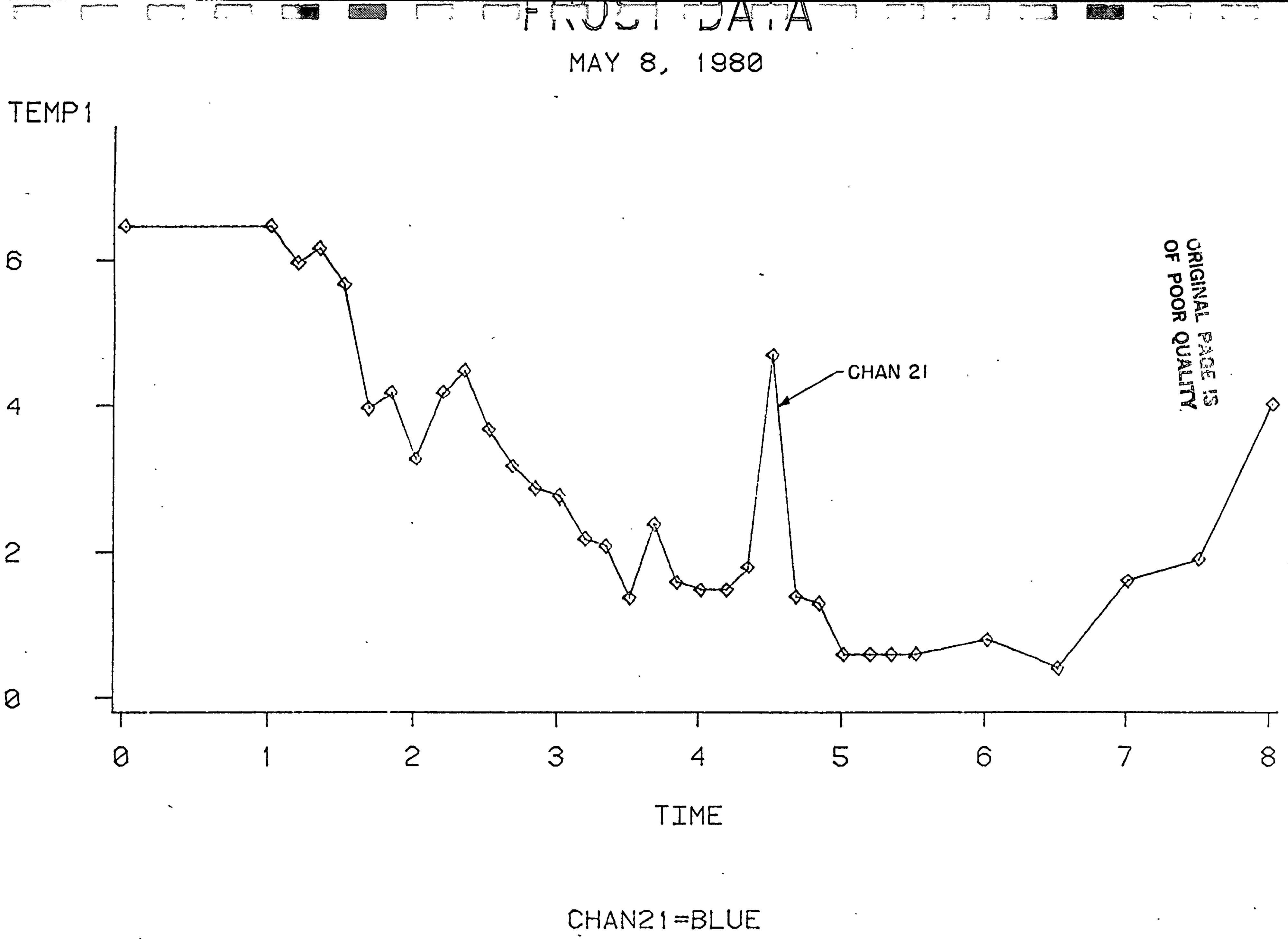
FROST DATA

MAY 8, 1980



ORIGINAL PAGE IS OF POOR QUALITY

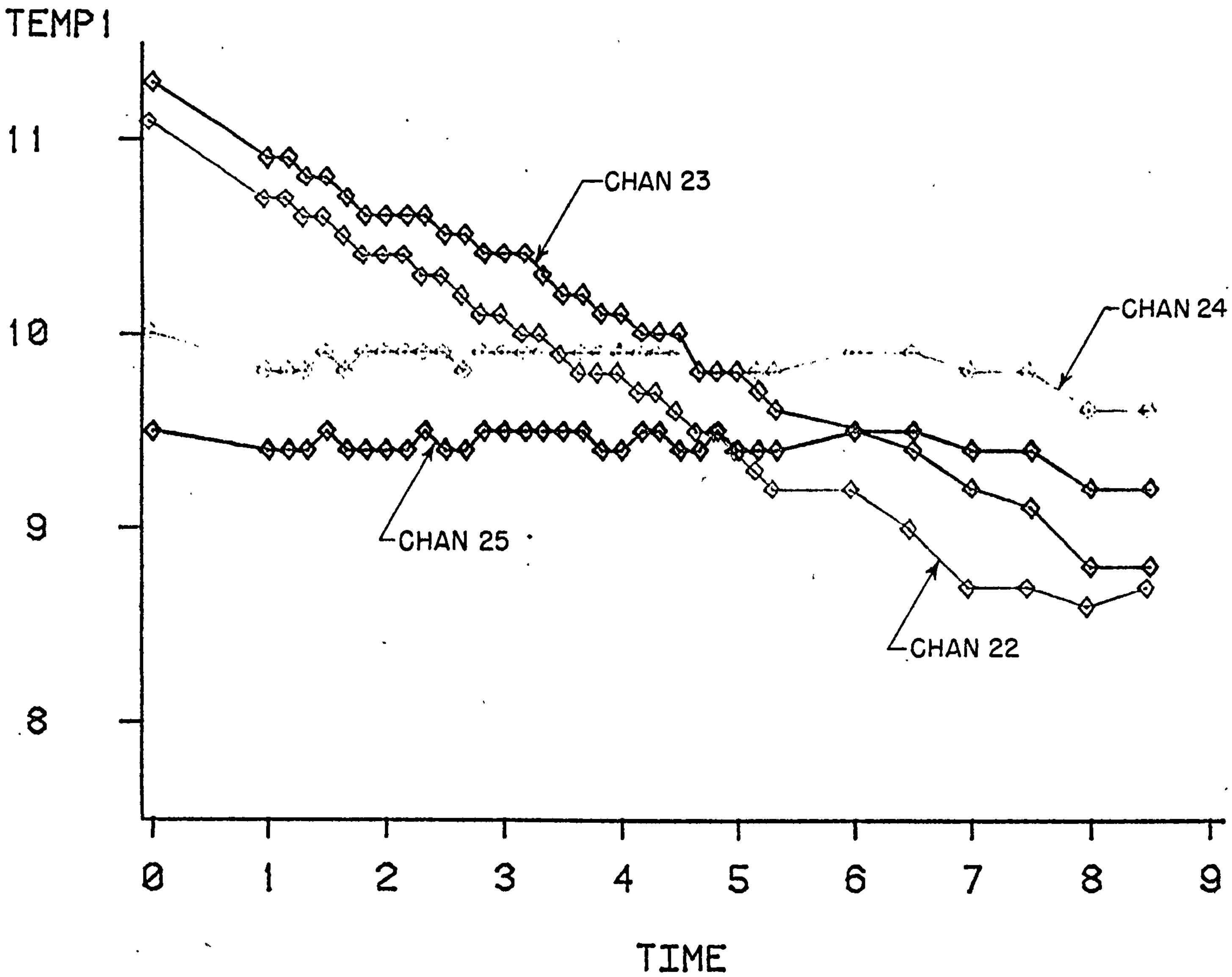
CHAN18=BLUE CHAN19=RED
CHAN20=GREEN
TIME IS IN HOURS, TEMP. IN DEG C



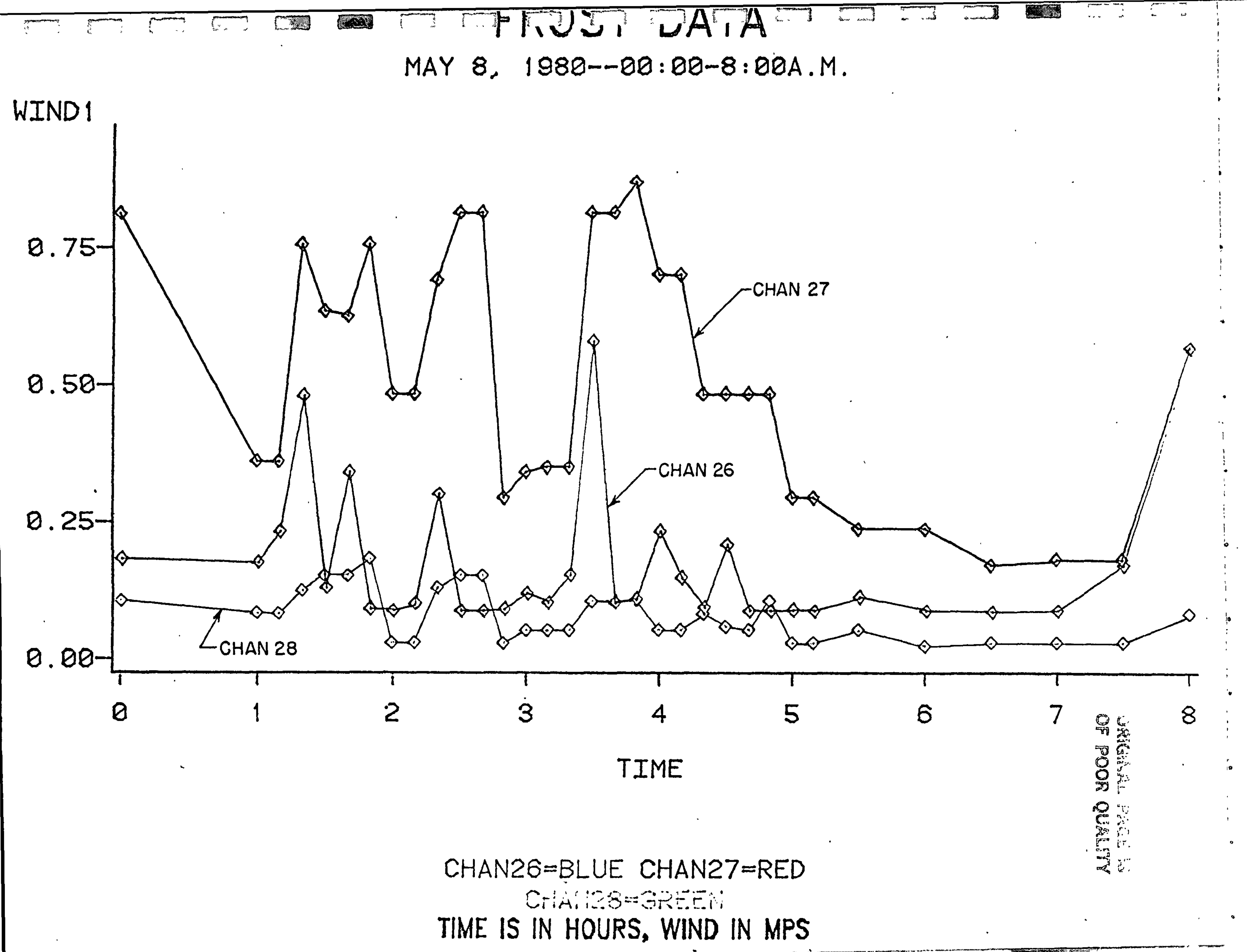
TIME IS IN HOURS, TEMP. IN DEG C

FROST DATA

MAY 8, 1980



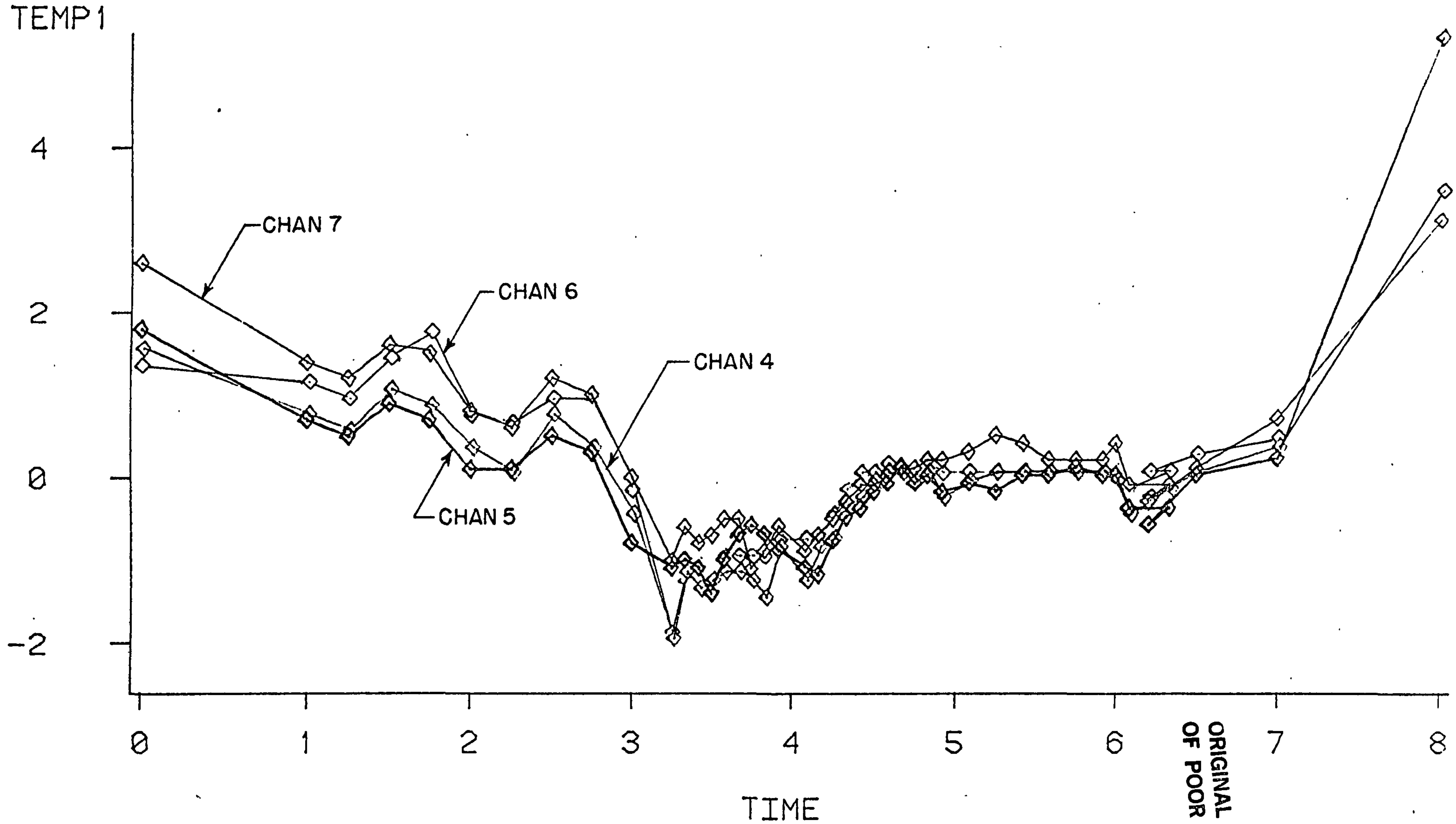
CHAN22=BLUE CHAN23=RED
CHAN24=GREEN CHAN25=BLACK
TIME IS IN HOURS, TEMP. IN DEG C



FROST DATA
MAY 8, 1980--00:00-8:00A.M.
WIND1
0.75
0.50
0.25
0.00
CHAN 27
CHAN 26
CHAN 28
0
1
2
3
4
5
6
7
8
TIME
ORIGINAL PAGE IS OF POOR QUALITY
CHAN26=BLUE CHAN27=RED
CHAN28=GREEN
TIME IS IN HOURS, WIND IN MPS

FROST DATA

MAY 9, 1980--00:00-8:00A.M.

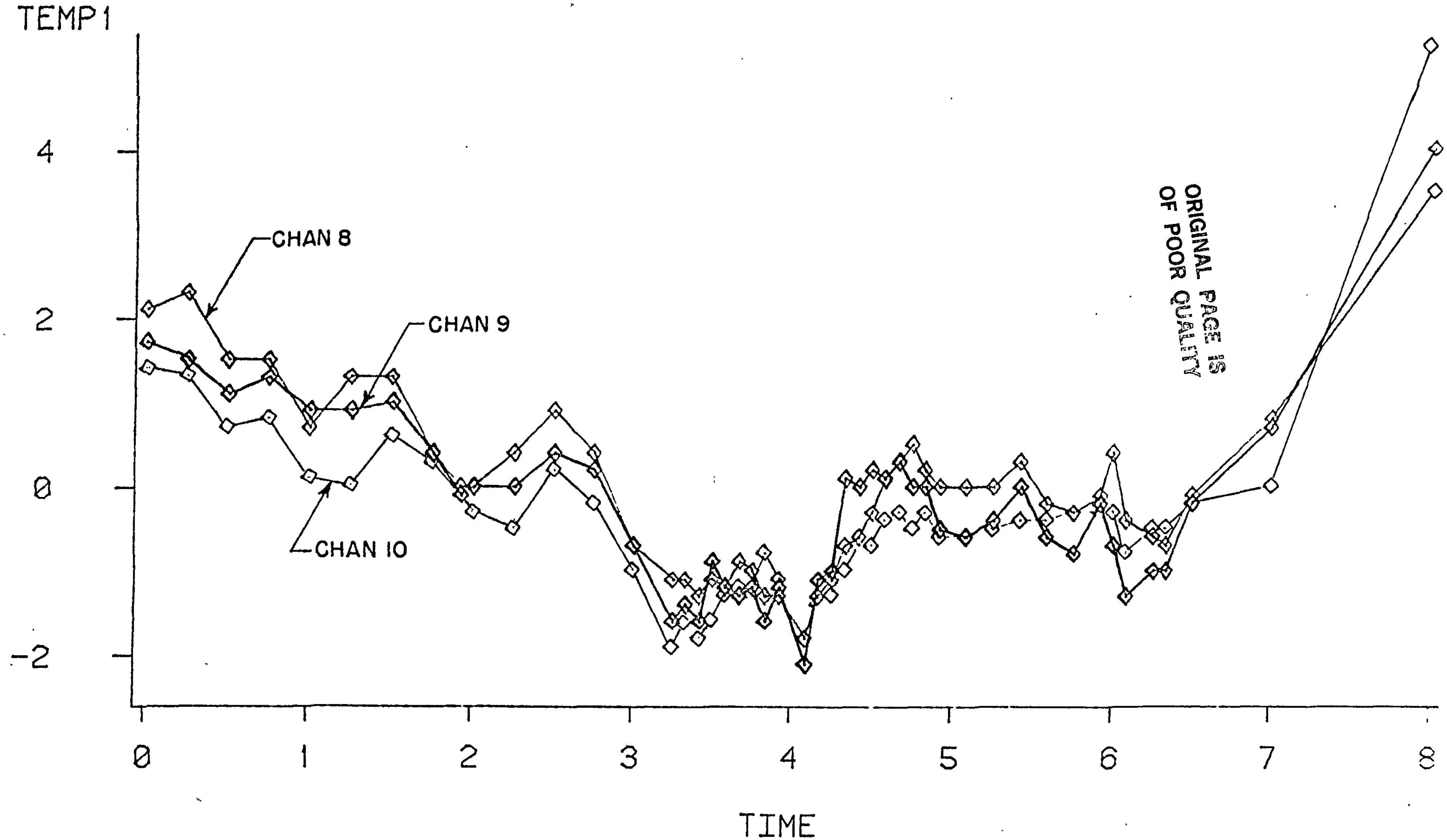


CHAN4=BLUE CHAN5=RED
CHAN6=GREEN CHAN7=BLACK

TIME IS IN HOURS, TEMP. IN DEG C

FROST DATA

MAY 9, 1980--00:00-8:00 A.M.



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CHAN10=GREEN

TIME IS IN HOURS, TEMP. IN DEG C

FROST DATA

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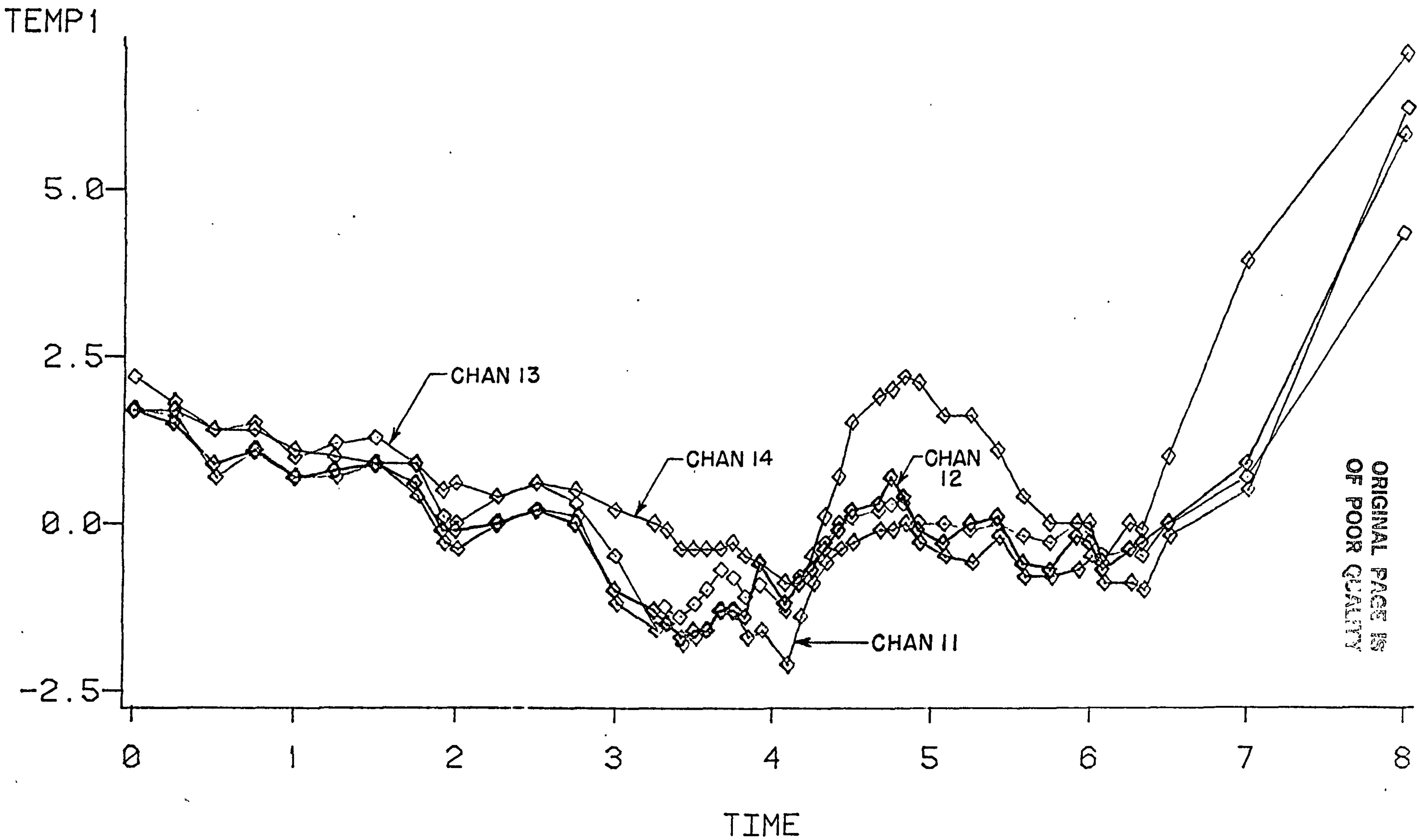

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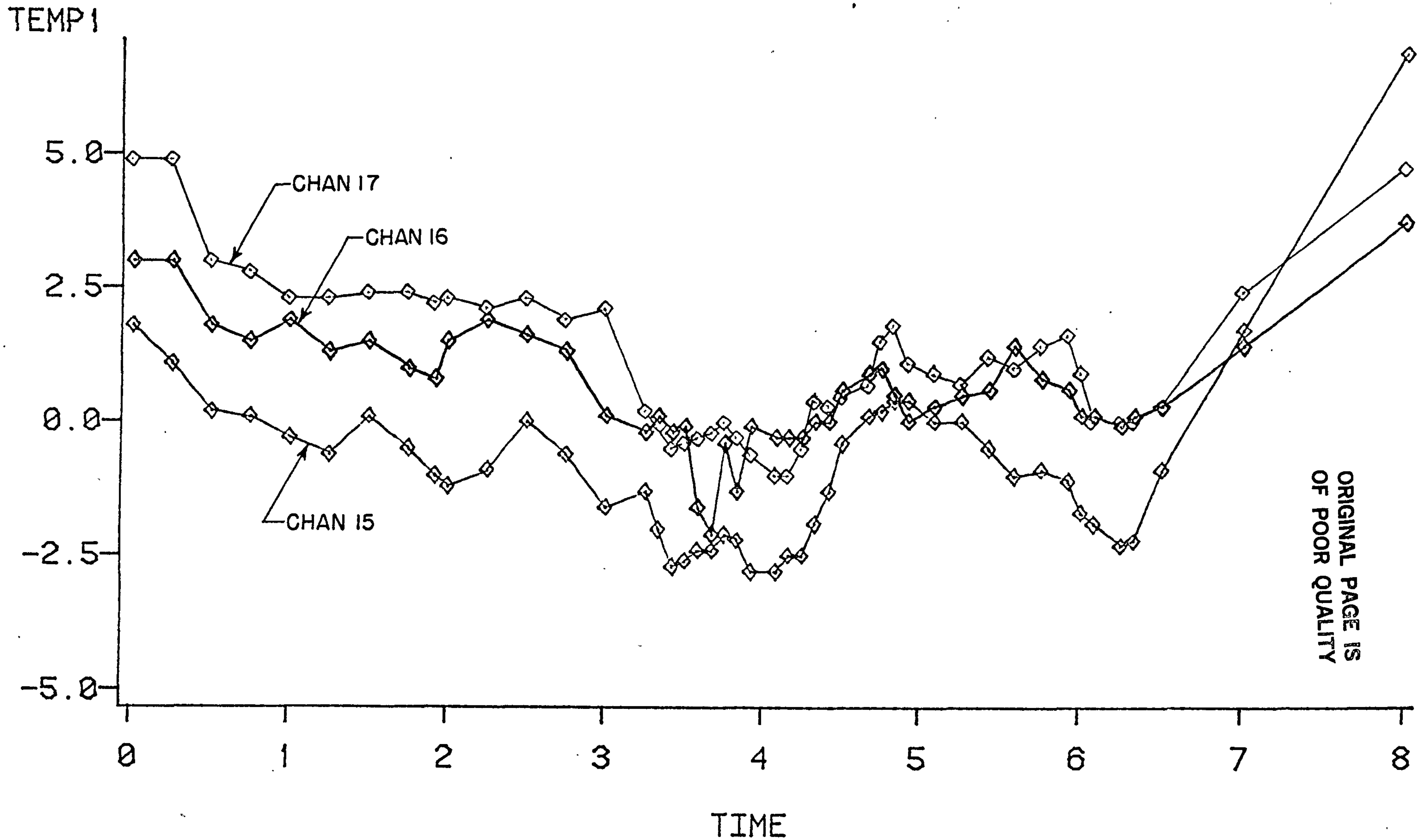
CHAN13=GREEN CHAN14=BLACK

TIME IS IN HOURS, TEMP. IN DEG C

MAY 9, 1980--00:00-8:00A.M.



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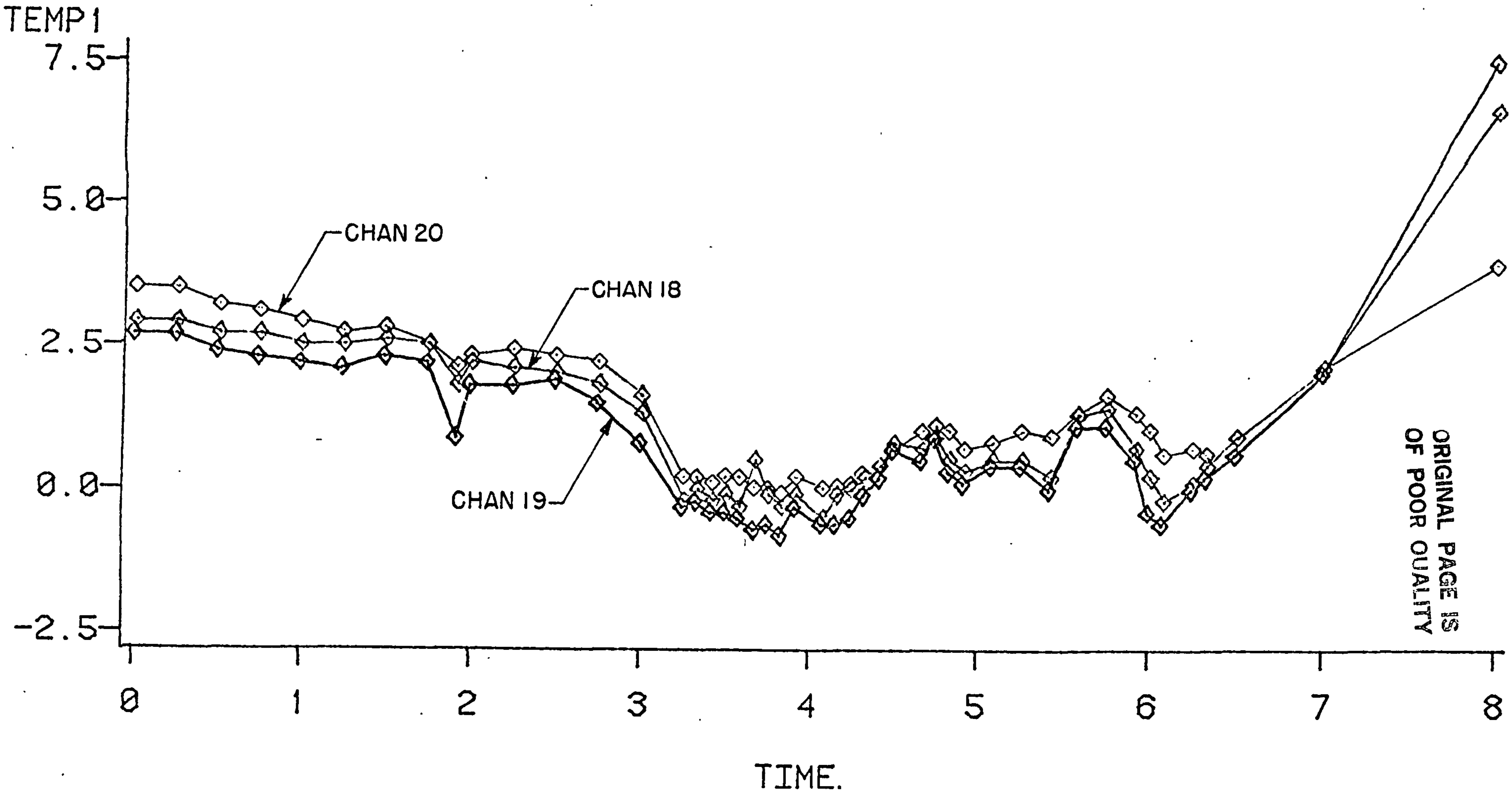
CHAN17=GREEN

TIME IS IN HOURS, TEMP. IN DEG C

MAY 9, 1980--00:00-8:00A.M.



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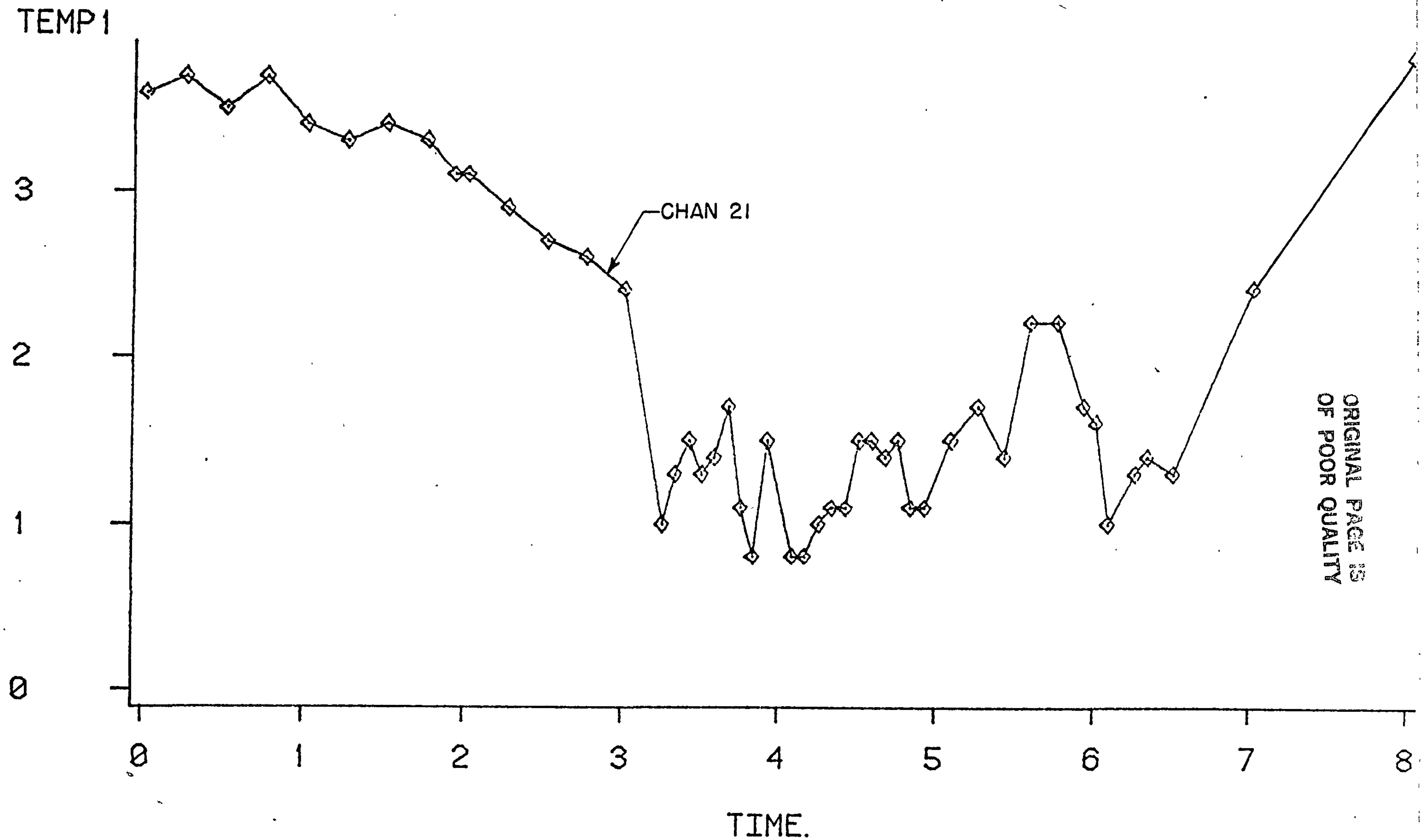
CHAN20=GREEN

TIME IS IN HOURS, TEMP. IN DEG C

FROST DATA

MAY 9, 1980--00:00-8:00A.M.



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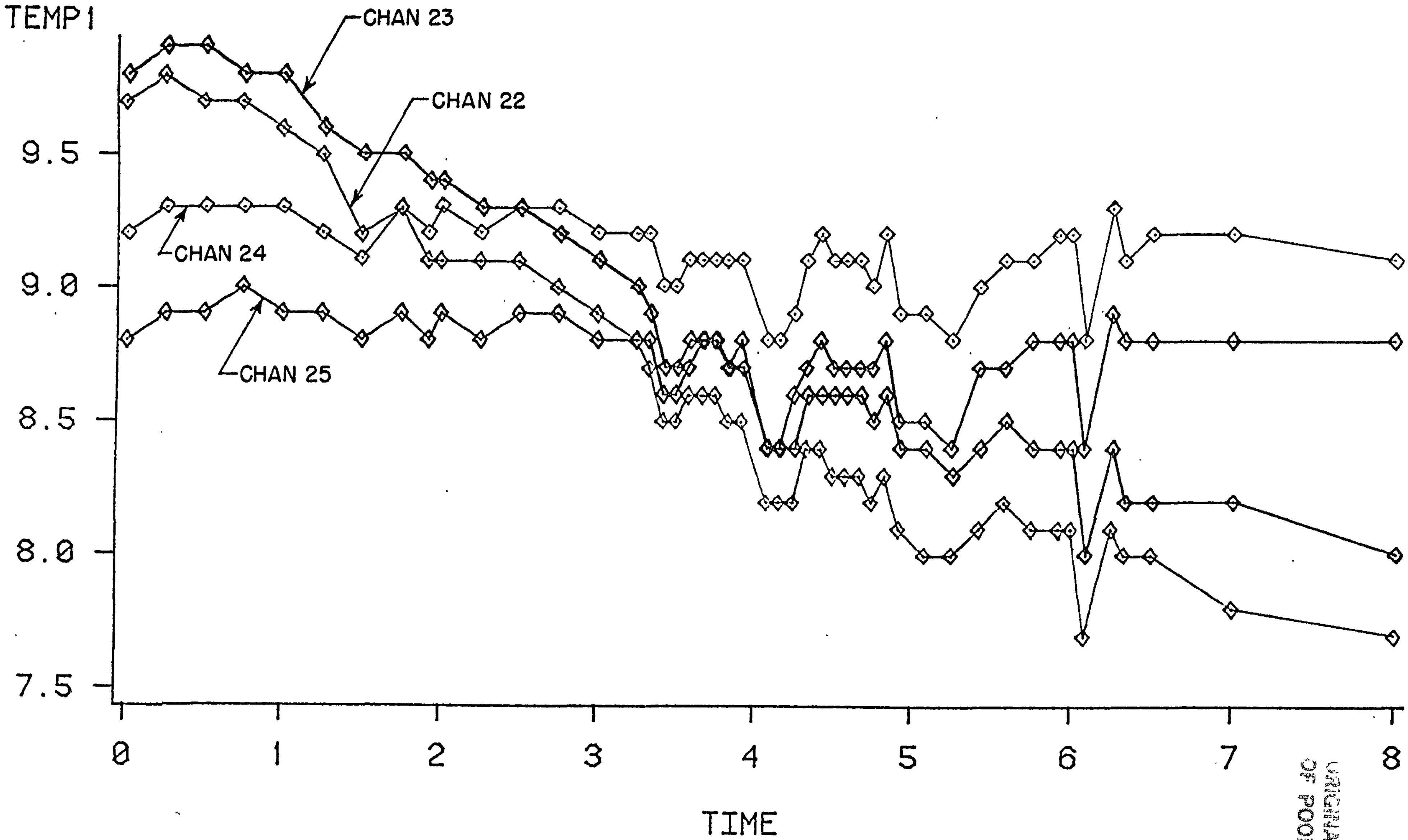

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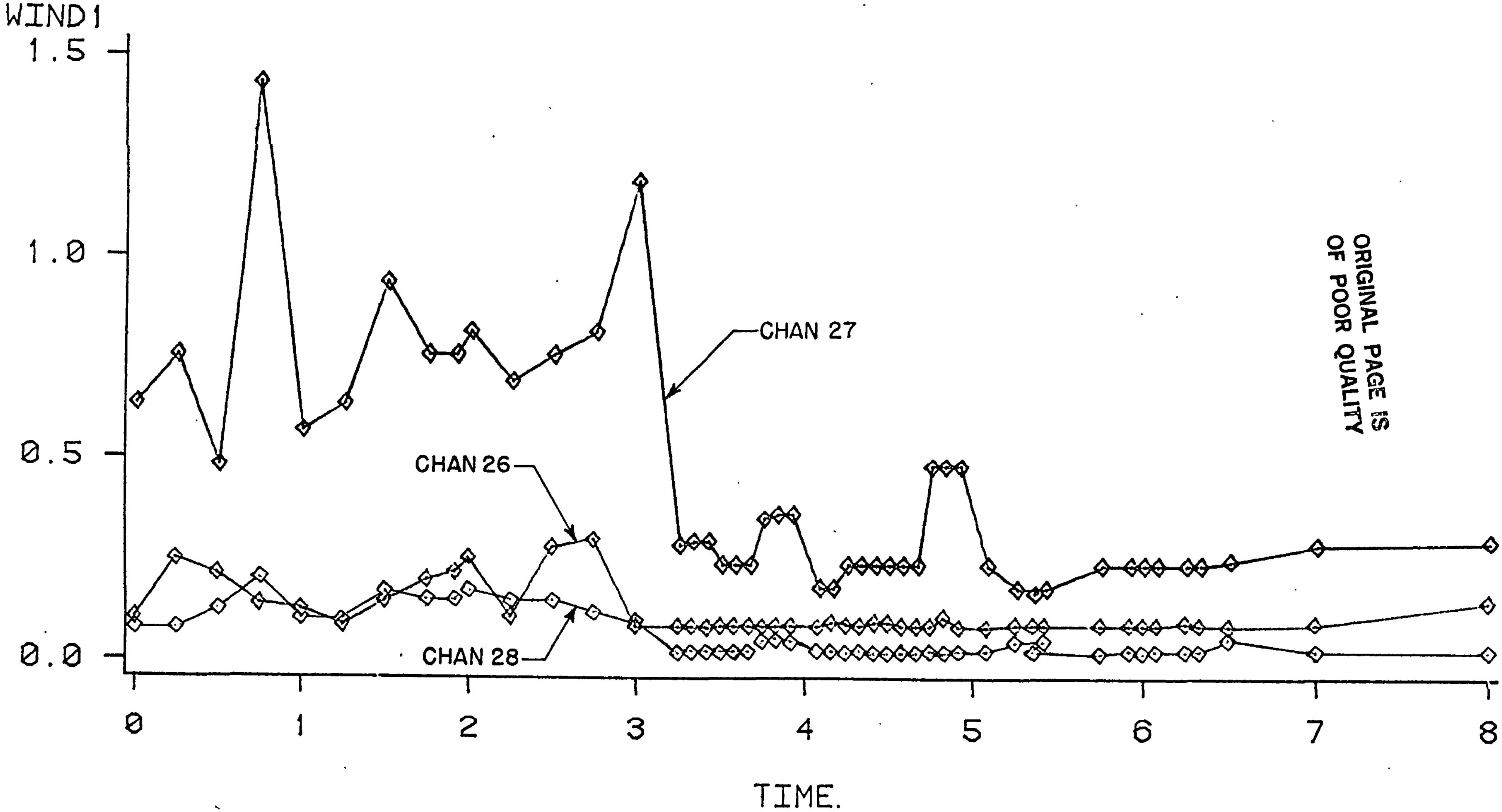
CHAN24=GREEN CHAN25=BLACK
TIME IS IN HOURS. TEMP. IN DEG C

FROST DATA

MAY 9, 1980--00:00-8:00A.M.

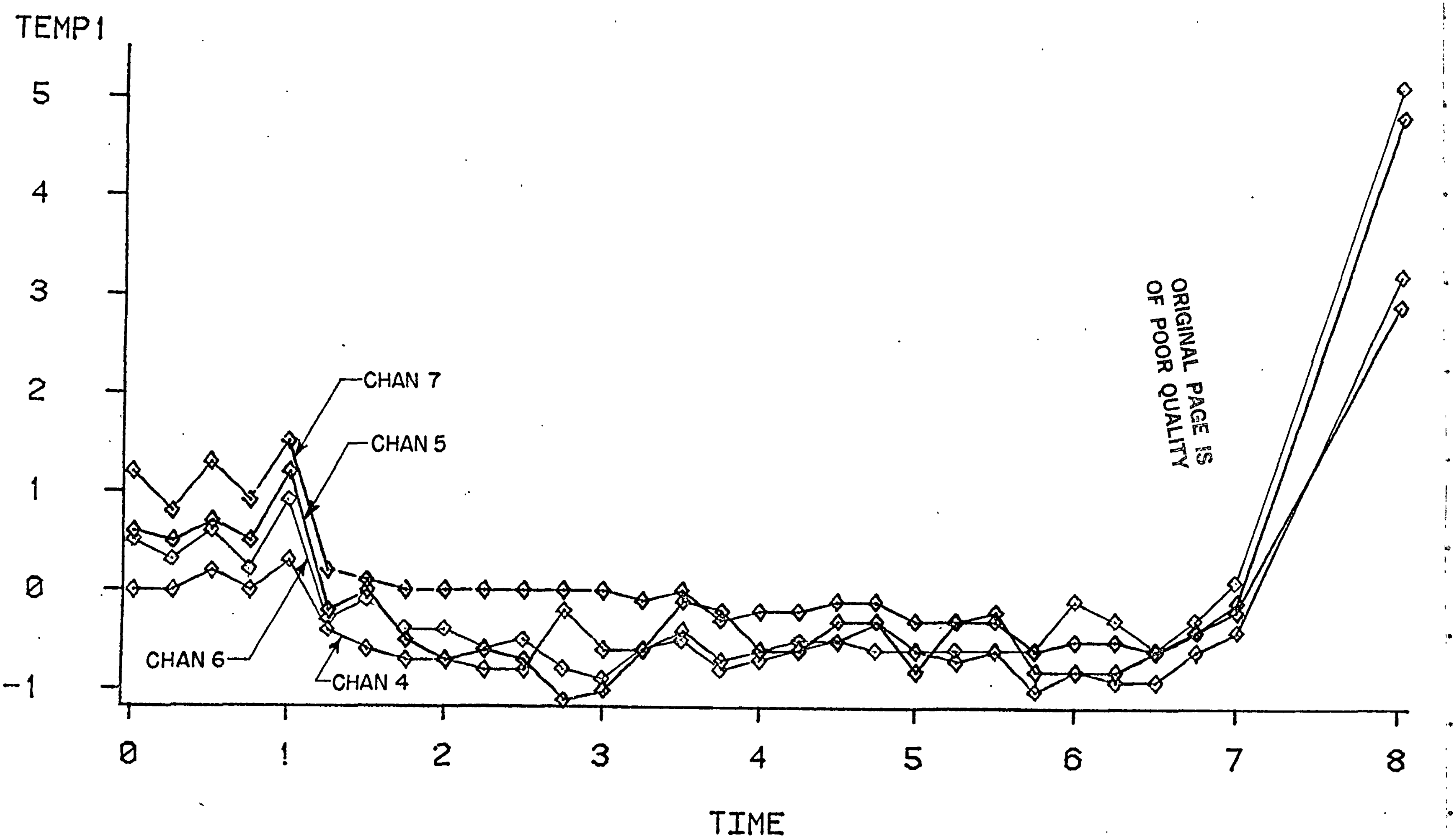


CHAN26=BLUE CHAN27=RED

TIME IS IN HOURS, WIND IN MPS

FROST DATA

MAY 10, 1980--00:00-8:00A.M.



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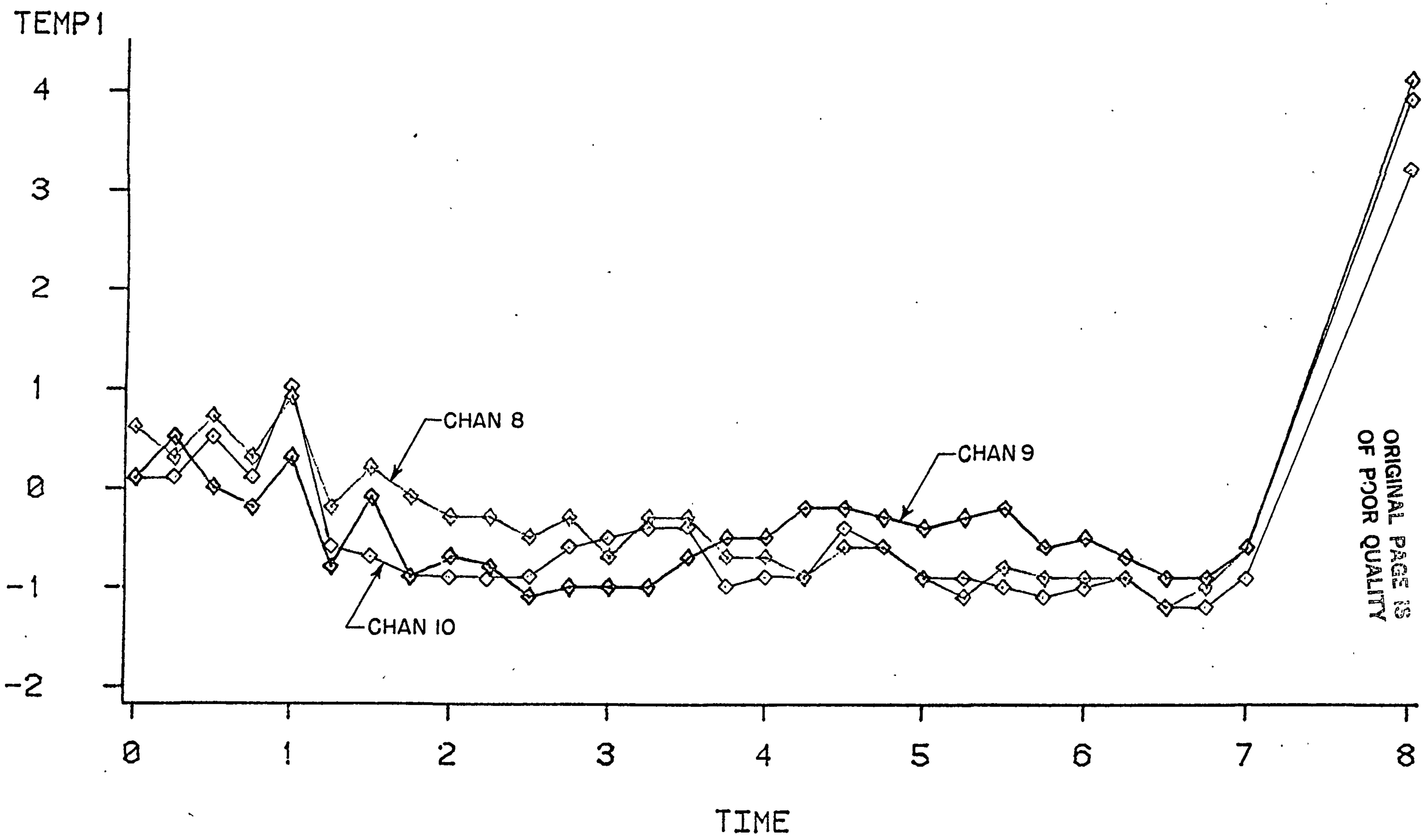
CHAN6=GREEN CHAN7=BLACK
TIME IS IN HOURS, TEMP. IN DEG C

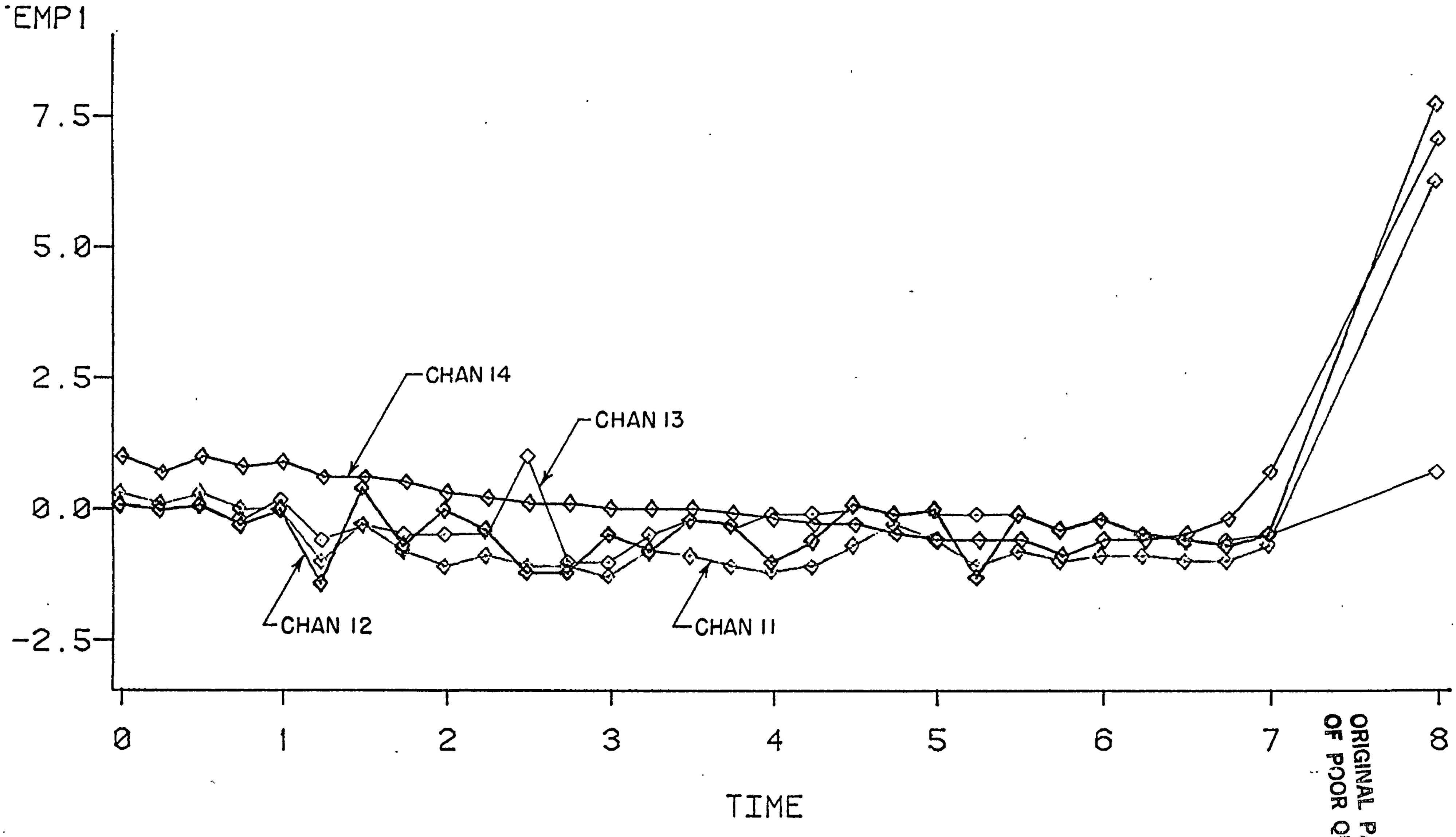


CHAN8=BLUE CHAN9=RED

TIME IS IN HOURS, TEMP. IN DEG C

FROST DATA

MAY 12, [illegible]



CHAN11=BLUE CHAN12=RED

[illegible] CHAN14=BLACK

TIME IS IN HOURS, TEMP. IN DEG C

FROST DATA

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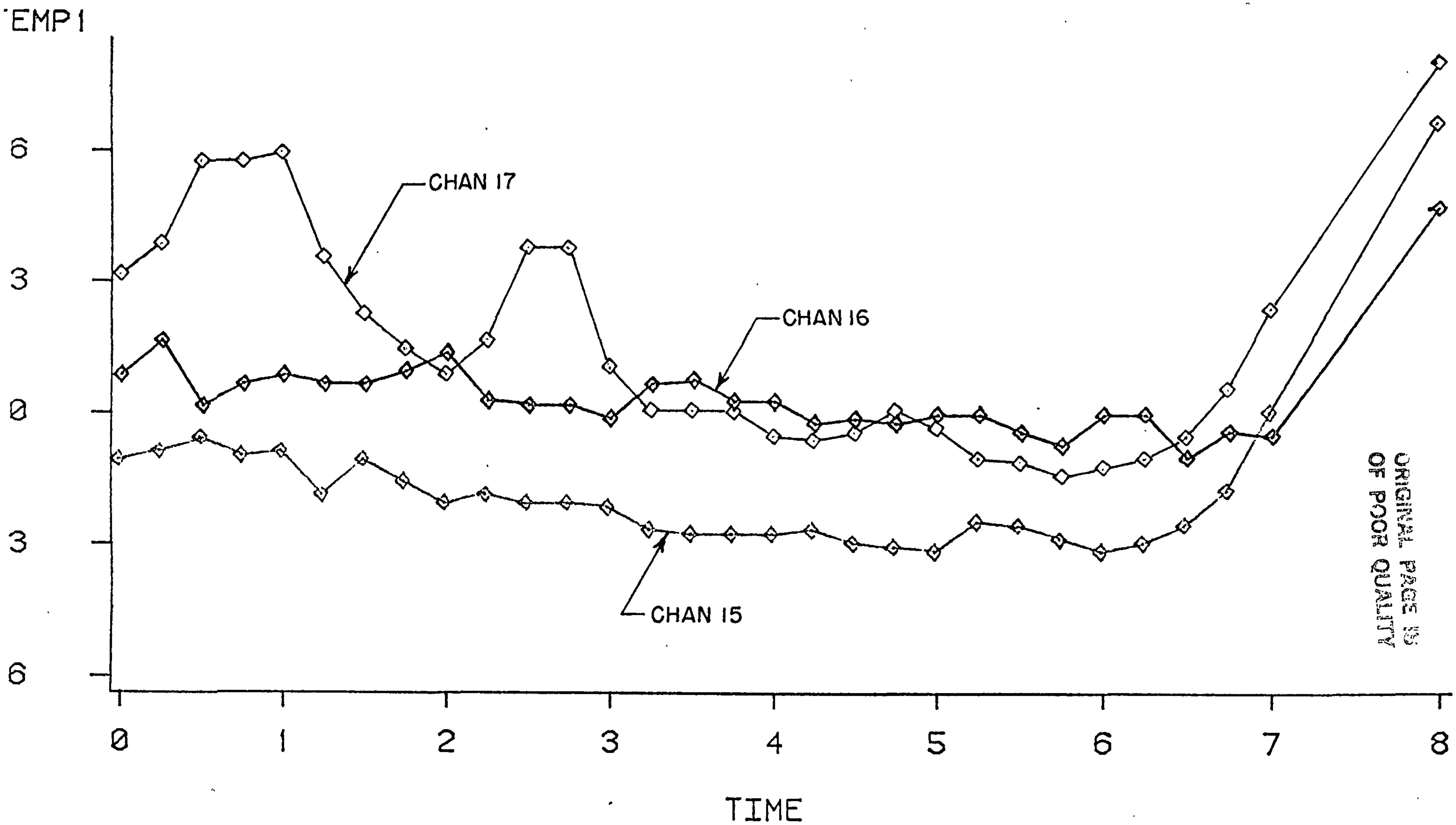

CHAN15=BLUE CHAN16=RED

[illegible]

TIME IS IN HOURS, TEMP. IN DEG C

FROST DATA

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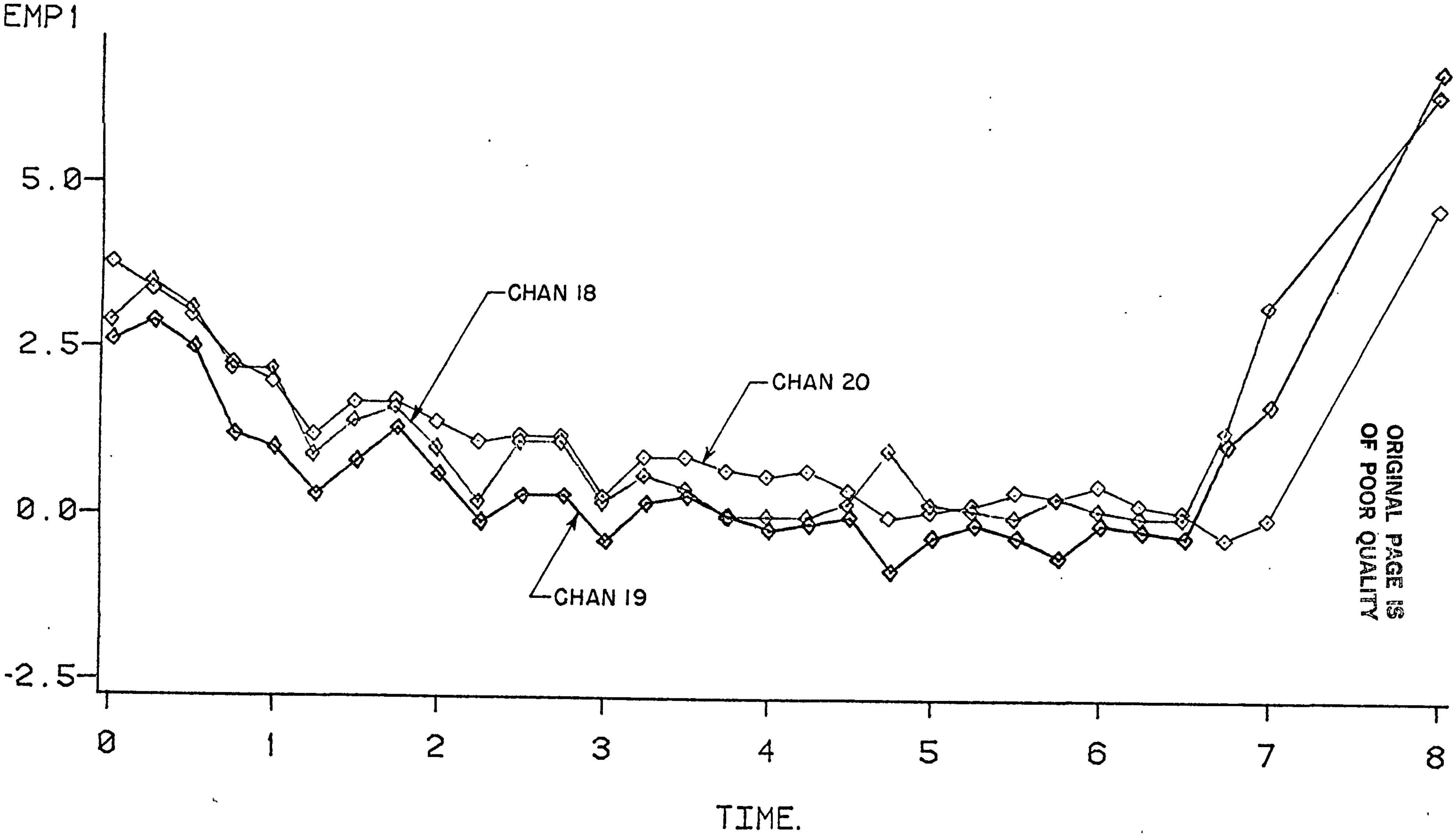

CHAN18=BLUE CHAN19=RED

TIME IS IN HOURS, TEMP. IN DEG C

FROST DATA

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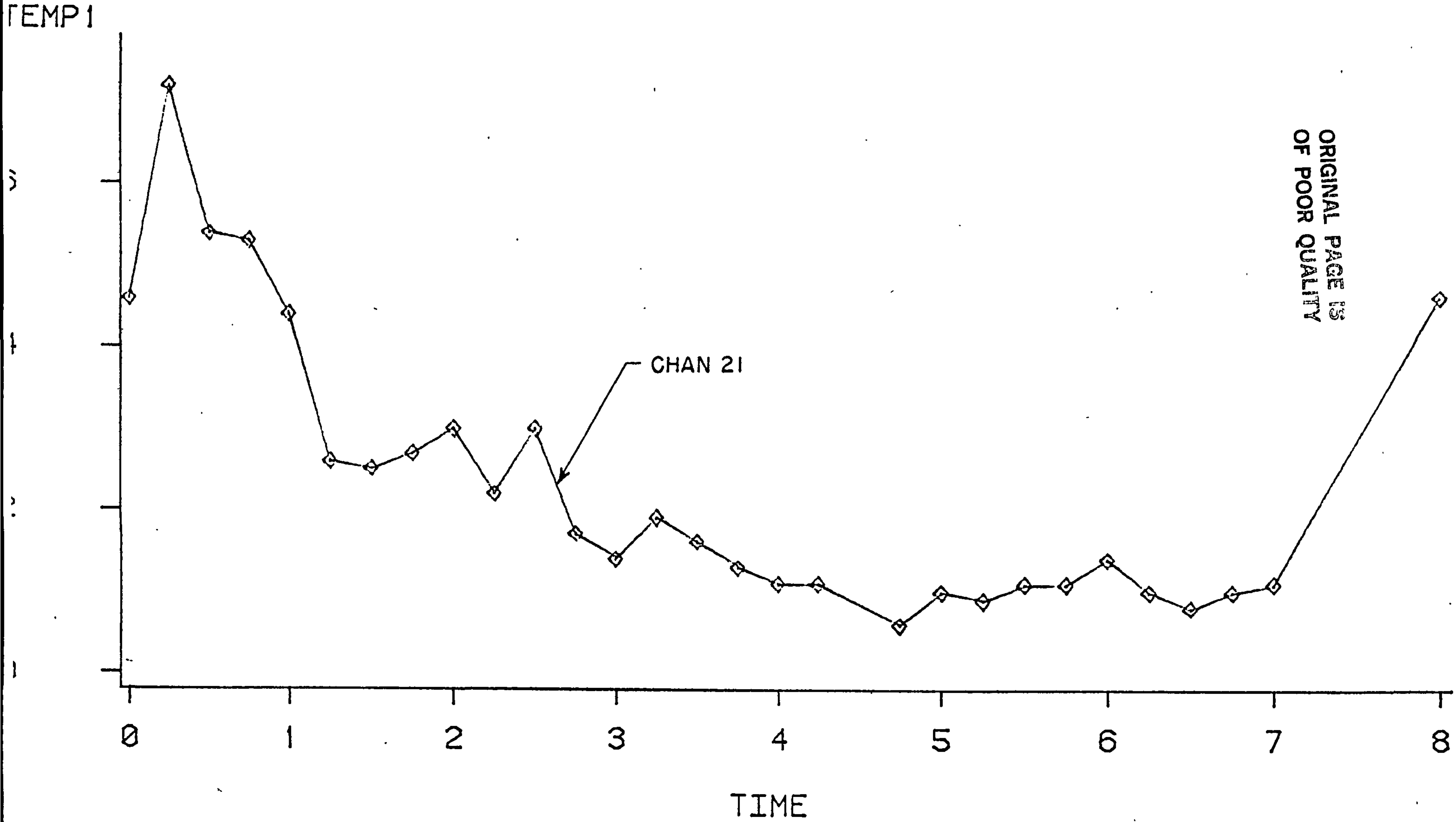

CHAN21=BLUE

TIME IS IN HOURS, TEMP. IN DEG C

FROST DATA

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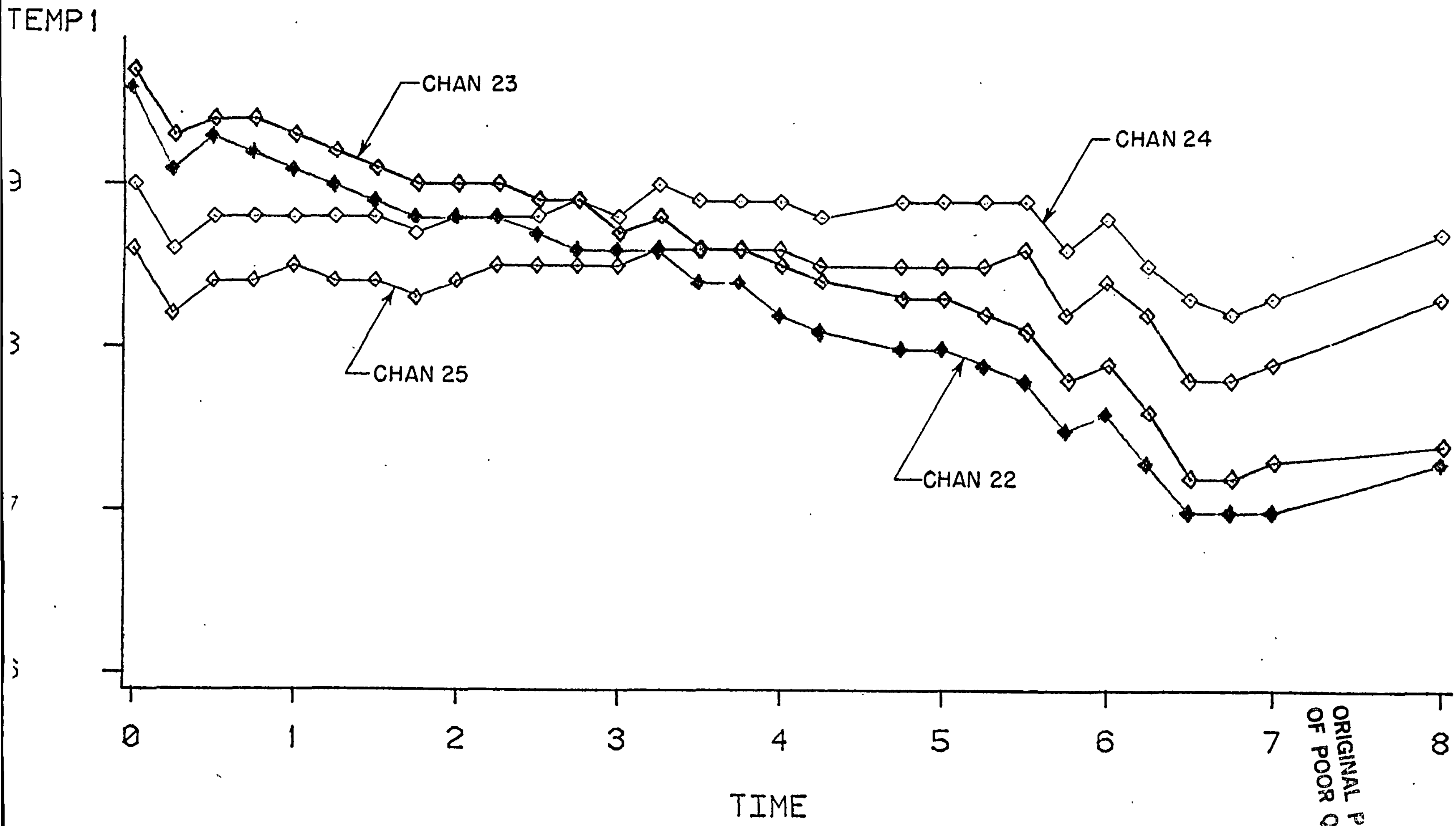


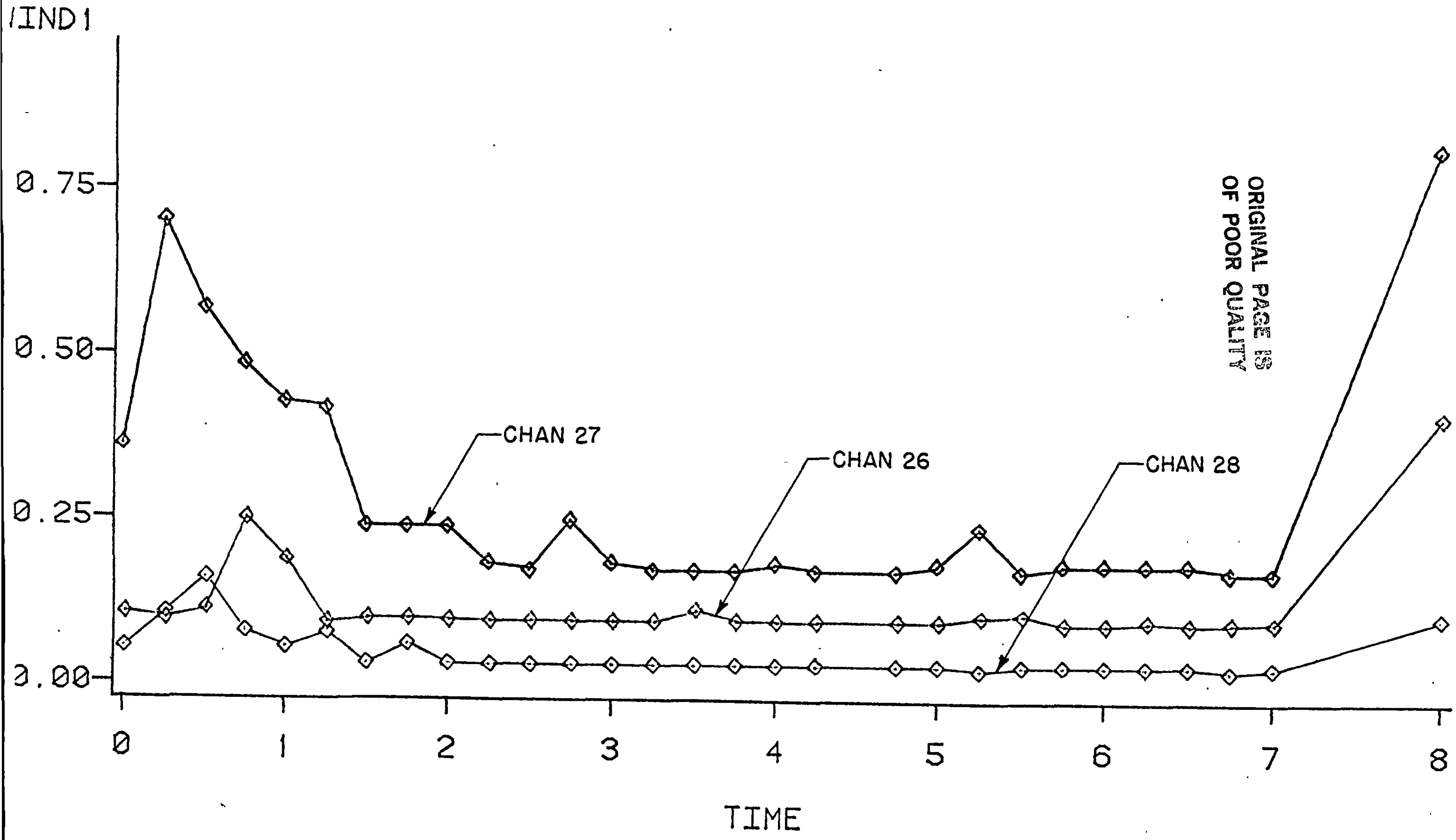
CHAN22=BLUE CHAN23=RED

CHAN24=GREEN CHAN25=BLACK

TIME IS IN HOURS, TEMP. IN DEG C

FROST DATA

MAY 18, 1980---22:28-8:22A.M.



CHAN26=BLUE CHAN27=RED

CHAN28=GREEN

TIME IS IN HOURS, WIND IN MPS

FROST DATA

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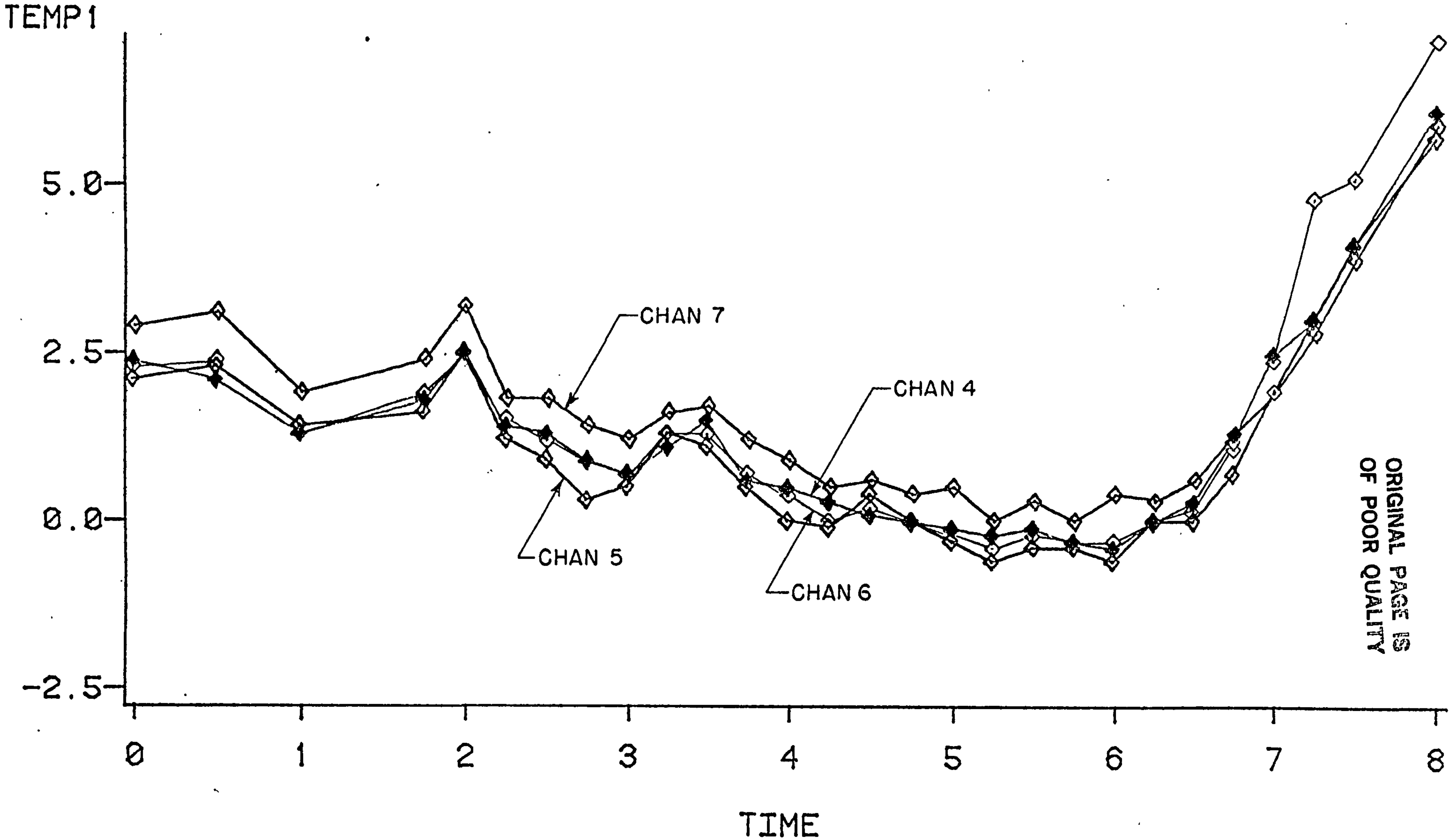
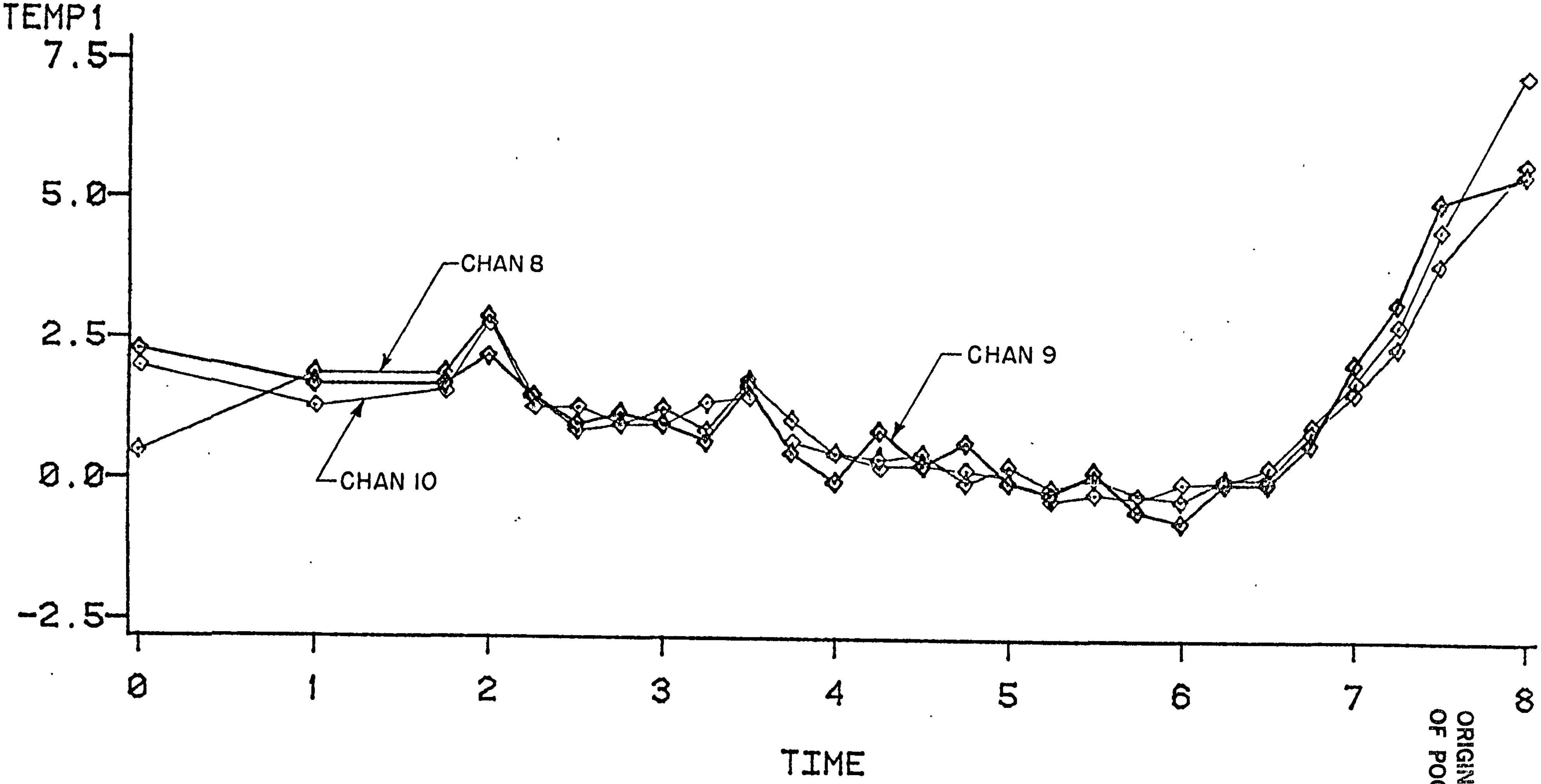


CHAN4=BLUE CHAN5=RED
CHAN6=GREEN CHAN7=BLACK
TIME IS IN HOURS, TEMP. IN DEG C

FROST DATA

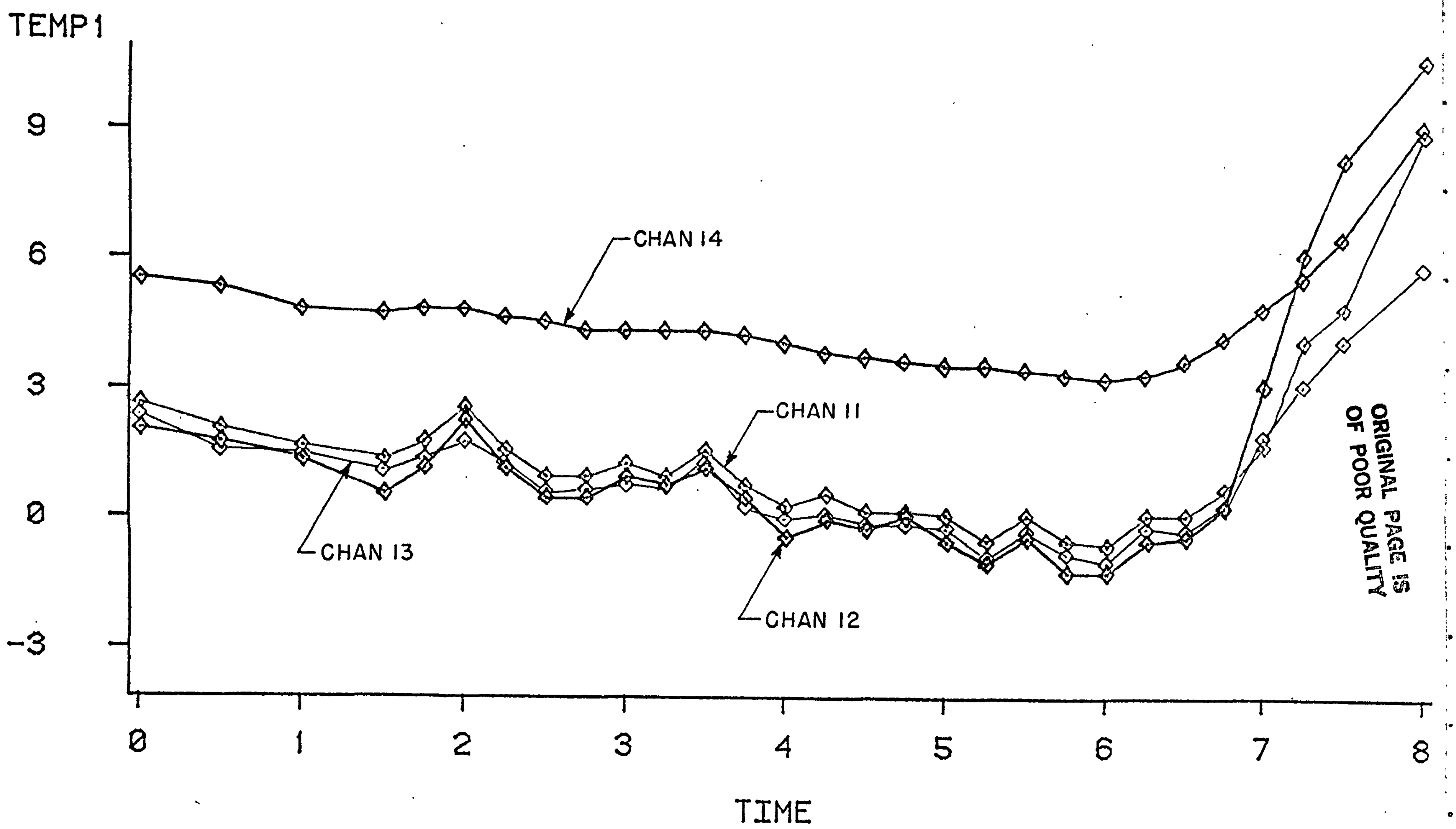
MAY 16, 1980--00:00-8:00A.M.



CHAN8=BLUE CHAN9=RED
CHAN10=GREEN
TIME IS IN HOURS, TEMP. IN DEG C

FROST DATA

MAY 16, 1980--00:00-8:00A.M.



CHAN11=BLUE CHAN12=RED
CHAN13=GREEN CHAN14=BLACK
TIME IS IN HOURS, TEMP. IN DEG C

FROST DATA

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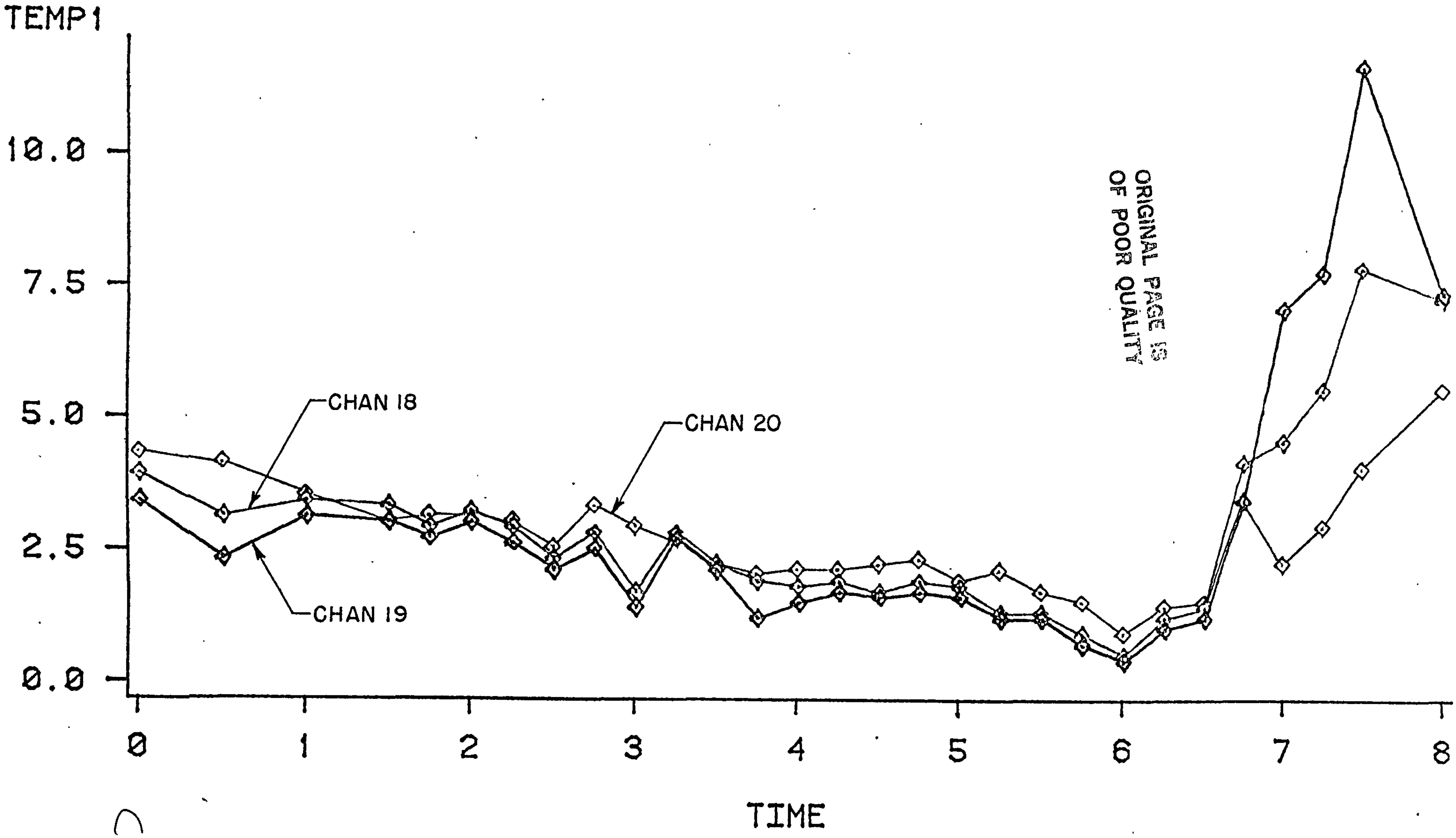

CHAN18=BLUE CHAN19=RED

CHAN20=GREEN

TIME IS IN HOURS, TEMP. IN DEG C

FROST DATA

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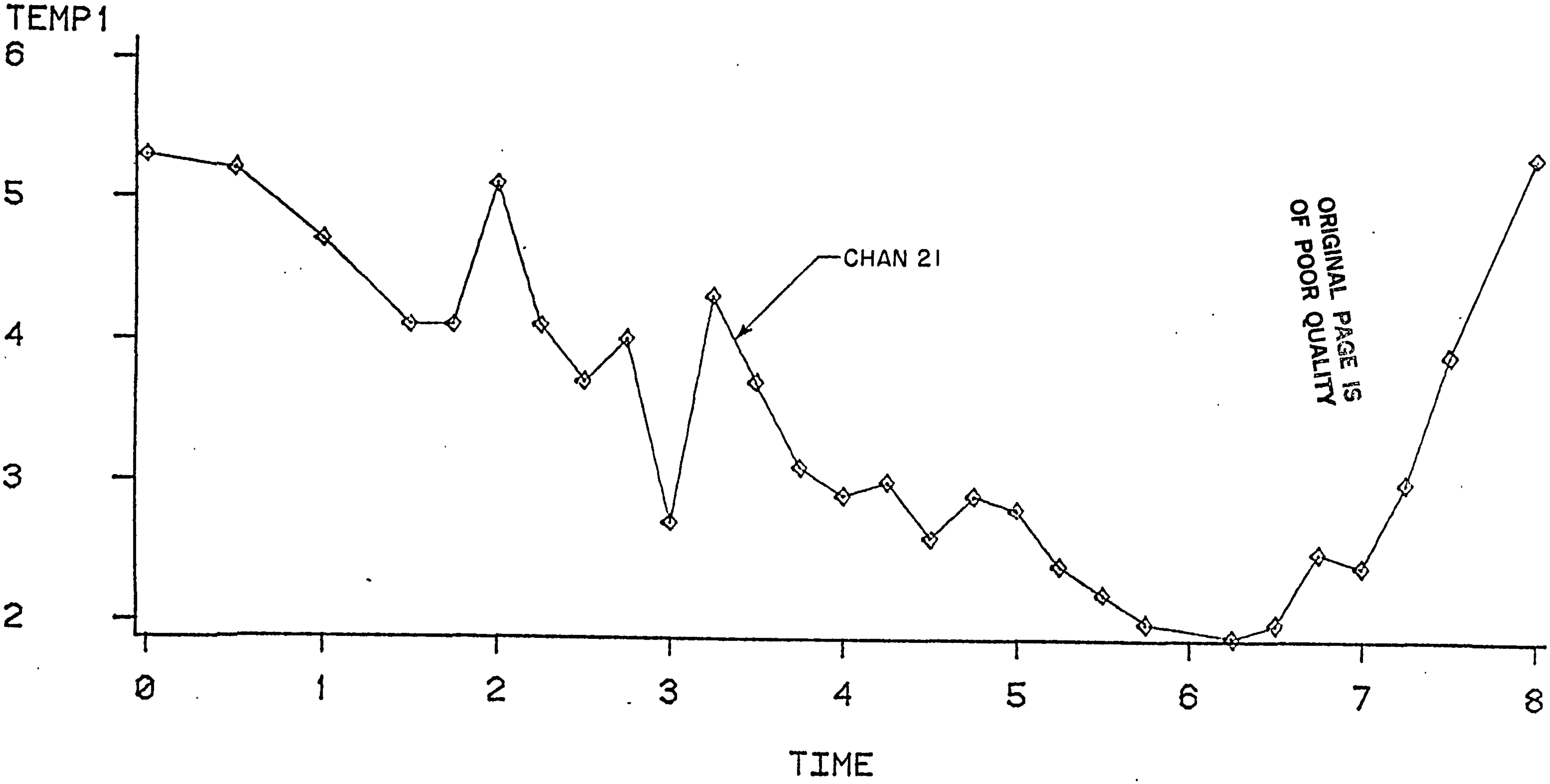

CHAN21

TIME IS IN HOURS, TEMP. IN DEG C

FROST DATA

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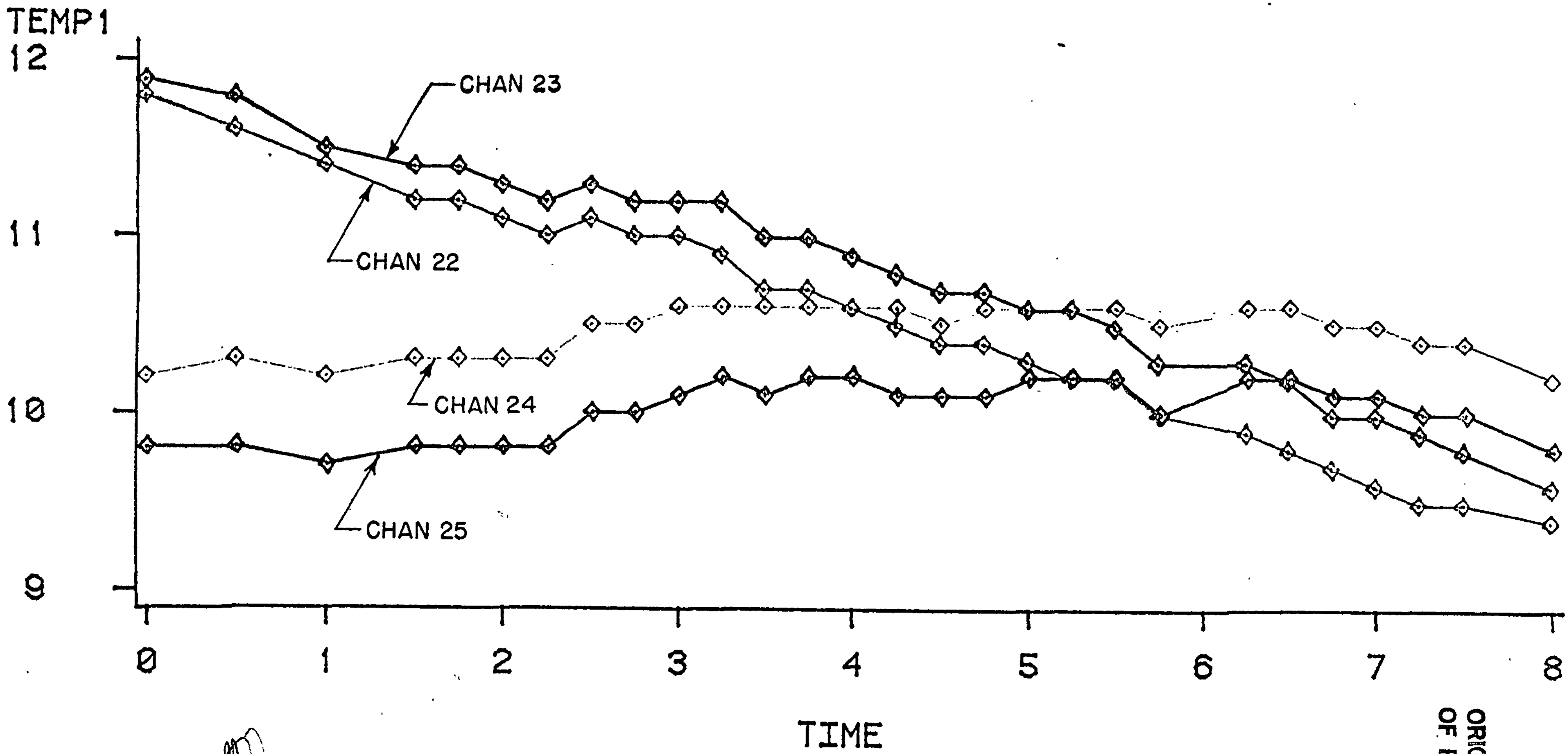

CHAN22=BLUE CHAN23=RED
CHAN24=GREEN CHAN25=BLACK
TIME IS IN HOURS, TEMP. IN DEG C

FROST DATA

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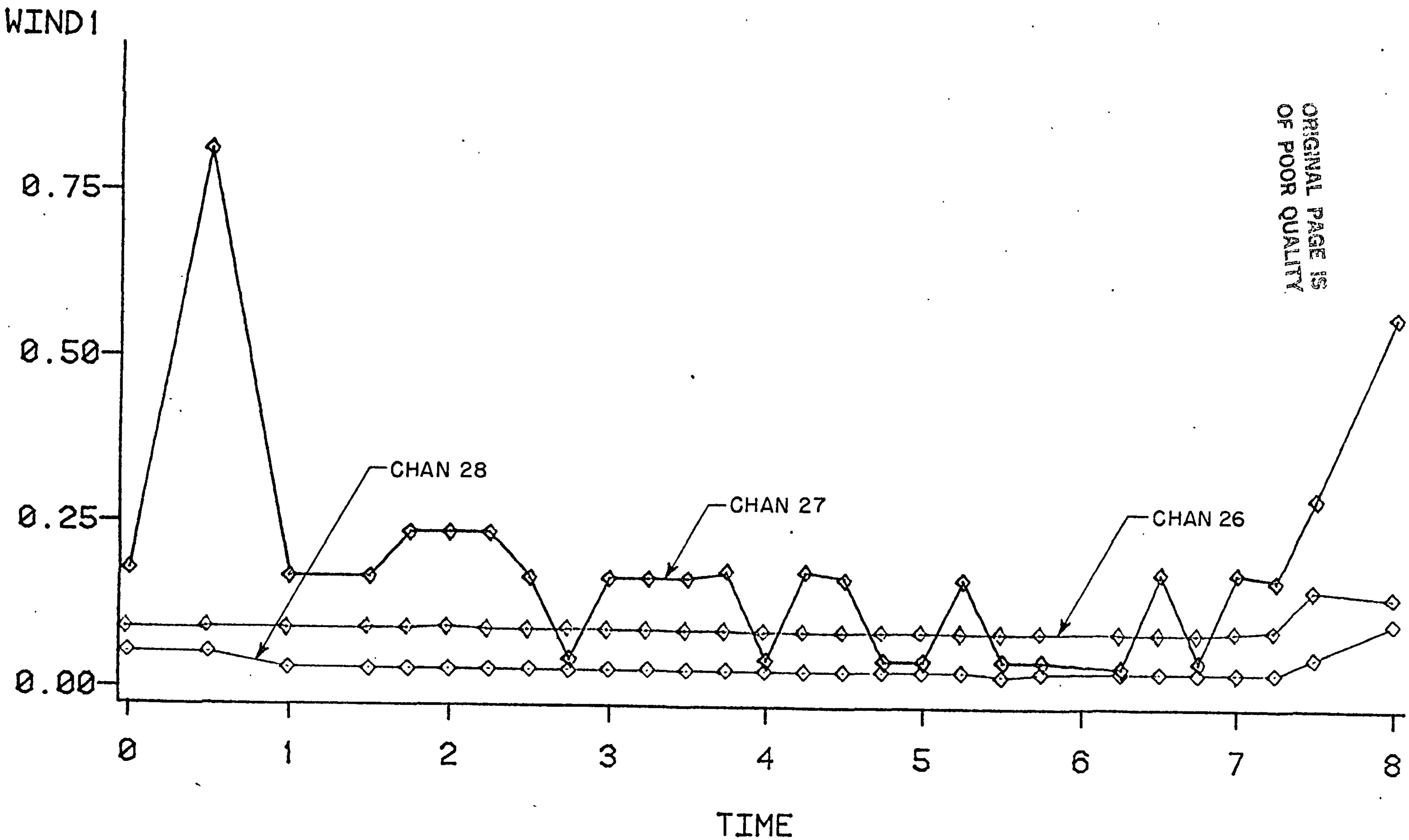

CHAN26=BLUE CHAN27=RED
CHAN28=GREEN

Appendix III

Tape Description for Pennsylvania Frost Data

TAPE DESCRIPTION

Tape name is FROST. FROST is a 9-track, no label tape, recorded at 800 bpi in ASCII.

FROST consists of 5 unlabeled files containing the following information:

File 1

Date: May 7 - June 30, 1980

Column:	1	2	3	4	5
	date	time	net radiometer	aspirator, North block	aspirator, South block

Note: On day 49 (June 18), the day was reset to 18.

File 2

Date: May 7 - June 6, 1980

Column:	1	2	3	4	5
	date	time	surface temp	tower ground level thermocouple	tower 1.5m aspirator

7	8	9
tower 5m thermocouple	tower 3m thermocouple	tower 3m aspirator

File 3

Date: May 7 - June 6, 1980

Column:	1	2	3	4	5
	date	time	tower 9m aspirator	trench 10cm thermocouple	trench 10cm thermocouple

6	7	8	9	10
trench 50cm thermocouple	trench 50cm thermocouple	wind speed	wind peak	wind average

File 4

Date: April 20- May 7, 1981

Column:	1	2	3	4	5
	date	time	aspirator North block	aspirator South block	surface temperature

6	7	8	9	10
tower 1.5m thermocouple	tower 1.5m aspirator	tower 3.0m aspirator	tower 5.0m thermocouple	tower 9.0m aspirator

Note: Files 4 and 5 contain data for the hours of 9:00 P.M. - 9:00 A.M. only.

File 5

Date: April 20 - May 7,1981

Column:	1	2	3	4	5
	date	time	10cm trench thermocouple	10cm trench thermocouple	50cm trench thermocouple

6	7	8	9
50cm trench thermocouple	wind speed	wind direction	wind average

Note: Column 7 - Wind speed was not working during this time.

Appendix IV

Dewpoint Temperatures for Pennsylvania Test Plots

Dew Point Temperatures for Pennsylvania Test Plots

Date	Time	Dew Point (°F)
May 8-9, 1980	0215	27
	0235	27
	0320	29
	0410	26
	0436	25
	0500	26
May 8-9, 1980	2350	33
	2355	31
	0115	29
	0150	28
	0308	27
	0322	27
	0400	26
	0443	29
	0450	30
	0525	30
	0600	28
	0617	27

Date	Time	Dew Point (°F)
May 9-10, 1980	0045	30
	0115	30
	0142	29
	0145	30
	0240	28
	0300	28
	0410	27
	0567	27
	0530	26
	0631	27
May 15-16, 1980	0100	35
	0151	35
	0202	34
	0248	32
	0305	32
	0305	33
	0334	32
	0353	32
	0410	31
	0414	30
	0420	31
	0425	31

Appendix V

Reduced Data for Pennsylvania Test Plot

ORIGINAL PAGE IS
OF POOR QUALITY

PENNSYLVANIA STATE COLD WEATHER DATA — MAY 7-8, 1980

TIME	SOIL	10CM SOIL	50CM SOIL	1.5M AIR	3.0M AIR	9.0M AIR	DEW POINT	WIND SPEED
18.0	53.4	54.7	49.8	53.4	53.8	54.0	27.0	2.8
19.0	52.5	54.5	49.8	53.1	53.1	53.2	27.0	4.2
20.0	48.9	54.1	50.0	50.7	50.7	51.4	27.0	2.3
21.0	47.8	53.6	50.0	48.7	48.7	49.6	27.0	.3
22.0	44.2	53.1	49.8	46.6	46.0	47.8	27.0	.6
23.0	39.4	52.7	50.0	43.7	44.1	46.8	27.0	.2
0.0	37.6	52.0	50.0	40.8	40.1	43.5	27.0	.2
1.0	35.8	51.3	49.6	39.4	38.8	43.5	27.0	.2
2.0	34.7	50.7	49.8	34.0	34.2	37.8	27.0	.1
3.0	34.0	50.2	49.8	33.3	34.0	36.9	27.0	.1
4.0	33.4	49.6	49.8	31.5	32.0	34.5	26.0	.1
5.0	32.0	48.9	49.6	30.4	29.7	32.9	26.0	.1
6.0	31.6	48.6	49.8	27.7	31.1	33.3	26.0	.1
7.0	34.2	47.7	49.6	32.0	38.3	34.7	26.0	.1

PENNSYLVANIA STATE COLD WEATHER DATA — MAY 8-9, 1980

TIME	SOIL	10CM SOIL	50CM SOIL	1.5M AIR	3.0M AIR	9.0M AIR	DEW POINT	WIND SPEED
18.0	52.0	53.4	48.4	48.0	49.6	47.8	33.0	4.9
19.0	49.1	52.5	48.6	45.3	45.7	45.7	33.0	.8
20.0	44.8	52.2	48.7	44.1	44.1	45.0	33.0	1.1
21.0	41.0	51.8	48.9	41.9	40.8	43.2	33.0	.4
22.0	37.4	51.3	48.9	37.4	38.7	40.8	33.0	.1
23.0	36.3	50.4	48.9	38.8	36.3	39.9	33.0	.1
0.0	35.1	49.5	48.6	37.4	36.9	38.5	31.0	.2
1.0	34.0	49.3	48.7	35.4	36.0	38.1	29.0	.2
2.0	33.1	48.4	48.7	34.7	35.2	37.6	28.0	.4
3.0	32.4	48.0	48.6	32.2	33.4	36.3	27.0	.2
4.0	30.4	46.8	47.8	31.5	30.9	33.4	26.0	.1
5.0	34.9	46.4	48.0	32.5	32.7	34.7	30.0	.1
6.0	32.0	45.9	47.8	32.2	31.3	33.8	30.0	.1
7.0	39.0	46.0	48.6	34.5	35.6	36.3	30.0	.1

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PENNSYLVANIA STATE COLD WEATHER DATA MAY 9-10, 1980

TIME	SOIL	10CM SOIL	50CM SOIL	1.5M AIR	3.0M AIR	9.0M AIR	DEW POINT	WIND SPEED
18.0	60.4	52.3	47.8	53.6	56.3	53.4	30.0	2.5
19.0	50.2	52.2	47.8	52.0	56.3	53.4	30.0	2.9
20.0	42.8	51.6	47.8	46.4	46.8	49.3	30.0	.9
21.0	37.9	51.1	47.8	37.2	43.7	47.8	30.0	.3
22.0	35.8	50.5	48.0	39.6	40.5	47.1	30.0	.2
23.0	35.1	49.8	48.2	38.7	38.8	43.9	30.0	.2
0.0	33.8	49.3	48.2	33.6	36.7	40.3	30.0	.1
1.0	33.6	48.4	47.8	33.6	33.8	39.9	30.0	.1
2.0	32.5	47.8	47.8	34.5	33.1	37.4	30.0	.1
3.0	32.0	47.5	47.8	31.8	31.3	34.5	28.0	.1
4.0	31.6	46.8	48.0	32.5	31.6	34.0	27.0	.1
5.0	30.9	46.4	48.0	32.0	31.5	33.8	27.0	.1
6.0	30.9	45.7	47.8	32.0	31.8	34.5	27.0	.1
7.0	33.3	44.6	46.9	31.1	35.1	34.0	27.0	.1

PENNSYLVANIA STATE COLD WEATHER DATA MAY 15-16, 1980

TIME	SOIL	10CM SOIL	50CM SOIL	1.5M AIR	3.0M AIR	9.0M AIR	DEW POINT	WIND SPEED
18.0	59.4	57.7	50.0	56.7	61.5	56.7	35.0	1.4
19.0	56.7	57.0	50.0	55.9	60.8	56.1	35.0	.4
20.0	51.8	56.7	50.4	51.4	51.4	53.6	35.0	.1
21.0	46.8	55.9	50.4	43.0	45.0	50.5	35.0	.1
22.0	44.6	55.0	50.4	43.0	45.0	50.5	35.0	.1
23.0	43.2	54.1	50.4	36.9	40.6	43.5	35.0	.1
0.0	42.0	53.2	50.4	35.6	38.1	41.5	35.0	.1
1.0	40.6	52.5	50.4	34.5	37.6	40.5	35.0	.1
2.0	40.6	52.0	50.5	38.1	37.4	41.2	34.0	.1
3.0	39.7	51.8	51.1	34.7	34.5	36.9	32.0	.1
4.0	39.2	51.1	51.1	33.6	34.7	37.2	32.0	.1
5.0	38.3	50.5	51.1	32.0	34.9	37.0	31.0	.1
6.0	37.8	49.8	51.1	33.3	32.7	35.4	31.0	.1
7.0	40.6	49.3	50.9	35.6	44.6	36.3	31.0	.1

Appendix VI

P-Model Analysis Results

Table 6.1 P-Model Error Analysis (Total)

P-MODEL ERROR ANALYSIS

PENNSYLVANIA STATE COLD WEATHER DATA

ALL NIGHTS - MAY 7-8, 8-9, 9-10, 15-16, 1980

POPULATION = 264
MEAN ERROR = .588
STND. DEV. = 4.117

Table 6.2 P-Model Analysis by Night

P-MODEL ANALYSIS BY NIGHT

ERROR ANALYSIS OF MAY 7-8, 1980

POPULATION = 66
MEAN ERROR = 3.333
STND. DEV. = 4.417

ERROR ANALYSIS OF MAY 8-9, 1980

POPULATION = 66
MEAN ERROR = -.712
STND. DEV. = 2.826

ERROR ANALYSIS OF MAY 9-10, 1980

POPULATION = 66
MEAN ERROR = -.288
STND. DEV. = 3.519

ERROR ANALYSIS OF MAY 15-16, 1980

POPULATION = 66
MEAN ERROR = .018
STND. DEV. = 4.270

Table 6.3 P-Model Analysis by Prediction Periods

P-MODEL ERROR ANALYSIS BY PREDICTION PERIODS

ERROR ANALYSIS OF 1-HOUR PREDICTIONS (FOUR NIGHTS)

POPULATION = 44
MEAN ERROR = -.300
STND. DEV. = 2.749

ERROR ANALYSIS OF 2-HOUR PREDICTIONS (FOUR NIGHTS)

POPULATION = 40
MEAN ERROR = -.250
STND. DEV. = 2.921

ERROR ANALYSIS OF 3-HOUR PREDICTIONS (FOUR NIGHTS)

POPULATION = 36
MEAN ERROR = -.020
STND. DEV. = 3.474

ERROR ANALYSIS OF 4-HOUR PREDICTIONS (FOUR NIGHTS)

POPULATION = 32
MEAN ERROR = .368
STND. DEV. = 3.950

ERROR ANALYSIS OF 5-HOUR PREDICTIONS (FOUR NIGHTS)

POPULATION = 28
MEAN ERROR = .682
STND. DEV. = 4.248

ERROR ANALYSIS OF 6-HOUR PREDICTIONS (FOUR NIGHTS)

POPULATION = 24
MEAN ERROR = .824
STND. DEV. = 4.449

ERROR ANALYSIS OF 7-HOUR PREDICTIONS (FOUR NIGHTS)

POPULATION = 20
MEAN ERROR = 1.447
STND. DEV. = 5.099

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Table 6.3 (Continued)

ERROR ANALYSIS OF 8-HOUR PREDICTIONS (FOUR NIGHTS)

POPULATION = 16
MEAN ERROR = 1.977
STND. DEV. = 5.495

ERROR ANALYSIS OF 9-HOUR PREDICTIONS (FOUR NIGHTS)

POPULATION = 12
MEAN ERROR = 2.179
STND. DEV. = 6.262

ERROR ANALYSIS OF 10-HOUR PREDICTIONS (FOUR NIGHTS)

POPULATION = 8
MEAN ERROR = 3.123
STND. DEV. = 6.170

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Table 6.4 P-Model Error Analysis

PMODL ERROR ANALYSIS FOR MAY 7-8, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE	**	**	**											
PRED	$$$$	$$$$	$$$$	49.4	48.2	47.2	46.2	45.3	44.4	43.5	42.8	42.0	41.3	40.7
OBS	53.3	53.0	50.6	48.7	46.5	43.6	40.7	39.3	33.9	33.2	31.4	30.3	27.6	31.9
ERR	$$$$	$$$$	$$$$	.7	1.7	3.5	5.4	5.9	10.5	10.4	11.4	11.7	13.7	8.7

MEAN OF ERRORS = 7.609
STD. DEV. OF ERRORS = 4.380

PMODL ERROR ANALYSIS FOR MAY 8-9, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE	**	**	**											
PRED	$$$$	$$$$	$$$$	42.5	41.2	40.0	38.9	37.9	37.0	36.2	35.4	34.7	34.0	33.4
OBS	47.9	45.2	44.0	41.8	37.3	38.8	37.3	35.3	34.6	32.1	31.4	32.5	32.1	34.4
ERR	$$$$	$$$$	$$$$	.6	3.8	1.2	1.6	2.6	2.4	4.1	4.0	2.2	1.9	-1.1

MEAN OF ERRORS = 2.126
STD. DEV. OF ERRORS = 1.555

PMODL ERROR ANALYSIS FOR MAY 9-10, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE	**	**	**											
PRED	$$$$	$$$$	$$$$	44.4	42.9	41.7	40.7	39.8	39.1	38.3	37.7	37.1	36.5	35.9
OBS	53.5	51.9	46.3	37.1	39.5	38.6	33.5	33.5	34.4	31.7	32.5	31.9	31.9	31.0
ERR	$$$$	$$$$	$$$$	7.2	3.4	3.1	7.2	6.3	4.6	6.6	5.2	5.1	4.6	4.9

MEAN OF ERRORS = 5.302
STD. DEV. OF ERRORS = 1.389

PMODL ERROR ANALYSIS FOR MAY 15-16, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE	**	**	**											
PRED	$$$$	$$$$	$$$$	49.5	47.9	46.5	45.3	44.2	43.2	42.4	41.6	40.9	40.3	39.7
OBS	56.6	55.9	51.4	42.9	42.9	36.8	35.5	34.4	38.0	34.6	33.5	31.9	33.2	35.5
ERR	$$$$	$$$$	$$$$	6.5	5.0	9.7	9.7	9.8	5.2	7.8	8.1	9.0	7.1	4.2

MEAN OF ERRORS = 7.457
STD. DEV. OF ERRORS = 2.036

PMODL ERROR ANALYSIS FOR MAY 7-8, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE		**	**	**										
PRED	$$$$	$$$$	$$$$	$$$$	47.0	45.7	44.5	43.4	42.5	41.7	40.9	40.2	39.6	39.1
OBS	53.3	53.0	50.6	48.7	46.5	43.6	40.7	39.3	33.9	33.2	31.4	30.3	27.6	31.9
ERR	$$$$	$$$$	$$$$	$$$$	.5	[illegible]	3.7	4.1	8.6	8.5	9.5	9.9	12.0	7.1

MEAN OF ERRORS = 6.603
STD. DEV. OF ERRORS = 3.788

PMODL ERROR ANALYSIS FOR MAY 8-9, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE		**	**	**										
PRED	$$$$	$$$$	$$$$	$$$$	40.3	38.9	37.7	36.6	35.6	34.6	33.7	32.9	32.1	31.4
OBS	47.9	45.2	44.0	41.8	37.3	38.8	37.3	35.3	34.6	32.1	31.4	32.5	32.1	34.4
ERR	$$$$	$$$$	$$$$	$$$$	2.9	.2	.4	1.3	1.0	2.5	2.4	.4	.0	-3.0

MEAN OF ERRORS = .809
STD. DEV. OF ERRORS = 1.702

PMODL ERROR ANALYSIS FOR MAY 9-10, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE		**	**	**										
PRED	$$$$	$$$$	$$$$	$$$$	34.9	33.5	32.4	31.6	30.9	30.3	29.9	29.4	29.0	28.7
OBS	53.5	51.9	46.3	37.1	39.5	38.6	33.5	33.5	34.4	31.7	32.5	31.9	31.9	31.0
ERR	$$$$	$$$$	$$$$	$$$$	-4.6	-5.1	-1.1	-2.0	-3.6	-1.4	-2.6	-2.5	-2.9	-2.3

MEAN OF ERRORS = -2.810
STD. DEV. OF ERRORS = 1.278

PMODL ERROR ANALYSIS FOR MAY 15-16, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE		**	**	**										
PRED	$$$$	$$$$	$$$$	$$$$	40.2	38.2	36.7	35.5	34.6	33.8	33.1	32.5	32.0	31.5
OBS	56.6	55.9	51.4	42.9	42.9	36.8	35.5	34.4	38.0	34.6	33.5	31.9	33.2	35.5
ERR	$$$$	$$$$	$$$$	$$$$	-2.8	1.4	1.2	1.1	-3.5	-.9	-.5	.5	-1.2	-4.0

MEAN OF ERRORS = -.864
STD. DEV. OF ERRORS = 2.000

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PMODL ERROR ANALYSIS FOR MAY 7-8, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE			**	**	**									
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	44.7	43.2	41.8	40.6	39.4	38.4	37.4	36.6	35.7
OBS	53.3	53.0	50.6	48.7	46.5	43.6	40.7	39.3	33.9	33.2	31.4	30.3	27.6	31.9
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	1.0	2.4	2.5	6.7	6.2	7.0	7.1	9.0	3.8

MEAN OF ERRORS = 5.086
STD. DEV. OF ERRORS = 2.703

PMODL ERROR ANALYSIS FOR MAY 8-9, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE			**	**	**									
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	35.1	33.3	31.8	30.6	29.5	28.5	27.9	27.7	27.6
OBS	47.9	45.2	44.0	41.8	37.3	38.8	37.3	35.3	34.6	32.1	31.4	32.5	32.1	34.4
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	-3.7	-4.0	-3.5	-4.0	-2.6	-2.9	-4.6	-4.4	-6.9

MEAN OF ERRORS = -4.066
STD. DEV. OF ERRORS = 1.234

PMODL ERROR ANALYSIS FOR MAY 9-10, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE			**	**	**									
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	37.1	35.2	33.6	32.2	31.0	30.0	29.1	28.3	27.5
OBS	53.5	51.9	46.3	37.1	39.5	38.6	33.5	33.5	34.4	31.7	32.5	31.9	31.9	31.0
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	-1.5	1.7	.1	-2.2	-.7	-2.5	-2.8	-3.7	-3.5

MEAN OF ERRORS = -1.684
STD. DEV. OF ERRORS = 1.752

PMODL ERROR ANALYSIS FOR MAY 15-16, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE			**	**	**									
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	40.5	38.7	37.3	36.1	35.1	34.2	33.5	32.8	32.2
OBS	56.6	55.9	51.4	42.9	42.9	36.8	35.5	34.4	38.0	34.6	33.5	31.9	33.2	35.5
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	3.7	3.2	2.8	-2.0	.5	.7	1.6	-.4	-3.3

MEAN OF ERRORS = .754
STD. DEV. OF ERRORS = 2.364

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PMODL ERROR ANALYSIS FOR MAY 7-8, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE				**	**	**								
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	41.5	39.7	38.2	36.8	35.5	34.3	33.3	32.3
OBS	53.3	53.0	50.6	48.7	46.5	43.6	40.7	39.3	33.9	33.2	31.4	30.3	27.6	31.9
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	.7	.4	4.3	3.6	4.1	4.0	5.7	.4

MEAN OF ERRORS = 2.897
STD. DEV. OF ERRORS = 2.070

PMODL ERROR ANALYSIS FOR MAY 8-9, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE				**	**	**								
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	37.2	36.1	35.0	33.9	33.0	32.1	31.3	30.5
OBS	47.9	45.2	44.0	41.8	37.3	38.8	37.3	35.3	34.6	32.1	31.4	32.5	32.1	34.4
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	-.1	.7	.3	1.8	1.6	-.4	-.8	-3.9

MEAN OF ERRORS = -.093
STD. DEV. OF ERRORS = 1.804

PMODL ERROR ANALYSIS FOR MAY 9-10, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE				**	**	**								
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	37.8	37.2	36.7	36.2	35.7	35.2	34.8	34.3
OBS	53.5	51.9	46.3	37.1	39.5	38.6	33.5	33.5	34.4	31.7	32.5	31.9	31.9	31.0
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	4.2	3.7	2.3	4.5	3.2	3.3	2.8	3.3

MEAN OF ERRORS = 3.416
STD. DEV. OF ERRORS = .713

PMODL ERROR ANALYSIS FOR MAY 15-16, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE				**	**	**								
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	34.7	33.2	32.0	31.1	30.6	30.2	30.0	29.8
OBS	56.6	55.9	51.4	42.9	42.9	36.8	35.5	34.4	38.0	34.6	33.5	31.9	33.2	35.5
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	-.8	-1.2	-6.1	-3.5	-2.9	-1.7	-3.2	-5.7

MEAN OF ERRORS = -3.140
STD. DEV. OF ERRORS = 1.954

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PMODL ERROR ANALYSIS FOR MAY 7-8, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE					**	**	**							
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	38.4	36.6	35.1	33.7	32.5	31.4	30.4
OBS	53.3	53.0	50.6	48.7	46.5	43.6	40.7	39.3	33.9	33.2	31.4	30.3	27.6	31.9
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	-.9	2.7	1.9	2.3	2.2	3.8	-1.5

MEAN OF ERRORS = 1.505
STD. DEV. OF ERRORS = 1.951

PMODL ERROR ANALYSIS FOR MAY 8-9, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE					**	**	**							
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	36.4	35.8	35.3	34.7	34.1	33.6	33.1
OBS	47.9	45.2	44.0	41.8	37.3	38.8	37.3	35.3	34.6	32.1	31.4	32.5	32.1	34.4
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	1.1	1.2	3.2	3.3	1.7	1.5	-1.4

MEAN OF ERRORS = 1.509
STD. DEV. OF ERRORS = 1.553

PMODL ERROR ANALYSIS FOR MAY 9-10, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE					**	**	**							
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	31.6	30.2	29.1	28.1	27.2	26.4	25.8
OBS	53.5	51.9	46.3	37.1	39.5	38.6	33.5	33.5	34.4	31.7	32.5	31.9	31.9	31.0
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	-2.0	-4.2	-2.7	-4.4	-4.7	-5.5	-5.2

MEAN OF ERRORS = -4.111
STD. DEV. OF ERRORS = 1.314

PMODL ERROR ANALYSIS FOR MAY 15-16, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE					**	**	**							
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	33.3	31.7	30.7	30.0	29.6	29.4	29.2
OBS	56.6	55.9	51.4	42.9	42.9	36.8	35.5	34.4	38.0	34.6	33.5	31.9	33.2	35.5
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	-1.1	-6.3	-4.0	-3.5	-2.3	-3.8	-6.3

MEAN OF ERRORS = -3.901
STD. DEV. OF ERRORS = 1.918

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PMODL ERROR ANALYSIS FOR MAY 7-8, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE						**	**	**						
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	37.3	35.8	34.5	33.3	32.2	31.2
OBS	53.3	53.0	50.6	48.7	46.5	43.6	40.7	39.3	33.9	33.2	31.4	30.3	27.6	31.9
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	3.4	2.6	3.1	3.0	4.6	-.7

MEAN OF ERRORS = 2.664
STD. DEV. OF ERRORS = 1.791

PMODL ERROR ANALYSIS FOR MAY 8-9, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE						**	**	**						
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	33.7	32.5	31.5	30.5	29.6	28.8
OBS	47.9	45.2	44.0	41.8	37.3	38.8	37.3	35.3	34.6	32.1	31.4	32.5	32.1	34.4
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	-.9	.4	.1	-2.0	-2.5	-5.6

MEAN OF ERRORS = -1.753
STD. DEV. OF ERRORS = 2.199

PMODL ERROR ANALYSIS FOR MAY 15-16, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE						**	**	**						
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	33.3	32.7	32.2	31.8	31.5	31.3
OBS	56.6	55.9	51.4	42.9	42.9	36.8	35.5	34.4	38.0	34.6	33.5	31.9	33.2	35.5
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	-4.7	-2.0	-1.4	-.1	-1.7	-4.3

MEAN OF ERRORS = -2.353
STD. DEV. OF ERRORS = 1.789

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PMODL ERROR ANALYSIS FOR MAY 7-8, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE							**	**	**					
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	31.6	30.1	28.8	27.7	26.8
OBS	53.3	53.0	50.6	48.7	46.5	43.6	40.7	39.3	33.9	33.2	31.4	30.3	27.6	31.9
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	-1.6	-1.3	-1.5	.1	-5.2

MEAN OF ERRORS = -1.895
STD. DEV. OF ERRORS = 1.951

PMODL ERROR ANALYSIS FOR MAY 8-9, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE							**	**	**					
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	33.1	32.1	31.2	30.3	29.6
OBS	47.9	45.2	44.0	41.8	37.3	38.8	37.3	35.3	34.6	32.1	31.4	32.5	32.1	34.4
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	1.0	.7	-1.3	-1.8	-4.9

MEAN OF ERRORS = -1.228
STD. DEV. OF ERRORS = 2.381

PMODL ERROR ANALYSIS FOR MAY 9-10, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE							**	**	**					
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	33.5	33.0	32.5	32.0	31.5
OBS	53.5	51.9	46.3	37.1	39.5	38.6	33.5	33.5	34.4	31.7	32.5	31.9	31.9	31.0
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	1.8	.5	.5	.0	.4

MEAN OF ERRORS = .655
STD. DEV. OF ERRORS = .653

PMODL ERROR ANALYSIS FOR MAY 15-16, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE							**	**	**					
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	37.1	36.6	36.1	35.6	35.3
OBS	56.6	55.9	51.4	42.9	42.9	36.8	35.5	34.4	38.0	34.6	33.5	31.9	33.2	35.5
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	2.5	3.0	4.2	2.4	-.3

MEAN OF ERRORS = 2.372
STD. DEV. OF ERRORS = 1.632

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PHODL ERROR ANALYSIS FOR MAY 7-8, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE								**	**	**				
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	31.0	29.6	28.5	27.5
OBS	53.3	53.0	50.6	48.7	46.5	43.6	40.7	39.3	33.9	33.2	31.4	30.3	27.6	31.9
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	-.3	-.7	.8	-4.5

MEAN OF ERRORS = -1.161
STD. DEV. OF ERRORS = 2.304

PHODL ERROR ANALYSIS FOR MAY 8-9, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE								**	**	**				
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	30.5	29.4	28.5	27.7
OBS	47.9	45.2	44.0	41.8	37.3	38.8	37.3	35.3	34.6	32.1	31.4	32.5	32.1	34.4
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	-.9	-3.0	-3.6	-6.8

MEAN OF ERRORS = -3.580
STD. DEV. OF ERRORS = 2.430

PHODL ERROR ANALYSIS FOR MAY 9-10, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE								**	**	**				
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	30.6	29.9	29.2	28.6
OBS	53.5	51.9	46.3	37.1	39.5	38.6	33.5	33.5	34.4	31.7	32.5	31.9	31.9	31.0
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	-1.9	-2.1	-2.7	-2.4

MEAN OF ERRORS = -2.265
STD. DEV. OF ERRORS = .361

PHODL ERROR ANALYSIS FOR MAY 15-16, 1980

HOUR	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
BASE								**	**	**				
PRED	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	33.7	33.1	32.6	32.2
OBS	56.6	55.9	51.4	42.9	42.9	36.8	35.5	34.4	38.0	34.6	33.5	31.9	33.2	35.5
ERR	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	$$$$	.1	1.2	-.6	-3.4

MEAN OF ERRORS = -.655
STD. DEV. OF ERRORS = 1.951

Figure 6.1.1

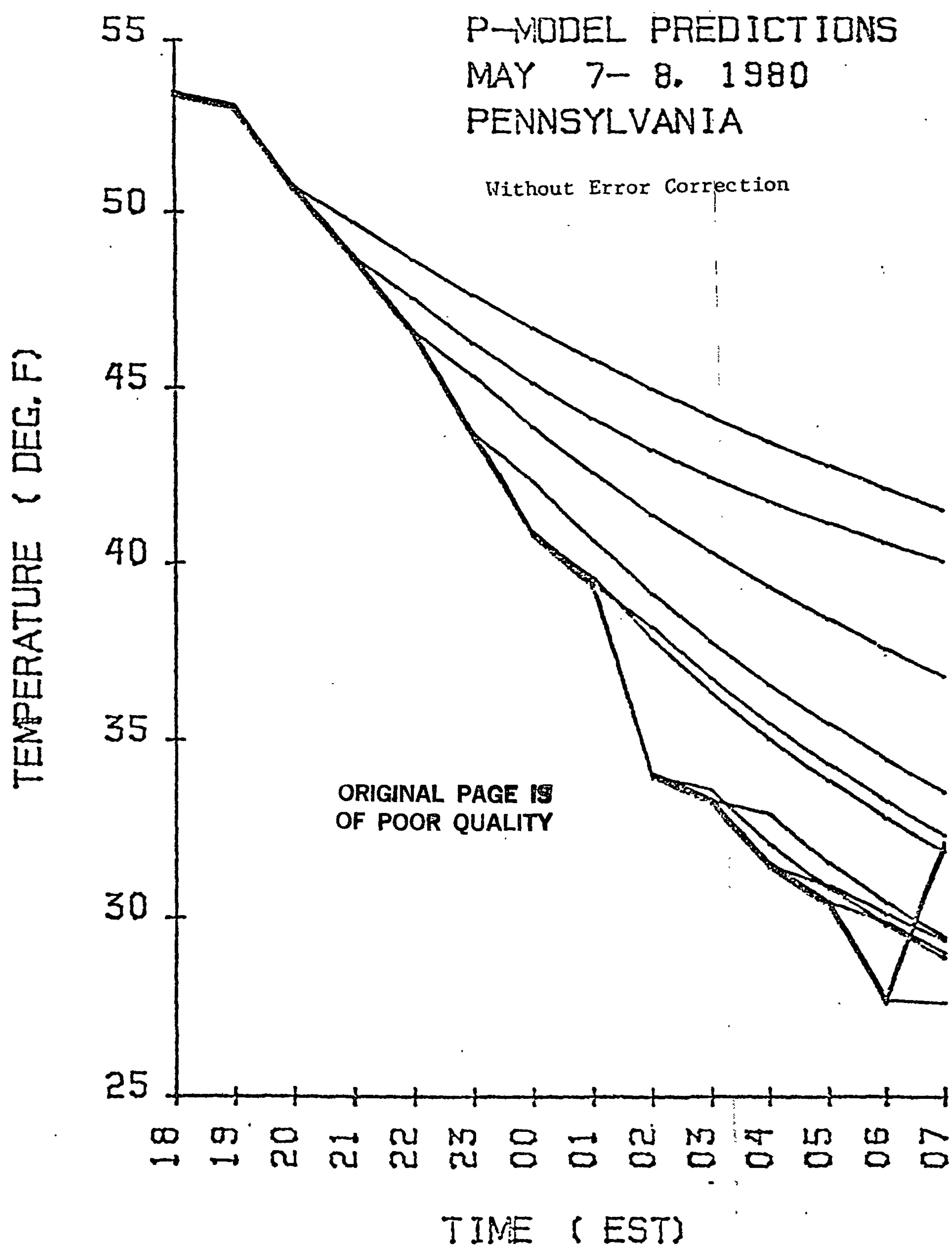

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Figure 6.1.2

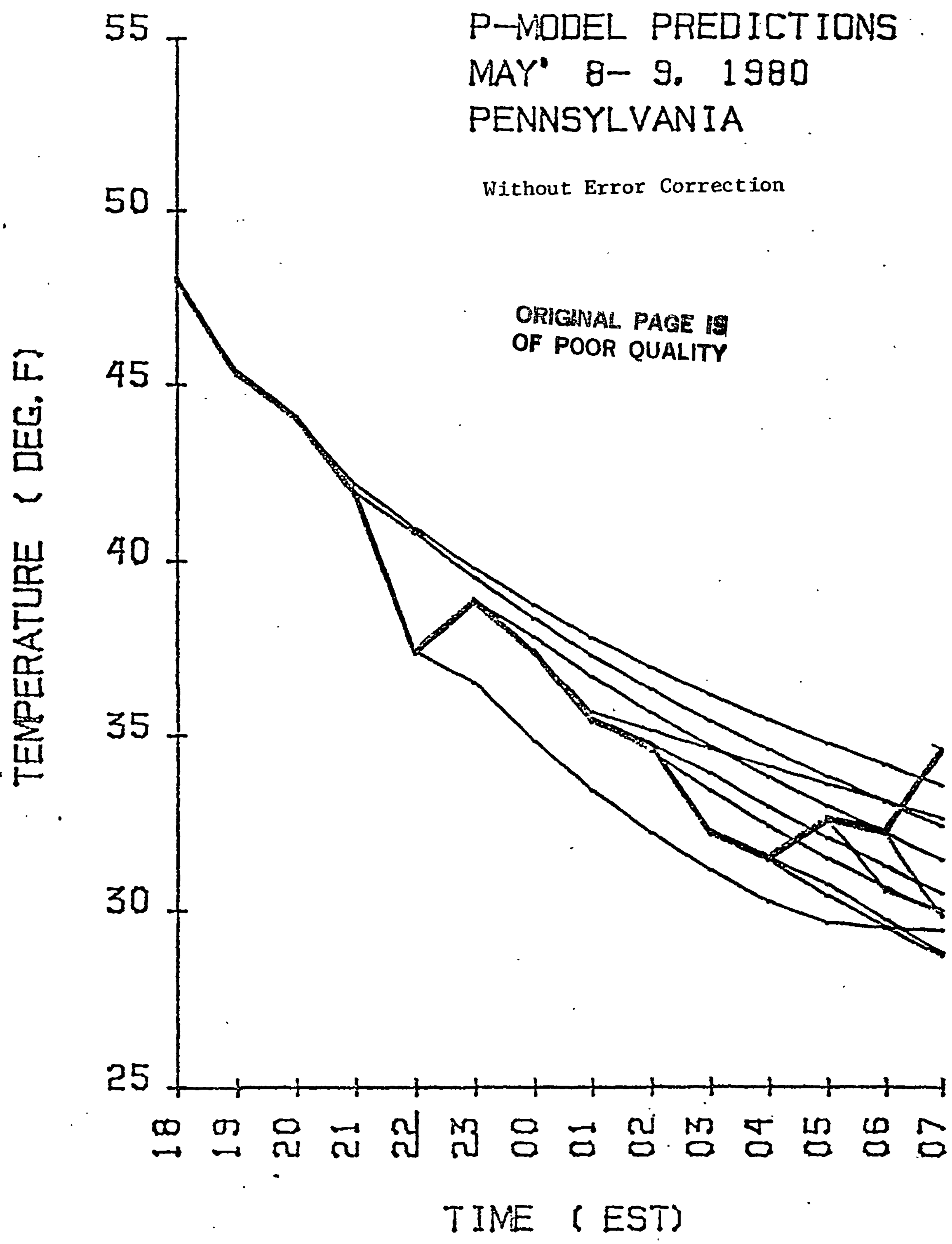

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Figure 6.1.3

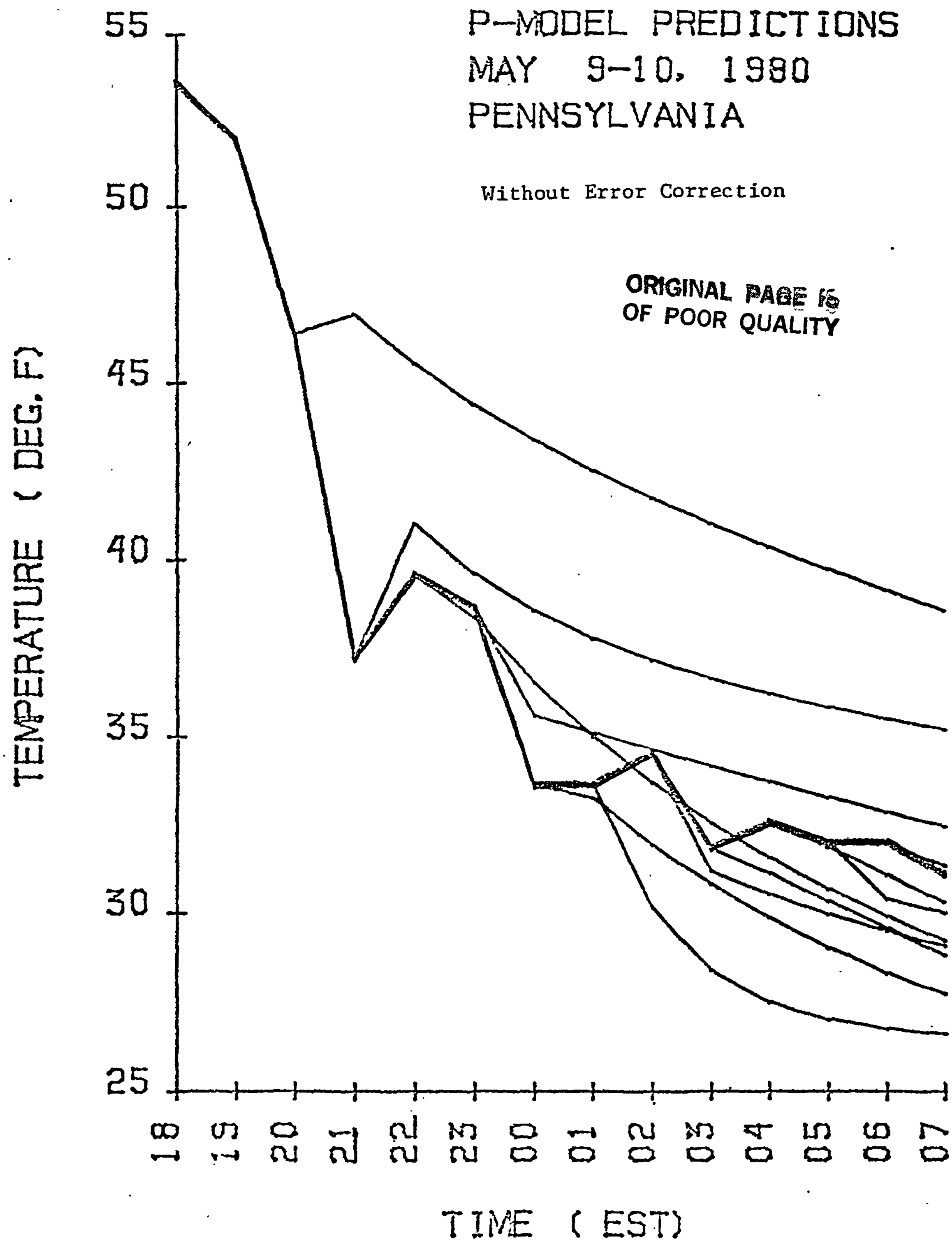

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Figure 6.1.4

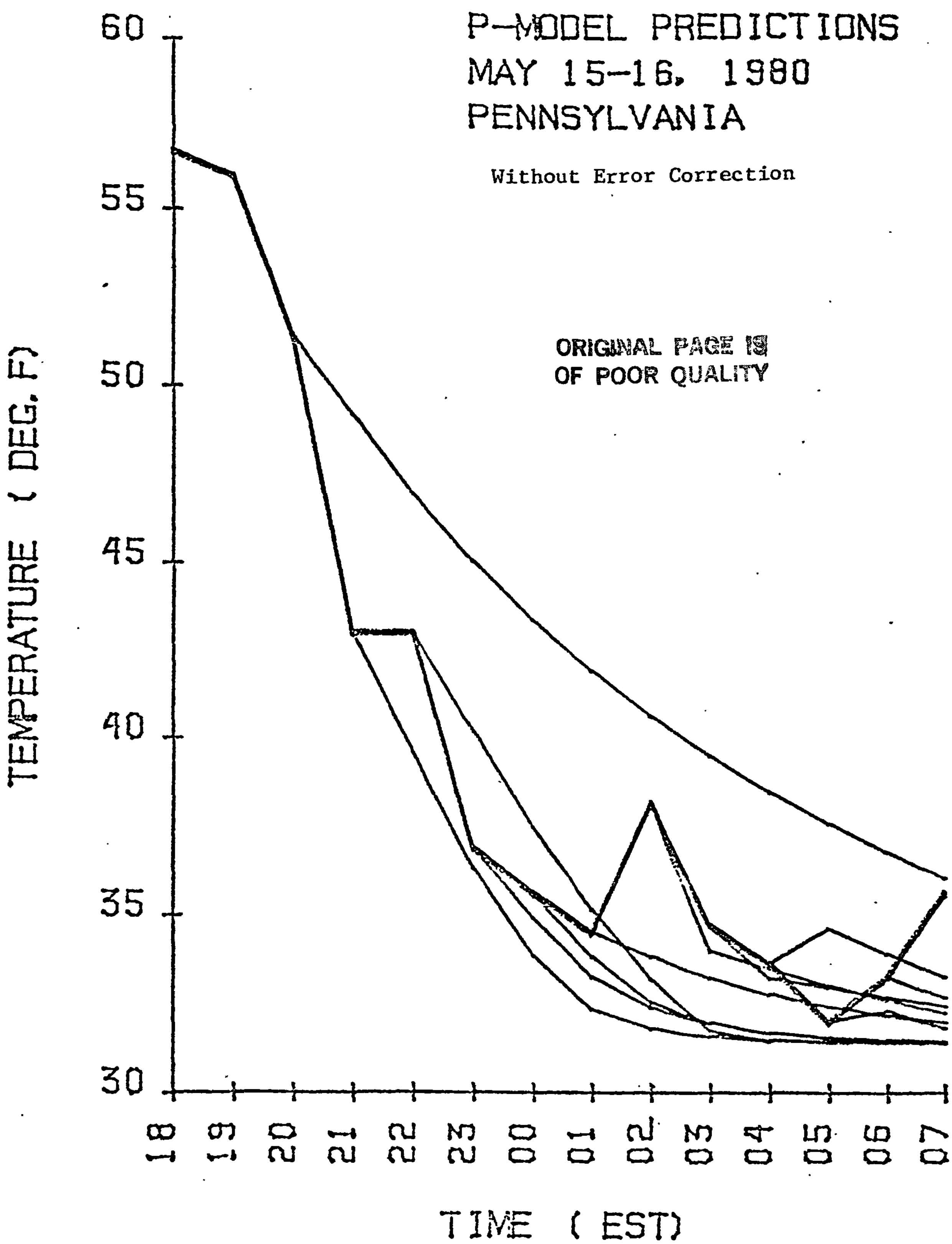

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Figure 6.2.1

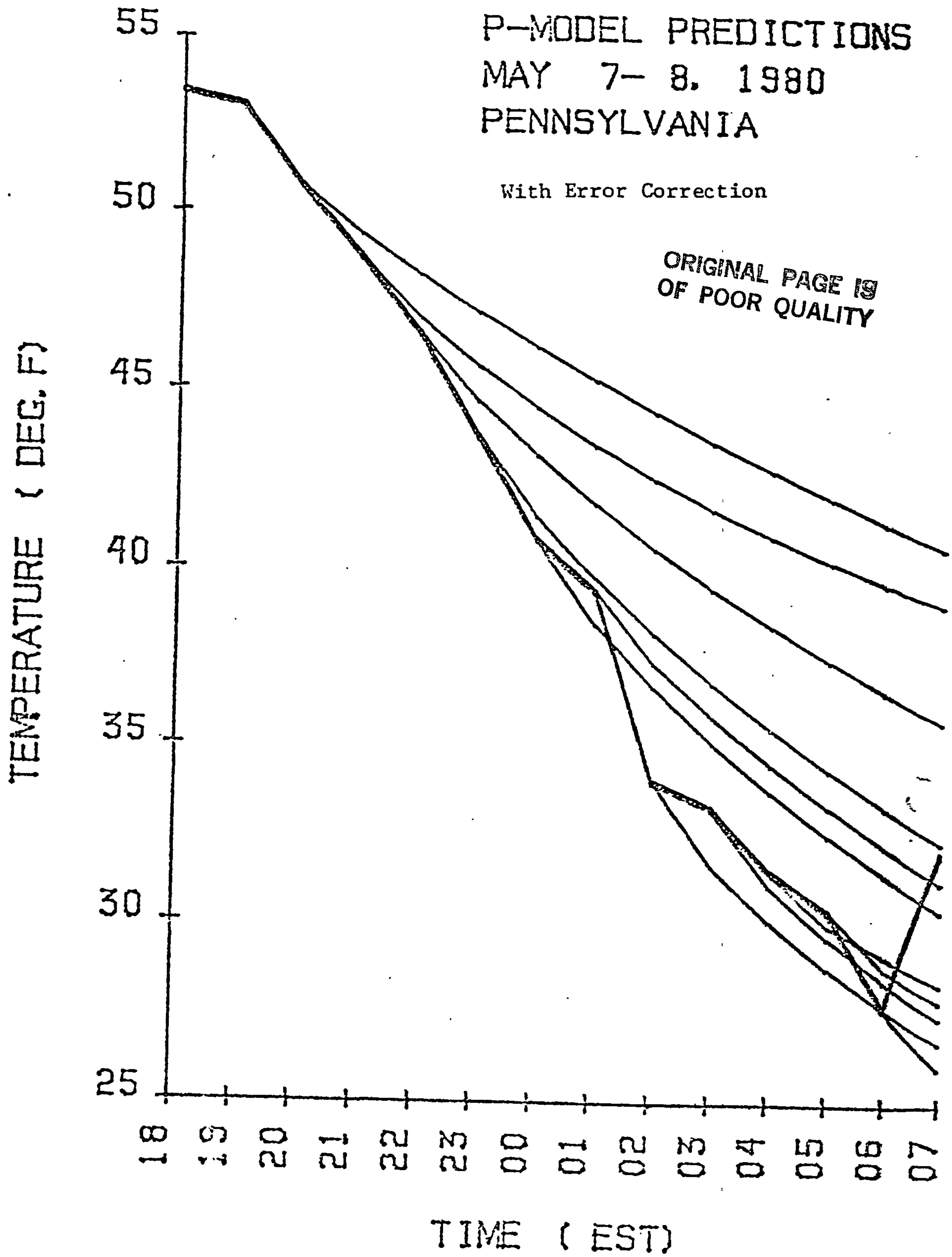
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Figure 6.2.2

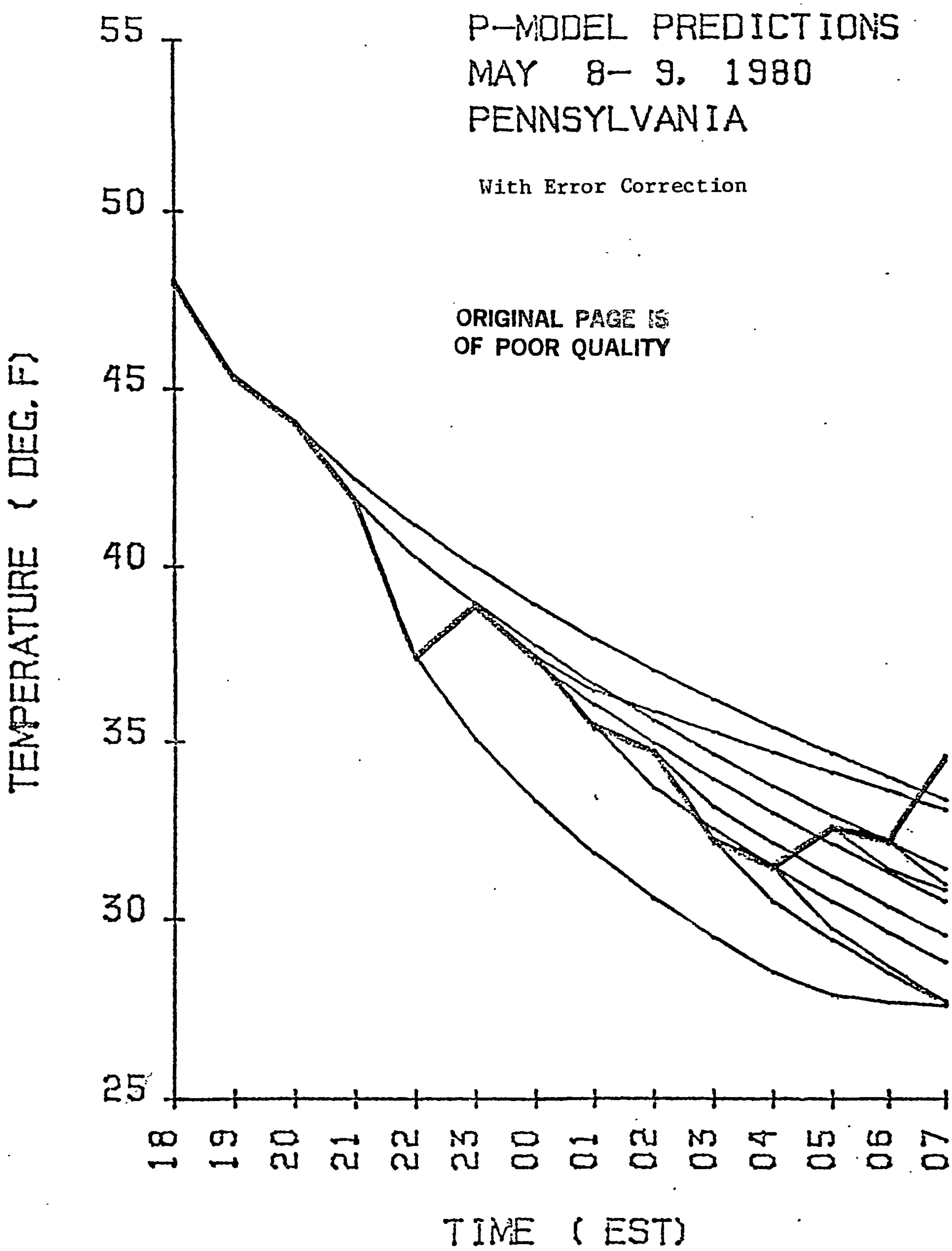
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Figure 6.2.3

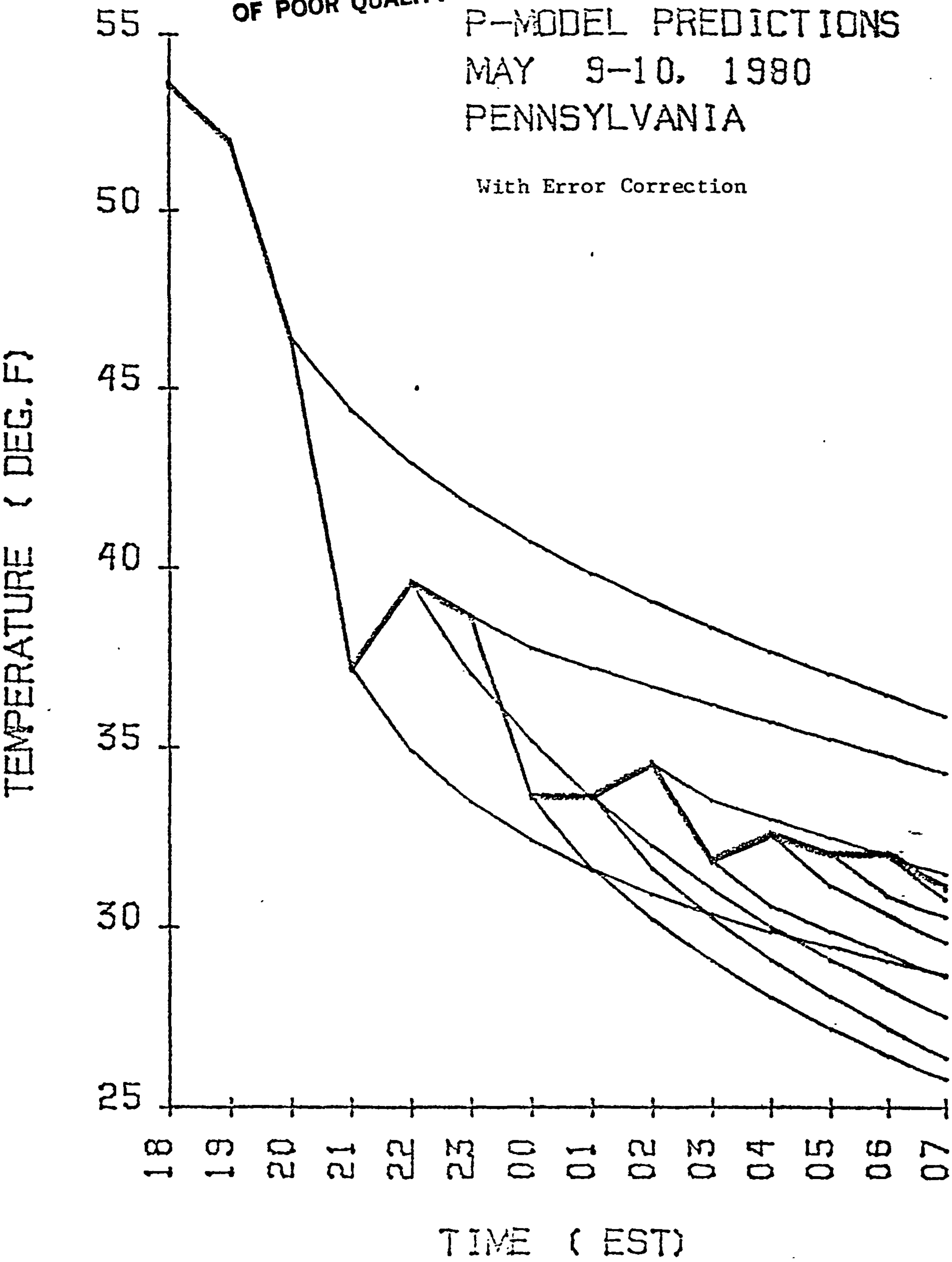
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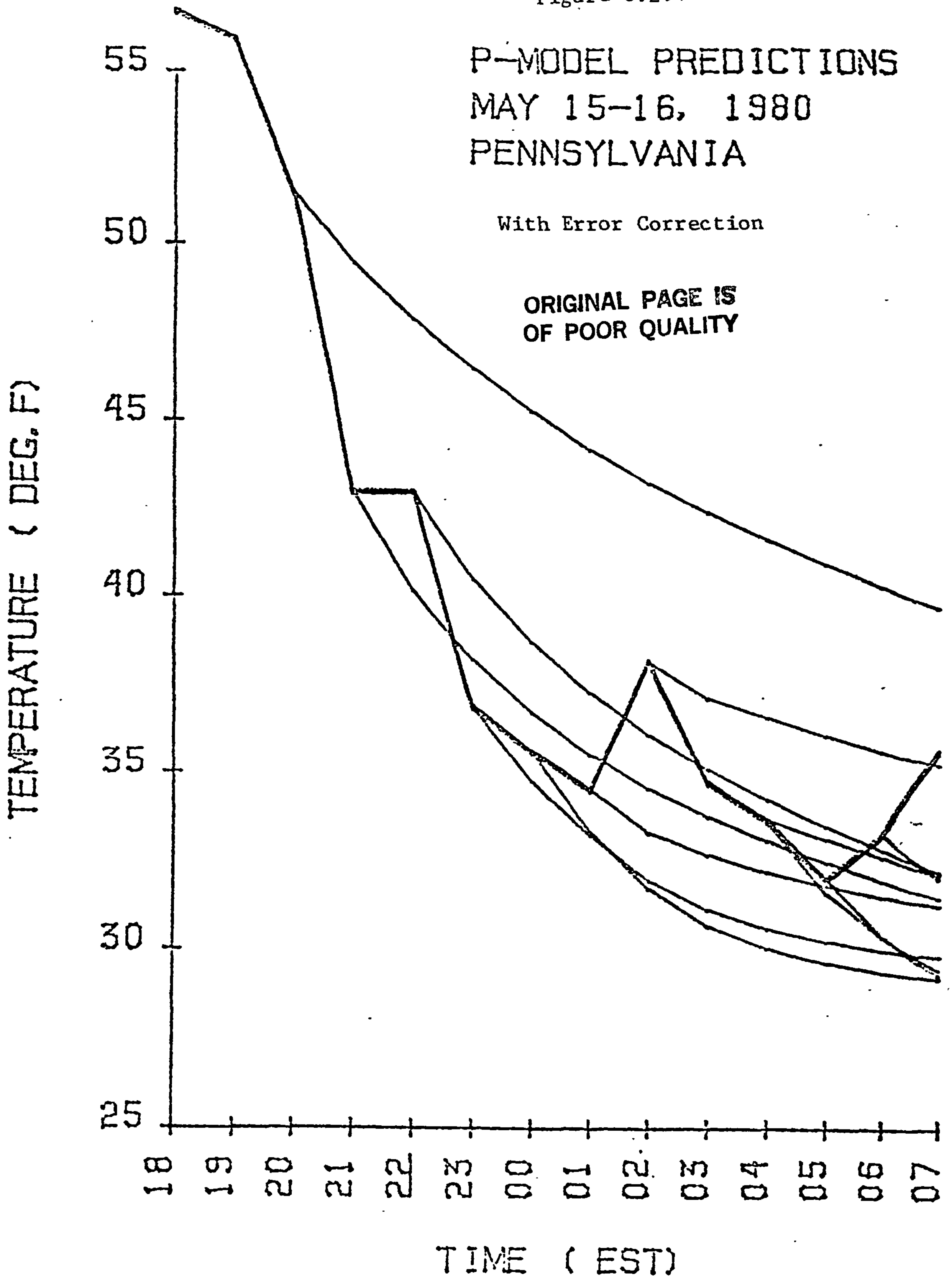
Figure 6.2.4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Appendix VII

Pennsylvania Orchard and Vineyard Survey

1978

PENNSYLVANIA ORCHARD & VINEYARD INVENTORY SURVEY

compiled by

PENNSYLVANIA CROP REPORTING SERVICE
2301 NORTH CAMERON STREET
HARRISBURG, PENNSYLVANIA 17110
TELEPHONE — 717-787-3904

WALLACE C. EVANS .... Statistician in Charge
P. GREGORY TRUCKOR .... Assistant Statistician in Charge

DIRECTOR OF THE SURVEY
CHRIS L. CADWALLADER, AGRICULTURAL STATISTICIAN

A Cooperative Function of

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PENNSYLVANIA
DEPARTMENT OF AGRICULTURE

UNITED STATES
DEPARTMENT OF AGRICULTURE

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FOREWORD

The Commonwealth of Pennsylvania has a prominent position in the nation's production of deciduous fruit.

Pennsylvania usually ranks fourth or fifth in apple and peach production, fifth in grape production, sixth in cherry production and eighth in pear production.

The fruit industry is a dynamic one and adapting to a changing fruit market takes considerable foresight, courage, work and money — fruit trees and grapevines need several years of care before a crop is produced.

This bulletin, which records significant developments in the important fruit industry of Pennsylvania, is intended to provide basic information as a guide in production and marketing plans for all sectors of the Pennsylvania fruit industry.

Accordingly, the Department is pleased to present the 1978 Orchard and Vineyard survey publication. This bulletin has been made possible through the joint effort of the U.S. Department of Agriculture and the Pennsylvania Department of Agriculture.

Sincerely yours,

Penrose Hallowell
Secretary of Agriculture

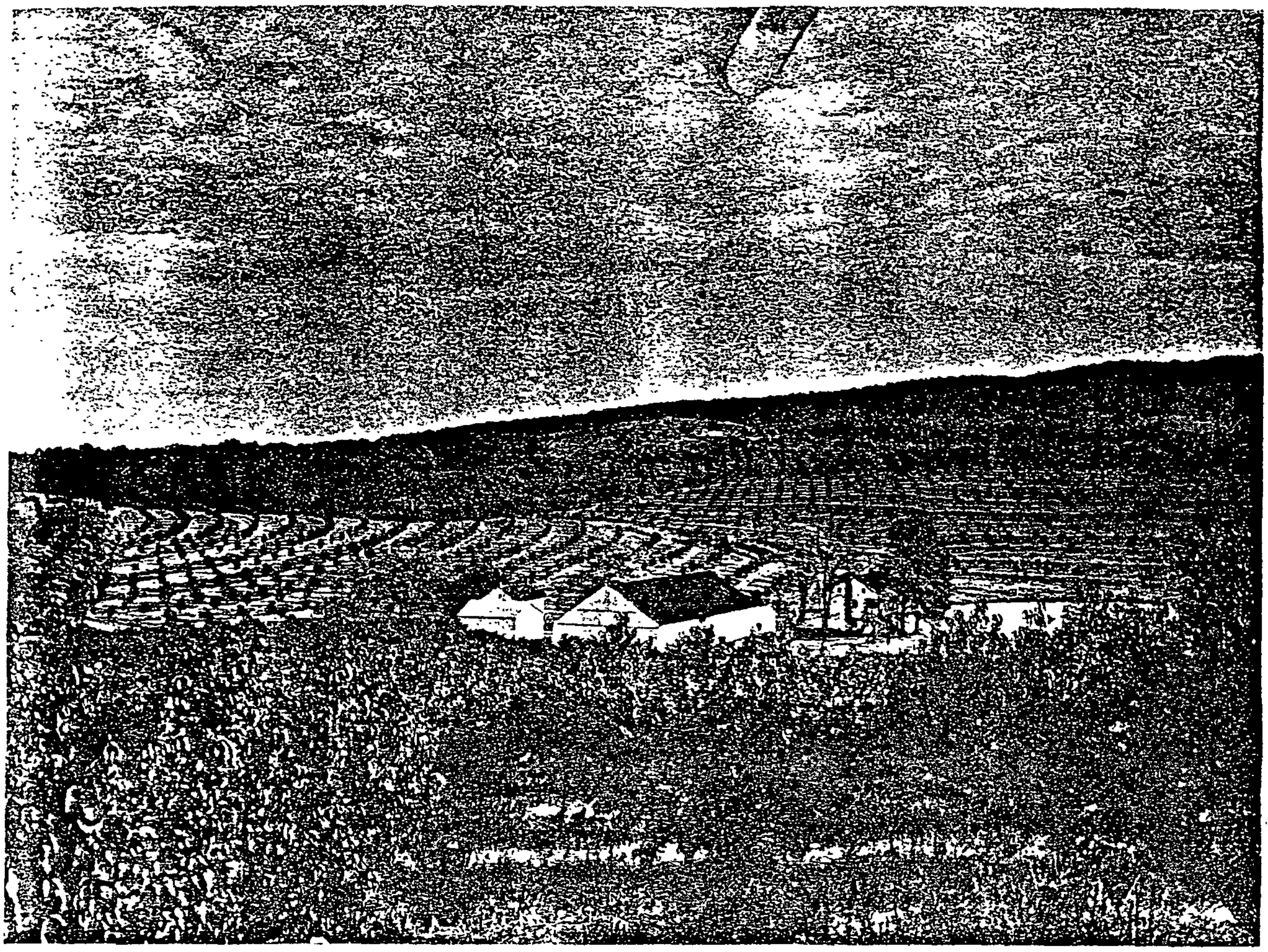

PHOTO CREDIT: Grant Heilman
Lititz, PA

ACKNOWLEDGEMENTS

THE PENNSYLVANIA CROP REPORTING SERVICE EXPRESSES APPRECIATION TO ALL FRUIT PRODUCERS WHO VOLUNTARILY COOPERATED IN FURNISHING DATA PERTAINING TO THEIR OPERATIONS. SPECIAL RECOGNITION IS EXTENDED TO THE FOLLOWING PEOPLE WHO CONTRIBUTED IN VARIOUS WAYS:

WILLIAM J. FLUKE, RETIRED STATISTICIAN-IN-CHARGE, PENNSYLVANIA SSO

CHARLES W. HAMMOND, STATISTICIAN-IN-CHARGE, NEW ENGLAND SSO

MARSHALL RITTER, EXTENSION SERVICE - PENNSYLVANIA STATE UNIVERSITY

THOMAS E. PIPER, EXTENSION SERVICE - ADAMS COUNTY

THOMAS OBOURN, EXTENSION SERVICE - ERIE COUNTY

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J. WARD COOPER, PROCUREMENT OFFICER - KNOUSE FOODS COOPERATIVE

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BARBARA CLEMENS
JAMES GOLDEN
SUE WAGNER - TYPIST

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DESCRIPTION OF THE 1978 PENNSYLVANIA ORCHARD AND VINEYARD SURVEY

By: Chris L. Cadwallader

INTRODUCTION: Pennsylvania has a prominent position in deciduous fruit production on the National level. The Commonwealth usually ranks fourth or fifth in apple and peach production, fifth in grape production, sixth in cherry production and seventh in pear production. To some, Pennsylvania may not easily be recognized as a major fruit producing state because of the relatively small, intensified fruit producing areas in relation to the size of Pennsylvania.

Of the total 67 counties in the state, ten counties had 78 percent of the apple acreage. Erie county alone had 96 percent of the grape acreage, and six counties had 76 percent of the state's peach acreage. There are 28,692,480 acres in the Keystone state with approximately 61,900 acres in orchards and vineyards. Therefore, fruit acreage accounts for only 2 tenths of one percent of Pennsylvania's total land mass. Adams, Berks, Cumberland, Erie, Franklin, Lancaster, Lehigh and York counties had 81 percent of the total fruit acreage in Pennsylvania.

The fruit industry is a dynamic one, annually contributing approximately 60 million dollars, or 10 percent, to the state's total value of cash receipts from all crops.

SURVEY OBJECTIVES: Each kind and variety of fruit has special production and marketing characteristics and challenges. Some are best adapted to certain exposures, slope and soil; some are needed as pollinators and some can be planted on size-controlled root stock. Some ripen early, mid-season and late season, helping to spread out the production and marketing work load. Some are quite perishable while some are firm, storable and transportable. Some are best eaten fresh or in culinary preparations such as salads, sauce, fruit cocktail, etc.; whereas some are best baked whole or as pie filling and some are best utilized for juice, wines, or brandy.

The purpose of this survey is to satisfy requests by various segments of the fruit industry for a detailed inventory of Pennsylvania's fruit tree numbers and grape vine acreage by age and variety. Growers, wholesalers, cooperatives, brokers, processors, retailers, input suppliers, research workers, county agents and government need and use the survey data for many important purposes. Growers provide the survey information, and the benefits derived through analysis of this data are channeled back to the growers through improved services.

This is the sixth in a series of Orchard and Vineyard inventory surveys conducted in 1953, 1957, 1964, 1967 and 1972 for Pennsylvania. This report will also be comparable with surveys compiled by other State Statistical Offices. If copies of the reports for other States are needed, they may be obtained by writing to the Pennsylvania Crop Reporting Service.

DEFINITION OF COMMERCIAL FRUIT OPERATION: A commercial orchard is defined as *one* having 100 or more trees of one of the following fruits being maintained for production: apples, peaches, pears, plums and prunes, sweet cherries, tart cherries or nectarines. A commercial vineyard is defined as one having two acres or more of grape vines maintained for production.

Fruit operations which did not meet these requirements were excluded in this survey. Also excluded from this survey were mature orchards and vineyards which qualified as commercial but were not being maintained for production at the time of data collection. The tables contained within this publication with (total) in the heading include counts from all commercial fruit operations regardless of number of trees or acres of the specified fruit. Tables with (commercial) in the heading exclude growers who do not have 100 or more trees for the respective fruit or two acres or more for grapes.

SURVEY METHODOLOGY: In June of 1977 the Crop Reporting Service began to solicit lists of potential fruit growers from County Agents, processing firms, grower associations and cooperatives, trade publications and various fruit directories. Over 80 lists were received and reviewed. This effort yielded 4,230 names. These names were then checked for duplication within the listings and upon completion, 2,680 names of *potential* fruit growers remained for inquiry.

In November of 1977 a screening questionnaire was developed and mailed. A second and third request were mailed to the non-respondents. A telephone follow-up was conducted in January and February of 1978 for the remaining non-respondents. Of the 2,680 names of potential fruit growers, 175 could not be contacted or verified.

In addition to the list building process mentioned above, the screening questionnaire and the survey questionnaire asked each individual to list names of fruit operations nearby. This "snowball technique" netted an additional 140 names of potential fruit growers for further inquiry.

The overall list building project resulted in a master list of 1,510 commercial fruit grower operations. The remaining potential fruit growers were either out of business or did not qualify as commercial operations.

The master list was mailed a survey questionnaire in March 1978 with a second request mailed in April to 1,100 non-respondents. Of the 870 non-respondents to the second request, 550 had over 10 acres of fruit and were personally contacted while 320 with less than 10 acres in fruit were interviewed by telephone.

From the master list of 1,510 fruit growers, 1,275 commercial fruit reports were summarized. The balance of 235 were non-commercial, abandoned, out of business, etc. Every effort has been made to publish survey results in a detailed format as possible without relaxing restrictions on disclosure of individual operations. Crop utilization and value estimates presented herein were obtained through the annual estimating programs of the Pennsylvania Crop Reporting Service.

OTHER VARIETIES: This category includes minor varieties of the specified fruit. Included are fruit tree numbers from growers who reported a small quality of "miscellaneous" or "other" varieties. A small percentage of data for some of the major varieties may be included in the "other" category.

HIGHLIGHTS OF SURVEY RESULTS

Number Of Commercial Orchards/Vineyards: The number of commercial fruit operations accounted for in the 1978 survey was 1,275 compared with 1,035 in the 1972 survey, a 23 percent increase. Commercial nectarine orchards increased 61 percent from 44 in 1972 to 71 in 1978. A total of 436 commercial grape vineyards were counted in 1978 compared with 348 in 1972, an increase of 25 percent. Apple orchards at 825, increased 22 percent from 674 in 1972. Commercial pear orchards increased 7 percent from 180 in 1972 to 193 in 1978, and peach orchards increased from 472 to 498, or 6 percent.

On the declining side, tart cherry orchards dropped 30 percent from 201 in 1972 to 140 in 1978. Commercial plum and prune orchards declined 28 percent from 108 in 1972 to 78 in 1978. Sweet cherry operations at 61 in 1978 compared with 73 in 1972, down 16 percent.

Trees In Commercial Orchards: For commercial tree numbers (100+ for each fruit), nectarine trees more than doubled, pear trees increased 23 percent, sweet cherry trees increased 19 percent and apple trees increased 18 percent, while plum and prune, tart cherry and peach trees declined 20, 16 and 3 percent respectively from 1972.

Age Of Trees: Of the total trees accounted for on all commercial fruit operations, 15.9 percent were in the 1-3 year age group, 14.6 percent in the 4-6 year age group, 48.2 percent in the 7-21 year age group and 21.3 percent in the 22 years plus age group.

Acreage Of Commercial Trees: The corresponding acreage for commercial fruit trees (100+ for each fruit) on the 1,275 commercial fruit farms in 1978 was 47,137.5. This is a 6 percent decline from the 50,304 acres in 1972. Increased tree planting densities are primarily responsible for the decline in acreage.

Acreage Of Commercial Vineyards: The acreage of commercial vineyards in 1978 was 14,245.4 compared with 9,865.8 in 1972, a 44 percent increase. All fruit production regions were up sharply from 1972 acreage levels.

Age Of Acreage In Vineyards: Of the total 14,271.3 acres of grapes on all commercial fruit farms, 10.0 percent were in the 1-3 year age group, 9.3 percent in the 4-6 year age group and 80.7 percent in the 7 years and older age group.

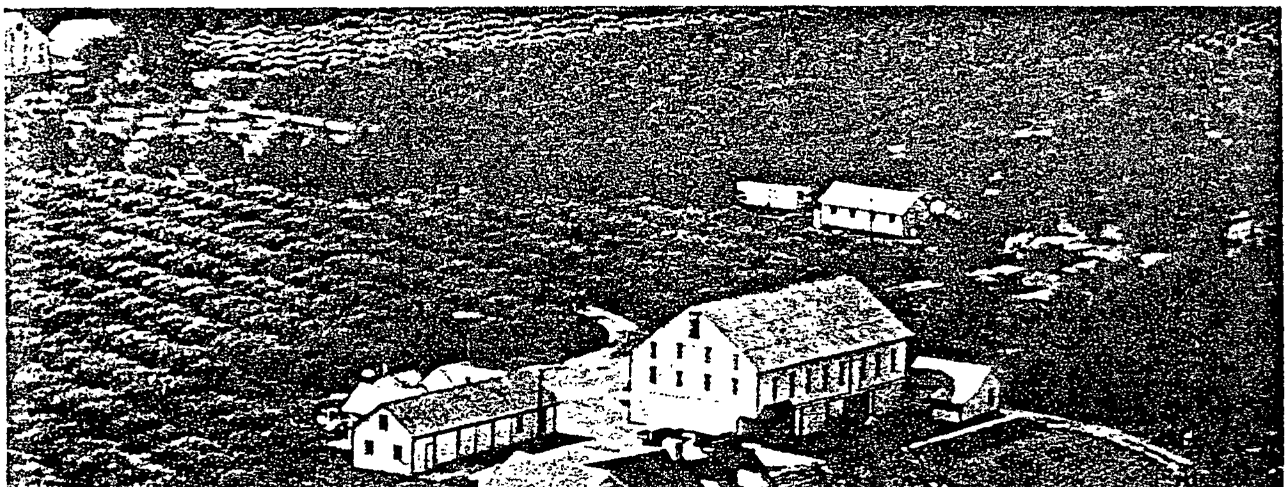

Photo Credit: Tom Piper

PENNSYLVANIA: ORCHARDS AND VINEYARDS (TOTAL & COMMERCIAL): NUMBER OF FARMS, TREES AND ACRES BY KIND OF FRUIT - 1964, 1967, 1972 & 1978

Fruit	Farms		Trees		Acres		Trees Per Acre	
	Total	Commercial	Total	Commercial	Total	Commercial	Total	Commercial
1964								
Apples...........	1/	984	1/	1,710,115	1/	39,837	1/	42
Peaches..........	1/	742	1/	1,050,311	1/	13,509	1/	78
Pears............	1/	188	1/	73,255	1/	994	1/	74
Tart Cherries....	1/	353	1/	322,416	1/	3,518	1/	92
Sweet Cherries...	1/	91	1/	27,680	1/	489	1/	57
Grapes...........	1/	303	-	-	1/	7,292	-	-
Plums & Prunes...	1/	1/	1/	1/	1/	1/	1/	1/
Nectarines.......	1/	1/	1/	1/	1/	1/	1/	1/
All Fruit........	1,446 3/		-	-	1/	65,639 2/	-	-
1967								
Apples...........	968	879	1,774,885	1,771,582	38,558	1/	46	1/
Peaches..........	780	665	1,074,108	1,069,598	13,297	1/	81	1/
Pears............	580	237	104,934	94,421	1,301	1/	81	1/
Tart Cherries....	481	283	275,473	270,906	3,236	1/	85	1/
Sweet Cherries...	386	86	32,944	26,296	702	1/	47	1/
Grapes...........	420	-	-	-	8,644	1/	-	-
Plums & Prunes...	363	127	49,505	42,173	944	1/	52	1/
Nectarines.......	141	35	26,931	24,039	352	1/	77	1/
All Fruit........	1,321 3/		-	-	67,034	1/	-	-
1972								
Apples...........	715	674	1,815,608	1,813,756	34,601	34,547	52	53
Peaches..........	545	472	887,001	882,550	11,076	10,955	80	81
Pears............	401	180	104,288	96,373	1,212	1,073	86	90
Tart Cherries....	318	201	220,667	217,610	2,613	2,550	84	85
Sweet Cherries...	232	73	32,343	28,230	618	526	52	54
Grapes...........	379	348	-	-	9,887.7	9,865.8	-	-
Plums & Prunes...	281	108	41,573	36,327	528	431	79	84
Nectarines.......	130	44	21,352	19,024	253	222	84	86
All Fruit........	1,035 3/		-	-	60,779.7	60,169.8	-	-
1978								
Apples...........	893	825	2,145,658	2,142,214	32,858.4	32,790.9	65	65
Peaches..........	616	498	856,842	852,052	9,781.7	9,727.5	88	88
Pears............	477	193	127,158	118,874	1,499.8	1,380.7	85	86
Tart Cherries....	302	140	186,387	183,768	2,000.5	1,967.0	93	93
Sweet Cherries...	269	61	38,019	33,068	545.7	472.5	70	70
Grapes...........	474	436	-	-	14,271.3	14,245.4	-	-
Plums & Prunes...	319	78	35,479	29,120	386.5	319.3	92	91
Nectarines.......	224	71	47,938	44,877	527.1	479.6	91	94
All Fruit........	1,275 3/		-	-	61,871.0	61,382.9	-	-

1/ Data not available.
2/ Does not include plum, prune or nectarine data.
3/ Total number of commercial fruit farms in Pennsylvania. Farms (total) is the total number of commercial fruit farms reporting. Farms (commercial) is the number of commercial fruit farms reporting 100 or more trees for each particular fruit or two or more acres for grapes.

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Photo Credit: Tom Piper

Photo Credit: Tom Piper

PENNSYLVANIA: ALL FRUIT (TOTAL): NUMBER AND PERCENT BREAKDOWN BY AGE GROUPS - 1978 1/

Fruit	1975-1977 (1-3 Years)		1972-1974 (4-6 Years)		1957-1971 (7-21 Years)		1956 & Earlier (22 Years +)		Total All Ages	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Apples...........	311,944	14.5	262,664	12.3	1,000,463	46.6	570,587	26.6	2,145,658	100.0
Peaches..........	176,261	20.6	158,743	18.5	470,106	54.9	51,732	6.0	856,842	100.0
Pears............	11,546	9.1	18,318	14.4	68,579	53.9	28,715	22.6	127,158	100.0
Tart Cherries....	27,597	14.8	31,239	16.8	64,065	34.4	63,486	34.0	186,387	100.0
Sweet Cherries...	6,084	16.0	4,019	10.6	15,444	40.6	12,472	32.8	38,019	100.0
Plums & Prunes...	4,454	12.6	5,622	15.8	20,775	58.6	4,628	13.0	35,479	100.0
Nectarines.......	9,909	20.7	19,974	41.6	17,868	37.3	187	.4	47,938	100.0
TOTAL............	547,795	15.9	500,579	14.6	1,657,300	48.2	731,807	21.3	3,437,481	100.0
Grapes...........	1,428.6	10.0	1,320.6	9.3	11,522.1	80.7	2/	2/	14,271.3	100.0

1/ Number of acres for grapes, number of trees for all other fruits.
2/ Included in the 7-21 year age group.

APPLES

Number of Orchards and Trees: A total of 893 apple growers were accounted for in the 1978 survey with 825 qualifying as commercial (100+ trees). In 1972 the total number of growers was 715 with 674 qualifying as commercial. Tree numbers have shown a continued gain since the first commercial fruit tree survey conducted in 1953. Commercial apple growers in 1978 had 2,142,214 trees compared with 1,813,756 trees in 1972, an 18 percent increase. Of the total 2,145,658 apple trees in 1978, 65 percent were standard size trees and 35 percent dwarf, semi-dwarf, spur type or trellis. Comparable percentages for the 1972 survey were 75 and 25 respectively. Of the 825 commercial apple growers, 180 or 22 percent accounted for 81 percent of the trees.

Acreage In Orchards: A total of 32,790.9 acres of land was being used by commercial apple orchards in 1978. This is a decline of 1,756.1 acres from 1972. The fact that commercial apple acreage declined 5 percent from 1972 while corresponding trees increased 18 percent is indicative of the 10 percent increase in size controlled rootstock during the same period. Trees per acre increased from 53 in 1972 to 65 in 1978.

Location Of Trees: Apples are widely grown throughout Pennsylvania but the inventory of commercial trees in Fruit Region I accounts for 64 percent of the total. This is a 2 percent decline from 1972. The ten leading counties (Adams, Franklin, Lehigh, Berks, York, Erie, Bedford, Cumberland, Snyder and Allegheny) contained 78 percent or 1,748,167 of the total 2,145,658 trees.

Age Of Trees: Of the total 2,145,658 apple trees, 14.5 percent were 1-3 years old, 12.3 percent 4-6 years old, 46.6 percent 7-21 years old and 26.6 percent 22 years or older. New plantings of standard size trees continued to decline in relation to the increase in size controlled tree planting. For trees planted since 1972, 75 percent were of size controlled types.

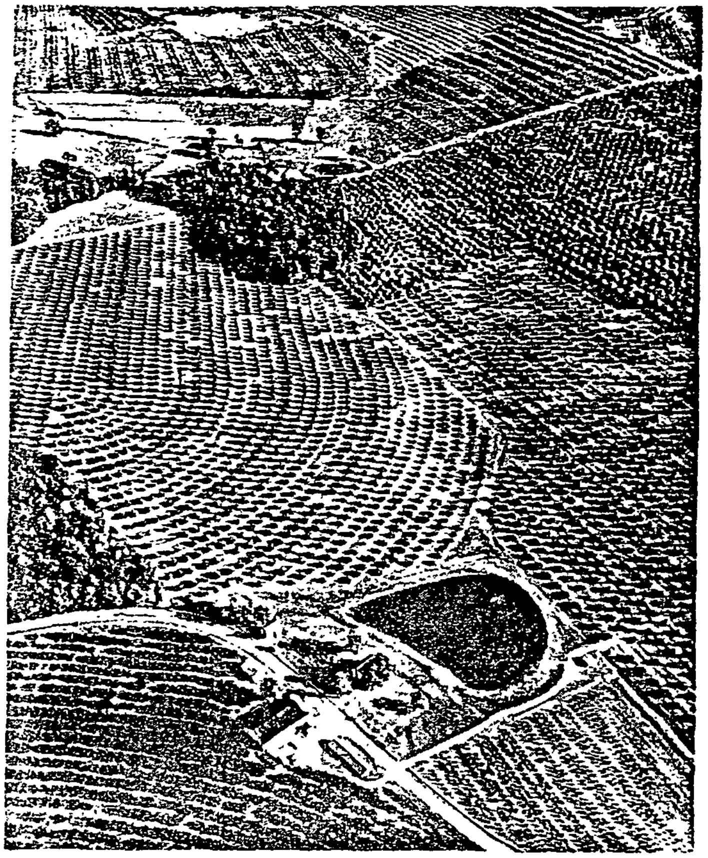


Photo Credit: Grant Heilman, Lititz, PA.

Varieties: Red Delicious continues to be the leading variety accounting for 28 percent of all trees in 1978. The number of Red Delicious trees increased 54 percent from 1972. Other leading varieties as a percent of total trees are: York Imperial — 19, Golden Delicious — 16, Rome Beauty — 11, Stayman — 9, Jonathan and McIntosh — 4. Of the total trees 1-3 years old, 40 percent were Red Delicious and 11 percent Golden Delicious.

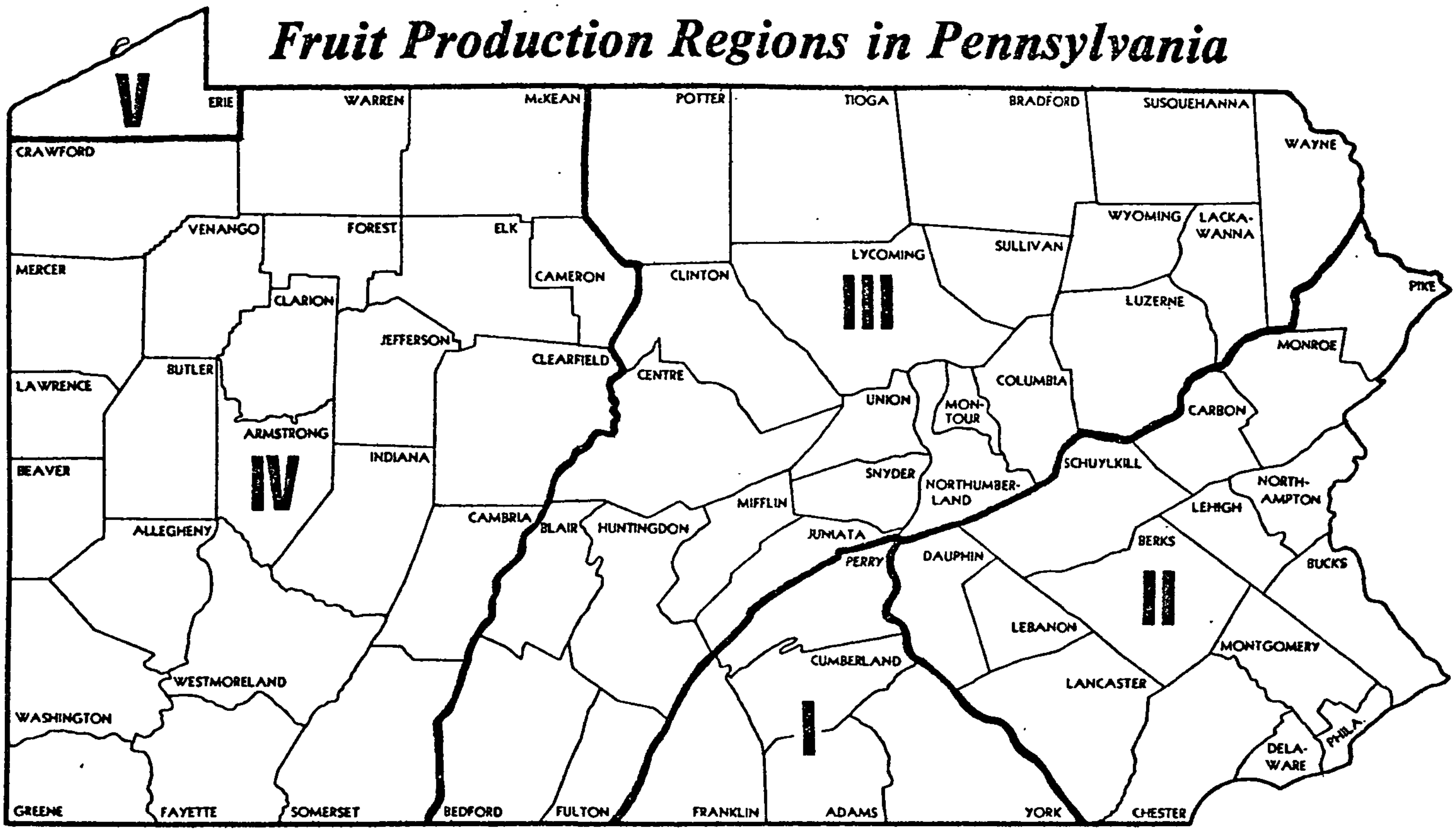
PENNSYLVANIA: APPLES (COMMERCIAL): COMPARISON OF GROWERS AND TREE NUMBERS BY REGION - 1967, 1972, and 1978

Region	1967 Survey		1972 Survey		1978 Survey		Percent Change 72/78	
	Number Of Orchards	Number Of Trees	Number Of Orchards	Number Of Trees	Number Of Orchards	Number Of Trees	Number Of Orchards	Number Of Trees
I...............	319	1,074,964	272	1,189,904	281	1,362,784	+ 3	+15
II...............	188	296,071	147	276,350	188	340,801	+28	+23
III...............	197	203,622	144	205,173	181	252,169	+26	+23
IV & V..........	175	196,925	111	142,329	175	186,460	+58	+31
PENNSYLVANIA.....	879	1,771,582	674	1,813,756	825	2,142,214	+22	+18

PENNSYLVANIA: APPLES (COMMERCIAL): COMPARISON OF NUMBER AND SIZE OF ORCHARDS BY REGION - 1967, 1972 and 1978

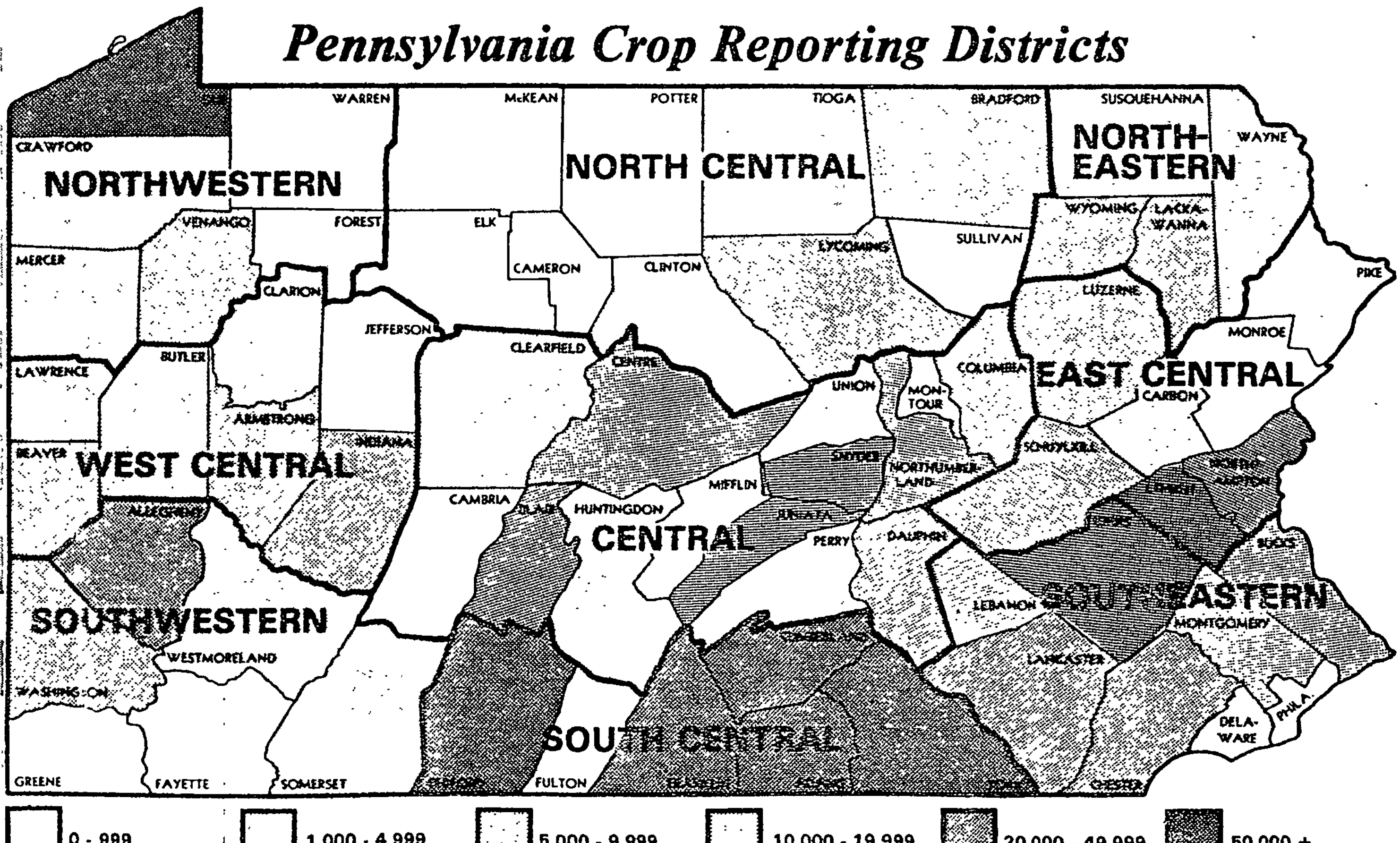
Region	Number Of Orchards			Number Of Orchards In Each Size Group											
				100-499 Trees			500-2,499 Trees			2,500-4,999 Trees			5,000 Trees & Over		
	1967	1972	1978	1967	1972	1978	1967	1972	1978	1967	1972	1978	1967	1972	1978
I...............	319	272	281	75	63	74	142	109	101	54	44	45	48	56	61
II...............	188	147	188	97	70	96	59	44	61	19	21	17	13	12	14
III...............	197	144	181	102	66	90	76	54	63	13	15	15	6	9	13
IV & V..........	175	111	175	89	51	108	71	47	52	11	8	10	4	5	5
PENNSYLVANIA.....	879	674	825	363	250	368	348	254	277	97	88	87	71	82	93

Fruit Production Regions in Pennsylvania



Number of Apple Trees by County - 1978

Pennsylvania Crop Reporting Districts



PENNSYLVANIA: APPLES (TOTAL): GROWERS, ACRES, TYPES OF TREES AND PRODUCTION BY COUNTY AND REGION, 1978

County And Region	Growers	Standard Type		Dwarf, Semi-Dwarf, Spur Type & Trellis		All Types			Production Bushels 2/
		Acres	Total Trees	Acres	Total Trees	Acres	Trees		
							Total	Trees Per Acre	
REGION I:									
Adams	161	12,433.8	673,950	1,983.1	255,341	14,416.9	929,291	65	5,157,369
Cumberland	16	722.0	39,799	121.5	11,682	843.5	51,481	61	367,563
Franklin	48	3,770.9	239,668	495.4	60,127	4,266.3	299,795	70	1,826,464
Perry	10	94.5	3,125	9.0	352	103.5	3,477	34	23,611
York	55	887.9	35,292	470.3	43,952	1,358.2	79,244	58	512,614
TOTAL	290	17,909.1	991,834	3,079.3	371,454	20,988.4	1,363,288	65	7,887,621
REGION II:									
Berks	35	399.0	35,577	816.2	51,433	1,215.2	87,010	72	400,863
Bucks	20	163.1	10,822	68.1	8,583	231.2	19,405	84	82,853
Carbon, Monroe & Pike	9	40.4	1,428	13.2	2,668	53.6	4,096	76	12,970
Chester	14	222.2	11,038	149.5	20,028	371.7	31,066	84	152,972
Dauphin	9	122.0	6,604	85.7	5,174	207.7	11,778	57	86,001
Delaware	8	53.0	1,541	19.1	2,287	72.1	3,828	53	18,621
Lancaster	23	224.6	8,779	139.4	12,386	364.0	21,165	58	136,602
Lebanon	4	45.0	2,133	31.5	4,622	76.5	6,755	88	33,160
Lehigh	20	833.5	71,016	721.7	30,808	1,555.2	101,824	66	284,353
Montgomery	16	155.9	4,562	41.3	4,790	197.2	9,352	47	51,726
Northampton	6	261.0	15,140	222.0	10,555	483.0	25,695	53	115,648
Schuylkill	42	249.0	12,828	63.5	6,952	312.5	19,780	63	128,273
TOTAL	206	2,768.7	181,468	2,371.2	160,286	5,139.9	341,754	67	1,504,042
REGION III:									
Bedford	21	496.0	24,261	200.0	27,317	696.0	51,578	74	164,992
Blair	6	509.0	22,514	130.0	12,580	639.0	35,094	55	227,400
Bradford	8	144.5	4,630	34.6	2,279	179.1	6,909	39	34,323
Centre	4	89.0	4,682	98.0	11,600	187.0	16,282	87	45,276
Clinton & Potter	4	29.1	1,076	1.2	174	30.3	1,250	41	7,689
Columbia	15	40.3	1,824	90.5	7,010	130.8	8,834	68	44,684
Huntingdon & Fulton	5	35.0	1,039	10.0	1,013	45.0	2,052	46	12,596
Juniata	14	307.7	17,397	81.0	7,161	388.7	24,558	63	112,769
Lackawanna	10	112.3	5,328	11.8	1,196	124.1	6,524	53	21,717
Luzerne	22	144.3	5,541	43.9	3,755	188.2	9,296	49	45,853
Lycoming	16	116.3	4,104	59.6	12,543	175.9	16,647	95	50,190
Mifflin	4	37.0	1,606	43.0	2,992	80.0	4,598	58	19,153
Montour & Northumberland	30	230.7	8,759	58.8	6,171	289.5	14,930	52	73,138
Snyder	19	488.8	24,550	145.5	15,754	634.3	40,304	64	217,331
Tioga	3	50.0	1,796	.6	60	50.6	1,856	37	5,675
Union	6	22.3	1,137	8.1	625	30.4	1,762	58	6,059
Wayne & Susquehanna	5	44.0	978	28.0	2,600	72.0	3,578	50	15,826
Wyoming	4	150.0	6,296	4.0	650	154.0	6,946	45	24,400
TOTAL	191	3,046.3	137,518	1,048.6	115,480	4,094.9	252,998	62	1,129,071
REGION IV:									
Allegheny	19	507.0	19,556	169.2	16,382	676.2	35,938	53	94,531
Armstrong	4	66.2	3,568	36.0	2,461	102.2	6,029	59	5,955
Beaver	16	60.5	2,798	35.8	5,263	96.3	8,061	84	20,536
Butler	6	17.0	1,247	12.4	588	29.4	1,835	62	3,510
Cambria	4	9.0	369	25.0	600	34.0	969	29	5,175
Clearfield	4	40.1	2,187	28.0	2,792	68.1	4,979	73	12,770
Crawford	7	17.5	714	27.0	2,070	44.5	2,784	63	6,003
Elk & McKean	4	13.5	648	1.2	118	14.0	766	55	4,340
Fayette, Somerset & Greene	5	81.0	4,166	15.5	1,349	96.5	5,515	57	44,629
Indiana	16	124.7	5,545	74.8	5,469	200.2	11,014	55	10,267
Jefferson & Clarion	3	21.0	423	17.0	3,775	38.0	4,198	110	4,385
Lawrence	10	59.6	2,491	24.0	1,783	83.6	4,274	51	20,475
Mercer	12	56.0	2,475	8.7	601	64.7	3,076	48	14,459
Venango	4	65.0	3,961	16.0	1,756	81.0	5,717	71	23,231
Washington	17	214.6	13,784	19.3	2,794	233.9	16,578	71	30,700
Westmoreland	8	25.2	840	29.5	3,343	54.7	4,183	77	300
TOTAL	139	1,377.9	64,772	539.4	51,144	1,917.3	115,916	61	301,266
REGION V:									
Erie	62	421.2	22,827	296.7	48,875	717.9	71,702	100	94,522
TOTAL	62	421.2	22,827	296.7	48,875	717.9	71,702	100	94,522
PENNSYLVANIA	893	25,523.2	1,398,419	7,335.2	747,239	32,858.4	2,145,658	65	10,916,522

1/ Some counties are combined to avoid disclosure of individual operations.
2/ Production in 1977 from acreage maintained for production in 1978.

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PENNSYLVANIA: APPLES (TOTAL): GROWERS, ACRES, TREES AND PRODUCTION BY SIZE OF OPERATION AND REGION, 1978

Size Of Operation (Trees)	Growers		Trees		Acres		Production 1/	
	Number	Percent	Number	Percent	Number	Percent	Bushels	Percent
Region I:								
1-99	9	3	504	-	9.0	-	2,143	-
100-199	20	7	2,870	-	69.1	-	17,358	-
200-499	54	19	18,513	1	347.6	2	138,584	2
500-999	49	17	33,042	3	675.8	3	240,183	3
1,000-2,499	52	18	86,665	7	1,723.4	8	725,639	9
2,500-4,999	45	15	168,236	12	2,984.5	15	1,105,384	14
5,000+	61	21	1,053,458	77	15,179.0	72	5,658,330	72
Total	290	100	1,363,288	100	20,988.4	100	7,887,621	100
Region II:								
1-99	18	9	953	-	15.5	-	5,111	-
100-199	45	22	5,823	2	117.4	2	38,576	2
200-499	51	25	15,996	5	303.9	6	100,079	7
500-999	34	16	22,628	7	413.0	8	114,238	8
1,000-2,499	27	13	41,517	12	663.6	13	178,183	12
2,500-4,999	17	8	63,222	18	783.2	15	309,622	21
5,000+	14	7	191,615	56	2,843.3	56	758,233	50
Total	206	100	341,754	100	5,139.9	100	1,504,042	100
Region III:								
1-99	15	8	829	-	18.0	-	5,470	-
100-199	48	24	6,447	3	141.9	4	33,826	3
200-499	42	21	13,861	5	284.2	7	63,084	6
500-999	34	17	24,192	10	551.3	13	121,351	11
1,000-2,499	29	15	45,345	18	908.2	22	227,441	20
2,500-4,999	15	8	53,422	21	687.0	17	220,017	19
5,000+	13	7	108,902	43	1,504.3	37	457,882	41
Total	196	100	252,998	100	4,094.9	100	1,129,071	100
Region IV:								
1-99	10	7	507	-	15.0	1	1,645	1
100-199	40	29	6,197	5	132.2	7	30,935	10
200-499	46	33	15,898	14	291.8	15	42,072	14
500-999	18	13	13,470	12	228.8	12	58,540	19
1,000-2,499	16	12	26,449	23	415.5	22	73,783	25
2,500-4,999	9	6	53,395	46	834.0	43	94,291	31
5,000+	2/	-	-	-	-	-	-	-
Total	139	100	115,916	100	1,917.3	100	301,266	100
Region V:								
1-99	16	26	651	1	10.0	1	751	1
100-199	9	14	1,586	2	20.0	3	3,512	4
200-499	13	21	5,936	8	77.1	11	8,564	9
500-999	7	11	5,393	8	81.7	11	16,267	17
1,000-2,499	11	18	18,236	25	193.7	27	16,590	18
2,500-4,999	3	5	11,815	17	169.4	24	18,088	19
5,000+	3	5	28,085	39	166.0	23	30,750	32
Total	62	100	71,702	100	717.9	100	94,522	100
All Regions:								
1-99	68	8	3,444	-	67.5	0	15,120	-
100-199	162	18	22,723	1	480.6	1	124,207	1
200-499	206	23	70,204	3	1,304.6	4	352,383	3
500-999	142	16	98,725	5	1,950.6	6	550,579	5
1,000-2,499	135	15	218,212	10	3,904.4	12	1,221,636	11
2,500+	180	20	1,732,350	81	25,150.7	77	8,652,597	80
PENNSYLVANIA	893	100	2,145,658	100	32,858.4	100	10,916,522	100

1/ Production in 1977 from acreage maintained for production in 1978.
2/ Combined with the 2,500-4,999 size group to avoid disclosure of individual operations.

PENNSYLVANIA: APPLES - COMPARISON OF COMMERCIAL & NON-COMMERCIAL GROWER AND TREE NUMBERS 1967, 1972, 1978

Trees	Number Of Growers			Number Of Trees		
	1967	1972	1978	1967	1972	1978
1-99 1/	89	41	68	3,303	1,852	3,444
100+	879	674	825	1,771,582	1,813,756	2,142,214
Total 1/	968	715	893	1,774,885	1,815,608	2,145,658

1/ Includes trees in orchards classified as commercial (100+ trees) for any fruit.

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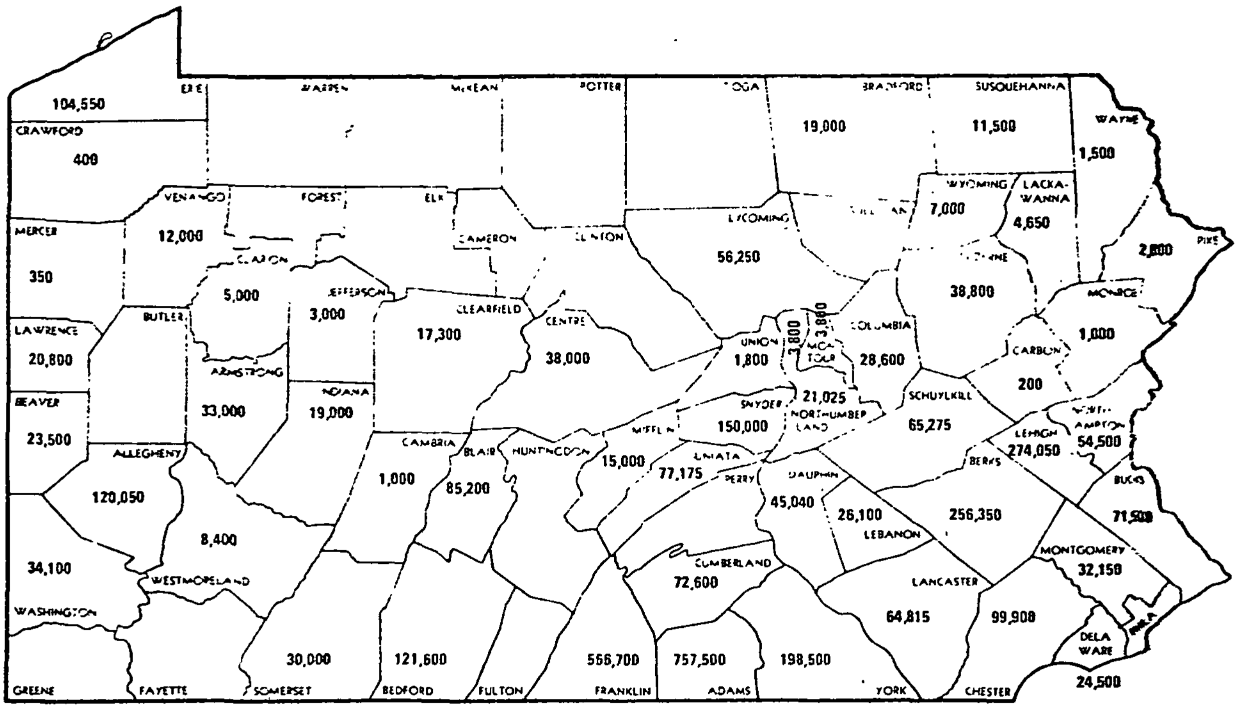
PENNSYLVANIA: APPLE COLD STORAGE BUSHEL CAPACITY BY COUNTY AND DISTRICT - 1978



PENNSYLVANIA: APPLE COLD STORAGE CAPACITY BY DISTRICT - 1978

District	Bushel	District	Bushel	District	Bushel
(1) Northwestern.......	117,300	(4) West Central......	104,300	(7) Southwestern......	192,500
(2) North Central......	75,250	(5) Central...........	483,940	(8) South Central.....	1,716,900
(3) Northeastern.......	24,650	(6) East Central......	435,825	(9) Southeastern......	575,315

Total Apple Cold Storage Bushel Capacity - 3,726,030

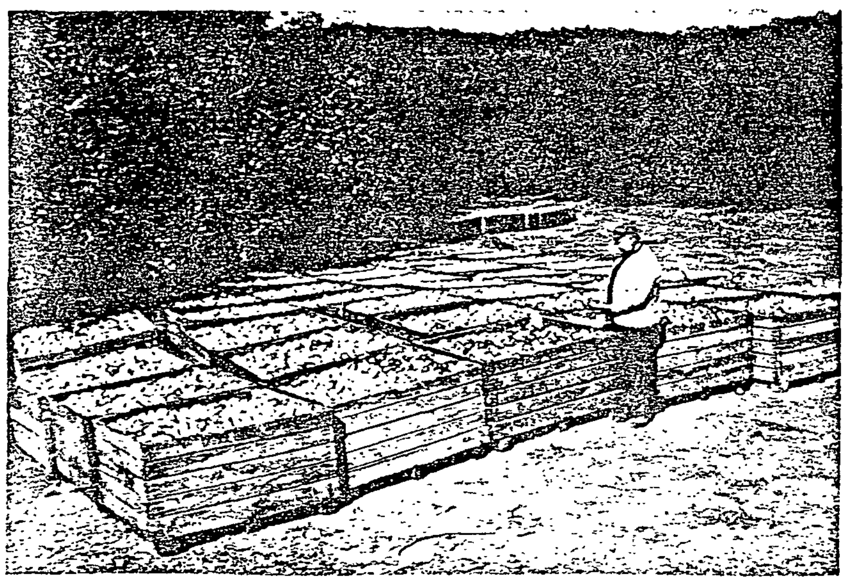


Photo Credit: Tom Piper

PENNSYLVANIA: APPLES (COMMERCIAL): PRODUCTION, DISPOSITION AND VALUE, 1930-1978

Year	Production 1/		Utilization						Price Per Pound 3/	Value Of Utilized Production
			Sales							
	Total	Utilized	Fresh & Home Use	Juice	Canned	Frozen	Other Sales	All Processed		
	Million Pounds								Cents	Thous.Dols
1930	424.0	424.0	100.5	2/	-	-	323.5	323.5	1.10	10,704
1940	359.0	348.5	225.3	2/	61.3	-	61.9	123.2	.60	4,728
1950	263.0	263.0	141.5	2/	67.1	5.8	48.6	121.5	1.60	9,718
1960	322.0	322.0	150.4	2/	125.4	19.7	26.5	171.6	3.90	12,526
1970	540.0	510.0	195.0	78.9	225.1	2.6	8.4	315.0	3.80	19,329
1971	540.0	505.0	185.0	124.4	186.8	1.5	7.3	320.0	3.90	19,695
1972	400.0	400.0	169.9	64.0	163.7	.8	1.6	230.1	5.40	21,680
1973	500.0	500.0	186.9	50.1	250.1	4.4	8.5	313.1	8.70	43,500
1974	480.0	480.0	168.1	62.7	222.1	3.8	23.3	311.9	8.30	39,840
1975	550.0	503.5	228.2	62.2	201.5	3.9	7.7	275.3	5.90	29,707
1976	360.0	359.0	151.5	69.2	128.5	6.1	3.7	207.5	8.30	29,797
1977	460.0	460.0	166.1	89.9	186.9	10.4	6.7	293.9	9.10	41,860
1978	400.0	400.0	158.9	70.3	151.8	3.2	15.8	241.1	8.90	35,600

1/ Total production is the quantity actually harvested plus quantities not harvested because of economic reasons. Utilized production is the amount sold plus the quantities used at home or held in storage. When total and utilized production are equal, economic abandonment and cullage quantities are considered at a "normal" level.
2/ Juice is included in "other sales".
3/ Fresh and processing prices combined.

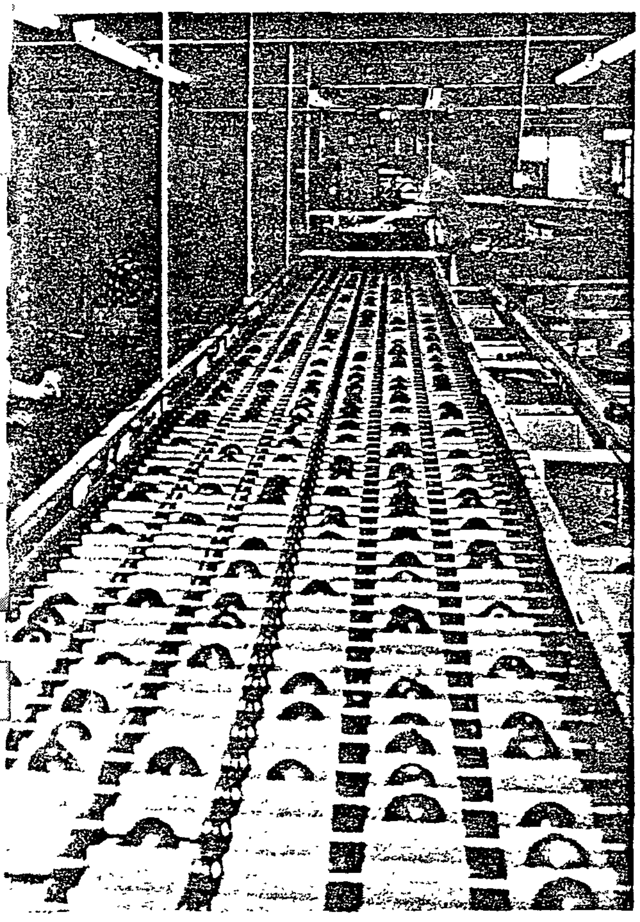


Photo Credit: Tom Piper

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PENNSYLVANIA: APPLES (TOTAL): COMPARISON OF ORCHARDS AND TREES OF ALL AGES BY COUNTIES, 1967, 1972 AND 1978

County & District	Tree Survey, 1967		Tree Survey, 1972 1/		Tree Survey, 1978	
	Number Of Orchards	Total Trees	Number Of Orchards	Total Trees	Number Of Orchards	Total Trees
Crawford	2	1,450	-	-	7	2,784
Erie	94	52,164	64	61,011	62	71,702
Forest	-	-	-	-	-	-
Mercer	4	29,972	-	-	12	3,076
Venango	6	10,005	4	9,351	4	5,717
Warren	-	-	-	-	-	-
NORTHWESTERN, TOTAL	106	93,591	-	-	85	83,279
Bradford	8	4,334	5	3,253	8	6,909
Cameron	-	-	-	-	-	-
Clinton	3	2/	4	1,122	2	2/
Elk	-	-	-	-	3	501
Lycoming	8	8,973	3	7,416	16	16,647
McKean	3	944	-	-	1	2/
Potter	1	2/	-	-	2	2/
Sullivan	-	-	-	-	-	-
Tioga	5	2,501	-	-	3	1,856
NORTH CENTRAL, TOTAL	28	17,684	-	-	35	27,428
Lackawanna	11	3,294	8	2,388	10	6,524
Susquehanna	3	1,920	-	-	2	3/
Wayne	5	1,778	-	-	3	3,578
Wyoming	9	6,428	4	5,309	4	6,946
NORTHEASTERN, TOTAL	28	13,420	-	-	19	17,048
Armstrong	3	5,037	3	4,405	4	6,029
Beaver	14	10,919	9	7,013	16	8,061
Butler	6	17,633	-	-	6	1,835
Clarion	1	2/	-	-	2	2/
Indiana	9	3,435	6	5,305	16	11,014
Jefferson	2	2/	-	-	1	2/
Lawrence	13	5,591	4	2,136	10	4,274
WEST CENTRAL, TOTAL	48	45,758	-	-	55	35,411
Blair	12	38,279	10	41,594	6	35,094
Cambria	2	206	-	-	4	969
Centre	3	10,340	3	16,046	4	16,282
Clearfield	5	3,147	-	-	4	4,979
Columbia	13	5,471	12	6,639	15	8,834
Dauphin	5	13,357	5	11,071	9	11,778
Huntingdon	4	5,078	-	-	4	1,502
Juniata	15	15,234	12	19,757	14	24,558
Mifflin	6	3,489	3	2,613	4	4,598
Montour	2	362	3	444	2	3/
Northumberland	25	16,063	19	10,769	28	14,930
Perry	6	3,088	3	2,539	10	3,477
Snyder	25	28,048	18	28,358	19	40,304
Union	3	555	-	-	6	1,762
CENTRAL, TOTAL	126	142,717	-	-	129	169,067
Carbon	5	894	4	566	6	2,661
Lehigh	26	81,783	17	75,516	20	101,824
Luzerne	23	11,477	16	6,906	22	9,296
Monroe	3	668	-	-	2	2/
Northampton	10	10,450	7	18,410	6	25,695
Pike	-	-	-	-	1	2/
Schuylkill	42	23,166	30	17,301	42	19,780
EAST CENTRAL, TOTAL	109	128,438	-	-	99	160,691
Allegheny	20	30,444	14	7,150	19	35,938
Fayette	2	2,227	-	-	1	2/
Greene	2	408	-	-	2	2/
Somerset	3	5,380	-	-	2	2/
Washington	17	12,613	6	6,886	17	16,578
Westmoreland	6	3,387	4	2,324	8	4,183
SOUTHWESTERN, TOTAL	50	54,459	-	-	49	62,214
Adams	183	693,828	165	806,145	161	929,291
Bedford	26	39,648	20	45,239	21	52,128
Cumberland	15	42,225	14	48,204	16	51,481
Franklin	78	277,425	50	275,991	48	299,795
Fulton	1	3/	-	-	1	3/
York	56	59,192	44	57,305	55	79,244
SOUTH CENTRAL, TOTAL	359	1,112,318	-	-	302	1,411,939
Berks	39	86,799	34	80,781	35	87,010
Bucks	10	9,312	8	11,417	20	19,405
Chester	15	29,047	11	19,426	14	31,066
Delaware	6	2/	3	2,655	8	3,828
Lancaster	23	20,390	18	21,153	23	21,165
Lebanon	6	11,149	4	9,249	4	6,755
Montgomery	14	6,569	1	6,105	16	9,352
Philadelphia	1	2/	-	-	-	-
SOUTHEASTERN, TOTAL	114	166,500	-	-	120	178,581
TOTAL, OTHER	-	-	30	46,340	-	-
PENNSYLVANIA	968	1,774,885	715	1,815,608	893	2,145,658

1/ Comparable data only available on counties listed for 1972 survey. 2/ Not published separately to avoid disclosure of individual operations. 3/ Susquehanna County combined with Wayne County; Fulton County combined with Bedford County; Montour County combined with Northumberland County to avoid disclosure of individual operations.

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PENNSYLVANIA: APPLES (TOTAL): NUMBER OF TREES BY COUNTIES AND AGE GROUPS, 1978 1/

County And District	Number Of Trees Maintained For Production According To Year Set Out					Percent Of Total
	1975-1977 (1-3 Yrs.)	1972-1974 (4-6 Yrs.)	1957-1971 (7-21 Yrs.)	1956 & Earlier (22 Yrs +)	Total All Ages	
Crawford	281	70	2,002	431	2,784	.13
Erie	15,688	17,696	26,519	11,799	71,702	3.34
Forest	-	-	-	-	-	-
Mercer	460	175	1,946	495	3,076	.14
Venango	2,075	506	2,035	1,101	5,717	.27
Warren	-	-	-	-	-	-
NORTHWESTERN, TOTAL	18,504	18,447	32,502	13,826	83,279	3.88
Bradford	2,116	398	1,382	3,013	6,909	.32
Cameron	-	-	-	-	-	-
Elk	-	261	115	125	501	.02
Lycoming	10,389	678	2,770	2,810	16,647	.78
Potter, Clinton & McKean	45	10	184	1,276	1,515	.07
Sullivan	-	-	-	-	-	-
Tioga	31	-	18	1,807	1,856	.09
NORTH CENTRAL, TOTAL	12,581	1,347	4,469	9,031	27,428	1.28
Lackawanna	596	635	1,388	3,905	6,524	.31
Wayne & Susquehanna	853	125	1,742	858	3,578	.17
Wyoming	700	101	222	5,923	6,946	.32
NORTHEASTERN, TOTAL	2,149	861	3,352	10,686	17,048	.80
Armstrong	825	75	3,718	1,411	6,029	.28
Beaver	1,118	1,279	4,145	1,519	8,061	.37
Butler	995	327	221	292	1,835	.09
Clarion & Jefferson	650	3,125	140	283	4,198	.20
Indiana	1,831	239	7,680	1,264	11,014	.51
Lawrence	347	191	1,843	1,893	4,274	.20
WEST CENTRAL, TOTAL	5,766	5,236	17,747	6,662	35,411	1.65
Blair	3,450	2,375	24,018	5,251	35,094	1.64
Cambria	-	20	668	281	969	.05
Centre	1,255	7,275	5,334	2,418	16,282	.76
Clearfield	2,325	145	2,013	496	4,979	.23
Columbia	2,259	2,215	3,305	1,055	8,834	.41
Dauphin	876	1,428	6,880	2,594	11,778	.55
Huntingdon	220	130	812	340	1,502	.07
Juniata	4,773	1,934	13,797	4,054	24,558	1.15
Mifflin	100	100	3,548	850	4,598	.21
Montour & Northumberland	3,036	2,295	7,619	1,980	14,930	.69
Perry	3	225	1,666	1,583	3,477	.16
Snyder	8,921	6,239	16,709	8,435	40,304	1.88
Union	384	2	623	753	1,762	.08
CENTRAL, TOTAL	27,602	24,383	86,992	30,090	169,067	7.88
Lehigh	17,111	11,128	51,684	21,901	101,824	4.75
Luzerne	1,427	769	2,164	4,936	9,296	.43
Northampton	4,065	5,110	15,584	936	25,695	1.20
Pike, Carbon & Monroe	255	2,041	379	1,421	4,096	.19
Schuylkill	3,993	2,932	8,787	4,068	19,780	.92
EAST CENTRAL, TOTAL	26,851	21,980	78,598	33,262	160,691	7.49
Allegheny	2,859	1,501	25,304	6,274	35,938	1.67
Somerset, Greene & Fayette	260	224	4,957	74	5,515	.26
Washington	1,054	1,169	12,958	1,397	16,578	.77
Westmoreland	1,611	180	2,011	381	4,183	.20
SOUTHWESTERN, TOTAL	5,784	3,074	45,230	8,126	62,214	2.90
Adams	118,428	87,794	455,096	267,973	929,291	43.31
Cumberland	5,414	4,246	16,813	25,008	51,481	2.40
Franklin	35,512	50,522	114,688	99,073	299,795	13.97
Fulton & Bedford	12,930	4,240	28,167	6,791	52,128	2.43
York	13,463	10,837	39,196	15,748	79,244	3.69
SOUTH CENTRAL	185,747	157,639	653,960	414,593	1,411,939	65.80
Berks	11,677	12,711	41,363	21,259	87,010	4.05
Bucks	2,703	3,831	6,362	6,509	19,405	.90
Chester	7,862	6,237	11,815	5,152	31,066	1.45
Delaware	988	8	1,478	1,354	3,828	.18
Lancaster	2,733	3,551	9,368	5,513	21,165	.99
Lebanon	485	2,247	2,812	1,211	6,755	.31
Montgomery	512	1,112	4,415	3,313	9,352	.44
Philadelphia	-	-	-	-	-	-
SOUTHEASTERN, TOTAL	26,960	29,697	77,613	44,311	178,581	8.32
PENNSYLVANIA	311,944	262,664	1,000,463	570,587	2,145,658	100.00
PERCENT OF TOTAL TREES	14.5	12.3	46.6	26.6	100.0	-

1/ Some counties are combined to avoid disclosure of individual operations.

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PENNSYLVANIA: APPLES (TOTAL): NUMBER OF STANDARD SIZE TREES BY COUNTIES AND AGE GROUPS - 1978 1/

County & District	Number Of Trees Maintained For Production According To Year Set Out					Percent Of Total
	1975-1977 (1-3 Yrs.)	1972-1974 (4-6 Yrs.)	1957-1971 (7-21 Yrs.)	1956 & Earlier (22 Yrs +)	Total All Ages	
Crawford	56	70	157	431	714	.05
Erie	2,594	1,705	8,845	9,683	22,827	1.63
Forest	-	-	-	-	-	-
Mercer	-	135	1,845	495	2,475	.18
Venango	1,000	-	1,860	1,101	3,961	.28
Warren	-	-	-	-	-	-
NORTHWESTERN, TOTAL	3,650	1,910	12,707	11,710	29,977	2.14
Bradford	515	185	1,087	2,843	4,630	.33
Cameron	-	-	-	-	-	-
Elk	-	213	115	125	453	.03
Lycoming	105	5	1,184	2,810	4,104	.30
Potter, Clinton & McKean	25	-	20	1,226	1,271	.09
Sullivan	-	-	-	-	-	-
Tioga	-	-	-	1,796	1,796	.13
NORTH CENTRAL, TOTAL	645	403	2,406	8,800	12,254	.88
Lackawanna	85	110	1,228	3,905	5,328	.38
Wayne & Susquehanna	-	-	120	858	978	.07
Wyoming	50	101	222	5,923	6,296	.45
NORTHWESTERN, TOTAL	135	211	1,570	10,686	12,602	.90
Armstrong	125	75	1,957	1,411	3,568	.25
Beaver	95	65	1,540	1,098	2,798	.20
Butler	485	315	155	292	1,247	.09
Clarion & Jefferson	-	-	140	283	423	.03
Indiana	94	127	4,060	1,264	5,545	.40
Lawrence	102	20	476	1,893	2,491	.18
WEST CENTRAL, TOTAL	901	602	8,328	6,241	16,072	1.15
Blair	-	-	17,263	5,251	22,514	1.61
Cambria	-	20	68	281	369	.03
Centre	35	120	2,139	2,388	4,682	.33
Clearfield	-	-	1,691	496	2,187	.16
Columbia	35	57	715	1,017	1,824	.13
Dauphin	87	79	3,894	2,544	6,604	.47
Huntingdon	-	60	89	340	489	.04
Juniata	761	320	12,262	4,054	17,397	1.24
Mifflin	100	100	566	840	1,606	.11
Montour & Northumberland	329	452	5,998	1,980	8,759	.63
Perry	-	143	1,439	1,543	3,125	.22
Snyder	723	701	14,935	8,191	24,550	1.76
Union	374	2	8	753	1,137	.08
CENTRAL, TOTAL	2,444	2,054	61,067	29,678	95,243	6.81
Lehigh	7,561	7,264	34,625	21,566	71,016	5.08
Luzerne	100	34	572	4,835	5,541	.40
Northampton	1,205	1,180	11,821	934	15,140	1.08
Carbon, Monroe & Pike	12	12	3	1,401	1,428	.10
Schuylkill	176	991	7,610	4,051	12,828	.92
EAST CENTRAL, TOTAL	9,054	9,481	54,631	32,787	105,953	7.58
Allegheny	2,346	596	10,501	6,113	19,556	1.40
Fayette, Greene & Somerset	100	-	4,017	49	4,166	.30
Washington	19	425	11,943	1,397	13,784	.98
Westmoreland	-	6	453	381	840	.06
SOUTHWESTERN, TOTAL	2,465	1,027	26,914	7,940	38,346	2.74
Adams	15,879	35,054	358,580	264,437	673,950	48.19
Cumberland	364	1,496	15,751	22,188	39,799	2.85
Franklin	16,137	29,373	99,367	94,791	239,668	17.14
Bedford & Fulton	100	140	18,089	6,482	24,811	1.78
York	854	1,772	18,551	14,115	35,292	2.52
SOUTH CENTRAL, TOTAL	33,334	67,835	510,338	402,013	1,013,520	72.48
Berks	428	3,642	13,223	18,284	35,577	2.54
Bucks	111	883	3,393	6,435	10,822	.77
Chester	85	185	6,286	4,482	11,038	.79
Delaware	80	-	152	1,309	1,541	.11
Lancaster	172	228	3,009	5,370	8,779	.63
Lebanon	-	75	847	1,211	2,133	.15
Montgomery	10	130	1,269	3,153	4,562	.33
Philadelphia	-	-	-	-	-	-
SOUTHEASTERN, TOTAL	886	5,143	28,179	40,244	74,452	5.32
PENNSYLVANIA	53,514	88,666	706,140	550,099	1,398,419	100.00
PERCENT OF TOTAL TREES	3.8	6.4	50.5	39.3	100.0	-

1/ Some counties are combined to avoid disclosure of individual operations.

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PENNSYLVANIA: APPLES (TOTAL): NUMBER OF SIZE CONTROLLED TREES BY COUNTIES AND AGE GROUPS, 1978 1/

County & District	Number Of Trees Maintained For Production According To Year Set Out					Percent Of Total
	1975-1977 (1-3 Yrs.)	1972-1974 (4-6 Yrs.)	1957-1971 (7-21 Yrs.)	1956 & Earlier (22 Yrs +)	Total All Ages	
Crawford	225	-	1,845	-	2,070	.28
Erie	13,094	15,991	17,674	2,116	48,875	6.54
Forest	-	-	-	-	-	-
Mercer	460	40	101	-	601	.08
Venango	1,075	506	175	-	1,756	.23
Warren	-	-	-	-	-	-
NORTHWESTERN, TOTAL	14,854	16,537	19,795	2,116	53,302	7.13
Bradford	1,601	213	295	170	2,279	.30
Cameron	-	-	-	-	-	-
Elk	-	48	-	-	48	.01
Lycoming	10,284	673	1,586	-	12,543	1.68
Potter, Clinton & McKean	20	10	164	50	244	.03
Sullivan	-	-	-	-	-	-
Tioga	31	-	18	11	60	.01
NORTH CENTRAL, TOTAL	11,936	944	2,063	231	15,174	2.03
Lackawanna	511	525	160	-	1,196	.16
Wayne & Susquehanna	853	125	1,622	-	2,600	.35
Wyoming	650	-	-	-	650	.08
NORTHEASTERN, TOTAL	2,014	650	1,782	-	4,446	.59
Armstrong	700	-	1,761	-	2,461	.33
Beaver	1,023	1,214	2,605	421	5,263	.70
Butler	510	12	66	-	588	.08
Clarion & Jefferson	650	3,125	-	-	3,775	.51
Indiana	1,737	112	3,620	-	5,469	.73
Lawrence	245	171	1,367	-	1,783	.24
WEST CENTRAL, TOTAL	4,865	4,634	9,419	421	19,339	2.59
Blair	3,450	2,375	6,755	-	12,580	1.69
Cambria	-	-	600	-	600	.08
Centre	1,220	7,155	3,195	30	11,600	1.55
Clearfield	2,325	145	322	-	2,792	.37
Columbia	2,224	2,158	2,590	38	7,010	.94
Dauphin	789	1,349	2,986	50	5,174	.69
Huntingdon	220	70	723	-	1,013	.14
Juniata	4,012	1,614	1,535	-	7,161	.96
Mifflin	-	-	2,982	10	2,992	.40
Montour & Northumberland	2,707	1,843	1,621	-	6,171	.82
Perry	3	82	227	40	352	.05
Snyder	8,198	5,538	1,774	244	15,754	2.11
Union	10	-	615	-	625	.08
CENTRAL, TOTAL	25,158	22,329	25,925	412	73,824	9.88
Lehigh	9,550	3,864	17,059	335	30,808	4.13
Luzerne	1,327	735	1,592	101	3,755	.50
Monroe, Carbon & Pike	243	2,029	376	20	2,668	.36
Northampton	2,860	3,930	3,763	2	10,555	1.41
Schuylkill	3,817	1,941	1,177	17	6,952	.93
EAST CENTRAL, TOTAL	17,797	12,499	23,967	475	54,738	7.33
Allegheny	513	905	14,803	161	16,382	2.19
Somerset, Greene & Fayette	160	224	940	25	1,349	.18
Washington	1,035	744	1,015	-	2,794	.37
Westmoreland	1,611	174	1,558	-	3,343	.45
SOUTHWESTERN, TOTAL	3,319	2,047	18,316	186	23,868	3.19
Adams	102,549	52,740	96,516	3,536	255,341	34.17
Bedford & Fulton	12,830	4,100	10,078	309	27,317	3.66
Cumberland	5,050	2,750	1,062	2,820	11,682	1.56
Franklin	19,375	21,149	15,321	4,282	60,127	8.05
York	12,609	9,065	20,645	1,633	43,952	5.88
SOUTH CENTRAL, TOTAL	152,413	89,804	143,622	12,580	398,419	53.32
Berks	11,249	9,069	28,140	2,975	51,433	6.88
Bucks	2,592	2,948	2,969	74	8,583	1.15
Chester	7,777	6,052	5,529	670	20,028	2.68
Delaware	908	8	1,326	45	2,287	.31
Lancaster	2,561	3,323	6,359	143	12,386	1.66
Lebanon	485	2,172	1,965	-	4,622	.62
Montgomery	502	982	3,146	160	4,790	.64
Philadelphia	-	-	-	-	-	-
SOUTHEASTERN, TOTAL	26,074	24,554	49,434	4,067	104,129	13.94
PENNSYLVANIA	258,430	173,998	294,323	20,488	747,239	100.00
PERCENT OF TOTAL TREES	34.6	23.3	39.4	2.7	100.0	-

1/ Some counties are combined to avoid disclosure of individual operations.

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PENNSYLVANIA: APPLES (TOTAL): ALL TYPES OF TREES BY VARIETY AND AGE GROUPS - 1978

Variety	1975-1977 (1-3 Yrs.)	1972-1974 (4-6 Yrs.)	1957-1971 (7-21 Yrs.)	1956 & Earlier (22 Yrs +)	Total All Ages	Percent Of Total
SUMMER:						
Beacon	1,644	1,464	7,759	131	10,998	.5
Early Blaze	359	1,128	1,635	240	3,372	.2
Early McIntosh	2,866	1,348	3,817	1,255	9,286	.4
Lodi	555	464	2,698	913	4,630	.2
Rambo	861	1,166	7,587	7,143	16,757	.8
Other Summer	2,364	1,055	4,125	1,916	9,460	.5
TOTAL SUMMER	8,659	6,625	27,621	11,598	54,503	2.6
FALL:						
Grimes Golden	117	112	1,539	2,876	4,644	.2
Jonathan	7,658	5,565	44,216	23,793	81,232	3.8
Paulared (Size Controlled Only)	3,890	426	775	-	5,091	.2
Smokehouse	195	556	1,467	1,260	3,478	.2
Tydemans Red (Size Controlled Only)	926	7,928	1,669	-	10,523	.5
Other Fall	2,425	1,280	5,198	2,642	11,545	.5
TOTAL FALL	15,211	15,867	54,864	30,571	116,513	5.4
WINTER:						
Cortland	6,168	4,180	10,678	9,740	30,766	1.4
Empire (Size Controlled Only)	2,939	216	620	-	3,775	.2
Golden Delicious	34,117	35,299	176,463	95,881	341,760	15.9
Greenings	2,945	1,976	8,285	2,888	16,094	.8
Idared	7,593	1,652	4,532	540	14,417	.7
Macoun	1,369	870	1,153	520	3,912	.2
McIntosh	17,068	12,861	32,512	18,517	80,958	3.8
Northern Spy	3,845	1,699	2,920	4,565	13,029	.6
Red Delicious	124,537	109,791	288,282	72,627	595,237	27.7
Rome Red	22,666	18,923	88,453	38,136	168,178	7.8
Rome Regular	10,607	7,551	25,109	33,008	76,275	3.6
Spartan	1,746	1,067	3,143	7	5,963	.3
Stayman	19,342	12,374	71,140	79,702	183,058	8.5
Winesap	2,366	2,590	13,269	5,923	24,148	1.1
York Red	11,695	12,317	90,443	46,567	161,022	7.5
York Regular	16,523	13,826	96,686	115,727	242,767	11.3
Other Winter	1,943	2,980	4,290	4,070	13,283	.6
TOTAL WINTER	288,074	240,172	917,978	528,418	1,974,642	92.0
TOTAL APPLES	311,944	262,664	1,000,463	570,587	2,145,658	100.0

PENNSYLVANIA: APPLES (TOTAL): TOTAL TREES, PERCENT AGE BREAKDOWN OF TREES, PRODUCTION AND YIELD BY VARIETY 1978

Variety	Total Trees	Percent Of Trees Planted In: 1975-1977 (1-3 Yrs.)	1972-1974 (4-6 Yrs.)	1957-1971 (7-21 Yrs.)	1956 & Earlier (22 Yrs. +)	Production 1/	Yield Per Tree 2/
		Percent	Percent	Percent	Percent	Bushels	Bushels
Beacon	10,998	15	13	71	1	28,502	3.0
Cortland	30,766	20	13	35	32	126,430	5.1
Early Blaze	3,372	11	34	48	7	5,125	1.7
Early McIntosh	9,286	31	15	41	13	31,460	4.9
Empire (Size Controlled Only)	3,775	78	6	16	-	1,700	2.0
Golden Delicious	341,760	10	10	52	28	2,152,577	7.0
Greenings	16,094	18	12	52	18	54,901	4.2
Grimes Golden	4,644	3	2	33	62	34,719	7.7
Idared	14,417	53	12	31	4	31,101	4.6
Jonathan	81,232	10	7	54	29	384,364	5.2
Lodi	4,630	12	10	58	20	24,196	5.9
Macoun	3,912	35	22	30	13	11,948	4.7
McIntosh	80,958	21	16	40	23	302,432	4.7
Northern Spy	13,029	30	13	22	35	42,271	4.6
Paulared (Size Controlled Only)	5,091	77	8	15	-	5,147	4.3
Rambo	16,757	5	7	45	43	101,726	6.4
Red Delicious	595,237	21	18	49	12	1,864,410	4.0
Rome Red	168,178	13	11	53	23	919,494	6.3
Rome Regular	76,275	14	10	33	43	509,751	7.8
Smokehouse	3,478	6	16	42	36	22,125	6.7
Spartan	5,963	29	18	53	-	13,393	3.2
Stayman	183,058	11	7	39	43	1,108,363	6.8
Tydemans Red (Size Controlled)	10,523	9	75	16	-	9,221	1.0
Winesap	24,148	10	11	55	24	103,529	4.8
York Red	161,022	7	8	56	29	1,160,075	7.8
York Regular	242,767	7	6	40	47	1,730,408	7.6
Other Summer	9,460	25	11	44	20	34,600	4.9
Other Fall	11,545	21	11	45	23	38,973	4.3
Other Winter	13,283	15	22	32	31	63,581	5.6
All Varieties	2,145,658	14	12	47	27	10,916,522	6.0

1/ Production in 1977 from acreage maintained for production in 1978.

2/ Yield calculations are derived excluding the 1-3 year age category trees.

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PENNSYLVANIA: APPLES (TOTAL): STANDARD TREES BY VARIETY AND AGE GROUPS - 1978

Variety	1975-1977 (1-3 Yrs.)	1972-1974 (4-6 Yrs.)	1957-1971 (7-21 Yrs.)	1956 & Earlier (22 Yrs. +)	Total All Ages
SUMMER					
Beacon (Fenton)	93	776	3,064	71	4,009
Earliblaze	64	297	1,599	65	2,025
Gravenstein	-	-	-	-	-
Lodi	96	119	1,764	888	2,867
Rambo	394	777	6,761	7,128	15,060
Strawberry	520	-	78	210	808
Yellow Transparent	32	5	304	338	679
Early McIntosh	118	302	2,121	1,219	3,760
Other Summer	119	330	1,739	1,297	3,485
TOTAL SUMMER	1,441	2,606	17,430	11,216	32,693
FALL					
Winter Banana	-	-	-	-	-
Grimes Golden	30	45	1,299	2,864	4,238
Jonathan	1,201	2,794	32,442	23,173	59,610
Wealthy	-	-	46	705	751
Tydemans Red	-	-	-	-	-
Smokehouse	15	91	1,188	1,258	2,552
Other Fall	452	375	2,764	1,905	5,496
TOTAL FALL	1,698	3,305	37,739	29,905	72,647
WINTER					
Baldwin	-	-	107	1,562	1,669
Cortland	757	583	6,759	8,025	16,124
Delicious (Red)	17,695	22,653	183,165	67,255	290,768
Golden Delicious	8,824	11,899	123,377	93,606	237,706
Idared	113	620	2,497	540	3,770
Macoun	-	210	750	475	1,435
McIntosh	1,145	1,828	19,459	18,347	40,779
Northern Spy	1,495	240	1,872	4,470	8,077
N.W. Greenling	-	1,976	8,082	2,888	12,946
Opalescant	-	50	20	469	539
Spartan	-	66	2,246	7	2,319
Stayman	1,709	2,879	56,524	78,747	139,859
Turley	-	-	484	697	1,181
Lowery	-	-	200	541	741
Red Gold	-	-	654	22	676
Rome Red	8,775	12,420	63,869	36,889	121,953
Rome Regular	3,859	5,708	23,739	32,843	66,149
York Red	3,485	10,227	69,432	41,283	124,427
York Regular	1,661	9,730	76,844	115,006	203,241
Other Winter	41	303	1,267	762	2,373
Winesap	816	1,363	9,624	4,544	16,347
TOTAL WINTER	50,375	82,755	650,971	508,978	1,293,079
TOTAL STANDARD	53,514	88,666	706,140	550,099	1,398,419

Photo Credit: Tom Piper

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BLACK AND WHITE PHOTOGRAPH

PENNSYLVANIA: APPLES (TOTAL): SIZE CONTROLLED TREES BY VARIETY AND AGE GROUPS - 1978

Variety	1975-1977 (1-3 Years)	1972-1974 (4-6 Years)	1957-1971 (7-21 Years)	1956 & Earlier (22 Years +)	Total All Ages
SUMMER:					
Beacon (Fenton).........	1,546	688	4,695	60	6,989
Earliblaze.............	305	831	36	175	1,347
Lodi...................	459	345	934	25	1,763
Jersey Mac.............	695	160	-	-	855
Early McIntosh..........	2,748	1,046	1,696	36	5,526
Ottawa - T-441 (Quinte).	199	336	910	-	1,445
Rambo..................	467	389	826	15	1,697
Other Summer...........	799	224	1,094	71	2,188
TOTAL SUMMER...........	7,218	4,019	10,191	382	21,810
FALL:					
Grimes Golden..........	87	67	240	12	406
Jonathan...............	6,457	2,771	11,774	620	21,622
Paulared...............	3,890	426	775	-	5,091
Smokehouse.............	180	465	279	2	926
Tydeman's Red..........	926	7,928	1,669	-	10,523
Other Fall.............	1,973	905	2,388	32	5,298
TOTAL FALL.............	13,513	12,562	17,125	666	43,866
WINTER:					
Cortland...............	5,411	3,597	3,919	1,715	14,642
Delicious (Red).........	106,842	87,138	105,117	5,372	304,469
Empire.................	2,939	216	620	-	3,775
Golden Delicious.......	25,293	23,400	53,086	2,275	104,054
Granny Smith...........	57	1,382	-	-	1,439
Idared.................	7,580	1,032	2,035	-	10,647
Macoun.................	1,369	660	403	45	2,477
Mutsa..................	1,020	258	589	-	1,867
N.W. Greening..........	2,945	-	203	-	3,148
Northern Spy...........	2,350	1,459	1,048	95	4,952
Stayman................	18,133	9,495	14,616	955	43,199
Winesap................	1,550	1,227	3,645	1,379	7,801
McIntosh...............	15,293	11,033	13,053	170	40,179
Rome, Red..............	13,891	6,503	24,584	1,247	46,225
Rome, Regular..........	6,748	1,843	1,370	165	10,126
Spartan................	1,746	1,001	897	-	3,644
York, Red..............	8,210	2,090	21,011	5,284	36,595
York, Regular..........	14,867	4,096	19,842	721	39,526
Other Winter...........	825	987	969	17	2,798
TOTAL WINTER...........	237,699	157,417	267,007	19,440	681,563
TOTAL SIZE CONTROL.........	258,430	173,998	294,323	20,488	747,239

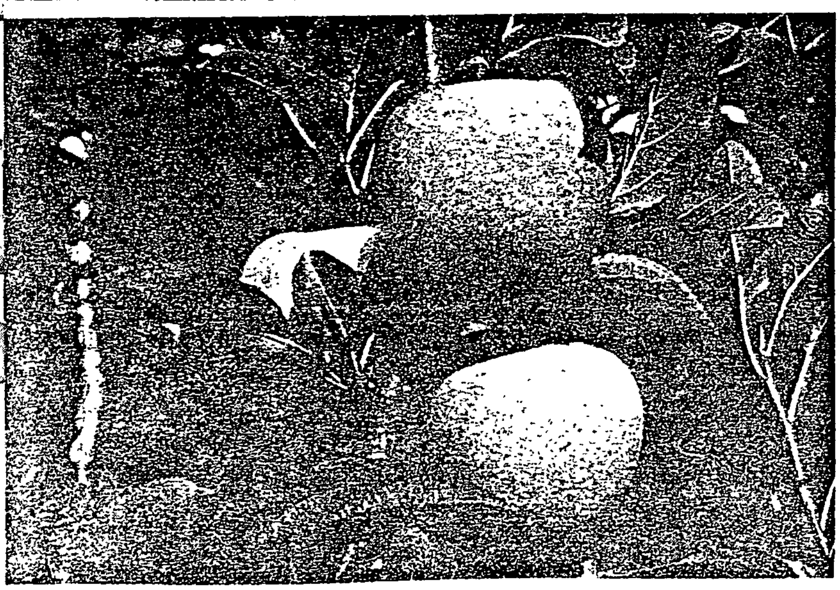

Photo Credit: Tom Piper

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PEACHES

Number Of Orchards And Trees: The number of commercial peach growers (100+ trees) increased from 472 in 1972 to 498 in 1978, or 6 percent. Commercial peach tree numbers have declined 60 percent from the 1953 survey total and 3 percent since 1972. The number of trees in 1978 at 852,052 compares with 882,550 in 1972, down 4 percent. Of the 498 commercial growers, 76, or 15 percent, accounted for 67 percent of the trees.

Photo Credit: Mrs. Gail McPherson

Acreage In Orchards: Commercial peach acreage declined 11 percent from 10,955 acres in 1972 to 9,727.5 acres in 1978. Trees per acre increased from 81 in 1972 to 88 in 1978.

Location Of Trees: Fruit Region I accounts for 541,510 trees or 64 percent of the total. The ten leading counties (Adams, Franklin, York, Lehigh, Berks, Lancaster, Juniata, Erie, Northampton and Snyder) contains 86 percent of the total 856,842 trees.

Age Of Trees: Of the 856,842 total peach trees, 20.6 percent are 1-3 years old, 18.5 percent 4-6 years old, 54.9 percent 7-21 years old and 6 percent 22 years or older.

Varieties: Redhaven is the leading variety, comprising 13 percent of the total 856,842 trees. Other leading varieties as a percent of total trees are: Sunhigh — 11, Loring — 11, Elberta — 7, Redskin — 6, and Blake — 5. Of the total trees 1-3 years old, 14 percent were Redhavens.

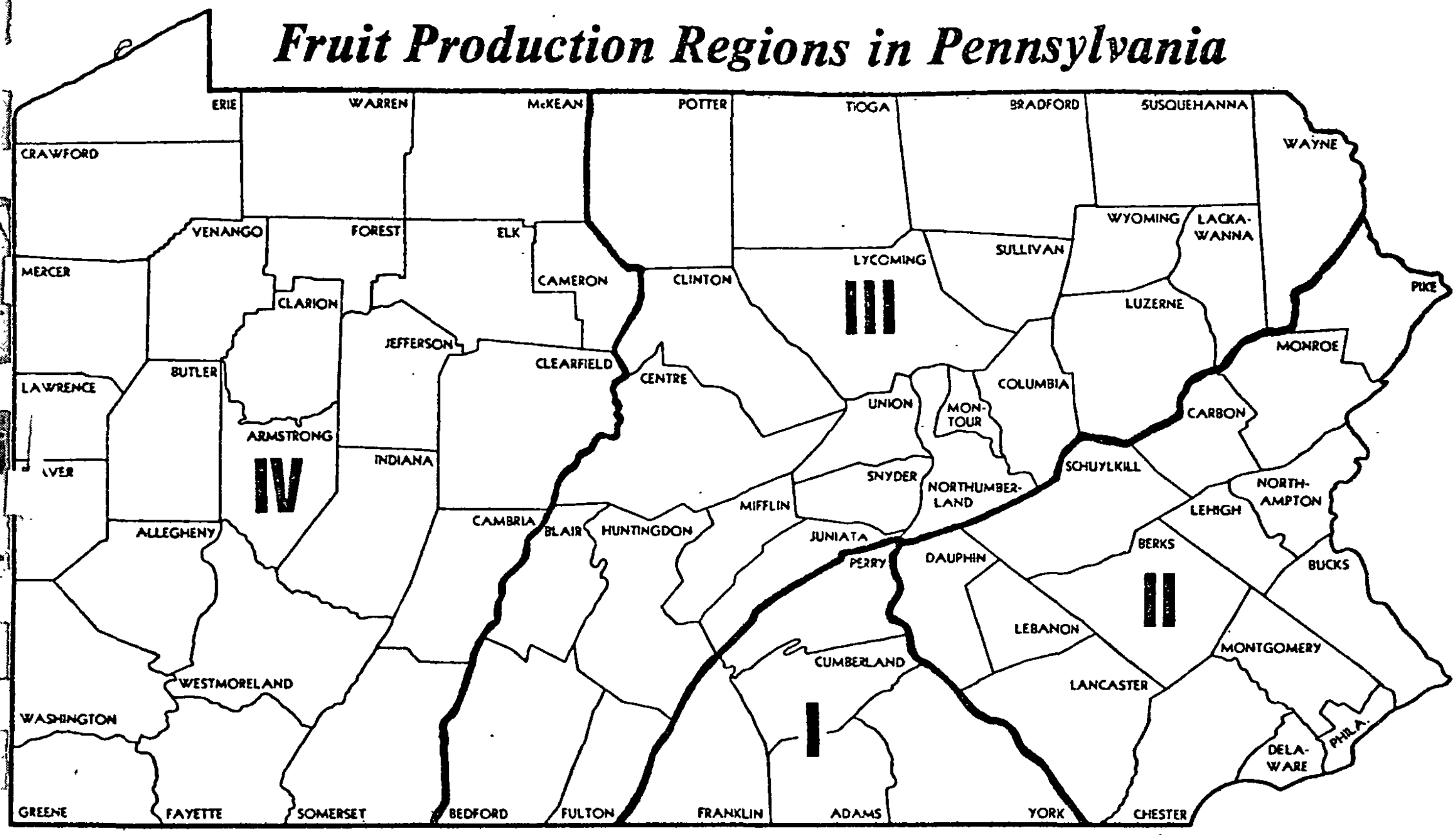
PENNSYLVANIA: PEACHES (COMMERCIAL): COMPARISON OF GROWERS AND TREE NUMBERS BY REGION - 1967, 1972 and 1978

Region	1967 Survey		1972 Survey		1978 Survey		Percent Change 72/78	
	Number Of Orchards	Number Of Trees	Number Of Orchards	Number Of Trees	Number Of Orchards	Number Of Trees	Number Of Orchards	Number Of Trees
I................	281	613,891	225	562,919	198	541,510	-12	-4
II...............	165	288,324	108	204,764	133	199,573	+23	-3
III..............	98	103,412	77	77,807	91	74,716	+18	-4
IV & V...........	121	63,971	62	37,060	76	36,253	+23	-2
PENNSYLVANIA.....	665	1,069,598	472	882,550	498	852,052	+ 6	-3

PENNSYLVANIA: PEACHES (COMMERCIAL): NUMBER AND SIZE OF ORCHARDS BY REGION, 1967, 1972 and 1978

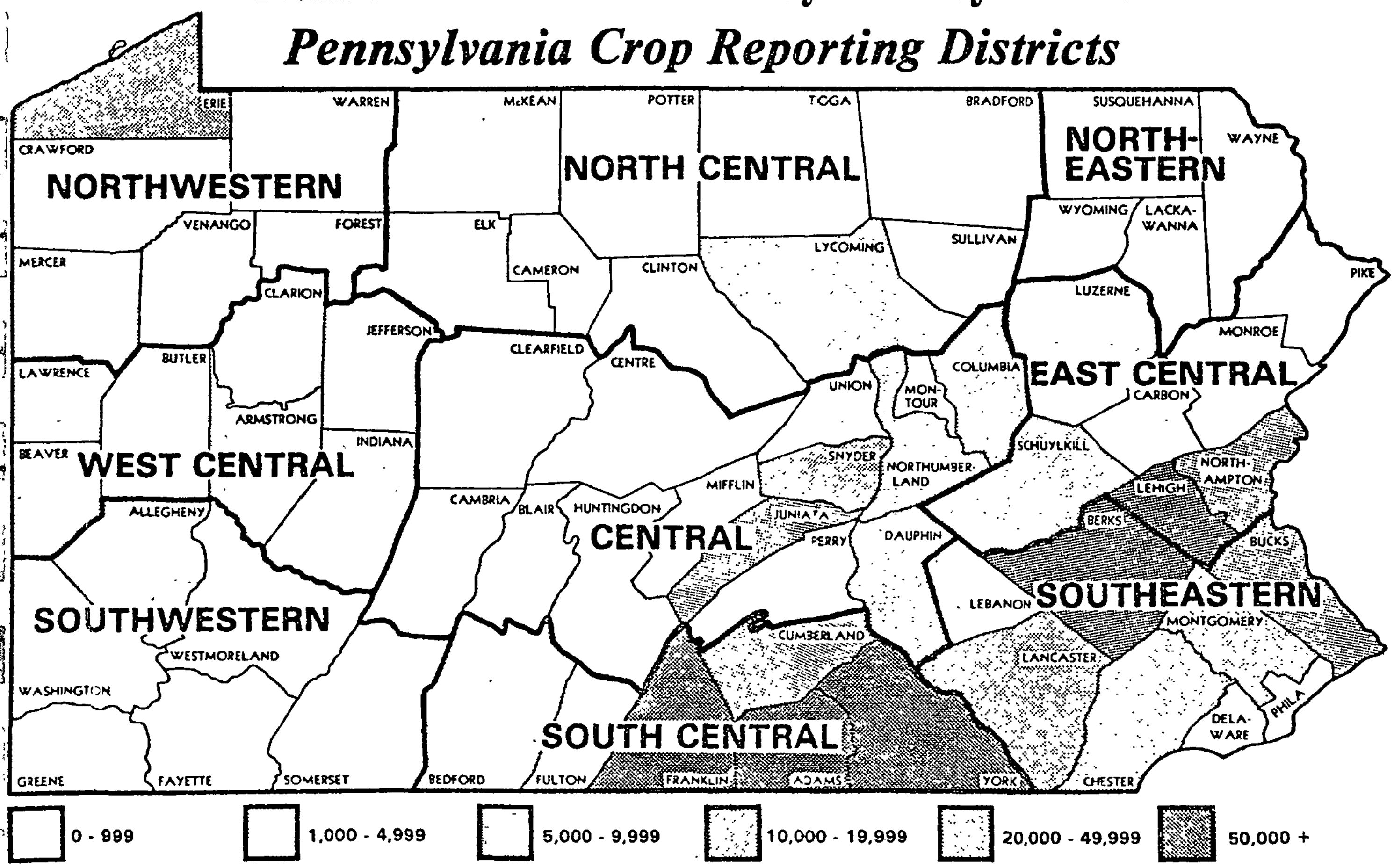
Region	Number Of Orchards			Number Of Peach Orchards By Size Groups											
				100-499 Trees			500-2,499 Trees			2,500-4,999 Trees			5,000 + Trees		
	1967	1972	1978	1967	1972	1978	1967	1972	1978	1967	1972	1978	1967	1972	1978
I............	281	225	198	90	67	60	125	103	87	40	29	31	26	26	20
II...........	165	108	133	59	37	67	75	49	49	17	15	14	14	7	3
III..........	98	77	91	47	39	52	41	31	31	7	5	6	3	2	2
IV & V.......	121	62	76	84	39	51	35	21	25	1	2	-	1	-	-
PENNSYLVANIA..	665	472	498	230	182	230	276	204	192	65	51	51	44	35	25

Fruit Production Regions in Pennsylvania



Number of Peach Trees by County - 1978

Pennsylvania Crop Reporting Districts



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PENNSYLVANIA: PEACHES (TOTAL): GROWERS, ACRES, TREES AND PRODUCTION BY COUNTY AND REGION, 1978 1/

County And Region	Growers		Acres		Total Trees		Trees Per Acre	Production 2/		Bushels Per Tree 3/
	Number	%	Number	%	Number	%		Bushels	%	
REGION I:										
Adams	106	17.2	2,968.5	30.3	255,654	29.8	86	422,698	26.0	2.1
Cumberland	9	1.5	156.0	1.6	14,551	1.7	93	26,664	1.7	1.9
Franklin	43	7.0	1,874.5	19.2	179,435	20.9	96	448,546	27.6	2.9
Perry	7	1.1	25.5	.3	2,294	.3	90	3,395	.2	2.0
York	48	7.8	1,110.4	11.3	90,423	10.6	81	221,041	13.6	3.0
TOTAL	213	34.6	6,134.9	62.7	542,357	63.3	88	1,122,344	69.1	2.5
REGION II:										
Berks	31	5.0	581.4	5.9	50,787	5.9	87	78,009	4.8	2.4
Bucks	14	2.3	114.5	1.2	10,045	1.2	88	20,953	1.3	2.2
Carbon & Monroe	5	.7	9.3	-	720	.1	77	1,015	.1	1.5
Chester	12	1.9	125.3	1.3	9,758	1.1	78	21,155	1.3	2.7
Dauphin	6	1.0	106.0	1.1	8,281	1.0	78	19,020	1.2	2.3
Delaware	6	1.0	34.7	.3	3,504	.4	101	5,359	.3	1.7
Lancaster	27	4.4	387.5	4.0	29,541	3.4	76	65,872	4.1	2.8
Lebanon	3	.5	58.0	.6	4,685	.6	81	11,075	.7	3.6
Lehigh	16	2.6	524.4	5.4	55,900	6.5	107	113,602	7.0	2.7
Montgomery	16	2.6	84.6	.9	6,393	.7	76	12,081	.7	2.5
Northampton	5	.8	215.0	2.2	16,120	1.9	75	24,720	1.5	2.3
Pike	-	-	-	-	-	-	-	-	-	-
Schuylkill	33	5.4	77.0	.8	5,670	.7	74	12,800	.8	2.5
TOTAL	174	28.2	2,317.7	23.7	201,404	23.5	87	385,661	23.8	2.6
REGION III:										
Bedford & Fulton	8	1.3	52.0	.6	5,169	.6	99	7,223	.4	1.7
Blair	4	.7	34.0	.3	3,413	.4	100	400	-	.1
Centre, Huntingdon & Mifflin	5	.8	61.0	.6	3,008	.3	49	4,765	.3	2.5
Clinton, Bradford, Susquehanna & Wyoming	5	.8	10.7	.1	846	.1	79	125	-	.2
Columbia	12	1.9	84.7	.9	7,561	.9	89	17,536	1.1	2.8
Juniata	12	1.9	272.6	2.8	21,755	2.5	80	19,710	1.2	1.2
Lackawanna	4	.7	3.2	-	271	-	85	222	-	.9
Luzerne	9	1.5	39.0	.4	2,538	.3	65	961	.1	.5
Lycoming	13	2.1	59.1	.6	5,919	.7	100	4,055	.3	1.4
Montour & Northumberland	21	3.4	97.2	.9	7,867	1.0	81	10,329	.7	2.1
Potter	-	-	-	-	-	-	-	-	-	-
Snyder	15	2.4	232.2	2.4	15,192	1.8	65	25,112	1.5	1.9
Tioga	-	-	-	-	-	-	-	-	-	-
Union	4	.7	24.5	.3	1,863	.2	76	2,413	.1	1.4
Wayne	-	-	-	-	-	-	-	-	-	-
TOTAL	112	18.2	970.2	9.9	75,402	8.8	78	92,851	5.7	1.6
REGION IV:										
Allegheny	12	1.9	30.7	.3	2,321	.3	76	2,566	.2	1.4
Armstrong	4	.7	26.1	.3	2,285	.3	88	2,105	.1	1.2
Beaver	9	1.5	22.4	.2	1,554	.2	69	1,162	.1	1.0
Butler	3	.5	2.8	-	250	-	89	35	-	.2
Cambria	-	-	-	-	-	-	-	-	-	-
Clearfield	-	-	-	-	-	-	-	-	-	-
Crawford, Elk & Venango	5	.8	3.6	-	382	-	106	552	-	2.1
Greene	-	-	-	-	-	-	-	-	-	-
Indiana	8	1.3	15.9	.2	1,775	.2	112	35	-	-
Lawrence	5	.8	19.1	.2	1,759	.2	92	2,071	.1	1.6
McKean	-	-	-	-	-	-	-	-	-	-
Mercer	8	1.3	46.4	.5	3,301	.4	71	4,479	.3	1.5
Somerset	-	-	-	-	-	-	-	-	-	-
Washington	12	1.9	27.7	.3	2,307	.3	83	1,655	.1	.8
Westmoreland, Clarion, Fayette & Jefferson	4	.7	12.5	.1	1,437	.1	115	280	-	.5
TOTAL	70	11.4	207.2	2.1	17,371	2.0	84	14,940	.9	1.1
REGION V:										
Erie	47	7.6	151.7	1.6	20,308	2.4	134	8,050	.5	.6
TOTAL	47	7.6	151.7	1.6	20,308	2.4	134	8,050	.5	.6
PENNSYLVANIA	616	100.0	9,781.7	100.0	856,842	100.0	88	1,623,846	100.0	2.4

1/ Some counties are combined to avoid disclosure of individual operations.
2/ Production in 1977 from acreage maintained for production in 1978.
3/ Yield calculations are derived excluding the 1-3 year age category trees.

OF POOR QUALITY

PENNSYLVANIA: PEACHES (TOTAL): GROWERS, ACRES, TREES AND PRODUCTION BY SIZE OF OPERATION AND REGION, 1978

Size Of Operation (Trees)	Growers		Trees		Acres		Production 1/	
	Number	Percent	Number	Percent	Number	Percent	Bushels	Percent
Region I:								
1-99	15	7	847	-	10.5	-	2,209	-
100-199	19	9	2,829	-	45.2	1	4,976	1
200-499	41	19	14,677	3	191.1	3	25,190	2
500-999	40	19	32,968	6	411.6	7	72,069	6
1,000-2,499	47	22	76,227	14	942.5	15	184,362	17
2,500-4,999	31	15	112,143	21	1,277.0	21	225,688	20
5,000+	20	9	302,666	56	3,257.0	53	607,850	54
Total	213	100	542,357	100	6,134.9	100	1,122,344	100
Region II:								
1-99	41	24	1,831	1	27.5	1	4,060	1
100-199	30	17	3,597	2	57.3	3	7,139	2
200-499	37	21	12,082	6	159.3	7	21,471	6
500-999	24	14	17,014	8	233.6	10	30,717	8
1,000-2,499	25	14	40,814	20	508.0	22	72,858	19
2,500-4,999	14	8	52,088	26	636.0	27	125,305	32
5,000+	3	2	73,978	37	696.0	30	124,111	32
Total	174	100	201,404	100	2,317.7	100	385,661	100
Region III:								
1-99	21	19	686	1	6.3	1	784	1
100-199	25	22	3,416	4	54.3	6	6,666	7
200-499	27	24	8,315	11	108.5	11	10,639	12
500-999	16	14	10,611	14	148.7	15	8,597	9
1,000-2,499	15	14	22,036	29	269.4	28	24,150	26
2,500-4,999	8	7	30,338	41	383.0	39	42,015	45
5,000+	2/	-	-	-	-	-	-	-
Total	112	100	75,402	100	970.2	100	92,851	100
Region IV:								
1-99	27	39	1,084	6	7.4	4	980	6
100-199	10	14	1,215	7	17.6	8	780	5
200-499	24	34	7,691	44	97.2	47	7,150	48
500-999	9	13	7,381	43	85.0	41	6,030	41
1,000-2,499	2/	-	-	-	-	-	-	-
2,500-4,999	-	-	-	-	-	-	-	-
5,000+	-	-	-	-	-	-	-	-
Total	70	100	17,371	100	207.2	100	14,940	100
Region V:								
1-99	14	30	342	2	2.5	2	69	1
100-199	5	11	715	3	7.7	5	720	9
200-499	12	25	3,551	17	31.9	21	584	7
500-999	11	23	7,822	39	57.5	38	5,345	66
1,000-2,499	5	11	7,878	39	52.1	34	1,332	17
2,500-4,999	-	-	-	-	-	-	-	-
5,000+	-	-	-	-	-	-	-	-
Total	47	100	20,308	100	151.7	100	8,050	100
All Regions:								
1-99	118	19	4,790	1	54.2	1	8,102	1
100-199	89	15	11,772	1	182.1	2	20,281	1
200-499	141	23	46,316	5	588.0	6	65,034	4
500+	268	43	793,964	93	8,957.4	91	1,530,429	94
PENNSYLVANIA	616	100	856,842	100	9,781.7	100	1,623,846	100

1/ Production in 1977 from acreage maintained for production in 1978.
2/ Combined with the 2,500-4,999 size group to avoid disclosure of individual operations.

PENNSYLVANIA: PEACHES - COMPARISON OF COMMERCIAL & NON-COMMERCIAL GROWER AND TREE NUMBERS 1967, 1972, 1978

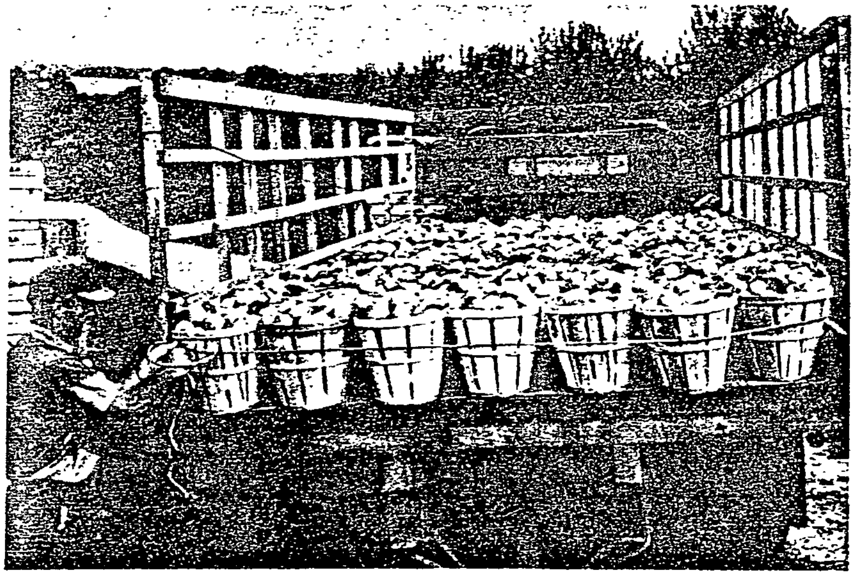
Trees	Number Of Growers			Number Of Trees		
	1967	1972	1978	1967	1972	1978
1-99 1/	115	73	118	4,510	4,451	4,790
100+	665	472	498	1,069,598	882,550	852,052
Total 1/	780	545	616	1,074,108	887,001	856,842

1/ Includes trees in orchards classified as commercial (100+ trees) for any fruit.

PENNSYLVANIA: PEACHES (COMMERCIAL): PRODUCTION, DISPOSITION AND VALUE, 1930-1978

Year	Production 1/	Utilization				Price Per Pound 3/	Value Of Production
		Home Use	Sales				
			Fresh	All Processed	All Sales		
	Million Pounds					Cents	Thous. Dols.
1930	50.1	15.0	-	-	-	3.54	1,775
1940	94.8	11.5	76.7	-	-	1.98	1,830
1950	105.3	10.0	89.6	4.8	95.3	4.38	4,607
1960	139.2	2.9	112.3	24.0	136.3	4.48	6,236
1970	84.0	2/	74.0	10.0	84.0	7.70	6,468
1971	105.0	2/	88.7	16.3	105.0	6.52	6,846
1972	80.0	2/	71.8	8.2	80.0	13.00	10,400
1973	81.0	2/	70.3	10.7	81.0	11.30	9,153
1974	100.0	2/	86.4	13.6	100.0	11.80	11,800
1975	90.0	2/	83.4	6.6	90.0	12.20	10,980
1976	90.0	2/	81.8	8.2	90.0	13.00	11,700
1977	95.0	2/	88.4	6.6	95.0	12.90	12,255
1978	85.0	2/	70.4	14.6	85.0	15.80	13,430

1/ Includes some quantities not harvested and excess cullage. 2/ Included in fresh utilization. 3/ Fresh and processing prices combined.



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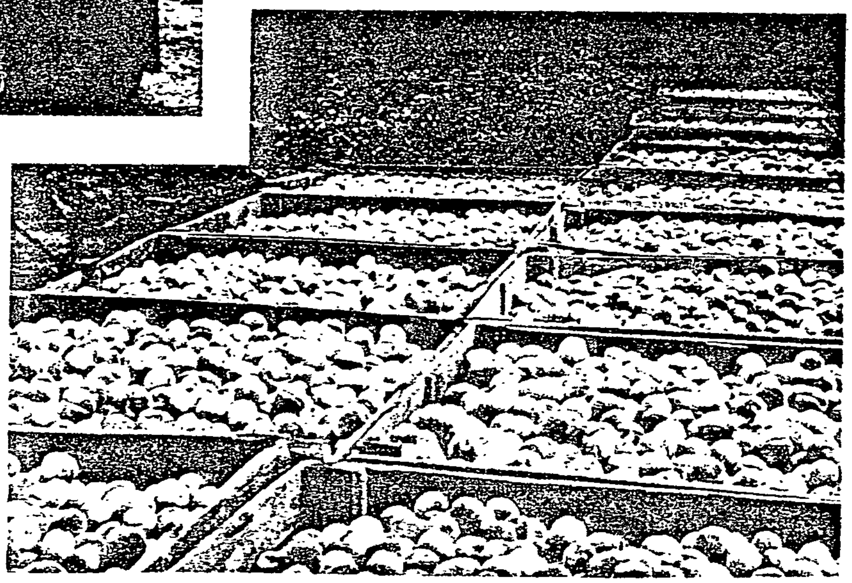

Photo Credit: Tom Piper

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PENNSYLVANIA: PEACHES (TOTAL): COMPARISON OF ORCHARDS AND TREES OF ALL AGES BY COUNTIES, 1967, 1972 AND 1978

County & District	Tree Survey, 1967		Tree Survey, 1972 1/		Tree Survey, 1978	
	Number-Orchards	Total Trees	Number-Orchards	Total Trees	Number-Orchards	Total Trees
Crawford	-	-	-	-	2	2/
Erie	103	38,144	55	23,572	47	20,308
Forest	-	-	-	-	-	-
Mercer	3	1,877	-	-	8	3,301
Venango	3	1,707	-	-	2	2/
Warren	-	-	-	-	-	-
NORTHWESTERN, TOTAL	109	41,728	-	-	59	23,861
Bradford	3	2/	-	-	1	2/
Cameron	-	-	-	-	-	-
Clinton	-	-	-	-	1	2/
Elk	-	-	-	-	1	2/
Lycoming	7	3,230	-	-	13	5,919
McKean	-	-	-	-	-	-
Potter	-	-	-	-	-	-
Sullivan	-	-	-	-	-	-
Tioga	1	2/	-	-	-	-
NORTH CENTRAL, TOTAL	11	4,324	-	-	16	6,632
Lackawanna	5	282	6	650	4	271
Susquehanna	1	2/	-	-	1	2/
Wayne	1	2/	-	-	-	-
Wyoming	3	1,510	-	-	2	2/
NORTHEASTERN, TOTAL	10	2,064	-	-	7	534
Armstrong	3	1,762	3	930	4	2,285
Beaver	6	832	3	705	9	1,554
Butler	3	188	-	-	3	250
Clarion	1	2/	-	-	1	2/
Indiana	3	395	-	-	8	1,775
Jefferson	1	2/	-	-	1	2/
Lawrence	10	2,523	-	-	5	1,759
WEST CENTRAL, TOTAL	27	6,725	-	-	31	8,635
Blair	5	1,616	5	1,968	4	3,413
Cambria	2	2/	-	-	-	-
Centre	1	2/	-	-	1	2/
Clearfield	4	1,157	-	-	-	-
Columbia	14	14,478	12	10,804	12	7,561
Dauphin	5	10,649	4	9,119	6	8,281
Huntingdon	2	2,840	-	-	2	2/
Juniata	10	32,048	10	26,812	12	21,755
Mifflin	4	2,497	-	-	2	2/
Montour	2	2/	-	-	1	3/
Northumberland	19	7,482	16	5,565	20	7,867
Perry	3	940	-	-	7	2,294
Snyder	18	16,103	11	14,028	15	15,192
Union	5	6,160	-	-	4	1,863
CENTRAL, TOTAL	94	98,374	-	-	86	71,234
Carbon	5	1,063	-	-	4	720
Lehigh	23	70,372	15	57,935	16	55,900
Luzerne	7	3,071	5	2,125	9	2,538
Monroe	3	170	-	-	1	3/
Northampton	7	12,230	4	7,078	5	16,120
Pike	-	-	-	-	-	-
Schuylkill	30	15,342	28	8,521	33	5,670
EAST CENTRAL, TOTAL	75	102,248	-	-	68	80,948
Allegheny	18	6,408	12	5,146	12	2,321
Fayette	1	2/	-	-	1	2/
Greene	1	2/	-	-	-	-
Somerset	-	-	-	-	-	-
Washington	14	6,187	6	4,897	12	2,307
Westmoreland	3	1,794	-	-	1	2/
SOUTHWESTERN, TOTAL	37	15,989	-	-	26	5,053
Adams	147	265,837	126	270,498	106	255,654
Bedford	10	9,478	8	2,071	7	5,169
Cumberland	10	15,193	-	-	9	14,551
Franklin	75	217,280	47	177,913	43	179,435
Fulton	1	3/	-	-	1	3/
York	62	115,489	46	94,979	48	90,423
SOUTH CENTRAL, TOTAL	305	623,277	-	-	214	545,232
Berks	41	100,341	32	65,551	31	50,787
Bucks	11	11,382	6	7,425	14	10,045
Chester	14	8,731	9	6,545	12	9,758
Delaware	4	2/	3	2,484	6	3,504
Lancaster	22	32,805	18	26,717	27	29,541
Lebanon	6	17,567	4	10,270	3	4,685
Montgomery	13	5,669	12	5,103	16	6,393
Philadelphia	1	2/	-	-	-	-
SOUTHEASTERN, TOTAL	112	179,379	-	-	109	114,713
TOTAL, OTHER	-	-	39	37,590	-	-
PENNSYLVANIA	780	1,074,108	545	887,001	616	856,842

1/ Comparable data only available on counties listed for 1972 survey. 2/ Not published separately to avoid disclosure of individual operations. 3/ Monroe county combined with Carbon county; Fulton county combined with Bedford county; Montour county combined with Northumberland county to avoid disclosure of individual operations.

PENNSYLVANIA: PEACHES (TOTAL): NUMBER OF TREES BY COUNTIES AND AGE GROUPS, 1978 1/

County And District	Number Of Trees Maintained For Production According To Year Set Out					Percent Of Total
	1975-1977 (1-3 Yrs.)	1972-1974 (4-6 Yrs.)	1957-1971 (7-21 Yrs.)	1956 & Earlier (22 Yrs +)	Total All Ages	
Erie	7,290	5,643	5,800	1,575	20,308	2.4
Forest	-	-	-	-	-	-
Mercer	275	583	2,333	110	3,301	.4
Venango & Crawford	165	60	23	4	252	-
Warren	-	-	-	-	-	-
NORTHWESTERN, TOTAL	7,730	6,286	8,156	1,689	23,861	2.8
Bradford, Clinton & Elk	10	-	703	-	713	.1
Cameron	-	-	-	-	-	-
Lycoming	2,950	728	2,225	16	5,919	.7
McKean	-	-	-	-	-	-
Potter	-	-	-	-	-	-
Sullivan	-	-	-	-	-	-
Tioga	-	-	-	-	-	-
NORTH CENTRAL, TOTAL	2,960	728	2,928	16	6,632	.8
Lackawanna	12	124	135	-	271	.1
Wayne	-	-	-	-	-	-
Wyoming & Susquehanna	215	6	42	-	263	-
NORTHEASTERN, TOTAL	227	130	177	0	534	.1
Armstrong	525	560	700	500	2,285	.3
Beaver	366	2	1,156	30	1,554	.2
Butler	80	120	50	-	250	-
Indiana	820	836	99	20	1,775	.2
Jefferson & Clarion	-	520	492	-	1,012	.1
Lawrence	482	515	662	100	1,759	.2
WEST CENTRAL, TOTAL	2,273	2,553	3,159	650	8,635	1.0
Blair	166	3,085	120	42	3,413	.4
Cambria	-	-	-	-	-	-
Centre, Huntingdon & Mifflin	1,098	492	1,290	128	3,008	.3
Clearfield	-	-	-	-	-	-
Columbia	1,399	1,485	2,957	1,720	7,561	.9
Dauphin	1,177	1,225	5,788	91	8,281	.9
Juniata	5,420	1,385	14,950	-	21,755	2.5
Montour & Northumberland	2,949	1,628	3,210	80	7,867	1.0
Perry	636	149	1,509	-	2,294	.3
Snyder	1,947	5,695	5,712	1,838	15,192	1.8
Union	100	253	1,510	-	1,863	.2
CENTRAL, TOTAL	14,892	15,397	37,046	3,899	71,234	8.3
Carbon & Monroe	61	420	239	-	720	.1
Lehigh	14,326	11,051	27,670	2,853	55,900	6.5
Luzerne	536	1,094	851	57	2,538	.3
Northampton	5,385	2,840	7,895	-	16,120	1.9
Pike	-	-	-	-	-	-
Schuylkill	451	1,443	3,519	257	5,670	.6
EAST CENTRAL, TOTAL	20,759	16,848	40,174	3,167	80,948	9.4
Allegheny	437	176	1,702	6	2,321	.2
Fayette & Westmoreland	-	325	100	-	425	.1
Greene	-	-	-	-	-	-
Somerset	-	-	-	-	-	-
Washington	351	307	1,596	53	2,307	.3
SOUTHWESTERN, TOTAL	788	808	3,398	59	5,053	.6
Adams	53,755	42,604	141,369	17,926	255,654	29.8
Bedford & Fulton	877	869	3,266	157	5,169	.6
Cumberland	645	2,156	11,750	-	14,551	1.7
Franklin	23,973	34,469	107,772	13,221	179,435	20.9
York	17,120	19,391	48,705	5,207	90,423	10.6
SOUTH CENTRAL, TOTAL	96,370	99,489	312,862	36,511	545,232	63.6
Berks	18,675	6,355	23,804	1,953	50,787	5.9
Bucks	616	896	6,753	1,780	10,045	1.2
Chester	1,923	442	6,976	417	9,758	1.1
Delaware	261	2,879	364	-	3,504	.4
Lancaster	5,697	3,515	19,270	1,059	29,541	3.5
Lebanon	1,575	480	2,630	-	4,685	.6
Montgomery	1,515	1,937	2,409	532	6,393	.7
Philadelphia	-	-	-	-	-	-
SOUTHEASTERN, TOTAL	30,262	16,504	62,206	5,741	114,713	13.4
PENNSYLVANIA	176,261	158,743	470,106	51,732	856,842	100.0
PERCENT OF TOTAL TREES	20.6	18.5	54.9	6.0	100.0	-

1/ Some counties are combined to avoid disclosure of individual operations.

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PENNSYLVANIA: PEACHES-(TOTAL): TREES BY VARIETY AND AGE GROUPS, 1978

Variety	1975-1977 (1-3 Years)	1972-1974 (4-6 Years)	1957-1971 (7-21 Years)	1956 & Earlier (22 Years +)	Total All Ages	% Of Total
Early:						
Dixie Red	1,142	1,080	1,115	300	3,637	.4
Earliglo	535	1,985	1,964	-	4,484	.5
Early Red Haven	305	1,536	76	-	1,917	.3
Early Red Fre	539	592	1,149	140	2,420	.3
Jerseyland	1,280	433	1,961	816	4,490	.5
Redhaven	23,879	27,656	55,539	4,748	111,822	13.1
Redskin	11,563	10,671	29,197	834	52,265	6.1
Sunhaven	3,421	5,614	11,079	217	20,331	2.4
Other Early	5,353	4,187	2,010	126	11,676	1.4
Total Early	48,017	53,754	104,090	7,181	213,042	25.0
Mid-Season:						
Ambergem	60	175	6,700	-	6,935	.8
Baby Gold	6,915	4,170	16,296	100	27,481	3.2
Belle of Georgia	288	211	1,007	132	1,638	.2
Blake	2,407	3,692	38,355	1,436	45,890	5.4
Cresthaven	7,984	8,350	1,092	60	17,486	2.0
Garnet Beauty	3,662	791	249	35	4,737	.6
Glohaven	1,323	1,372	1,104	125	3,924	.4
Hale Harrison Brilliant	129	357	2,629	440	3,555	.4
Halehaven	969	2,253	10,236	5,784	19,242	2.2
Harbelle	1,561	1,441	176	-	3,178	.4
Harken	3,004	810	200	-	4,014	.5
Harmony	4,408	3,019	577	-	8,004	.9
Golden Jubilee	451	548	2,437	656	4,092	.5
Loring	16,966	13,033	58,644	1,069	89,712	10.5
Madison	897	978	6,284	40	8,199	1.0
Ranger	85	330	2,090	95	2,600	.3
Red Elberta	82	310	928	494	1,814	.2
Red Crest	73	91	797	34	995	.1
Richhaven	213	1,358	6,203	385	8,159	1.0
Southhaven	65	303	813	50	1,231	.1
Suncrest	4,000	3,695	2,057	-	9,752	1.0
Sunhigh	16,653	20,247	52,316	5,837	95,053	11.1
Triogem	7,453	3,524	15,533	2,808	29,318	3.4
Washington	4,963	2,332	9,486	109	16,890	2.0
Other Mid-Season	9,570	4,758	16,984	1,818	33,130	3.8
Total Mid-Season	94,181	78,148	253,193	21,507	447,029	52.0
Late:						
Brackett	-	93	156	238	487	.1
Elberta	1,686	2,466	33,758	17,361	55,271	6.5
Gemmers Late	300	245	400	10	955	.1
J. H. Hale	1,778	1,584	10,558	1,664	15,584	1.8
Jefferson	700	1,576	17,773	317	20,366	2.4
Jerseyqueen	11,285	8,279	17,646	242	37,452	4.4
Late Sunhaven - Slaybaugh	870	1,192	646	-	2,708	.3
Monroe	2,289	662	1,931	100	4,982	.6
Rio Oso Gem	10,608	8,097	25,391	1,785	45,881	5.3
Sweet Sue	1,451	60	80	-	1,591	.2
White Hale	236	392	1,647	154	2,429	.3
Other Late	2,860	2,195	2,837	1,173	9,065	1.0
Total Late	34,063	26,841	112,823	23,044	196,771	23.0
TOTAL ALL VARIETIES	176,261	158,743	470,106	51,732	856,842	100.0

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PEARS

Number of Orchards And Trees: Commercial pear orchards (100+ Trees) at 193 in 1978 increased 7 percent from the 180 total in 1972. The corresponding tree numbers increased 23 percent from 96,373 in 1972 to 118,874 in 1978.

Acreage In Orchards: Commercial pear acreage increased 29 percent from 1,073 acres in 1972 to 1,380.7 in 1978. Trees per acre declined from 90 in 1972 to 86 in 1978. Pears were the only fruit to decline in trees per acre since the 1972 survey.

Location Of Trees: Fruit Region I accounts for 57 percent of the 118,874 commercial trees. Adams county alone contains 45 percent of the total 127,158 trees. The leading six counties (Adams, Schuylkill, York, Erie, Lehigh and Franklin) contain 73 percent of the total trees.

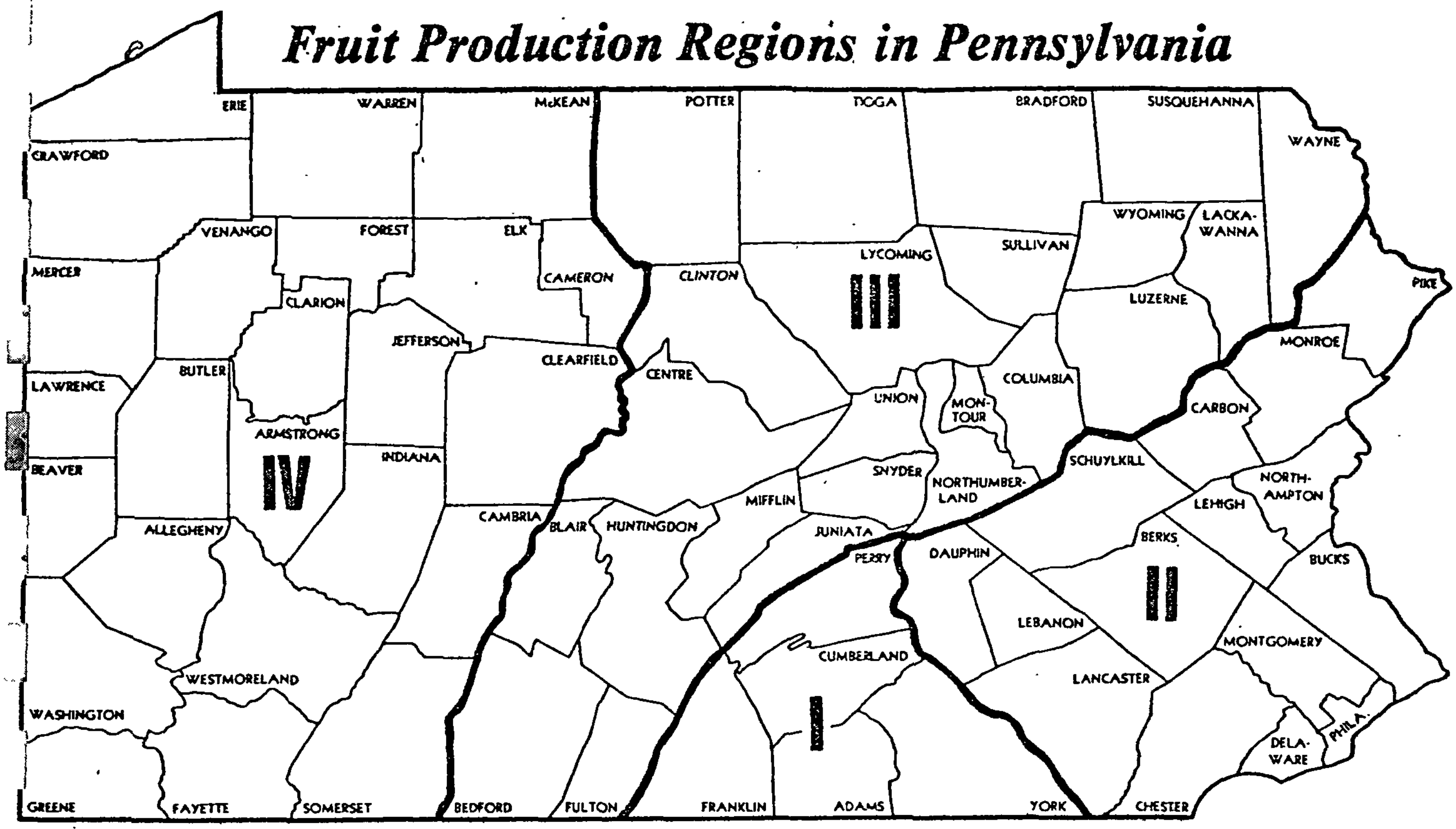
Age Of Trees: Of the 127,158 total pear trees, 9.1 percent are 1-3 years old, 14.4 percent 4-6 years old, 53.9 percent 7-21 years old and 22.6 percent 22 years or older.

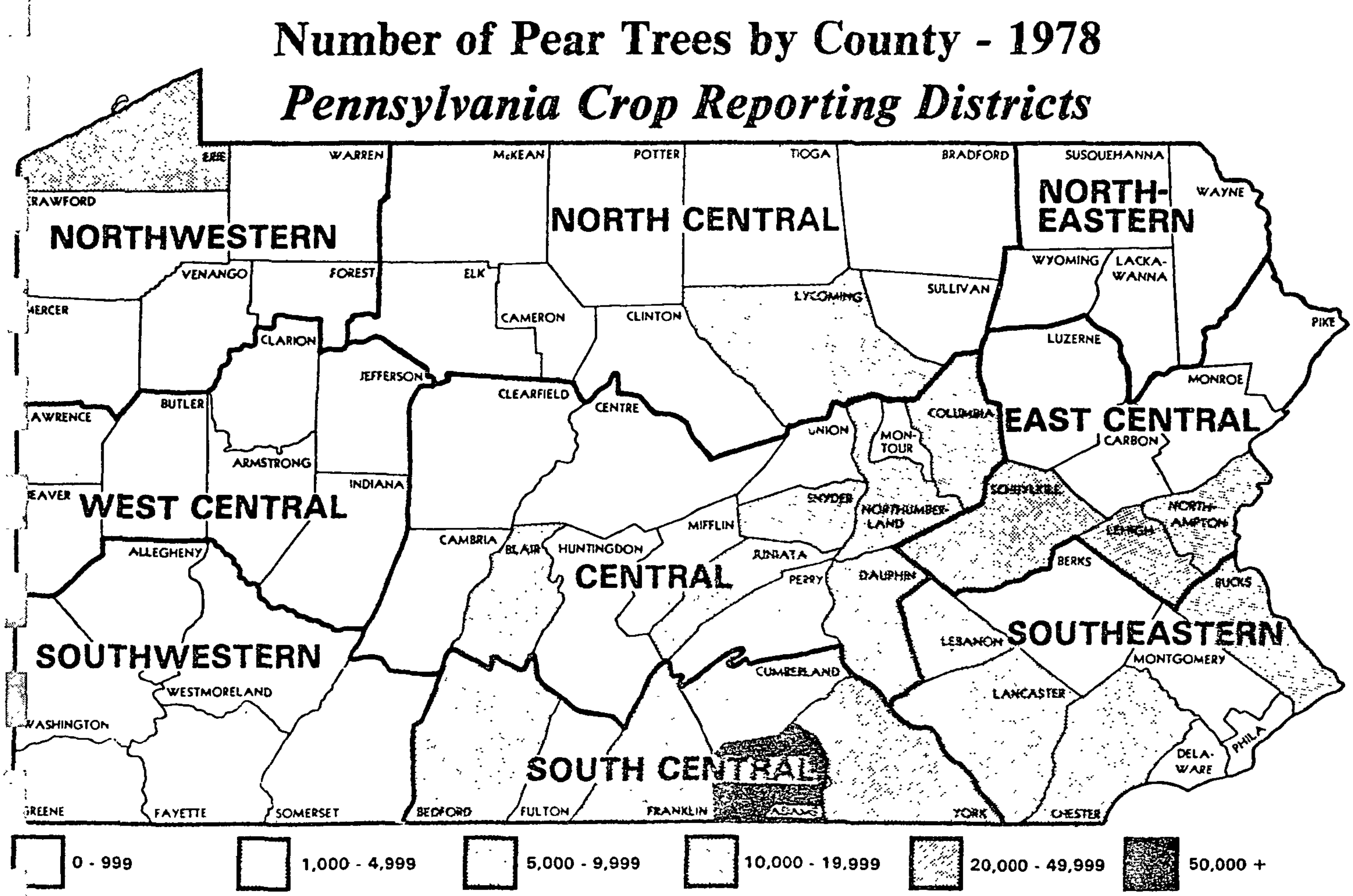
Varieties: The Bartlett pear is by far the most popular variety in Pennsylvania comprising 65 percent of the total 127,158 trees. Other leading varieties as a percent of total trees are: Bosc — 17, D'Anjou — 7, Clapps Favorite and Sekel — 2 percent each.

PENNSYLVANIA: PEARS (COMMERCIAL): COMPARISON OF GROWERS AND TREE NUMBERS BY REGION - 1972 & 1978

Region	1972 Survey		1978 Survey		Percent Change 72/78	
	Number Of Orchards	Number Of Trees	Number Of Orchards	Number Of Trees	Number Of Orchards	Number Of Trees
I	75	48,936	80	68,107	+ 7	+39
II	44	26,210	55	31,292	+25	+19
III	28	12,047	41	13,535	+46	+12
IV & V	33	9,180	17	5,940	-48	-35
PENNSYLVANIA	180	96,373	193	118,874	+ 7	+23

Photo Credit: Tom Piper





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PENNSYLVANIA: PEARS-(TOTAL): GROWERS, ACRES, TREES AND PRODUCTION BY COUNTY AND REGION, 1972 & 1978

County & Region	Growers		Acres		Trees				Production (Bushels) 1/
					Total		Trees Per Acre		
	1972	1978	1972	1978	1972	1978	1972	1978	
Region I:									
Adams	73	72	432	678.0	37,994	57,107	88	84	82,709
Franklin	17	22	38	49.0	3,202	4,853	85	99	6,769
York	38	36	87	96.0	7,836	6,981	90	72	12,068
Other	5	15	25	25.0	2,226	1,530	89	61	965
Total	133	145	582	848.0	51,258	70,471	88	83	102,511
Region II:									
Berks	22	21	47	36.7	2,615	3,140	56	86	4,708
Bucks	6	11	16	18.0	1,044	1,495	67	83	9,989
Chester	6	8	25	14.0	738	1,188	30	85	2,292
Dauphin	3	5	30	30.9	2,891	3,440	96	111	5,333
Lancaster	15	19	54	43.3	4,822	2,915	90	67	6,312
Lebanon	3	3	15	8.0	1,110	1,030	76	129	3,065
Lehigh	13	14	75	90.3	7,194	5,541	96	61	13,063
Montgomery	8	8	9	6.1	456	386	50	63	768
Northampton	6	6	17	13.0	1,371	1,771	81	136	5,552
Schuylkill	24	32	69	101.7	6,350	12,012	92	118	12,893
Other	8	11	8	10.1	448	702	52	70	664
Total	114	138	365	372.1	29,039	33,621	80	90	64,639
Region III:									
Bedford	4	9	2	16.2	153	1,293	83	80	554
Blair	4	4	14	19.0	2,729	2,203	195	116	9,700
Bradford	3	4	5	7.9	535	632	107	80	585
Columbia	10	10	24	22.0	1,980	1,919	84	87	4,005
Juniata	5	7	17	21.1	1,126	1,912	66	91	1,260
Lackawanna	6	7	2	2.0	183	197	110	99	232
Luzerne	10	16	17	14.0	466	925	27	66	919
Mifflin	3	3	3	6.0	169	297	50	50	700
Northumberland	13	14	13	18.0	652	1,327	47	74	1,777
Snyder	9	12	15	15.8	1,215	1,202	79	76	1,033
Other	9	26	23	49.2	4,078	3,547	177	72	7,164
Total	76	112	135	191.2	13,286	15,454	98	81	27,929
Region IV:									
Allegheny	10	10	8	6.0	455	363	60	61	919
Beaver	3	5	1	3.0	73	202	103	67	105
Indiana	3	10	3	5.0	131	417	44	83	74
Washington	3	3	5	1.0	368	24	74	24	-
Other	12	27	22	12.5	1,791	875	81	70	431
Total	31	55	39	27.5	2,818	1,881	72	68	1,529
Region V:									
Erie	47	27	91	61.0	7,887	5,731	87	94	8,305
Total	47	27	91	61.0	7,887	5,731	87	94	8,305
PENNSYLVANIA	401	477	1,212	1,499.8	104,288	127,158	86	85	204,913

1/ Production in 1977 from acreage maintained for production in 1978. Comparable data for 1972 not available.

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PENNSYLVANIA: PEARS (TOTAL): GROWERS, ACRES, TREES AND PRODUCTION BY SIZE OF OPERATION AND REGION, 1978

Size Of Operation (Trees)	Growers		Trees		Acres		Production 1/	
	Number	Percent	Number	Percent	Number	Percent	Bushels	Percent
egion I:								
-99	65	45	2,364	3	29.3	4	6,149	6
.00-199	27	19	3,455	5	53.6	6	7,129	7
200-499	25	17	7,568	11	105.5	12	11,052	11
500-999	12	8	8,277	12	84.5	10	9,592	9
,000-2,499	11	8	16,917	24	165.1	20	26,195	26
,500-4,999	5	3	31,890	45	410.0	48	42,394	41
,000+	2/	-	-	-	-	-	-	-
Total	145	100	70,471	100	848.0	100	102,511	100
egion II:								
-99	83	60	2,329	7	36.8	10	5,211	8
100-199	25	18	3,679	11	49.3	13	16,915	26
200-499	17	13	4,423	13	62.8	17	9,399	15
00-999	7	5	4,285	13	54.2	15	8,388	13
,000-2,499	6	4	18,905	56	169.0	45	24,726	38
1,500-4,999	3/	-	-	-	-	-	-	-
5,000+	3/	-	-	-	-	-	-	-
Total	138	100	33,621	100	372.1	100	64,639	100
egion III:								
1-99	71	64	1,919	12	27.2	14	2,546	9
100-199	18	16	2,479	16	34.5	18	2,761	10
00-499	16	14	5,108	33	64.5	34	5,217	19
00-999	7	6	5,948	39	65.0	34	17,405	62
,000-2,499	4/	-	-	-	-	-	-	-
2,500-4,999	-	-	-	-	-	-	-	-
5,000+	-	-	-	-	-	-	-	-
otal	112	100	15,454	100	191.2	100	27,929	100
egion IV & V:								
1-99	65	79	1,672	22	25.8	29	1,761	18
100-199	6	7	840	11	11.3	13	469	5
00-499	7	9	2,072	27	21.9	25	1,945	20
00-999	4	5	3,028	40	29.5	33	5,659	57
,000-2,499	4/	-	-	-	-	-	-	-
2,500-4,999	-	-	-	-	-	-	-	-
5,000+	-	-	-	-	-	-	-	-
otal	82	100	7,612	100	88.5	100	9,834	100
All Regions:								
1-99	284	60	8,284	6	119.1	8	15,667	8
.00-199	76	16	10,453	9	148.7	10	27,274	13
00-499	65	14	19,171	16	254.7	17	27,613	13
00+	52	10	89,250	69	977.3	65	134,359	66
PENNSYLVANIA	477	100	127,158	100	1,499.8	100	204,913	100

1/ Production from 1977 from acreage maintained for production in 1978.
/ Combined with the 2,500-4,999 size group to avoid disclosure of individual operations.
3/ Combined with the 1,000-2,499 size group to avoid disclosure of individual operations.
4/ Combined with the 500-999 size group to avoid disclosure of individual operations.

PENNSYLVANIA: PEARS - COMPARISON OF COMMERCIAL & NON-COMMERCIAL GROWER AND TREE NUMBERS 1967, 1972, 1978

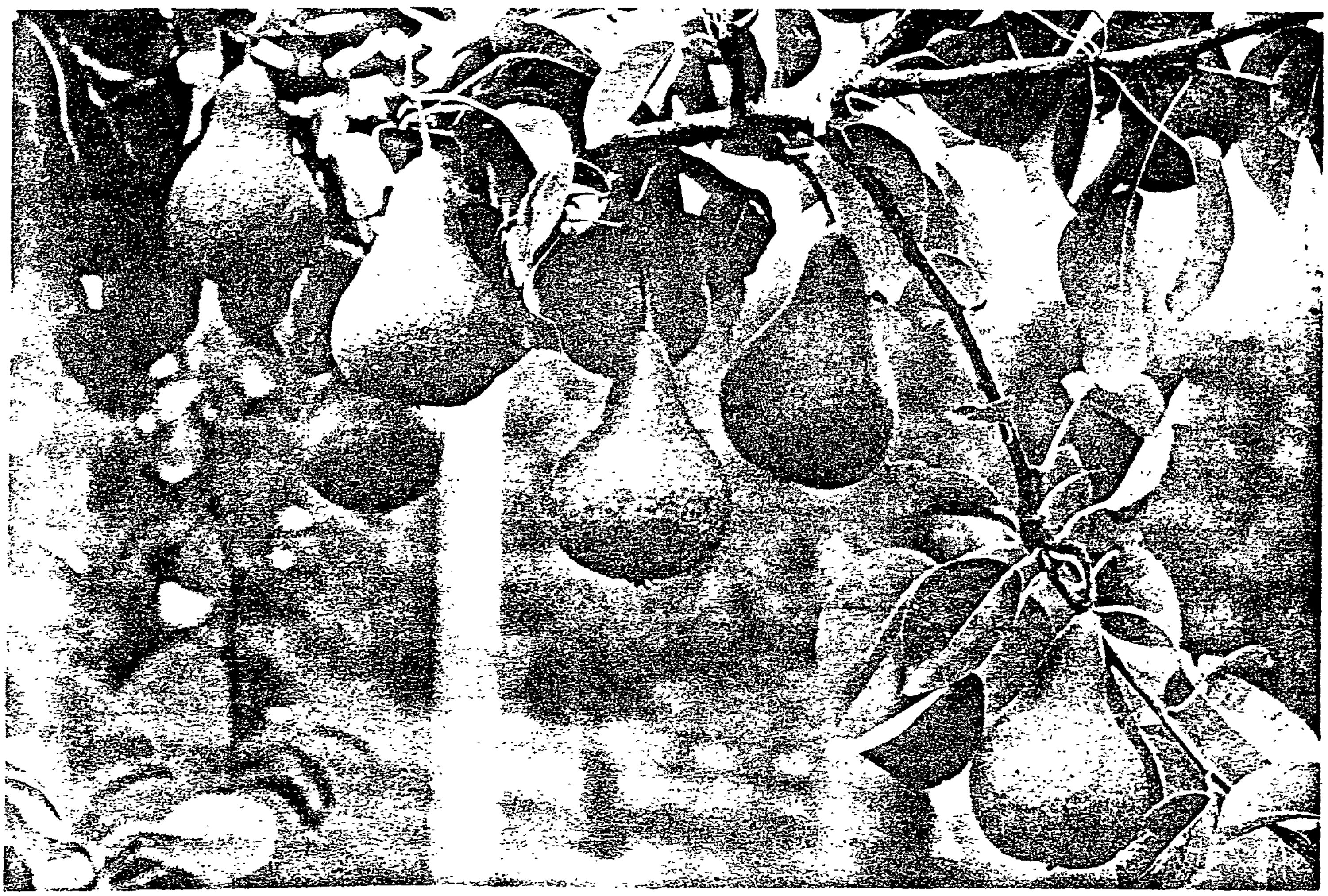
Trees	Number Of Growers			Number Of Trees		
	1967	1972	1978	1967	1972	1978
-99 1/	343	221	284	10,513	7,915	8,284
00+	237	180	193	94,421	96,373	118,874
Total 1/	580	401	477	104,934	104,288	127,158

/ Includes trees in orchards classified as commercial (100+ trees) for any fruit.

PENNSYLVANIA: PEARS (COMMERCIAL): PRODUCTION, DISPOSITION AND VALUE, 1930-1978

Year	Production 1/	Utilization				Price Per Ton 4/	Value Of Production
		Home Use	Sales				
			Fresh	All Processed	All Sales		
	Tons					Dollars	Thous. Dols.
1930	14,255	5,950	8,275	-	8,275	44	626
1940	12,425	3,975	7,825	-	7,825	34	401
1950	5,250	2,500	2,750	-	2,750	78	410
1960	2,750	650	2,100	-	2,100	102	280
1970	4,100	2/	2/	2/	4,100	153	627
1971	3,700	2/	2/	2/	3,700	128	474
1972	3,700	3/	3,300	-	3,300	196	647
1973	1,900	3/	1,900	-	1,900	230	437
1974	4,100	2/	2/	2/	4,100	235	964
1975	4,500	2/	2/	2/	4,500	216	972
1976	3,700	2/	2/	2/	3,700	232	858
1977	4,700	2/	2/	2/	4,700	252	1,184
1978	3,300	2/	2/	2/	3,300	286	944

1/ Includes some quantities not harvested and excess cullage. 2/ Not published to avoid dislosure of individual operations.
3/ Included in fresh utilization. 4/ Fresh and processing prices combined.



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PENNSYLVANIA: PEARS (TOTAL): NUMBER OF TREES BY COUNTIES AND AGE GROUPS - 1978 1/

County & District	Number Of Trees Maintained For Production According To Year Set Out: 1975-1977 (1-3 Years)	1972-1974 (4-6 Years)	1957-1971 (7-21 Years)	1956 & Earlier (22 Years +)	Total All Ages	Percent Of Total
Crawford	15	-	142	12	169	.1
Erie	350	348	1,749	3,284	5,731	4.5
Forest	-	-	-	-	-	-
Mercer & Venango	39	6	46	-	91	.1
Warren	-	-	-	-	-	-
NORTHWESTERN, TOTAL	404	354	1,937	3,296	5,991	4.7
Bradford	-	-	467	165	632	.5
Cameron	-	-	-	-	-	-
Clinton	-	-	-	-	-	-
Elk	-	-	-	-	-	-
Lycoming	35	5	1,244	801	2,085	1.6
McKean	-	-	-	-	-	-
Sullivan	-	-	-	-	-	-
Tioga & Potter	-	-	131	250	381	.3
NORTH CENTRAL, TOTAL	35	5	1,842	1,216	3,098	2.4
Lackawanna	10	21	111	55	197	.2
Wayne	-	-	-	-	-	-
Wyoming & Susquehanna	-	-	557	-	557	.4
NORTHEASTERN, TOTAL	10	21	668	55	754	.6
Beaver	8	57	104	33	202	.2
Butler, Armstrong, Clarion & Jefferson	20	25	35	16	96	.1
Indiana	124	117	152	24	417	.3
Lawrence	-	-	103	20	123	.1
WEST CENTRAL, TOTAL	152	199	394	93	838	.7
Blair	400	773	730	300	2,203	1.
Cambria & Centre	-	100	50	15	165	.1
Columbia	185	239	1,041	454	1,919	1.5
Dauphin	971	454	1,884	131	3,440	2.7
Huntingdon & Clearfield	7	60	225	50	342	.3
Juniata	1,077	-	835	-	1,912	1.5
Mifflin	-	-	297	-	297	.2
Montour & Northumberland	137	574	502	179	1,392	1.1
Perry	12	20	272	-	304	.2
Snyder	82	183	754	183	1,202	1.0
Union	40	2	115	55	212	.2
CENTRAL, TOTAL	2,911	2,405	6,705	1,367	13,388	10.5
Carbon, Monroe & Pike	8	263	8	52	331	.3
Lehigh	6	211	1,211	4,113	5,541	4.4
Luzerne	97	103	214	511	925	.7
Northampton	45	298	1,427	1	1,771	1.4
Schuylkill	141	316	7,847	3,708	12,012	9.4
EAST CENTRAL, TOTAL	297	1,191	10,707	8,385	20,580	16.2
Allegheny	56	25	195	87	363	.3
Fayette, Somerset & Westmoreland	30	75	31	-	136	.1
Greene	-	-	-	-	-	-
Washington	-	-	-	24	24	-
SOUTHWESTERN, TOTAL	86	100	226	111	523	.4
Adams	3,546	8,932	34,075	10,554	57,107	44.9
Bedford	675	480	118	20	1,293	1.0
Cumberland	396	127	703	-	1,226	1.0
Franklin	1,308	720	1,911	914	4,853	3.8
Fulton	-	-	-	-	-	-
York	339	2,540	2,977	1,125	6,981	5.5
SOUTH CENTRAL, TOTAL	6,264	12,799	39,784	12,613	71,460	56.2
Berks	719	206	1,812	403	3,140	2.5
Bucks	215	208	1,066	6	1,495	1.2
Chester	332	23	807	26	1,188	.9
Delaware	2	-	72	297	371	.3
Lancaster	119	639	1,489	669	2,916	2.3
Lebanon	-	40	990	-	1,030	.8
Montgomery	-	128	80	178	386	.3
Philadelphia	-	-	-	-	-	-
SOUTHEASTERN, TOTAL	1,387	1,244	6,316	1,579	10,526	8.3
PENNSYLVANIA	11,546	18,318	68,579	28,715	127,158	100.0
PERCENT OF TOTAL TREES	9.1	14.4	53.9	22.6	100.0	

1/ Some counties are combined to avoid disclosure of individual operations.

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PENNSYLVANIA: PEARS (TOTAL): TREES BY VARIETY AND AGE GROUPS, 1978

Variety	1975 - 1977 (1-3 Years)	1972 - 1974 (4-6 Years)	1957 - 1971 (7-21 Years)	1956 & Earlier (22 Years +)	Total All Ages	Percent Of Total
REGION I:						
Bartlett...........	2,581	6,774	22,616	10,578	42,549	60.4
Bosc...............	1,990	3,551	7,706	891	14,138	20.0
Clapps Favorite....	252	255	745	101	1,363	1.9
D'Anjou............	588	650	4,912	518	6,668	9.5
Devoe..............	30	5	302	8	345	.5
Gorham.............	-	213	689	212	1,114	1.6
Magness............	-	60	1,320	39	1,419	2.0
Moonglo............	-	10	177	-	187	.3
Seckel.............	80	321	736	121	1,258	1.8
Starks.............	-	300	220	7	527	.7
Other..............	70	200	515	118	903	1.3
TOTAL..............	5,601	12,339	39,938	12,593	70,471	100.0
REGION II:						
Bartlett...........	1,066	1,580	13,482	7,533	23,661	70.4
Bosc...............	990	686	1,483	702	3,861	11.5
Clapps Favorite....	47	97	222	118	484	1.4
D'Anjou............	17	212	1,258	395	1,882	5.6
Gorham.............	17	5	169	132	323	1.0
Magness............	12	-	65	53	130	.4
Seckel.............	200	84	675	295	1,254	3.7
Starks.............	-	6	345	65	416	1.2
Other..............	209	116	994	291	1,610	4.8
TOTAL..............	2,558	2,786	18,693	9,584	33,621	100.0
REGION III:						
Bartlett...........	1,719	1,982	5,732	2,148	11,581	74.9
Bosc...............	555	401	342	277	1,585	10.3
Clapps Favorite....	-	70	363	175	608	3.9
D'Anjou............	237	20	215	60	532	3.4
Devoe..............	-	55	331	30	416	2.7
Moonglo............	105	-	11	-	116	.8
Seckel.............	6	11	42	322	381	2.5
Other..............	113	1	110	11	235	1.5
TOTAL..............	2,745	2,540	7.146	3.023	15,454	100.0
REGION IV:						
Bartlett...........	202	286	713	142	1,343	71.4
Bosc...............	33	2	85	10	130	6.9
Other..............	57	17	255	79	408	21.7
TOTAL..............	292	305	1,053	231	1,881	100.0
REGION V:						
Bartlett...........	182	255	1,061	2,479	3,977	69.4
Bosc...............	238	60	501	508	1,307	22.8
Other..............	30	33	187	197	447	7.8
TOTAL..............	350	348	1,749	3,284	5,731	100.0
ALL REGIONS:						
Bartlett...........	5,750	10,877	43,604	22,880	83,111	65.4
Bosc...............	3,715	4,700	10,117	2,488	21,021	16.5
Clapps Favorite....	309	422	1,424	414	2,569	2.0
D'Anjou............	847	882	6,418	989	9,136	7.2
Devoe..............	30	65	727	44	866	.7
Gorham.............	57	233	902	411	1,619	1.3
Magness............	22	62	1,423	92	1,605	1.3
Moonglo............	202	10	203	-	415	.3
Seckel.............	255	425	1,509	757	2,987	2.3
Starks.............	22	306	614	72	1,014	.8
Other..............	295	336	1,626	558	2,815	2.2
PENNSYLVANIA..........	16,546	18,318	68,579	23,715	127,158	100.0

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CHERRIES

Number Of Orchards And Trees: The number of commercial tart cherry growers (100+ Trees) has steadily declined since the first commercial fruit tree survey conducted in 1953. Commercial growers (100+ Trees) in 1978 at 140 was down 30 percent from the 201 accounted for in 1972. Commercial tart cherry growers had 183,768 trees in 1978 compared with 217,610 in 1972, a 15 percent decline. Commercial sweet cherry growers at 61 declined 16 percent from 1972 while corresponding tree numbers increased from 28,230 to 33,068, or 17 percent.

Acreage In Orchards: Commercial tart cherry acreage at 1,967 declined 23 percent from 2,550 in 1972 while commercial sweet cherry acreage declined from 526 to 472.5 or 10 percent during the same period. Tart cherry trees per acre increased from 85 in 1972 to 93 in 1978 while sweet cherry trees per acre increased from 54 to 70 in 1978.

Location Of Trees: Adams, Erie, Franklin and York counties contain 94 percent of the total 186,387 tart cherry trees. Fruit Region I accounts for 80 percent of the total trees. For sweet cherries, Lancaster, Erie, Adams, Franklin and Northampton counties contain 73 percent of the 38,019 total trees.

Age Of Trees: Of the total 186,387 tart cherry trees, 14.8 percent were 1-3 years old, 16.8 percent 4-6 years old, 34.4 percent 7-21 years old and 34.0 percent 22 years or older. Of the total 38,019 sweet cherry trees the age percentage breakdown was 16.0, 10.6, 40.6 and 32.8 respectively.

Varieties: Montmorency tart cherry trees account for 97 percent of the total trees, English Morello 2 percent and other varieties 1 percent. Dark sweet cherry trees comprise 72 percent of total trees while light sweet cherry trees accounted for 23 percent. Leading varieties as a percent of the total 38,019 trees are: Windsor — 16.3, Bing — 15.2, Napoleon — 10.1, Hedelfingen — 9.9 and Schmits Biggereau — 9.2.

PENNSYLVANIA: TART CHERRIES: COMPARISON OF COMMERCIAL AND NON-COMMERCIAL GROWER AND TREE NUMBERS, - 1967, 1972, and 1978

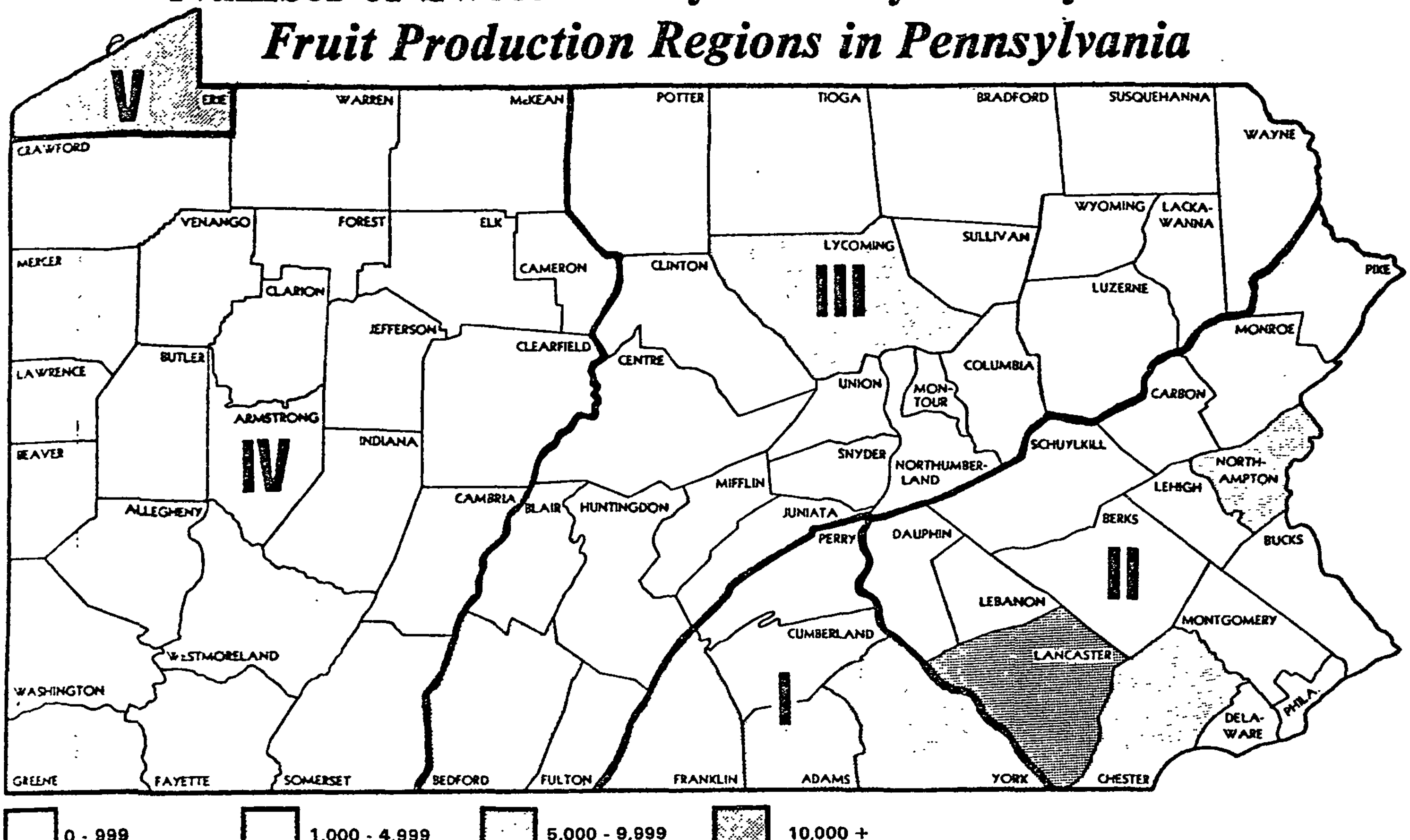
Trees	Number Of Growers			Number Of Trees		
	1967	1972	1978	1967	1972	1978
-99	198	117	162	4,567	3,057	2,619
100+	283	201	140	270,906	217,610	183,768
Total	481	318	302	275,473	220,667	186,387

PENNSYLVANIA: SWEET CHERRIES: COMPARISON OF COMMERCIAL AND NON-COMMERCIAL GROWER AND TREE NUMBERS, - 1967, 1972, and 1978

Trees	Number Of Growers			Number Of Trees		
	1967	1972	1978	1967	1972	1978
-99	300	159	208	6,648	4,113	4,951
100+	86	73	61	26,296	28,230	33,068
Total	386	232	269	32,944	32,343	38,019

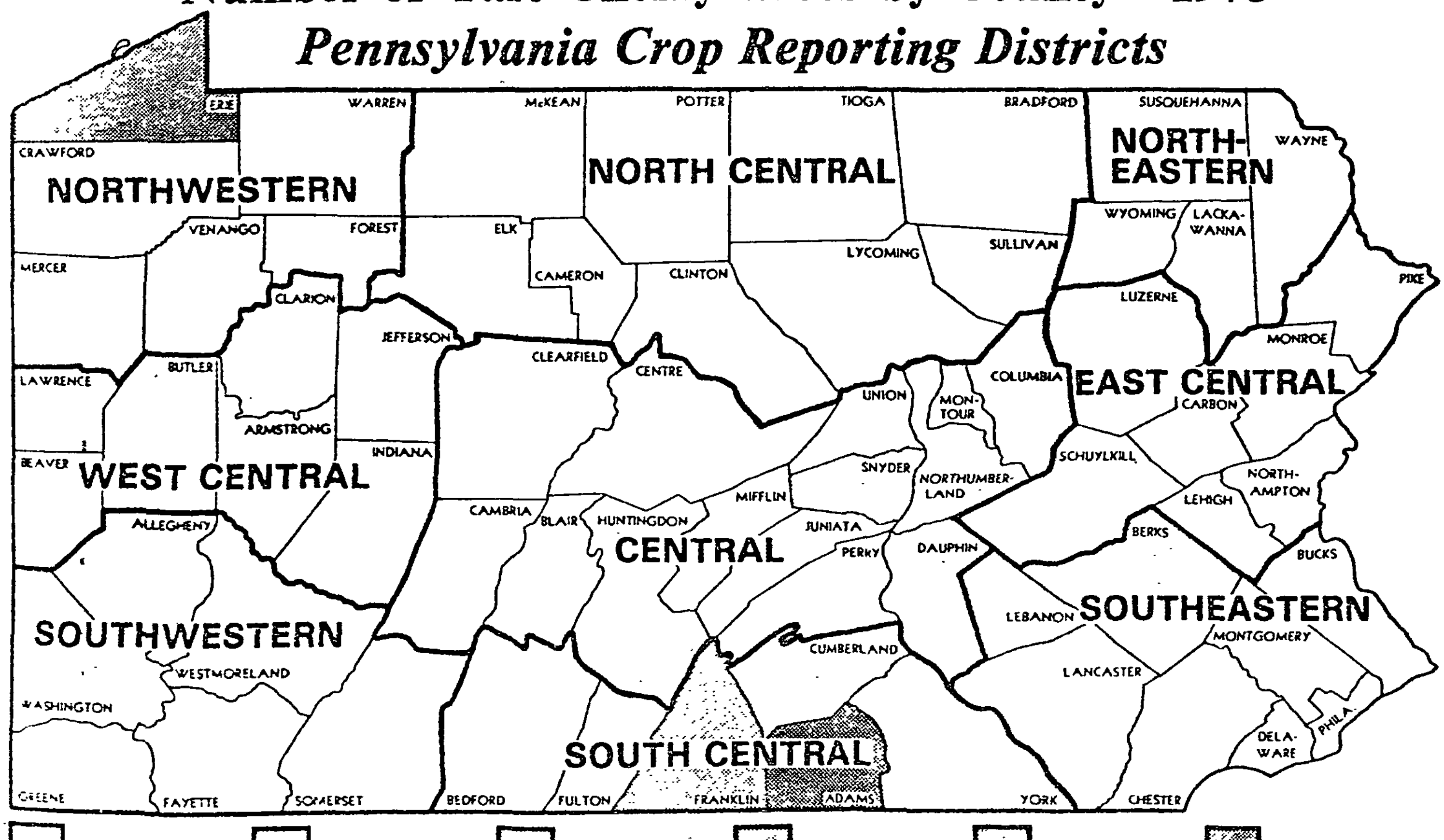
Number of Sweet Cherry Trees by County - 1978

Fruit Production Regions in Pennsylvania



Number of Tart Cherry Trees by County - 1978

Pennsylvania Crop Reporting Districts



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PENNSYLVANIA: TART & SWEET CHERRIES (COMMERCIAL): PRODUCTION, DISPOSITION AND VALUE, 1940-1978

Year	Production 1/		Utilization			Price Per Pound 2/	Value Of Utilized Production
				Processed			
	Total	Utilized	Fresh	Canned	All Processed		
				Tart Cherries (Mil.Lbs.)		Cents	Thous.Dols.
1940	12.6	12.6	6.1	5.5	6.5	3.5	441
1950	16.8	16.8	5.0	10.4	11.8	8.2	1,378
1960	18.0	18.0	2.9	9.8	15.1	8.4	1,512
1970	14.0	14.0	.5	5.5	13.5	7.8	1,092
1971	12.7	12.7	.9	7.0	11.8	11.3	1,435
1972	12.3	11.1	.7	7.9	10.4	8.7	966
1973	6.3	6.3	.4	4.7	5.9	19.8	1,247
1974	13.1	13.1	.9	8.6	12.2	19.8	2,594
1975	12.6	11.5	1.1	6.8	10.4	11.4	1,311
1976	7.6	7.6	1.0	5.3	6.6	25.8	1,961
1977	3.2	3.2	.5	2.6	2.7	29.8	954
1978	6.2	6.2	.8	4.5	5.4	41.7	2,585
				Sweet Cherries (Tons)		$/Ton	
1940	2,200	2,100	-	-	-	105	220
1950	1,500	1,500	-	-	-	171	256
1960	500	500	-	-	-	370	185
1970	600	600	-	-	-	500	300
1971	800	800	-	-	-	449	359
1972	200	190	-	-	-	415	79
1973	660	660	-	-	-	640	422
1974	730	730	-	-	-	700	511
1975	860	860	-	-	-	730	628
1976	460	460	-	-	-	792	364
1977	350	350	-	-	-	836	293
1978	750	750	-	-	-	836	627

1/ Total production is the quantity actually harvested plus quantities not harvested because of economic reasons. Utilized production is the amount sold plus the quantities used at home or held in storage. When total and utilized production are equal, economic abandonment and cullage quantities are considered at a "normal" level.
2/ Fresh and processing prices combined.

Photo Credit: Tom Piper

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PENNSYLVANIA: CHERRIES (TOTAL): GROWERS, ACRES, TREES AND PRODUCTION BY COUNTY - 1978 1/

County & District	Growers		Acres		Total Trees		Trees Per Acre		Production 2/		Yield Per Acre 3/	
	Tart	Sweet	Tart	Sweet	Tart	Sweet	Tart	Sweet	Tart	Sweet	Tart	Sweet
	Number								Lbs.			
Crawford & Mercer	3	3	.6	.3	55	22	92	73	798	220	1,330	733
Erie	32	20	290.8	145.8	23,791	8,999	82	62	404,970	171,865	1,393	1,179
Forest	-	-	-	-	-	-	-	-	-	-	-	-
Venango	-	-	-	-	-	-	-	-	-	-	-	-
Warren	-	-	-	-	-	-	-	-	-	-	-	-
NORTHWESTERN, TOTAL	35	23	291.4	146.1	23,846	9,021	82	62	405,768	172,085	1,393	1,178
Bradford	4/	4/	4/	4/	4/	4/	4/	4/	4/	4/	4/	4/
Cameron	-	-	-	-	-	-	-	-	-	-	-	-
Clinton	-	-	-	-	-	-	-	-	-	-	-	-
Elk	-	-	-	-	-	-	-	-	-	-	-	-
Lycoming	10	9	3.7	9.1	346	1,092	94	120	3,470	2,380	938	262
McKean	-	-	-	-	-	-	-	-	-	-	-	-
Potter	-	-	-	-	-	-	-	-	-	-	-	-
Sullivan	-	-	-	-	-	-	-	-	-	-	-	-
Tioga	-	-	-	-	-	-	-	-	-	-	-	-
Lackawanna	-	4/	-	4/	-	4/	-	4/	-	4/	-	4/
Susquehanna	4/	4/	4/	4/	4/	4/	4/	4/	4/	4/	4/	4/
Wayne	-	-	-	-	-	-	-	-	-	-	-	-
Wyoming	-	-	-	-	-	-	-	-	-	-	-	-
NORTH CENTRAL & NORTHEASTERN TOTAL	12	13	10.7	11.5	1,021	1,320	95	115	19,470	6,210	1,820	540
Armstrong, Clarion, and Jefferson	5	3	3.7	2.5	199	175	54	70	950	100	257	40
Beaver & Lawrence	6	7	.3	.4	27	38	90	95	-	-	-	-
Butler	-	-	-	-	-	-	-	-	-	-	-	-
Indiana	5	3	1.7	.7	133	61	78	87	190	50	112	71
WEST CENTRAL, TOTAL	16	13	5.7	3.6	359	274	63	76	1,140	150	200	42
Blair, Cambria, Huntingdon & Mifflin	4	5	7.0	12.6	524	1,018	75	81	10,500	5,700	1,500	452
Centre & Clearfield	3	-	10.0	-	800	-	80	-	1,000	-	100	-
Columbia	6	5	2.4	3.3	100	122	42	37	1,350	3,910	563	1,185
Dauphin	5	6	8.3	18.6	470	769	57	41	6,004	17,074	723	918
Juniata	4	7	4.5	12.5	270	946	60	76	6,100	22,250	1,356	1,780
Montour & Northumberland	8	9	6.1	3.2	464	205	76	64	15,255	8,584	2,501	2,683
Perry	6	4	5.8	3.8	485	203	84	53	7,208	3,500	1,243	921
Snyder	7	7	13.3	4.9	1,015	275	76	56	35,970	32,350	2,705	6,602
Union	3	3	.1	.5	7	43	70	86	166	1,080	1,660	2,160
CENTRAL, TOTAL	46	46	57.5	59.4	4,135	3,581	72	60	83,553	94,448	1,453	1,590
Carbon & Luzerne	4	6	.2	.2	12	17	60	85	46	94	230	470
Lehigh	8	8	.5	3.0	49	300	98	100	1,095	1,513	2,190	504
Monroe	-	-	-	-	-	-	-	-	-	-	-	-
Northampton	3	3	2.2	18.1	215	1,958	98	108	6,100	25,000	2,773	1,381
Pike	-	-	-	-	-	-	-	-	-	-	-	-
Schuylkill	8	9	1.6	1.1	122	68	76	62	1,645	520	1,028	473
EAST CENTRAL, TOTAL	23	26	4.5	22.4	398	2,343	88	105	8,886	27,127	1,975	1,211
Allegheny	5	5	.5	.3	51	26	102	87	-	-	-	-
Fayette, Somerset & Westmoreland	6	8	1.8	3.6	151	247	84	69	100	1,630	56	453
Greene	-	-	-	-	-	-	-	-	-	-	-	-
SOUTHWESTERN, TOTAL	11	13	2.3	3.9	202	273	88	70	100	1,630	44	418
Adams	63	37	1,375.4	48.8	133,670	2,838	97	58	2,151,839	55,098	1,565	1,129
Bedford & Fulton	5	8	3.0	13.2	297	1,062	99	80	3,500	2,395	1,167	181
Cumberland	3	4	17.0	2.8	1,376	131	81	47	12,565	2,850	739	1,018
Franklin	15	18	100.8	31.2	10,367	2,241	103	72	116,200	43,325	1,153	1,389
York	29	27	51.1	18.0	4,146	1,337	81	74	137,806	15,386	2,697	855
SOUTH CENTRAL, TOTAL	115	94	1,547.3	114.0	149,856	7,609	97	67	2,421,910	119,054	1,565	1,044
Berks & Lebanon	13	12	34.5	4.6	3,046	470	88	102	60,036	12,315	1,740	2,677
Bucks	5	5	5.6	1.6	340	83	61	52	5,285	810	944	506
Chester, Delaware & Montgomery	9	7	5.2	23.1	289	1,168	56	51	5,800	9,000	1,115	390
Lancaster	17	17	35.8	155.5	2,895	11,877	81	76	44,918	79,633	1,254	512
Philadelphia	-	-	-	-	-	-	-	-	-	-	-	-
SOUTHEASTERN, TOTAL	44	41	81.1	184.8	6,570	13,598	81	74	116,039	101,758	1,431	551
PENNSYLVANIA	302	269	2,000.5	545.7	186,387	38,019	93	70	3,056,866	522,462	1,528	957

1/ Some counties are combined to avoid disclosure of individual operations.
2/ Production in 1977 from acreage maintained for production in 1978.
3/ Actual yield will be slightly higher due to non-bearing acres included in calculations.
4/ Included in North Central and Northeastern total.

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PENNSYLVANIA: TART CHERRIES (TOTAL): GROWERS, ACRES, TREES AND PRODUCTION BY SIZE OF OPERATION AND REGION, 1978

Size Of Operation (Trees)	Growers		Trees		Acres		Production 1/	
	Number	Percent	Number	Percent	Number	Percent	Pounds	Percent
Region I:								
1-99	35	30	756	1	9.0	1	14,930	1
100-199	19	16	2,440	2	35.5	2	85,365	4
200-499	30	25	9,988	7	122.0	8	313,970	13
500-999	11	9	7,727	5	78.8	5	255,786	10
1,000-2,499	10	9	14,086	9	165.0	11	294,842	12
2,500-4,999	7	6	24,660	16	286.0	18	545,698	22
5,000+	6	5	90,369	60	851.7	55	915,027	38
Total	118	100	150,026	100	1,548.0	100	2,425,618	100
Region II:								
1-99	52	74	550	8	7.5	8	9,030	7
100-199	5	7	602	8	8.3	9	7,800	6
200-499	8	12	2,026	27	28.7	32	43,996	34
500-999	5	7	4,272	57	45.5	51	70,101	53
1,000-2,499	2/	-	-	-	-	-	-	-
2,500-4,999	-	-	-	-	-	-	-	-
5,000+	-	-	-	-	-	-	-	-
Total	70	100	7,450	100	90.0	100	130,927	100
Region III:								
1-99	39	74	665	15	8.0	15	11,583	12
100-199	6	11	849	19	13.5	26	13,980	15
200-499	8	15	2,948	66	30.9	59	67,750	73
500-999	3/	-	-	-	-	-	-	-
1,000-2,499	-	-	-	-	-	-	-	-
2,500-4,999	-	-	-	-	-	-	-	-
5,000+	-	-	-	-	-	-	-	-
Total	53	100	4,462	100	52.4	100	93,313	100
Region IV & V:								
1-99	36	59	648	3	9.0	3	2,064	-
100-199	9	15	1,046	4	12.5	4	9,450	2
200-499	7	11	2,278	9	25.5	8	40,200	10
500-999	4	7	2,587	11	27.0	9	18,190	5
1,000-2,499	5	8	17,890	73	236.1	76	337,104	83
2,500-4,999	4/	-	-	-	-	-	-	-
5,000+	4/	-	-	-	-	-	-	-
Total	61	100	24,449	100	310.1	100	407,008	100
All Regions:								
1-99	162	53	2,619	1	33.5	2	37,607	1
100-199	39	13	4,937	3	69.8	3	116,595	4
200+	101	34	178,831	96	1,897.2	95	2,902,664	95
PENNSYLVANIA	302	100	186,387	100	2,000.5	100	3,056,866	100

1/ Production in 1977 from acreage maintained for production in 1978.
2/ Combined with the 500-999 size group to avoid disclosure of individual operations.
3/ Combined with the 200-499 size group to avoid disclosure of individual operations.
4/ Combined with the 1,000-2,499 size group to avoid disclosure of individual operations.

PENNSYLVANIA: SWEET CHERRIES (TOTAL): GROWERS, TREES, ACRES AND PRODUCTION BY SIZE OF OPERATION AND REGION, 1978

Size Of Operation (Trees)	Growers		Trees		Acres		Production 1/	
	Number	Percent	Number	Percent	Number	Percent	Pounds (000)	Percent
1-99	208	77	4,951	13	73.2	14	85,301	16
100-199	29	11	3,776	10	56.4	10	95,769	18
200-499	16	6	5,267	14	88.9	16	103,197	20
500+	16	6	24,025	63	327.2	60	238,195	46
PENNSYLVANIA	269	100	38,019	100	545.7	100	522,462	100

1/ Production in 1977 from acreage maintained for production in 1978.

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PENNSYLVANIA: TART CHERRIES (TOTAL): COMPARISON OF ORCHARDS AND TREES OF ALL AGES BY COUNTIES - 1967, 1972 and 1978

County & District	Tree Survey, 1967		Tree Survey, 1972 1/		Tree Survey, 1978	
	Number-Orchards	Total Trees	Number-Orchards	Total Trees	Number-Orchards	Total Trees
Crawford	-	-	-	-	2	2/
Erie	92	58,587	55	36,869	32	23,791
Forest	-	-	-	-	-	-
Mercer	-	-	-	-	1	2/
Venango	-	-	-	-	-	-
Warren	-	-	-	-	-	-
NORTHWESTERN, TOTAL	92	58,587	-	-	35	23,846
Bradford	2	520	-	-	1	3/
Cameron	-	-	-	-	-	-
Clinton	1	2/	-	-	-	-
Elk	-	-	-	-	-	-
Lycoming	3	490	-	-	10	1,021
McKean	-	-	-	-	-	-
Potter	-	-	-	-	-	-
Sullivan	-	-	-	-	-	-
Tioga	1	2/	-	-	-	-
NORTH CENTRAL, TOTAL	7	1,220	-	-	11	1,021
Lackawanna	4	2/	-	-	-	-
Susquehanna	1	2/	-	-	1	3/
Wayne	2	2/	-	-	-	-
Wyoming	1	2/	-	-	-	-
NORTHEASTERN, TOTAL	8	231	-	-	1	3/
Armstrong	3	140	-	-	3	64
Beaver	3	39	-	-	5	22
Butler	1	2/	-	-	-	-
Clarion	1	2/	-	-	1	2/
Indiana	3	68	-	-	5	133
Jefferson	1	2/	-	-	1	2/
Lawrence	5	42	-	-	1	2/
WEST CENTRAL, TOTAL	17	572	-	-	16	359
Blair	2	600	-	-	1	2/
Cambria	1	2/	-	-	-	-
Centre	2	225	-	-	2	2/
Clearfield	3	208	-	-	1	2/
Columbia	5	2/	4	374	6	100
Dauphin	4	606	-	-	5	470
Huntingdon	3	365	-	-	1	2/
Juniata	6	696	5	380	4	270
Mifflin	3	864	-	-	2	2/
Montour	1	2/	-	-	2	2/
Northumberland	6	307	-	-	6	361
Perry	4	2,051	4	1,702	6	485
Snyder	12	2,006	9	764	7	1,015
Union	1	2/	-	-	3	7
CENTRAL, TOTAL	53	8,030	-	-	46	4,135
Carbon	1	2/	-	-	3	12
Lehigh	10	296	5	96	8	49
Luzerne	3	2/	-	-	1	3/
Monroe	2	2/	-	-	-	-
Northampton	1	2/	-	-	3	215
Pike	-	-	-	-	-	-
Schuylkill	7	127	6	124	8	122
EAST CENTRAL, TOTAL	24	2,171	-	-	23	398
Allegheny	8	140	3	81	5	51
Fayette	-	-	-	-	1	2/
Greene	-	-	-	-	-	-
Somerset	1	2/	-	-	1	2/
Washington	5	587	3	485	3	21
Westmoreland	2	2/	-	-	1	2/
SOUTHWESTERN, TOTAL	16	794	-	-	11	202
Adams	125	160,697	104	141,249	63	133,670
Bedford	8	250	5	329	5	297
Cumberland	6	3,308	6	4,669	3	1,376
Franklin	35	24,033	20	12,492	15	10,367
Fulton	-	-	-	-	-	-
York	34	9,030	29	11,379	29	4,146
SOUTH CENTRAL, TOTAL	208	197,318	-	-	115	149,856
Berks	18	2,290	10	1,035	12	1,411
Bucks	8	207	4	95	5	340
Chester	6	306	-	-	6	253
Delaware	2	2/	-	-	3	36
Lancaster	16	1,879	12	2,054	17	4,530
Lebanon	3	1,801	-	-	1	3/
Montgomery	3	2/	-	-	-	-
Philadelphia	-	-	-	-	-	-
SOUTHEASTERN, TOTAL	56	6,550	-	-	44	6,570
TOTAL, OTHER			34	6,490		
PENNSYLVANIA	481	275,473	313	220,667	302	186,387

1/ Comparable data only available on counties listed for 1972 survey. 2/ Not published to avoid disclosure of individual operations.
3/ Bradford and Susquehanna Counties combined with Lycoming Co., Luzerne Co. combined with Carbon Co., Lebanon Co. combined with Lancaster Co. to avoid disclosure of individual operations.

PENNSYLVANIA: TART CHERRIES (TOTAL): NUMBER OF TREES BY COUNTIES AND AGE GROUPS, 1978 1/

County And District	Number Of Trees Maintained For Production According To Year Set Out					Percent Of Total
	1975-1977 (1-3 Yrs.)	1972-1974 (4-6 Yrs.)	1957-1971 (7-21 Yrs.)	1956 & Earlier (22 Yrs +)	Total All Ages	
Crawford & Mercer	34	-	3	18	55	-
Erie	-	2,674	2,023	19,094	23,791	12.8
Forest	-	-	-	-	-	-
Venango	-	-	-	-	-	-
Warren	-	-	-	-	-	-
NORTHWESTERN, TOTAL	34	2,674	2,026	19,112	23,846	12.8
Bradford, Susquehanna & Lycoming	272	234	400	115	1,021	.6
Cameron	-	-	-	-	-	-
Clinton	-	-	-	-	-	-
Elk	-	-	-	-	-	-
McKean	-	-	-	-	-	-
Potter	-	-	-	-	-	-
Sullivan	-	-	-	-	-	-
Tioga	-	-	-	-	-	-
Lackawanna	-	-	-	-	-	-
Wayne	-	-	-	-	-	-
Wyoming	-	-	-	-	-	-
NORTH CENTRAL & NORTHEASTERN, TOTAL	272	234	400	115	1,021	.6
Armstrong, Clarion & Jefferson	-	-	154	45	199	.1
Beaver & Lawrence	2	-	18	7	27	-
Butler	-	-	-	-	-	-
Indiana	-	12	117	4	133	.1
WEST CENTRAL, TOTAL	2	12	289	56	359	.2
Blair, Huntingdon & Mifflin	210	34	250	30	524	.3
Cambria	-	-	-	-	-	-
Centre & Clearfield	200	350	125	125	800	.4
Columbia	35	8	55	2	100	-
Dauphin	47	171	15	237	470	.3
Juniata	30	-	240	-	270	.1
Northumberland & Montour	252	10	102	100	464	.3
Perry	125	13	132	215	485	.3
Snyder	704	-	183	128	1,015	.5
Union	-	1	3	3	7	-
CENTRAL, TOTAL	1,603	587	1,105	840	4,135	2.2
Lehigh	18	9	10	12	49	-
Luzerne & Carbon	7	-	-	5	12	-
Monroe	-	-	-	-	-	-
Northampton	105	-	110	-	215	.1
Pike	-	-	-	-	-	-
Schuylkill	2	3	112	5	122	.1
EAST CENTRAL, TOTAL	132	12	232	22	398	.2
Allegheny	-	1	20	30	51	-
Fayette, Somerset & Westmoreland	70	-	60	-	130	.1
Greene	-	-	-	-	-	-
Washington	2	-	19	-	21	-
SOUTHWESTERN, TOTAL	72	1	99	30	202	.1
Adams	23,028	22,372	48,391	39,879	133,670	71.7
Bedford	-	60	225	12	297	.2
Cumberland	20	165	525	666	1,376	.7
Franklin	550	3,600	5,666	551	10,367	5.6
Fulton	-	-	-	-	-	-
York	822	680	2,017	627	4,146	2.2
SOUTH CENTRAL, TOTAL	24,420	26,877	56,824	41,735	149,856	80.4
Berks & Lebanon	8	419	1,959	660	3,046	1.7
Bucks	85	8	217	30	340	.2
Chester	158	20	75	-	253	.1
Delaware	2	-	33	1	36	-
Lancaster	809	395	806	885	2,895	1.5
Montgomery	-	-	-	-	-	-
Philadelphia	-	-	-	-	-	-
SOUTHEASTERN, TOTAL	1,062	842	3,090	1,576	6,570	3.5
PENNSYLVANIA	27,597	31,239	64,065	63,486	186,387	100.0
PERCENT OF TOTAL TREES	14.8	16.8	34.4	34.0	100.0	-

1/ Some counties are combined to avoid disclosure of individual operations.

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PENNSYLVANIA: SWEET CHERRIES (TOTAL): TREES BY VARIETY AND AGE GROUPS - 1978

Variety	1975-1977 (1-3 Years)	1972-1974 (4-6 Years)	1957-1971 (7-21 Years)	1956 & Earlier (22 Years +)	Total All Ages	Percent Of Total
DARK:						
Bing................	741	1,109	2,490	1,439	5,779	15.2
Black Tartarian.....	129	207	293	293	922	2.4
Hedelfingen.........	950	536	1,274	995	3,755	9.9
Lambert.............	87	113	690	140	1,030	2.7
Smidts Biggereau....	916	295	1,430	871	3,512	9.2
Vista...............	429	192	542	210	1,373	3.6
Windsor.............	160	261	2,466	3,302	6,189	16.3
Other...............	719	507	2,533	960	4,719	12.4
TOTAL DARK..........	4,131	3,220	11,718	8,210	27,279	71.7
LIGHT:						
Emperor Francis.....	273	280	755	431	1,739	4.6
Napoleon............	22	77	959	2,775	3,833	10.1
Starks Gold.........	42	124	628	123	917	2.4
Other...............	1,616	318	1,384	933	4,251	11.2
TOTAL LIGHT.........	1,953	799	3,726	4,262	10,740	28.3
TOTAL ALL VARIETIES....	6,084	4,019	15,444	12,472	38,019	100.0
PERCENT OF TOTAL.......	16.0	10.6	40.6	32.8	100.0	

PENNSYLVANIA: TART CHERRIES (TOTAL): TREES BY VARIETY AND AGE GROUPS - 1978

Variety	1975-1977 (1-3 Years)	1972-1974 (4-6 Years)	1957-1971 (7-21 Years)	1956 & Earlier (22 Years +)	Total All Ages	Percent Of Total
Montmorency...........	27,467	29,825	62,794	60,873	180,959	97.1
English Morello........	-	1,000	603	2,407	4,010	2.2
Other..................	130	414	668	206	1,418	.7
TOTAL ALL VARIETIES....	27,597	31,239	64,065	63,486	186,387	100.0

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GRAPES

Number And Location Of Vineyards: The number of commercial grape vineyards (2+ Acres) increased from 348 in 1972 to 436 in 1978, a 25 percent increase. Of the total 474 vineyards in 1978, 361 or 76 percent were in Erie County. The number of vineyards throughout the rest of Pennsylvania more than doubled from 1972.

Acreage In Vineyards: The acreage in commercial grape vineyards in 1978 was 14,245.4 compared with 9,865.8 in 1972, a 44 percent increase. Of the total 436 commercial vineyards 177 with 20.0 acres or more accounted for 86 percent of all commercial grape acreage. Geneva double curtain acreage increased from 657.1 acres in 1972 to 2,771.9 acres in 1978. This is 19.4 percent of the total 14,271.3 acres. An additional 90.9 acres of Geneva double curtain were intended for 1978.

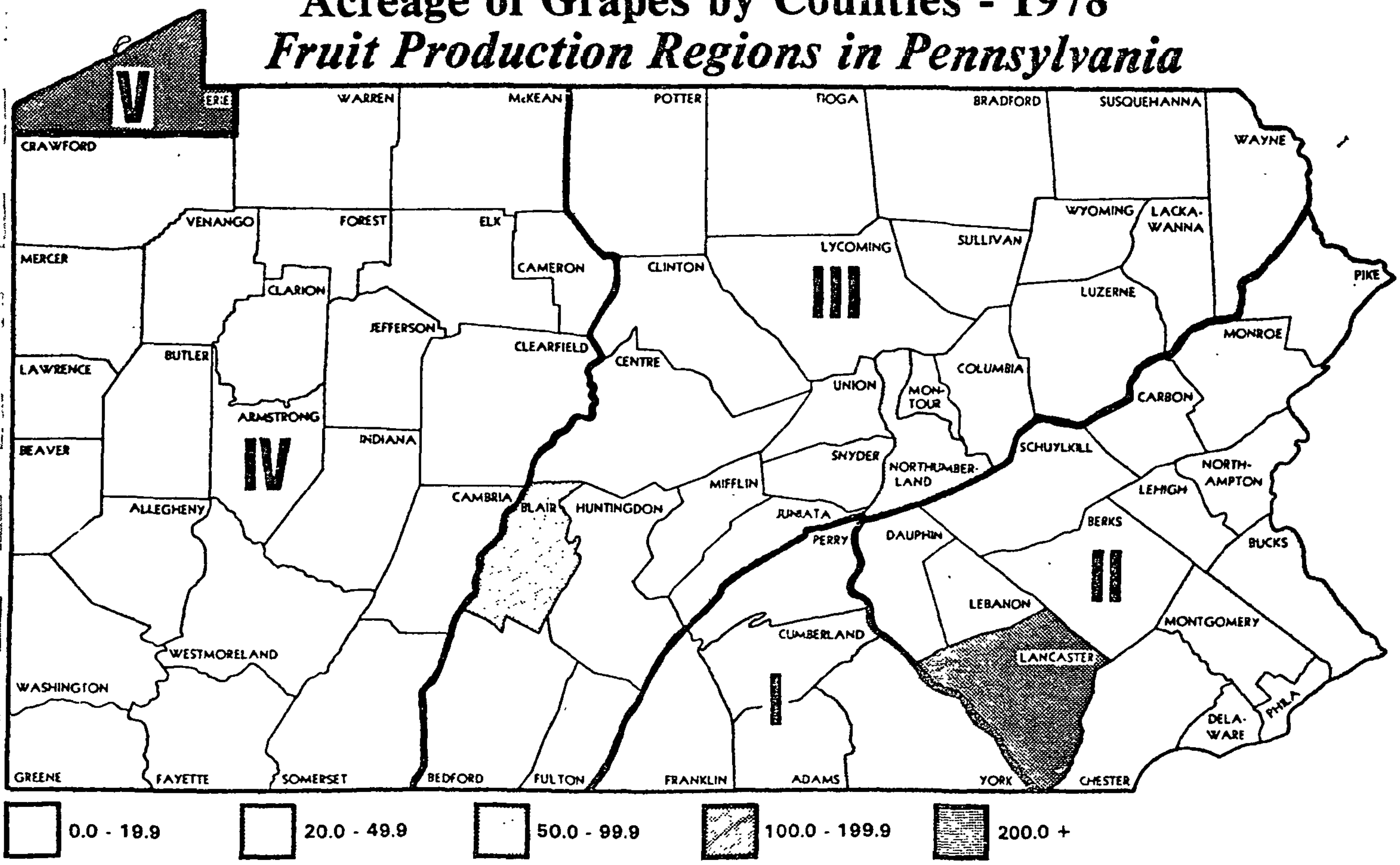
Age Of Grape Acreage: Of the total 14,271.3 acres of grapes, 10.0 percent were 1-3 years old, 9.3 percent 4-6 years old and 80.7 percent 7 years or older. For Concord acreage 7.8 percent was 1-3 years old, 5.4 percent 4-6 years old and 86.7 percent 7 years or older.

Varieties: Concord acreage at 11,751.2 accounted for 82.3 percent of the total 14,271.3 acres. Although all varieties increased in acreage since 1972, French Hybrids, Delaware and Catawba acreage more than doubled. Of all the French Hybrid acreage in the 1-3 year age group 80 percent was in counties other than Erie. This is primarily due to an increased number of wineries established in recent years.

PENNSYLVANIA: GRAPES (TOTAL): COMPARISON OF NUMBER OF VINEYARDS AND ACRES BY REGION, 1972 & 1978.

Region	1972 Survey		1978 Survey	
	Number Of Vineyards	Number Of Acres	Number Of Vineyards	Number Of Acres
I	7	12.3	16	90.4
II	14	36.1	56	251.5
III	13	22.8	21	163.6
IV	12	17.6	20	97.7
V	333	9,798.9	361	13,668.1
PENNSYLVANIA	379	9,887.7	474	14,271.3

Acreage of Grapes by Counties - 1978
Fruit Production Regions in Pennsylvania



PENNSYLVANIA: GRAPES (TOTAL): GROWERS, ACRES AND PRODUCTION BY SIZE OF OPERATION, 1972 And 1978 1/

Size Of Operation In Acres	Growers Number 1972	Growers Number 1978	Growers Percent 1972	Growers Percent 1978	Acres Number 1972	Acres Number 1978	Acres Percent 1972	Acres Percent 1978	Production Tons 1972	Production Tons 1977	Production Percent 1972	Production Percent 1977	Yield Tons/Acre 1972	Yield Tons/Acre 1977	Geneva Double Curtain Acres 1972	Geneva Double Curtain Acres 1977	Geneva Double Curtain Acres 1978
.1-1.9......	31	38	8	8	21.9	25.9	-	-	67	30	-	-	3.1	1.2	-	3.2	3.2
2.0-4.9......	45	80	12	17	142.6	236.0	1	2	609	393	1	1	4.3	1.7	2.5	19.6	20.6
5.0-9.9......	76	90	20	19	499.7	579.7	5	4	2400	1134	5	4	4.8	2.0	5.0	80.2	86.6
10.0-19.9.....	73	89	19	19	937.4	1202.0	10	8	4922	2524	10	8	5.0	2.1	16.5	86.6	92.6
20.0-49.9.....	104	105	28	22	3138.6	3243.5	32	23	16007	7856	34	24	5.1	2.4	109.6	289.5	294.5
50.0-99.9.....	35	44	9	9	2525.6	3022.7	26	21	11884	7544	25	23	4.7	2.5	70.5	481.2	533.2
100.0-199.9....	11	20	3	4	1426.4	2761.0	14	19	6561	6625	14	21	4.6	2.4	83.0	836.1	841.1
200.0 & Over...	4	8	1	2	1145.5	3200.5	12	23	5269	6127	11	19	4.6	1.9	370.0	975.5	991.0
PENNSYLVANIA...	379	474	100	100	9887.7	14271.3	100	100	47719	32233	100	100	4.8	2.3	657.1	2771.9	2862.8

1/ Production in 1977 from acreage maintained for production in 1978.

PENNSYLVANIA: GRAPES (TOTAL): GROWERS, ACRES AND PRODUCTION BY COUNTY AND REGION - 1978

County & Region	Growers	Acres	Production - Tons 1/ Harvested	Production - Tons 1/ Not Harvested
REGION I:				
Adams......................	4	20.3	28.4	6.0
Cumberland.................	4	20.4	19.5	-
York.......................	8	49.7	22.4	3.0
TOTAL......................	16	90.4	70.3	9.0
REGION II:				
Berks......................	6	12.3	9.5	-
Bucks......................	8	36.0	50.2	-
Dauphin....................	3	12.6	12.2	-
Lancaster..................	17	111.6	141.4	4.0
Lehigh.....................	4	11.5	7.0	3.8
Montgomery.................	6	30.4	41.7	1.5
Other......................	12	37.1	35.2	1.1
TOTAL......................	56	251.5	297.2	10.4
REGION III:				
Blair......................	4	76.1	250.0	-
Luzerne....................	3	9.3	.2	.2
Northumberland.............	4	30.0	15.6	.1
Other......................	10	48.2	24.8	-
TOTAL......................	21	163.6	290.6	.3
REGION IV:				
Allegheny..................	6	19.5	1.3	-
Indiana....................	3	12.9	2.2	-
Mercer.....................	3	43.0	60.0	-
Other......................	8	22.3	13.8	-
TOTAL......................	20	97.7	77.3	-
REGION V:				
Erie.......................	351	13,668.1	31,497.8	195.0
Total......................	351	13,668.1	31,497.8	195.0
PENNSYLVANIA.................	474	14,271.3	32,233.2	214.7

1/ Production in 1977 from acreage maintained for production in 1978

PENNSYLVANIA: GRAPES (TOTAL): NUMBER OF GRAPE VINEYARDS BY SIZE OF OPERATION AND COUNTY - 1978

County	.1-1.9	2.0-4.9	5.0-9.9	10.0-19.9	20.0-49.9	50.0-99.9	100.0-199.9	200.0 & Over	Total
	Number Of Vineyard Acres In Each Size Group								
Erie................	2	44	65	79	100	43	20	8	361
Other Counties......	36	36	25	10	5	1	-	-	113
PENNSYLVANIA........	38	80	90	89	105	44	20	8	474

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PENNSYLVANIA: GRAPES (TOTAL): NUMBER OF GROWERS, ACRES OF VINES BY VARIETY, COUNTY & AGE GROUPS

Variety	County	Number Of Growers	Number Of Acres Maintained For Production According To Year Set Out				Geneva Double Curtain	
			1975-1977 (1-3 Years)	1972-1974 (4-6 Years)	1971 & Older (7 Years +)	Total Acres All Ages	Total Acres 1977	Total Acres Intended 1978
Catawba..........	Erie	77	202.5	305.0	394.4	901.9	197.0	197.0
	Other	15	4.6	6.8	1.4	12.8	3.7	4.7
	PA..........	92	207.1	311.8	395.8	914.7	200.7	201.7
Concord.........	Erie	355	890.9	621.0	10103.2	11615.1	2222.0	2307.6
	Other	64	26.4	17.7	92.0	136.1	1.4	1.4
	PA..........	419	917.3	638.7	10195.2	11751.2	2223.4	2309.0
Delaware........	Erie	35	16.0	22.5	315.9	354.4	189.0	189.0
	Other	18	3.5	11.3	3.5	18.3	2.2	3.6
	PA..........	53	19.5	33.8	319.4	372.7	191.2	192.6
Fredonia........	Erie	10	-	.7	36.6	37.3	8.0	8.0
	Other	16	8.6	1.0	11.7	21.3	1.2	1.2
	PA..........	26	8.6	1.7	48.3	58.6	9.2	9.2
Niagara.........	Erie	79	87.4	61.8	287.3	436.5	78.8	80.8
	Other	34	2.6	5.0	27.1	34.7	2.4	3.3
	PA..........	113	90.0	66.8	314.4	471.2	81.2	84.1
Aurora..........	Erie	4	-	1.5	16.0	17.5	3.0	3.0
	Other	12	12.8	2.4	.9	16.1	-	-
	PA..........	16	12.8	3.9	16.9	33.6	3.0	3.0
Baco Noir.......	Erie	11	3.4	3.8	10.0	17.2	8.5	8.5
	Other	10	2.1	10.2	.6	12.9	-	-
	PA..........	21	5.5	14.0	10.6	30.1	8.5	8.5
Chancellor......	Erie	5	10.0	5.6	6.3	21.9	5.0	5.0
	Other	11	10.4	9.6	.2	20.2	-	-
	PA..........	16	20.4	15.2	6.5	42.1	5.0	5.0
Chelois.........	Erie	5	1.5	6.0	3.5	11.0	-	-
	Other	18	2.8	28.9	5.1	36.8	-	-
	PA..........	23	4.3	34.9	8.6	47.8	-	-
DeChanac........	Erie	3	-	4.8	4.0	8.8	4.8	4.8
	Other	14	10.9	11.6	-	22.5	-	-
	PA..........	17	10.9	16.4	4.0	31.3	4.8	4.8
Seyval Blanc....	Erie	12	2.0	18.8	28.0	48.8	8.5	8.5
	Other	22	14.1	30.7	5.6	50.4	2.0	2.0
	PA..........	34	16.1	49.5	33.6	99.2	10.5	10.5
Fosh............	Erie	3	-	-	9.0	9.0	-	-
	Other	24	10.6	21.9	2.4	34.9	2.0	2.0
	PA..........	27	10.6	21.9	11.4	43.9	2.0	2.0
Vidal 256.......	Erie	8	15.0	6.0	6.5	27.5	8.0	8.0
	Other	14	10.3	18.5	-	28.8	-	-
	PA..........	22	25.3	24.5	6.5	56.3	8.0	8.0
Other Native....	Erie	35	5.1	32.0	69.7	106.8	19.2	19.2
	Other	29	14.8	4.3	24.3	43.4	1.2	1.2
	PA.........	64	19.9	36.3	94.0	150.2	20.4	20.4
Other French Hybrids........	Erie	8	-	3.5	16.6	20.1	2.0	2.0
	Other	37	53.8	30.7	17.4	101.9	2.0	2.0
	PA.........	45	53.8	34.2	34.0	122.0	4.0	4.0
Total Native....	Erie	1/	1201.9	1043.0	11207.1	13452.0	2714.0	2801.6
	Other	1/	60.5	46.1	160.0	266.6	12.1	15.4
	PA.........	1/	1262.4	1089.1	11367.1	13718.6	2726.1	2817.0
Total French Hybrids........	Erie	1/	31.9	50.0	99.9	181.8	39.8	39.8
	Other	1/	127.8	164.5	32.2	324.5	6.0	6.0
	PA.........	1/	159.7	214.5	132.1	506.3	45.8	45.8
Total Vinifera.	Erie	5	1.3	12.0	21.0	34.3	-	-
	Other	12	5.2	5.0	1.9	12.1	-	-
	PA.........	17	6.5	17.0	22.9	46.4	-	-
Total All Varieties.	Erie	361	1235.1	1105.0	11328.0	13668.1	2753.8	2841.4
	Other	113	193.5	215.6	194.1	603.2	18.1	21.4
	PA.........	474	1428.6	1320.6	11522.1	14271.3	2771.9	2862.8
Percent Of All Acres			10.0	9.3	80.7	100.0	19.4	-

1/ Data unavailable.

PENNSYLVANIA: GRAPES (TOTAL): COMPARISON OF VARIETIES BY ACRES, 1972 & 1978

Variety	1972 Survey Acres	Percent Of Total	1978 Survey Acres	Percent Of Total	Percent Change 78/72
Catawba	344.5	3.5	914.7	6.4	+166
Concord	8,835.3	89.3	11,751.2	82.3	+ 33
Delaware	130.8	1.3	372.7	2.6	+185
Fredonia	56.3	.6	58.6	.4	+ 4
Niagara	236.6	2.4	471.2	3.3	+ 99
Other Native	85.0	.9	150.2	1.1	+ 77
Total Native	9,688.5	98.0	13,718.6	96.1	+ 42
Total French Hybrids	176.3	1.8	506.3	3.6	+187
Total Vinifera	22.9	.2	46.4	.3	+103
Total All Varieties	9,887.7	100.0	14,271.3	100.0	+ 44

PENNSYLVANIA: GRAPES: AVERAGE PRICE PAID BY PENNSYLVANIA WINERIES AND PROCESSORS FOR PENNSYLVANIA GROWN GRAPES BY VARIETY 1976-1978 1/- 2/

Year	Concord	Catawba	Delaware	Niagara	Other Native	French Hybrids	Other	Average
1976	$ 195	$ 128	$ 198	$ 170	$ 250	$ 258	$ 600	$ 193
1977	254	175	199	220	225	304	744	252
1978	210	226	279	177	301	326	861	212

1/ Dollars Per Ton. 2/ Source - Grape production and utilization survey.

PENNSYLVANIA: GRAPES (COMMERCIAL): PRODUCTION, DISPOSITION AND VALUE, 1930-1978

Year	Production 1/		Utilization: Sales				Price Per Unit 2/	Value Of Production
	Total	Utilized	Fresh	Juice	Other Sales	All Sales		
	Tons						$/Ton	Thous.Dols.
1930	22,400	22,400	4,680	-	17,720	22,400	43	963
1940	17,300	17,300	10,350	6,950	3/	17,300	39	675
1950	30,900	29,700	2,900	26,800	3/	29,700	112	3,326
1960	33,500	33,500	1,940	31,560	3/	33,500	119	3,986
1970	45,000	45,000	1,800	36,230	3,970	45,000	147	6,615
1971	57,000	57,000	2,170	51,470	3,360	57,000	137	7,809
1972	37,600	37,600	2,275	32,410	2,915	37,600	172	6,467
1973	40,000	40,000	2,390	33,367	4,243	40,000	221	8,840
1974	53,000	53,000	1,275	42,217	9,508	53,000	198	10,494
1975	48,000	48,000	1,660	39,250	7,090	48,000	168	8,064
1976	59,000	59,000	1,350	46,270	11,380	59,000	168	9,912
1977	30,000	29,650	1,350	23,350	4,950	29,650	231	6,849
1978	57,500	57,500	1,300	42,300	13,900	57,500	232	13,340

1/ Total production is the quantity actually harvested plus quantities not harvested because of economic reasons. Utilized production is the amount sold plus the quantities used at home or held in storage. When total and utilized production are equal, economic abandonment cullage quantities are considered at a "normal" level.
2/ Fresh and processing prices combined.
3/ Included in fresh sales.

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PENNSYLVANIA: GRAPES: QUANTITY OF PENNSYLVANIA GROWN GRAPES BY VARIETY DELIVERED TO WINERIES AND PROCESSING PLANTS, 1976-1978 1/

Variety	Pennsylvania Plants And Wineries			Out-Of-State Plants And Wineries			Total 2/		
	1976	1977	1978	1976	1977	1978	1976	1977	1978
	Tons								
Concord	42,690.6	21,409.5	38,622.6	10,155.0	5,155.0	13,490.0	52,845.6	26,564.5	52,112.6
Catawba	-2-	-2-	-2-	-2-	-2-	-2-	2,092.9	693.1	1,523.4
Delaware	-3-	-3-	-3-	-3-	-3-	-3-	194.9	152.7	239.4
Niagara	-4-	-4-	-4-	-4-	-4-	-4-	1,489.4	712.5	1,300.2
Other Native	-5-	-5-	-5-	-5-	-5-	-5-	176.9	89.2	179.8
(2+3+4+5)	1,862.1	1,054.5	2,478.8	2,092.0	593.0	764.0	3,954.1	1,647.5	3,242.8
French Hybrid	592.1	517.0	696.7	187.0	43.0	73.9	779.1	560.0	770.6
Other	47.9	7.9	17.6	0.0	0.0	0.0	47.9	7.9	17.6
TOTAL	45,192.7	22,988.9	41,815.7	12,434.0	5,791.0	14,327.9	57,626.7	28,779.9	56,143.6

1/ Source - Grape production and utilization survey. 2/ Excludes small amount of cullage.

PENNSYLVANIA: GRAPES: UTILIZATION BY VARIETY OF GRAPES USED IN PENNSYLVANIA WINERIES AND PROCESSING PLANTS, 1976-1978 1/

Variety	Wine			Sweet Juice + Other			Total 2/		
	1976	1977	1978	1976	1977	1978	1976	1977	1978
	Tons								
Concord	258.5	1,143.0	2,508.9	72,097.0	32,829.9	57,836.2	72,355.5	33,972.9	60,345.1
Catawba	912.3	311.1	1,070.4	0.0	0.0	0.0	912.3	311.1	1,070.4
Delaware	72.9	141.7	295.5	0.0	0.0	0.0	72.9	141.7	295.5
Niagara	282.4	334.5	565.6	2,295.0	1,199.0	2,015.0	2,577.4	1,533.5	2,580.6
Other Native	140.9	134.2	248.7	0.0	0.0	0.0	140.9	134.2	248.7
French Hybrid	705.8	595.1	847.6	0.0	0.0	0.0	705.8	595.1	847.6
Other	51.3	9.7	25.6	0.0	0.0	0.0	51.3	9.7	25.6
TOTAL	2,424.1	2,669.3	5,562.3	74,392.0	34,026.9	59,851.2	76,816.1	36,698.2	65,413.5

1/ Source - 2/ Excludes small amount of cullage.

PENNSYLVANIA: GRAPES: UTILIZATION BY VARIETY OF PENNSYLVANIA GROWN GRAPES TO ALL WINERIES AND PROCESSORS, 1976-1978 1/

Year	Concord	Catawba	Delaware	Niagara	Other Native	French Hybrids	Other Varieties	Total 2/
	Tons							
	Wine							
1976	8,055.6	2,092.9	194.9	305.4	176.9	779.1	47.9	11,643.7
1977	4,383.2	693.1	152.7	239.5	89.2	560.0	7.9	6,125.6
1978	10,605.3	1,523.4	239.4	510.2	179.8	770.6	17.6	13,846.3
	Juice + Other							
1976	44,790.0	0.0	0.0	1,184.0	0.0	0.0	0.0	45,983.0
1977	22,103.3	0.0	0.0	473.0	0.0	78.0	0.0	22,654.3
1978	41,507.3	0.0	0.0	790.0	0.0	0.0	0.0	42,297.3
	Total							
1976	52,845.6	2,092.9	194.9	1,489.4	176.9	779.1	47.9	57,626.7
1977	26,486.5	693.1	152.7	712.5	89.2	638.6	7.9	28,779.9
1978	52,112.6	1,523.4	239.4	1,300.2	179.8	770.6	17.6	56,143.6

1/ Source - 2/ Excludes small amount of cullage.

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PLUMS AND PRUNES

Number Of Orchards And Trees: There were 78 commercial plum and prune orchards (100+ Trees) in 1978 compared with 108 in 1972, a 28 percent decrease. Corresponding tree numbers decreased from 36,327 in 1972 to 29,120 in 1978, down 20%.

Acreage In Orchards: Commercial plum and prune acreage declined 26 percent from 431 acres in 1972 to 319.3 acres in 1978. Trees per acre increased from 84 in 1972 to 91 in 1978.

Location of Trees: Fruit Region I accounts for 54 percent of the total 35,479 trees. Adams county alone accounts for 33 percent of all trees. The leading four counties (Adams, Franklin, Dauphin and Erie) account for 60 percent of the total trees.

Age Of Trees: Of the 35,479 total plum and prune trees, 12.6 percent were 1-3 years old, 15.8 percent 4-6 years old, 58.6 percent 7-21 years old and 13.0 percent 22 years old or older.

Varieties: European varieties accounted for 72 percent of the total 35,479 trees while Japanese varieties comprised 19 percent and other varieties 9 percent. Stanley is the leading variety accounting for 42 prcent of the total trees. Other leading varieties as a percent of total trees are: Fellenburg — 5, President — 4, Bluefree and Shiro Gold — 3.

PENNSYLVANIA: PLUMS & PRUNES - COMPARISON OF COMMERCIAL & NON COMMERCIAL GROWER AND TREE NUMBERS, 1967, 1972, 1978

Trees	Number Of Growers			Number Of Trees		
	1967	1972	1978	1967	1972	1978
1 - 99 1/	236	173	241	7,332	5,246	6,359
100 +	127	108	78	42,173	36,327	29,120
TOTAL 1/	363	281	319	49,505	41,573	35,479

1/ Include trees in orchards classified as commercial (100 + Trees) for any fruit.

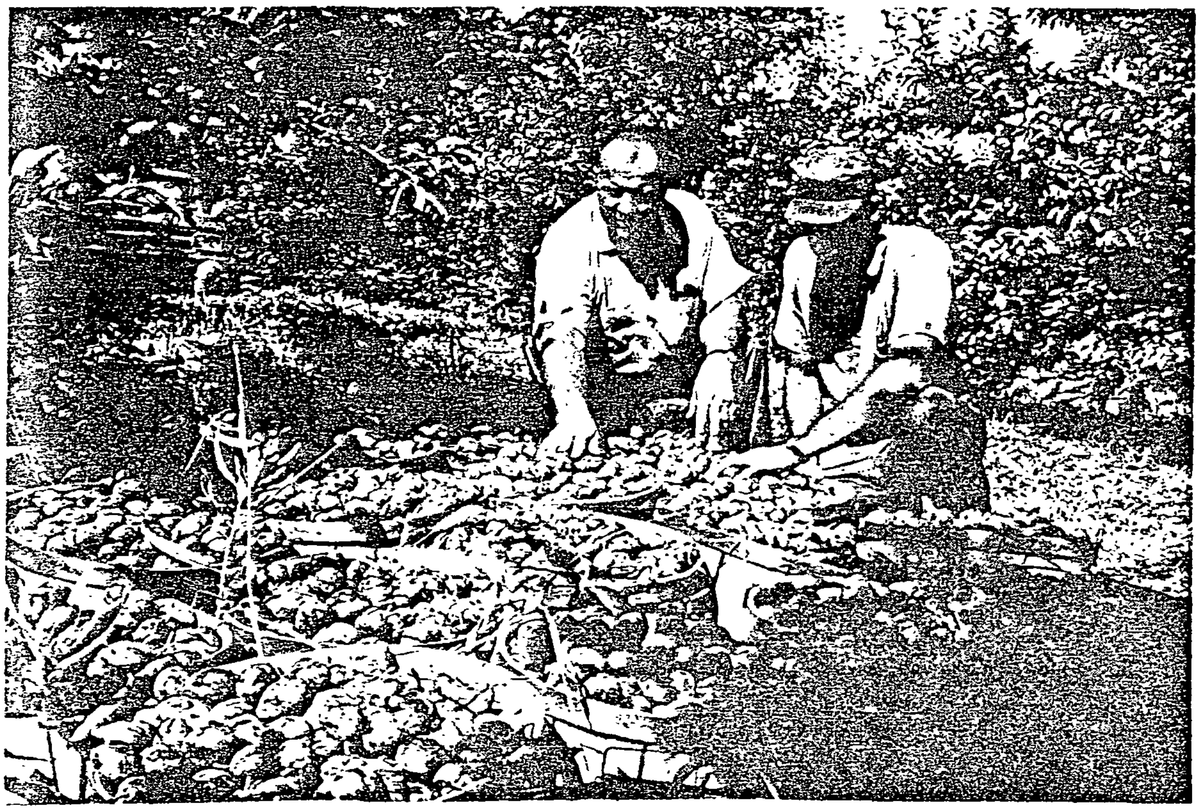
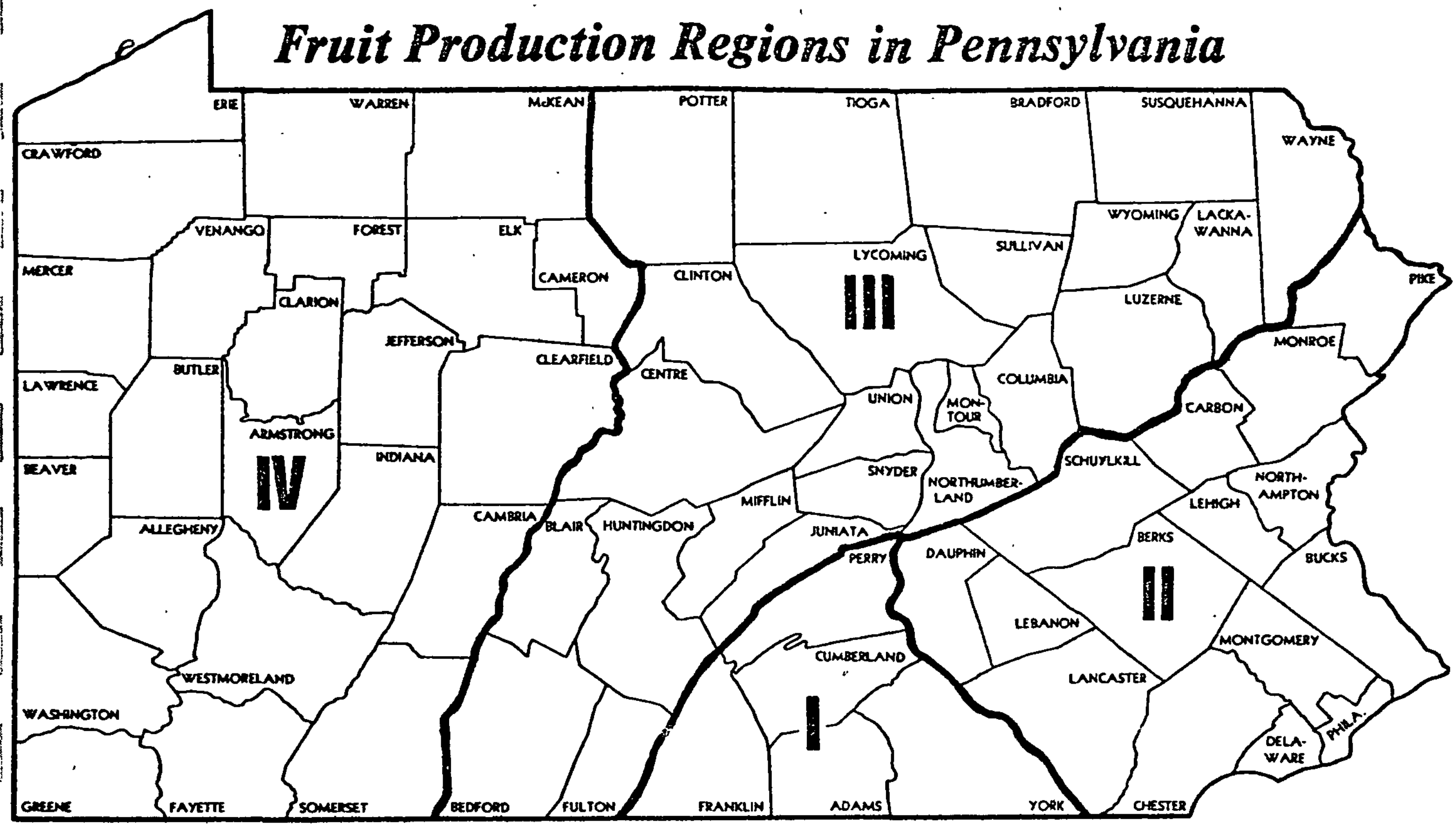


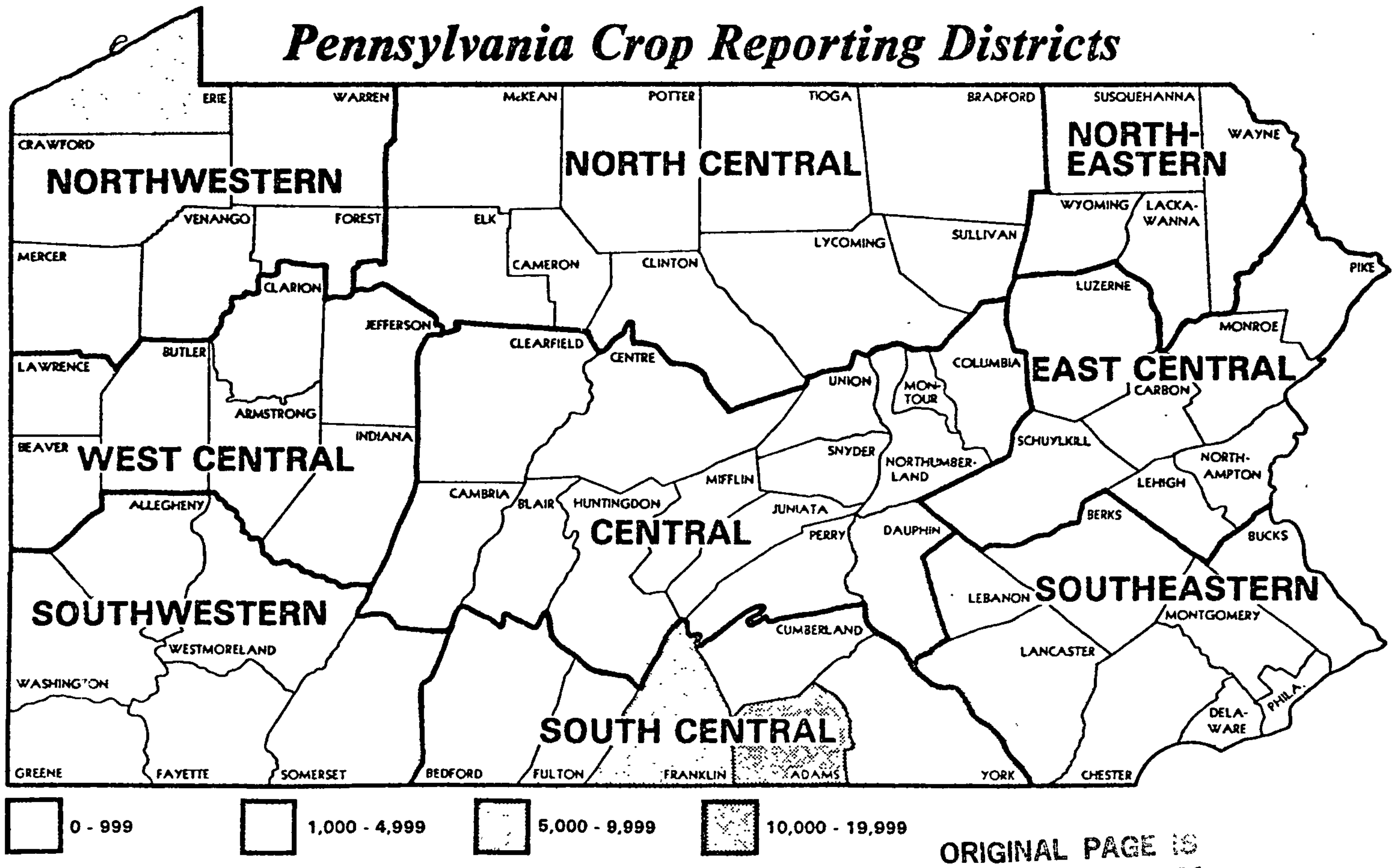
Photo Credit: Tom Piper

Fruit Production Regions in Pennsylvania



Number of Plum and Prune Trees by County - 1978

Pennsylvania Crop Reporting Districts



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PENNSYLVANIA: PLUMS & PRUNES (TOTAL): GROWERS, ACRES, TREES, PRODUCTION BY COUNTY & REGION - 1978 1/

County & Region	Growers		Acres		Total Trees		Trees Per Acre	Production 2/		Yield Per Tree 3/ (Bu.)
	Number	%	Number	%	Number	%		Bushels	%	
REGION I:										
Adams	40	12.5	122.4	31.7	11,659	32.9	95	15,531	31.4	1.6
Cumberland	3	.9	2:0	.5	146	.4	73	245	.5	1.7
Franklin	16	5.0	56.0	14.5	5,185	14.6	93	6,245	12.6	1.2
Perry	4	1.3	1.2	.3	95	.3	79	16	-	.3
York	32	10.1	25.3	6.6	1,973	5.5	78	3,441	7.0	2.0
TOTAL	95	29.8	206.9	53.6	19,058	53.7	92	25,478	51.5	1.5
REGION II:										
Berks	16	5.0	12.0	3.1	993	2.8	83	939	1.9	1.1
Bucks	7	2.1	5.5	1.4	580	1.6	105	1,191	2.4	2.2
Carbon	3	.9	.6	.2	58	.2	97	26	.1	.6
Chester	6	1.9	3.4	.9	315	.9	93	590	1.2	2.0
Dauphin & Lebanon	7	2.2	21.3	5.5	2,513	7.1	118	3,317	6.7	1.3
Delaware	4	1.3	1.1	.3	81	.2	74	55	.1	.7
Lancaster	16	5.0	15.4	4.0	1,293	3.7	84	1,033	2.1	.9
Lehigh	6	1.9	9.7	2.5	870	2.4	90	1,946	3.9	2.6
Monroe & Pike	2	.6	1.1	.3	106	.3	91	20	-	3.3
Montgomery	4	1.3	2.0	.5	185	.5	93	285	.6	1.9
Northampton	5	1.6	3.6	.9	318	.9	88	694	1.4	3.2
Schuylkill	21	6.6	4.4	1.1	386	1.1	88	774	1.6	2.3
TOTAL	97	30.4	80.1	20.7	7,692	21.7	96	10,870	22.0	1.7
REGION III:										
Bedford	4	1.3	1.7	.4	161	.5	95	48	.1	.3
Blair	-	-	-	-	-	-	-	-	-	-
Bradford & Tioga	3	.9	.9	.3	75	.2	83	298	.6	4.0
Huntingdon, Centre, and Montour	5	1.6	2.1	.6	175	.4	83	195	.4	1.4
Clinton	-	-	-	-	-	-	-	-	-	-
Columbia	5	1.6	11.0	2.8	922	2.6	84	1,709	3.5	1.9
Fulton	-	-	-	-	-	-	-	-	-	-
Juniata	6	1.9	8.0	2.1	739	2.1	92	2,052	4.1	2.9
Lackawanna	4	1.3	.5	.1	46	.1	92	21	-	.6
Luzerne	8	2.5	4.1	1.0	318	.9	78	199	.4	.9
Lycoming	9	2.8	3.4	.9	264	.8	78	454	.9	2.8
Mifflin	-	-	-	-	-	-	-	-	-	-
Northumberland	10	3.1	11.3	2.9	967	2.7	86	889	1.8	1.5
Potter	-	-	-	-	-	-	-	-	-	-
Snyder	5	1.6	10.9	2.8	904	2.6	83	3,238	6.6	3.8
Susquehanna & Wyoming	3	.9	.4	.1	42	.1	105	4	-	.3
Union	3	.9	.3	.1	32	.1	107	35	.1	1.3
Wayne	-	-	-	-	-	-	-	-	-	-
TOTAL	65	20.4	54.6	14.1	4,645	13.1	85	9,142	18.5	2.4
REGION IV:										
Allegheny	10	3.1	3.0	.8	269	.8	90	253	.5	1.0
Armstrong	3	.9	3.5	.9	335	.9	96	54	.1	.2
Beaver	4	1.3	1.9	.5	171	.5	90	8	-	.1
Clarion, Jefferson, Butler & Clearfield	4	1.3	.9	.2	73	.2	81	39	.1	-
Cambria	-	-	-	-	-	-	-	-	-	-
Mercer, Crawford	5	1.6	5.8	1.5	527	1.5	91	271	.5	.6
Elk	-	-	-	-	-	-	-	-	-	-
Fayette	-	-	-	-	-	-	-	-	-	-
Greene	-	-	-	-	-	-	-	-	-	-
Indiana	9	2.8	4.0	1.0	334	.9	84	178	.4	.5
Lawrence	3	.9	2.1	.6	160	.5	76	457	.9	2.9
McKean	-	-	-	-	-	-	-	-	-	-
Somerset	-	-	-	-	-	-	-	-	-	-
Venango	-	-	-	-	-	-	-	-	-	-
Westmoreland, and Washington	5	1.6	1.7	.4	145	.4	85	185	.4	2.2
TOTAL	43	13.5	22.9	5.9	2,014	5.7	88	1,445	2.9	.9
REGION V:										
Erie	19	5.9	22.0	5.7	2,070	5.8	94	2,535	5.1	.8
TOTAL	19	5.9	22.0	5.7	2,070	5.8	94	2,535	5.1	.8
PENNSYLVANIA	319	100.0	386.5	100.0	35,479	100.0	92	49,470	100.0	1.6

1/ Some counties are combined to avoid disclosure of individual operations.
2/ Production in 1977 from acreage maintained for production in 1978.
3/ Yield calculations are derived excluding the 1-3 year age category trees.

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PENNSYLVANIA: PLUMS & PRUNES (TOTAL): GROWERS, ACRES, TREES, PRODUCTION BY SIZE OF OPERATION, 1978

Size Of Operation (Trees)	Growers		Acres		Trees		Production 1/		Yield 2/	
	Number	Percent	Number	Percent	Number	Percent	Bushels	Percent	Bushels Per Tree	Bushels Per Acre
1-99............	241	75.5	67.2	17.4	6,359	17.9	10,285	20.8	1.6	153
100-199..........	42	13.2	70.2	18.2	5,659	16.0	8,115	16.4	1.4	116
200-499..........	26	8.2	85.6	22.2	7,695	21.7	10,220	20.6	1.3	119
500-999..........	5	1.6	43.0	11.1	3,439	9.7	8,250	16.7	2.4	192
1000 +...........	5	1.5	120.0	31.1	12,327	34.7	12,600	25.5	1.0	105
PENNSYLVANIA....	319	100.0	386.5	100.0	35,479	100.0	49,470	100.0	1.4	128

1/ Production in 1977 from acreage maintained for production in 1978. 2/ Actual yield will be slightly higher due to non bearing trees and acres included for this calculation.

PENNSYLVANIA: PLUMS & PRUNES (TOTAL): TREES BY VARIETY AND AGE GROUPS, 1978

Variety	1975 - 1977 (1-3 Years)	1972 - 1974 (4-6 Years)	1957 - 1971 (7-21 Years)	1956 & Earlier (22 Years +)	Total All Ages	Percent Of Total
European:						
Stanley............	2,313	2,629	7,416	2,520	14,878	41.9
Fellenberg..........	42	282	1,240	260	1,824	5.1
President...........	337	461	671	40	1,509	4.3
Bluefre.............	262	82	730	8	1,082	3.0
Other European......	278	456	5,038	532	6,304	17.8
TOTAL EUROPEAN......	3,232	3,910	15,095	3,360	25,597	72.1
Japanese:						
Methley.............	68	127	587	93	875	2.5
Santa Rosa..........	102	256	458	41	857	2.4
Shiro (Gold)........	89	376	523	238	1,226	3.4
Other Japanese......	408	456	2,377	400	3,641	10.3
TOTAL JAPANESE......	667	1,215	3,945	772	6,599	18.6
TOTAL OTHER............	555	497	1,735	496	3,283	9.3
TOTAL ALL VARIETIES....	4,454	5,622	20,775	4,628	35,479	100.0

PENNSYLVANIA: PLUMS AND PRUNES (COMMERCIAL): NUMBER OF ORCHARDS AND TREES BY SIZE GROUPS, SELECTED COUNTIES, 1978

County	100 - 199 Trees	200 - 499 Trees	500 + Trees	Total
Adams - No. Of Orchards.......	5	6	4	15
Adams - No. Of Trees..........	809	1,576	8,477	10,862
Erie - No. Of Orchards........	4	4	-	8
Erie - No. Of Trees...........	626	1,215	-	1,841
Others - No. Of Orchards......	33	16	6	55
Others - No. Of Trees.........	4,224	4,904	7,289	16,417
PENNSYLVANIA - No. Of Orchards	42	26	10	78
PENNSYLVANIA - No. Of Trees...	5,659	7,695	15,766	29,120

PENNSYLVANIA: PLUMS AND PRUNES (TOTAL): NUMBER OF TREES BY COUNTIES AND AGE GROUPS, 1978 1/

County And District	Number Of Trees Maintained For Production According To Year Set Out					Percent Of Total
	1975-1977 (1-3 Yrs.)	1972-1974 (4-6 Yrs.)	1957-1971 (7-21 Yrs.)	1956 & Earlier (22 Yrs +)	Total All Ages	
Erie	20	192	766	1,092	2,070	5.8
Mercer and Crawford	70	-	432	25	527	1.5
NORTHWESTERN, TOTAL	90	192	1,198	1,117	2,597	7.3
Bradford and Tioga	20	10	25	20	75	.2
Lycoming	102	31	81	50	264	.8
NORTH CENTRAL, TOTAL	122	41	106	70	339	1.0
Lackawanna	8	8	14	16	46	.1
Susquehanna and Wyoming	30	-	12	-	42	.1
NORTHEASTERN, TOTAL	38	8	26	16	88	.2
Armstrong	-	165	5	165	335	.9
Beaver	-	28	143	-	171	.5
Butler, Clarion and Jefferson	-	12	36	-	48	.1
Indiana	8	233	70	23	334	.9
Lawrence	-	-	130	30	160	.5
WEST CENTRAL, TOTAL	8	438	384	218	1,048	2.9
Centre, Clearfield, Huntingdon & Montour	36	25	79	60	200	.6
Columbia	40	54	628	200	922	2.6
Dauphin	489	334	1,509	41	2,373	6.7
Juniata	40	-	699	-	739	2.1
Northumberland	383	59	525	-	967	2.7
Perry	40	5	50	-	95	.3
Snyder	43	41	530	290	904	2.5
Union	5	2	25	-	32	.1
CENTRAL, TOTAL	1,076	520	4,045	591	6,232	17.6
Carbon	17	22	11	8	58	.2
Lehigh	115	108	291	350	864	2.4
Luzerne	105	75	-	138	318	.9
Monroe and Pike	100	-	-	6	106	.3
Northampton	103	45	170	-	318	.9
Schuylkill	44	71	261	10	386	1.1
EAST CENTRAL, TOTAL	484	321	733	512	2,050	5.8
Allegheny	8	52	177	32	269	.8
Washington and Westmoreland	5	70	70	-	145	.4
SOUTHWESTERN, TOTAL	13	122	247	32	414	1.2
Adams	1,860	2,002	6,469	1,328	11,659	32.9
Bedford	-	73	88	-	161	.4
Cumberland	-	-	146	-	146	.4
Franklin	105	615	4,229	236	5,185	14.6
York	225	520	1,079	149	1,973	5.6
SOUTH CENTRAL, TOTAL	2,190	3,210	12,011	1,713	19,124	53.9
Berks	174	253	509	57	993	2.8
Bucks	30	31	478	41	580	1.6
Chester	25	20	270	-	315	.9
Delaware	-	38	15	28	81	.2
Lancaster and Lebanon	169	328	753	183	1,433	4.1
Montgomery	35	100	-	50	185	.5
SOUTHEASTERN, TOTAL	433	770	2,025	359	3,587	10.1
PENNSYLVANIA	4,454	5,622	20,775	4,628	35,479	100.0
PERCENT OF TOTAL TREES	12.6	15.8	58.6	13.0	100.0	100.0

1/ Some counties are combined to avoid disclosure of individual operations.

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NECTARINES

Number Of Orchards And Trees: Consumer acceptance of nectarines has increased substantially during recent years. The number of commercial nectarine orchards (100+ Trees) increased from 44 in 1972 to 71 in 1978, up 61 percent. The number of trees in commercial nectarine orchards climbed from 19,024 in 1972 to 44,877 in 1978.

Acreage In Orchards: Commercial nectarine acreage more than doubled from 222 acres in 1972 to 479.6 in 1978. During the same period trees per acre increased from 86 to 94.

Location Of Trees: Fruit Region I accounted for 58 percent of the total 47,938 nectarine trees. The leading three counties (Franklin, York and Adams) accounted for 58 percent of the total trees.

Age Of Trees: Of the total 47,938 nectarine trees, 20.7 percent were 1-3 years old, 41.6 percent 4-6 years old, 37.3 percent 7-21 years old and .4 percent 22 years or older.

Varieties: Leading varieties as a percent of total trees are: Redgold — 24, Sunglo — 17, Nectared — 11, and Favertop — 8.

PENNSYLVANIA: NECTARINES - COMPARISON OF COMMERCIAL & NON COMMERCIAL GROWER AND TREE NUMBERS
1967 - 1972 - 1978

Trees	Number Of Growers			Number Of Trees		
	1967	1972	1978	1967	1972	1978
1-99 1/..............	106	86	153	2,892	2,328	3,061
100 +.................	35	44	71	24,039	19,024	44,877
Total 1/..............	141	130	224	26,931	21,352	47,938

1/ Include trees in orchards classified as commercial (100 + Trees) for any fruit.

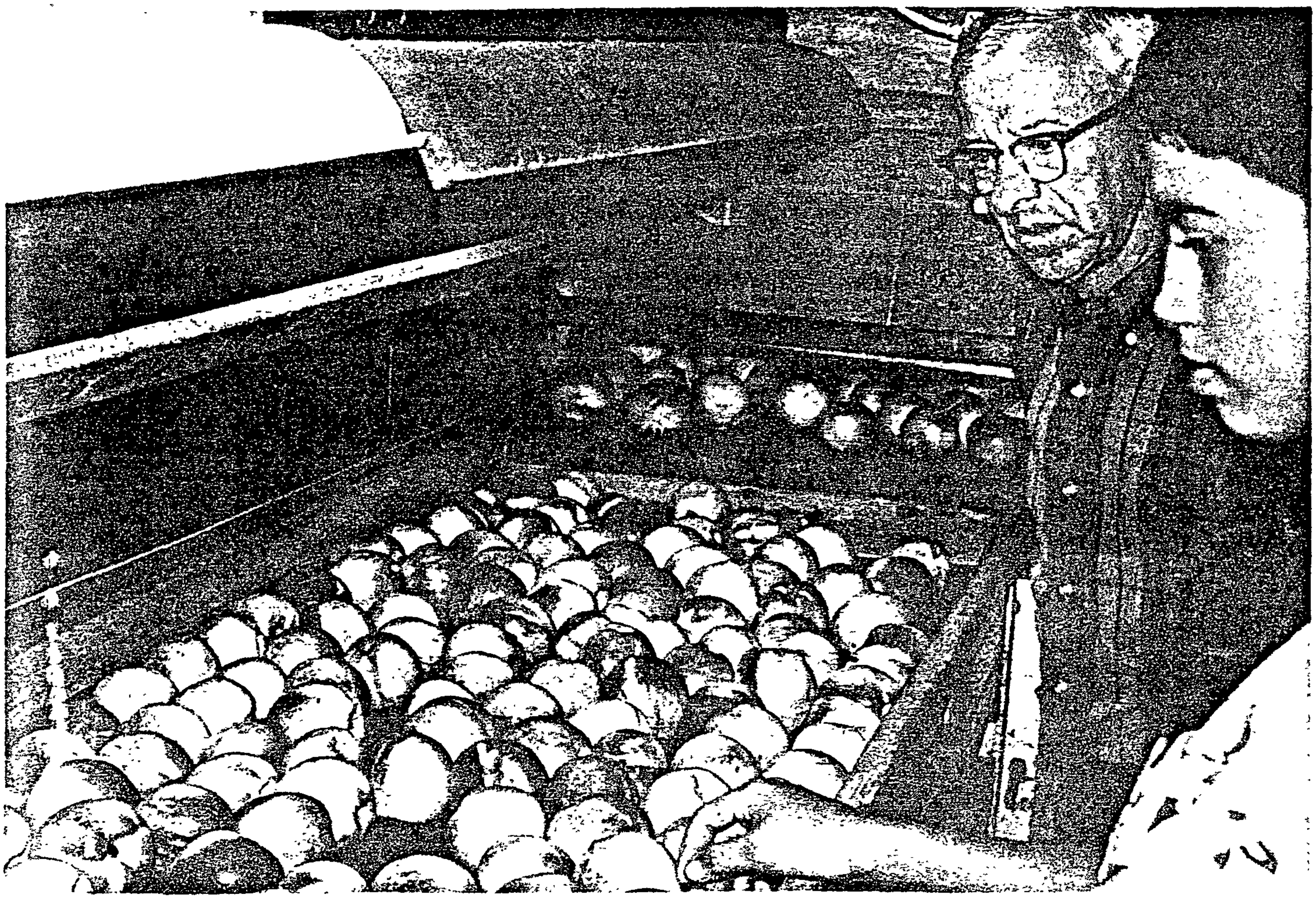
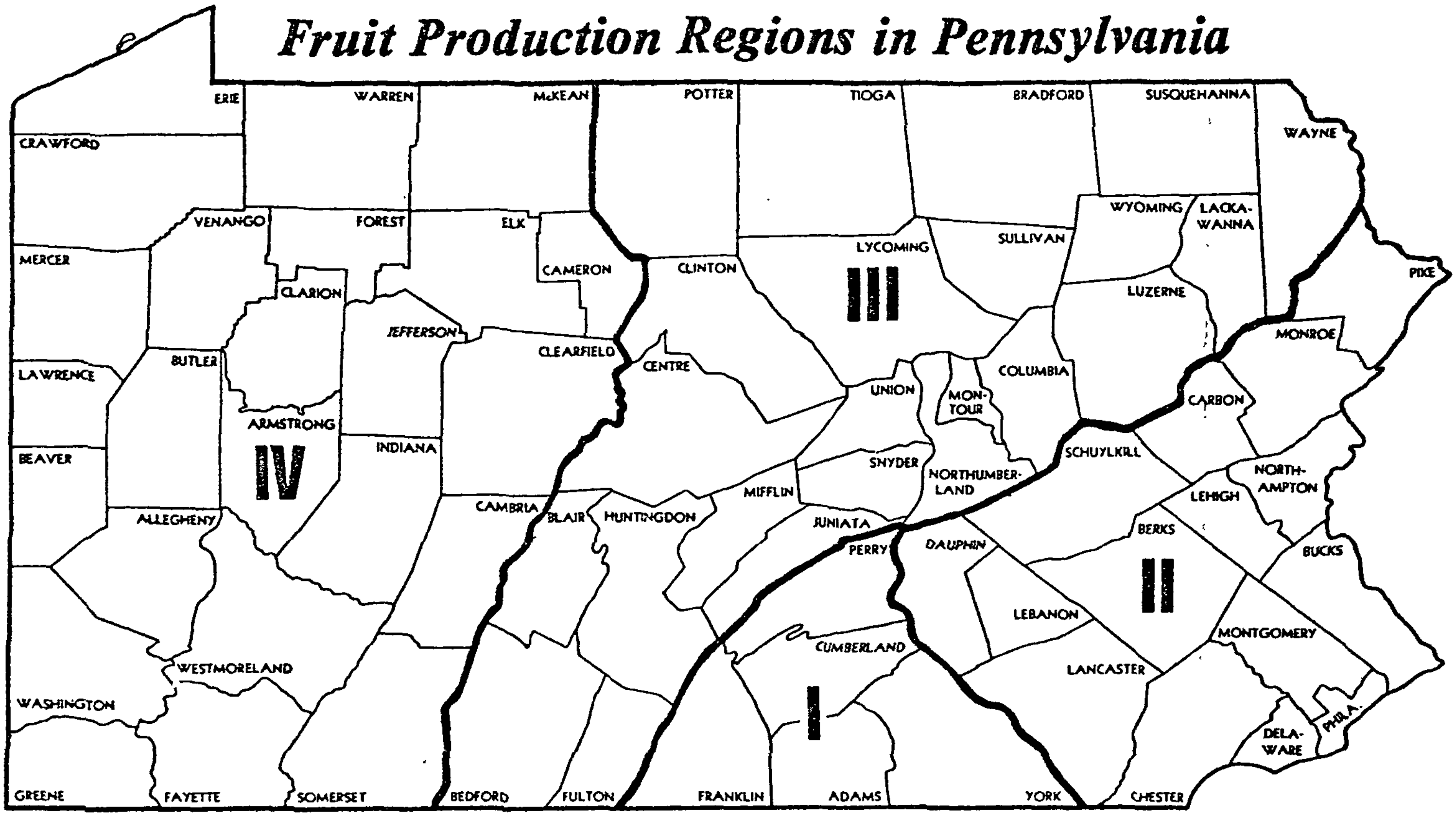


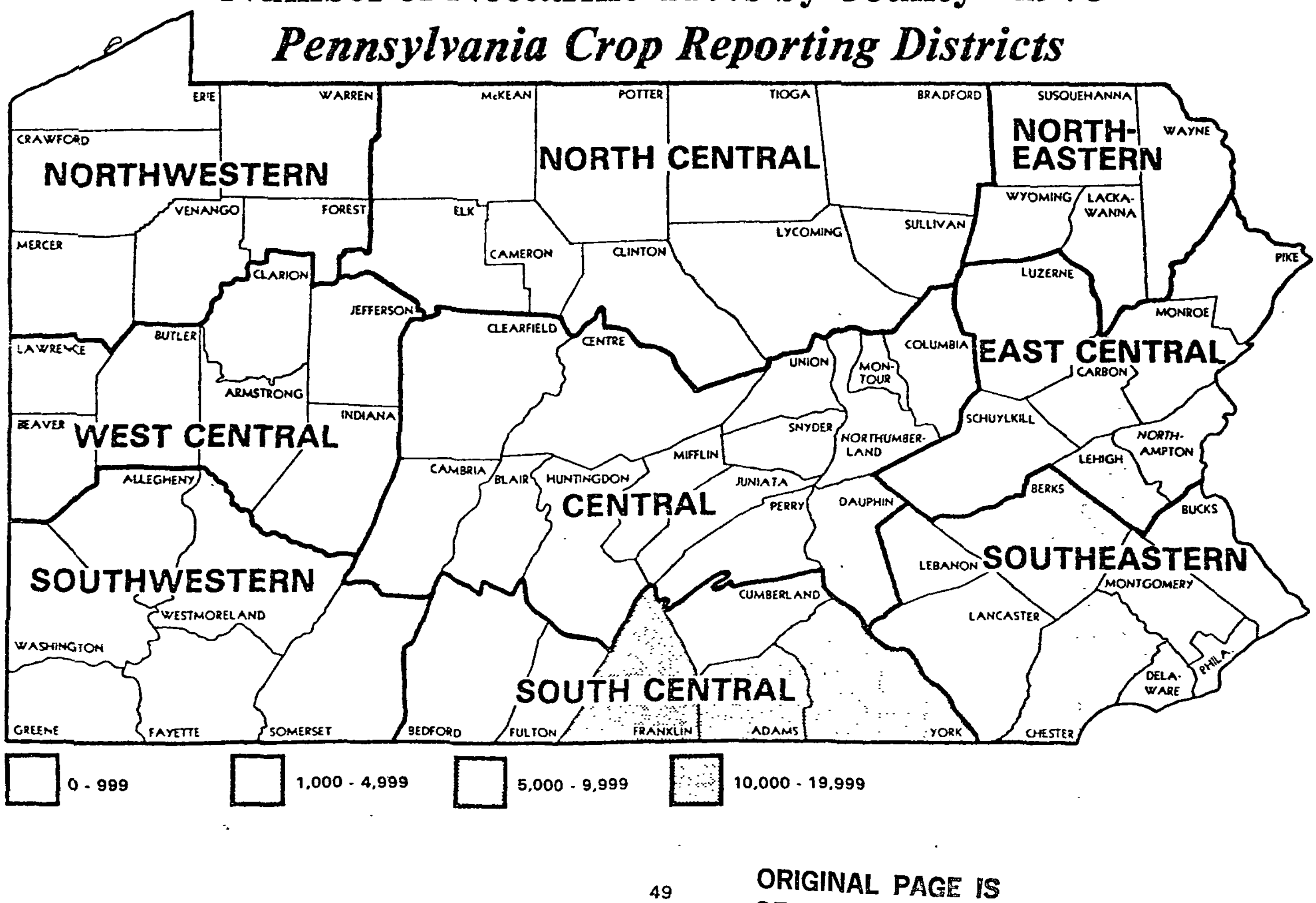
Photo Credit: Tom Piper

Fruit Production Regions in Pennsylvania



Number of Nectarine Trees by County - 1978

Pennsylvania Crop Reporting Districts



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PENNSYLVANIA: NECTARINES (TOTAL): GROWERS, TREES, ACRES, PRODUCTION, BY COUNTY & REGION, 1978 1/

County & Region	Growers Number	Growers Percent	Acres Number	Acres Percent	Total Trees Number	Total Trees Percent	Trees Per Acre	Production 2/ Bushels	Production 2/ Percent	Yield Per Tree 3/ (Bushels)
REGION I:										
Adams	23	10.3	75.3	14.3	6,592	13.7	88	6,979	8.6	1.4
Cumberland & Perry	7	3.1	1.6	.3	107	.2	67	62	.1	.9
Franklin	16	7.1	172.8	32.8	13,206	27.6	76	42,032	51.7	3.6
York	26	11.6	69.7	13.2	7,863	16.4	113	10,776	13.3	1.4
TOTAL	72	32.1	319.4	60.6	27,768	57.9	87	59,849	73.7	2.4
REGION II:										
Berks	15	6.8	43.4	8.2	4,184	8.7	96	3,385	4.2	1.3
Bucks	5	2.2	2.2	.4	185	.4	84	300	.4	1.6
Carbon & Schuylkill	12	5.4	5.7	1.0	308	.6	54	465	.6	1.6
Chester	5	2.2	8.7	1.7	1,021	2.1	117	255	.3	2.5
Dauphin & Lebanon	6	2.7	19.0	3.6	1,740	3.6	92	1,984	2.4	1.6
Delaware	3	1.3	.8	.2	57	.1	71	75	.1	1.6
Lancaster	9	4.0	3.6	.7	277	.6	77	196	.2	1.1
Lehigh	9	4.0	19.4	3.7	1,943	4.1	100	6,197	7.6	3.7
Monroe	-	-	-	-	-	-	-	-	-	-
Montgomery	4	1.8	5.2	1.0	700	1.5	135	344	.4	.9
Northampton	5	2.2	3.4	.6	421	.9	124	162	.2	.6
Pike	-	-	-	-	-	-	-	-	-	-
TOTAL	73	32.6	111.4	21.1	10,836	22.6	97	13,363	16.4	1.9
REGION III:										
Bedford	3	1.3	3.2	.6	413	.9	129	86	.1	.2
Blair & Huntingdon	3	1.3	3.8	.7	377	.8	99	80	.1	.2
Bradford	-	-	-	-	-	-	-	-	-	-
Centre	-	-	-	-	-	-	-	-	-	-
Clintón	-	-	-	-	-	-	-	-	-	-
Columbia	5	2.2	4.5	.9	479	1.0	106	1,063	1.3	3.8
Fulton	-	-	-	-	-	-	-	-	-	-
Juniata	5	2.2	13.6	2.6	1,215	2.5	89	1,100	1.4	1.6
Lackawanna	-	-	-	-	-	-	-	-	-	-
Luzerne & Susquehanna	6	2.7	1.0	.2	86	.2	86	8	-	.2
Lycoming	6	2.7	26.0	4.9	2,609	5.4	100	4,011	5.0	1.6
Mifflin	-	-	-	-	-	-	-	-	-	-
Montour & Northumberland	8	3.6	3.8	.7	274	.6	72	193	.2	1.2
Potter	-	-	-	-	-	-	-	-	-	-
Snyder	7	3.2	11.7	2.2	1,482	3.1	127	140	.2	1.0
Tioga	-	-	-	-	-	-	-	-	-	-
Union	3	1.3	.9	.2	53	.1	59	25	-	.5
Wayne	-	-	-	-	-	-	-	-	-	-
Wyoming	-	-	-	-	-	-	-	-	-	-
TOTAL	46	20.5	68.5	13.0	6,988	14.6	102	6,706	8.3	1.4
REGION IV:										
Allegheny	5	2.2	4.8	.9	437	.9	91	375	.5	.9
Beaver	6	2.8	4.2	.8	373	.7	89	120	.1	.3
Butler	-	-	-	-	-	-	-	-	-	-
Cambria	-	-	-	-	-	-	-	-	-	-
Clarion	-	-	-	-	-	-	-	-	-	-
Clearfield	-	-	-	-	-	-	-	-	-	-
Crawford & Mercer	3	1.3	.5	.1	33	.1	66	48	.1	1.5
Elk	-	-	-	-	-	-	-	-	-	-
Fayette	-	-	-	-	-	-	-	-	-	-
Greene	-	-	-	-	-	-	-	-	-	-
Indiana & Jefferson	4	1.8	9.3	1.8	660	1.4	71	3	-	-
Lawrence	4	1.8	2.2	.4	225	.5	102	306	.4	2.2
McKean	-	-	-	-	-	-	-	-	-	-
Somerset & Washington	5	2.2	1.4	.3	121	.3	86	190	.2	1.6
Venango	-	-	-	-	-	-	-	-	-	-
Westmoreland	-	-	-	-	-	-	-	-	-	-
TOTAL	27	12.1	22.4	4.3	1,849	3.9	83	1,042	1.3	.8
REGION V:										
Erie	6	2.7	5.4	1.0	497	1.0	92	219	.3	.6
TOTAL	6	2.7	5.4	1.0	497	1.0	92	219	.3	.6
PENNSYLVANIA	224	100.0	527.1	100.0	47,938	100.0	91	81,179	100.0	2.1

1/ Some counties are combined to avoid disclosure of individual operations.
2/ Production in 1977 from acreage maintained for production in 1978.
3/ Yield calculations are derived excluding the 1-3 year age category trees.

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PENNSYLVANIA: NECTARINES - TOTAL: GROWERS, TREES, ACRES AND PRODUCTION BY SIZE OF OPERATION - 1978

Size Of Operation (Trees)	Growers		Trees		Acres		Production 1/		Yield 2/	
	Number	Percent	Number	Percent	Number	Percent	Bushels	Percent	Bushels Per Tree	Bushels Per Acre
1-99............	153	68.3	3,061	6.4	47.5	9.0	3,868	4.8	1.3	81.4
100-199..........	29	13.0	4,747	9.9	49.9	9.5	4,887	6.0	1.0	97.9
200-499..........	19	8.5	6,035	12.6	63.0	12.0	9,709	12.0	1.6	154.1
500-999..........	13	5.8	8,453	17.6	92.7	17.6	8,210	10.1	1.0	88.6
1000-2499........	5	2.2	5,542	11.6	54.0	10.2	4,005	4.9	.7	74.2
2500+............	5	2.2	20,100	41.9	220.0	41.7	50,500	62.2	2.5	229.5
PENNSYLVANIA.....	224	100.0	47,938	100.0	527.1	100.0	81,179	100.0	1.7	154.0

1/ Production in 1977 from acreage maintained for production in 1978.
2/ Actual yield will be slightly higher due to nonbearing trees and acres included for this calculation.

PENNSYLVANIA: NECTARINES - TOTAL: TREES BY VARIETY AND AGE GROUPS - 1978

Variety	1975-1977 (1-3 Years)	1972-1974 (4-6 Years)	1957-1971 (7-21 Years)	1956 & Earlier (22 Years +)	Total All Ages	Percent Of Total
Sun Glo......................	1,306	3,001	3,663	-	7,970	16.6
Red Gold.....................	3,042	6,586	2,025	-	11,653	24.3
Favertop.....................	690	2,602	293	-	3,585	7.5
Francesco....................	11	540	50	-	601	1.2
Reolglo......................	389	680	563	-	1,632	3.4
Starks Delicious.............	571	455	560	20	1,606	3.4
Sun Grande...................	140	305	1,881	-	2,326	4.8
Fantasia.....................	134	550	79	-	763	1.6
Nectared.....................	1,205	1,089	2,765	47	5,106	10.7
Other........................	2,421	4,166	5,989	120	12,696	26.5
TOTAL ALL VARIETIES..........	9,909	19,974	17,868	187	47,938	100.0

PENNSYLVANIA: NECTARINES - COMMERCIAL: NUMBER OF ORCHARDS AND TREES BY SIZE GROUPS, SELECTED COUNTIES - 1978

County	100-199 Trees	200-499 Trees	500 + Trees	Total
Adams - No. Of Orchards.......	4	3	4	11
Adams - No. Of Trees..........	479	640	4,745	5,864
Franklin - No. Of Orchards....	-	3	5	8
Franklin - No. Of Trees.......	-	1,000	12,002	13,002
Others - No. Of Orchards......	25	13	14	52
Others - No. Of Trees.........	4,255	4,395	17,348	26,011
PENNSYLVANIA - No. Of Orchards	29	19	23	71
PENNSYLVANIA - No. Of Trees...	4,747	6,035	34,095	44,877

PENNSYLVANIA: NECTARINES (TOTAL): NUMBER OF TREES BY COUNTIES AND AGE GROUPS, 1978 1/

County & Region	Number Of Trees Maintained For Production According To Year Set Out					Percent Of Total
	1975-1977 (1-3 Yrs.)	1972-1974 (4-6 Yrs.)	1957-1971 (7-21 Yrs.)	1956 & Earlier (22 Yrs +)	Total All Ages	
REGION I:						
Adams	1,533	1,905	3,119	35	6,592	13.8
Cumberland & Perry	40	15	44	8	107	.2
Franklin	1,411	6,194	5,560	41	13,206	27.5
York	59	6,697	1,063	44	7,863	16.4
TOTAL	3,043	14,811	9,786	128	27,768	57.9
REGION II:						
Berks	1,614	1,510	1,060	0	4,184	8.7
Bucks	0	25	160	0	185	.4
Carbon & Schuylkill	24	142	142	0	308	.6
Chester	917	30	74	0	1,021	2.1
Dauphin & Lebanon	517	482	741	0	1,740	3.6
Delaware	10	12	35	0	57	.1
Lancaster	102	80	75	20	277	.6
Lehigh	262	510	1,170	1	1,943	4.1
Monroe	0	0	0	0	0	-
Montgomery	300	345	40	15	700	1.5
Northampton	155	210	51	5	421	.9
Pike	0	0	0	0	0	-
TOTAL	3,901	3,346	3,548	41	10,836	22.6
REGION III:						
Bedford	0	290	117	6	413	.9
Blair & Huntingdon	40	337	0	0	377	.8
Bradford	0	0	0	0	0	-
Centre	0	0	0	0	0	-
Clinton	0	0	0	0	0	-
Columbia	200	235	34	10	479	1.0
Fulton	0	0	0	0	0	-
Juniata	515	15	685	0	1,215	2.5
Lackawanna	0	0	0	0	0	-
Luzerne & Susquehanna	52	20	14	0	86	.2
Lycoming	73	36	2,500	0	2,609	5.4
Mifflin	0	0	0	0	0	-
Montour & Northumberland	116	53	105	0	274	.6
Potter	0	0	0	0	0	-
Snyder	1,347	32	102	1	1,482	3.1
Tioga	0	0	0	0	0	-
Union	2	51	0	0	53	.1
Wayne	0	0	0	0	0	-
Wyoming	0	0	0	0	0	-
TOTAL	2,345	1,069	3,557	17	6,988	14.6
REGION IV:						
Allegheny	25	77	335	0	437	.9
Beaver	0	176	197	0	373	.8
Butler	0	0	0	0	0	-
Cambria	0	0	0	0	0	-
Clarion	0	0	0	0	0	-
Clearfield	0	0	0	0	0	-
Crawford & Mercer	0	0	33	0	33	.1
Elk	0	0	0	0	0	-
Fayette	0	0	0	0	0	-
Greene	0	0	0	0	0	-
Indiana & Jefferson	360	250	50	0	660	1.3
Lawrence	85	15	125	0	225	.5
McKean	0	0	0	0	0	-
Somerset & Washington	0	60	60	1	121	.3
Venango	0	0	0	0	0	-
Westmoreland	0	0	0	0	0	-
TOTAL	470	578	800	1	1,849	3.9
REGION V:						
Erie	150	170	177	0	497	1.0
TOTAL	150	170	177	0	497	1.0
PENNSYLVANIA	9,909	19,974	17,868	187	47,938	100.0
PERCENT OF TOTAL	20.7	41.6	37.3	.4	100.0	-

1/ Some counties are combined to avoid disclosure of individual operations.

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PENNSYLVANIA: ALL FRUIT (TOTAL): ACRES BY KIND AND COUNTY - 1978

County	Apples	Peaches	Pears	Tart Cherries	Sweet Cherries	Plums & Prunes	Nectarines	Grapes	Ranking All Fruit Acreage
Adams	14,416.9	2,958.5	678.0	1,375.4	48.8	122.4	75.3	20.3	1
Allegheny	676.2	30.7	6.0	.5	.3	3.0	4.8	19.5	14
Armstrong	102.2	26.1	1/	1.3	1/	3.5	-	1/	32
Beaver	96.3	22.4	3.0	.2	.3	1.9	4.2	1/	33
Bedford	696.3	1/	16.2	3.0	13.1	1.7	3.2	-	11
Berks	1,215.2	531.4	36.7	19.5	4.6	12.0	43.4	12.3	6
Blair	639.0	34.0	19.0	1/	1/	-	1/	76.1	10
Bradford	179.1	1/	7.9	1/	1/	1/	-	1/	27
Bucks	231.2	114.5	18.0	5.6	1.6	5.5	2.2	36.0	18
Butler	29.4	2.8	1/	-	-	1/	-	-	52
Cambria	34.0	-	1/	-	1/	-	-	-	50
Cameron	-	-	-	-	-	-	-	-	-
Carbon	1/	1/	1/	1/	1/	.6	1/	1/	49
Centre	187.0	1/	1/	1/	-	1/	-	1/	26
Chester	371.7	125.3	14.0	4.8	22.9	3.4	8.7	1/	15
Clarion	1/	1/	1/	1/	1/	1/	-	1/	51
Clearfield	68.1	-	1/	1/	-	1/	-	-	40
Clinton	1/	1/	-	-	-	-	-	-	53
Columbia	130.8	84.7	22.0	2.4	3.3	11.0	4.5	-	23
Crawford	44.5	1/	2.5	1/	1/	1/	1/	1/	42
Cumberland	843.5	156.0	19.0	17.0	2.8	2.0	1/	20.4	8
Dauphin	207.7	106.0	30.9	8.3	18.6	1/	1/	12.6	17
Delaware	72.1	34.7	5.0	.4	1/	1.1	.8	1/	35
Elk	1/	1/	-	-	-	-	-	-	58
Erie	717.9	151.7	61.0	290.8	145.8	22.0	5.4	13,668.1	2
Fayette	1/	1/	1/	.5	1/	-	-	-	61
Forest	-	-	-	-	-	-	-	-	-
Franklin	4,265.3	1,874.5	49.0	100.8	31.2	56.0	172.8	-	3
Fulton	1/	1/	-	-	1/	-	-	-	47
Greene	1/	-	-	-	-	-	-	-	59
Huntingdon	1/	1/	1/	1/	1/	1/	1/	-	45
Indiana	200.2	15.9	5.0	1.7	.7	4.0	1/	12.9	25
Jefferson	1/	1/	1/	1/	-	-	1/	-	56
Juniata	388.7	272.6	21.1	4.5	12.5	8.0	13.6	1/	12
Lackawanna	124.1	3.2	2.0	-	1/	.5	-	1/	34
Lancaster	364.0	387.5	43.3	35.8	155.5	15.4	3.6	111.6	7
Lawrence	83.6	19.1	1.5	1/	1/	2.1	2.2	-	37
Lebanon	76.5	58.0	8.0	1/	-	1/	1/	1/	29
Lehigh	1,555.2	524.4	93.3	.5	3.0	9.7	19.4	11.5	5
Luzerne	183.2	39.[illegible]	14.0	1/	1/	4.1	1/	9.3	24
Lycoming	175.9	53.[illegible]	24.2	3.7	9.1	3.4	26.0	1/	21
McKean	1/	-	-	-	-	-	-	-	60
Mercer	64.7	46.4	1/	1/	1/	1/	1/	43.0	30
Mifflin	80.0	1/	6.0	1/	1/	-	-	1/	36
Monroe	1/	1/	1/	-	-	1/	-	-	57
Montgomery	197.2	84.6	6.1	-	1/	2.0	5.2	30.4	20
Montour	1/	1/	1.2	1/	-	1/	-	1/	48
Northampton	483.0	216.0	13.0	2.2	18.1	3.6	3.4	1/	13
Northumberland	1/	1/	18.0	4.0	3.2	11.3	3.8	30.0	19
Perry	103.5	25.5	6.0	5.8	3.8	1.2	1/	-	31
Philadelphia	-	-	-	-	-	-	-	-	-
Pike	1/	-	1/	-	-	1/	-	-	55
Potter	1/	-	1/	-	-	-	-	-	62
Schuylkill	312.5	77.0	101.7	1.6	1.1	4.4	1/	1/	16
Snyder	634.3	232.2	15.8	13.3	4.9	10.9	11.7	-	9
Somerset	1/	-	1/	1/	1/	-	1/	-	38
Sullivan	-	-	-	-	-	-	-	-	-
Susquehanna	1/	1/	1/	1/	1/	1/	1/	1/	46
Tioga	50.6	-	1/	-	1/	1/	-	-	44
Union	30.4	24.5	3.2	1/	.5	.3	.9	-	43
Venango	81.0	1/	1/	-	-	-	-	-	39
Warren	-	-	-	-	-	-	-	-	-
Washington	233.9	27.7	1.0	.2	2.5	1/	1/	1/	22
Wayne	1/	-	-	-	-	-	-	-	54
Westmoreland	54.7	1/	1/	1/	-	1/	-	1/	41
Wyoming	154.0	1/	1/	-	-	1/	-	-	28
York	1,358.2	1,110.4	96.0	51.1	18.0	25.3	69.7	49.7	4
Acreage Not Listed Above	638.9	246.3	34.2	45.6	19.5	34.2	42.3	107.6	-
PENNSYLVANIA	32,858.4	9,787.7	1,499.3	2,000.5	545.7	386.5	527.1	14,271.3	61,871.0

1/ Not published to avoid disclosure of individual operations.

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PENNSYLVANIA: PEACHES, NECTARINES, PEARS, PLUMS AND PRUNES AVERAGE WEIGHT PER BUSHEL OF PRODUCTION — 1977

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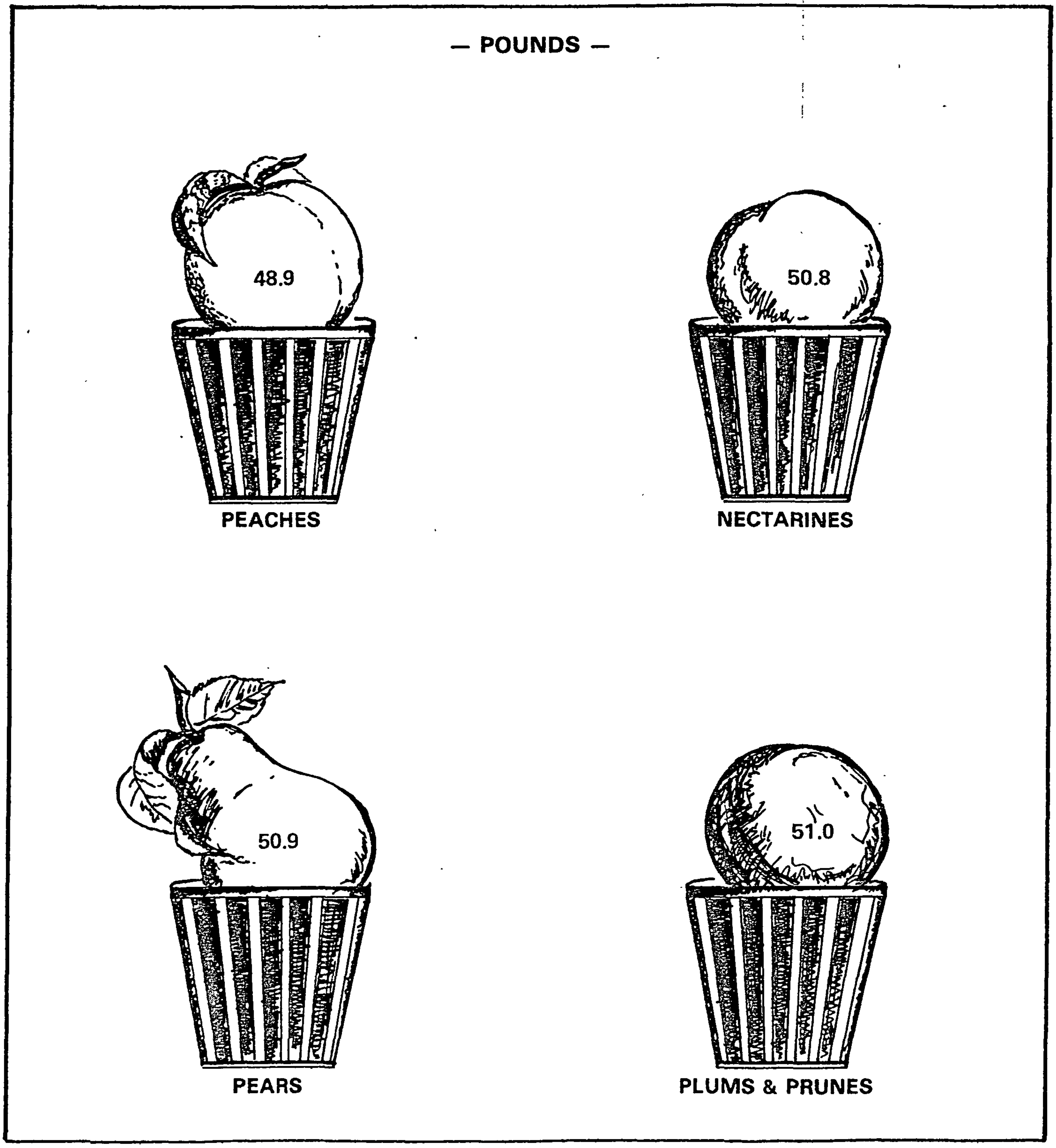

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PENNSYLVANIA: APPLES, PEACHES, VARIETIES REPORTED - 1978 1/

APPLE VARIETIES

1. Arkansas (Black Twig)
2. Astragin
3. August Early
4. Baldwin
5. Barry
6. Baxter
7. Beacon (Fenton)
8. Belle Flower
9. Ben Davis (Gano)
10. Bentley
11. Bisbee
12. Blushing Golden
13. Bright McIntosh
14. Burgandy
15. Champion
16. Chesepeke
17. Connell Red (Fireside)
18. Cortland
19. Crabapple
20. Crandell
21. Criterion
22. Dalgo Crabapple
23. Double Red
24. Dutchess
25. Earliblaze
26. Early Delicious
27. Early Glo
28. Early Harvest
29. Early McIntosh
30. Early Red
31. Early Red June
32. Empire
33. Fallwater
34. Franklin
35. Gala Beauty (Rome Red)
36. Gold Spur
37. Golden Delicious
38. Granny Smith
39. Gravenstein
40. Green Stark
41. N.W. Greening
42. R.I. Greening
43. Harvest Sweet
44. Holdrons
45. Holliday
46. Idared
47. Jersey Mac
48. Jersey Red
49. John Blemish
50. John Grimes
51. Jonagold
52. Jonagrime
53. Jonared
54. Jonathan
55. Jonee
56. Jonee Mac
57. July Red
58. Jumbo (NY16884)
59. Kendell Mac
60. King
61. King Luscious
62. Laodyapple
63. Lakeland
64. Lodi (King Lotus)
65. Lowery
66. Macoun
67. Madien Blush
68. McIntosh
69. Melba
70. Melrose
71. Milton
72. Minnjon
73. Mollys Delicious
74. Monroe
75. Muts
76. Nero Red
77. Niagara
78. Nittany
79. Northern Spy
80. Ohio Nonperill
81. Opalescent
82. Ottawa (T441 Quinte)
83. Ozark Gold
84. Paradise (Sweet)
85. Paula Red
86. Pippin
87. Praire Spy
88. Pricilla
89. Prima
90. Prime Gold
91. Puratin
92. Rambo
93. Raritan
94. Red Astrachan
95. Red Bird
96. Red Bliss
97. Red Delicious
98. Red Doctor
99. Red Gold
100. Red Ruby
101. Red Spy
102. Red Warrior
103. Rome Red
104. Rome Regular
105. Russits
106. Seek-No-Further
107. Sharon Red
108. Sheepnose
109. Smokehouse
110. Snowapple
111. Spartan
112. Spigold
113. Starks Splendor
114. Starr
115. Stayman
116. Strawberry
117. Sun Gold
118. Sutton Beauty
119. Sweet Bough
120. Thompsons
121. Tinsmith
122. Tolman Sweet
123. Turley
124. Turleywine
125. Twenty Ounce
126. Tydemans Red
127. Viking
128. Wagner
129. Wayne
130. Wealthy
131. Wellington
132. Williamsearly Red
133. Wincester
134. Winesap
135. Winter Banana
136. Wolf River
137. Yellow Horse
138. Yellow Transparent
139. York Imperial
140. York Red

PEACH VARIETIES

1. Adams Late
2. After Glo
3. Ambergem
4. Autumglo
5. Baby Gold
6. Beekman
7. Belle Of Georgia
8. Biscoe
9. Blake
10. Brakett
11. Canadian Harmony
12. Canadian Queen
13. Candor
14. Cardinal
15. Carman
16. Champion
17. Collins (N.J. 200)
18. Colora
19. Comanchee
20. Coronet
21. Crawford
22. Cresthaven
23. Cumberland
24. Dawn
25. Dixe Queen
26. Dixired
27. Eariglo
28. Earired
29. Early Blake
30. Early East
31. Early Red Fre
32. Early Red Haven
33. Early Red Rose
34. Early White Giant
35. Eclipse
36. Edens
37. Elberta
38. Emory
39. Envoy
40. Fairhaven
41. Fertile Hale
42. Frost King
43. Garnet Beauty
44. Gemmers Late
45. Glohaven
46. Golden East (N.J. 87)
47. Golden Gem
48. Golden Jubilee
49. Golden Ray
50. Halberta
51. Halehaven
52. Hale Harrison Brilliant
53. Harbelle
54. Harbinger
55. Harbrite
56. Harmony
57. Harken
58. Harrow
59. Harvest Queen
60. Honey Dew
61. Iron Mountain
62. J.H. Hale
63. Jefferson
64. Jersey Belle
65. Jerseyland
66. Jerseyqueen
67. July Elberta
68. Kalhaven
69. Keystone
70. Late Glo
71. Late Rose
72. Late Sun Haven (Slaybaugh Special)
73. Late Yellow
74. Lizzie
75. Loring
76. Madison
77. Marglow
78. Marhigh
79. Marqueen
80. Marsun
81. Maryland
82. Monroe
83. Moore Early Red
84. Newday (N.J. 79)
85. N.J. 178
86. N.J. 193
87. N.J. 233
88. Norman
89. Peachcot
90. Poppy
91. Ranger
92. Rare Ripe
93. Raritan Rose
94. Red Cap
95. Red Crest
96. Red Elberta
97. Red Glo
98. Red Globe
99. Red Hale
100. Red Haven
101. Red Kist
102. Redqueen (N.J. 212)
103. Red Rose
104. Redskin
105. Redwin
106. Reliance
107. Richaven
108. Rio Oso Gem
109. Rodchester
110. Royal Vexe
111. Sentenial
112. Shippers Late Red
113. Slappy
114. Somerset
115. South Haven
116. Southland
117. Springold
118. Starkling Delicious
119. Starks Earliglo
120. Starks Late Glo
121. Sullivan Elberta
122. Summercrest
123. Summerqueen
124. Summer Rose
125. Sunbright
126. Suncrest
127. Sunhaven
128. Sunhigh
129. Sunqueen
130. Sunrise
131. Sunshine
132. Sweet Sue
133. Trio Gem
134. Valiant
135. Vedette
136. Velvet
137. Veteran
138. Washington
139. White Giant
140. White Hale
141. White Rose
142. Wild Rose
143. Winter Gem
144. Yakima Hale
145. Yellow Cross
146. Yellow Elberta

1/ Some duplication and "Farmer Brands" may be contained in these lists.

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PENNSYLVANIA: PEARS, CHERRIES, PLUMS-PRUNES, NECTARINES AND GRAPES VARIETIES REPORTED - 1978 1/

PEARS

1. Aurora
2. Bartlett
3. Bosc
4. Clapps Favorite
5. D'Anjou
6. Devoe
7. Dutchess
8. Dymond
9. Ewart
10. Fame
11. Flemish Beauty
12. Gorham
13. Honey
14. Lawrence
15. Lincoln
16. Magness
17. Marlatte
18. Maxine
19. Moonglo
20. New York 10274
21. Red Bartlett
22. Reinier Red
23. Russit
24. Sekel
25. Sheldon
26. Starkrimson
27. Starks Delicious
28. Sugar Pear Miniature
29. Tyson

CHERRIES - SWEET

1. Big Jo
2. Bing
3. Black Giant
4. Black Oxhart
5. Black Republican
6. Black Tartarian
7. Chinook
8. Emperor Francis
9. Golden Sharon
10. Hardy Giant
11. Heldelfingen
12. Hershey Special
13. Lambert
14. Napoleon
15. Olsters
16. Onterio
17. PA White
18. Queen-Anne
19. Rainier
20. Red Che
21. Sam
22. Schmidts Biggereau
23. Senaca Star
24. Starks Gold
25. Sweet Shower
26. Ulster
27. Van
28. Venus
29. Victor
30. Vista
31. White Oxheart
32. Wickson
33. Yellow Oxheart
34. Yellow Spanish

CHERRIES - TART

1. Early Richmond
2. English Morella
3. Montmorency

PLUMS - PRUNES

European

1. Bluefre
2. Bradshaw
3. Damson
4. Duarte
5. Fellemberg
6. German Blue
7. Grand Prize
8. Green Gage
9. Italian
10. Lombard
11. N.Y. State
12. Ozark Premier
13. President
14. Stanley
15. Yellow Egg

Japanese

1. Burbank
2. Burmosa
3. Mamouth Cardinal
4. Eldorado
5. Elephant Heart
6. Formosa
7. Great Yellow
8. Methley
9. Red Heart
10. Sant Rosa
11. Satsuma
12. Shiro (Gold)
13. Wicson

Other

1. Delicious
2. Duryea
3. Hershey Blue
4. Idaho
5. Mac Verna
6. Maxiview
7. Medley
8. Oxheart
9. Rare Ripe
10. Red Ace
11. Sharon
12. Starks Delicious
13. Yellow Gage
14. Yellow Gold

American

1. Ace Mariposa
2. Superior
3. North Dakota

NECTARINES

1. Anderson
2. Apricot
3. Bowden
4. Cavalier
5. Champion
6. Che Kee
7. Cremson Great
8. Delicious
9. Early Gold
10. Early Red
11. Fantasia
12. Flavertop
13. Francesco
14. Fussless Berta
15. Garden State
16. Harko
17. Hershey
18. Hersiey
19. Independence
20. King
21. La Grande
22. Late Glo
23. Late La Grande
24. Lexington
25. Mericrest
26. Nectacrest
27. Nectaheart
28. Nectalate
29. Nectared #1
30. Nectared #2
31. Nectared #3
32. Nectared #4
33. Nectared #5
34. Nectared #6
35. Nectared #7
36. Nectared #8
37. Nectared #9
38. Nectarose
39. New Jersey
40. New York State
41. Packhouse
42. Pochahontas
43. Red Chief
44. Red Glow
45. Red Gold
46. Red June
47. Red Bud
48. Slaybaugh
49. Star Grande
50. Starks Delicious
51. Sun Glo
52. Sun Gold
53. Sun Grand
54. Sure Crop

GRAPES

Native

1. Buffalo
2. Caco
3. Catawba
4. Concord
5. Delaware
6. Diamond
7. Dutchess
8. Fredonia
9. Himrod
10. Isabella
11. Niagara
12. Portland
13. Seneca
14. Sheridan
15. Sherman
16. Steuben
17. Van Buren
18. Worden

French Hybrid

1. Avrora (Seibel 5279)
2. Baco Noir (Baco #1)
3. Cascade (Seibel 13053)
4. Chancellor (Seibel 7053)
5. Chelois (Seibel 10878)
6. Colobel (Seibel 8357)
7. De Chanac (Seibel 9549)
8. Marechal Fosh (Kuhlman 188-2)
9. Rosette (Seibel 1000)
10. Seibel 5276
11. Seibel 9110
12. Seyvel Blanc (Villard 5276)
13. Vidal 256
14. Landot 4511
15. Leon Millot
16. Muscat
17. Verdelett

Other

1. Agawan
2. Alden
3. Chambouron
4. Gadwin 113
5. Interlaken Seedless
6. Moores Earley
7. Moresdiamond

Vinifers

1. Cabernet Souvignor
2. Johannisburger Resiling
3. Pinot Chardonnay

1/ Some duplication and "Farmer Brands" may be contained in these lists.

APPLES: TOTAL: NUMBER OF TREES FOR LEADING VARIETIES IN SELECTED STATES 1/

Rank	Pennsylvania		New England		New York		North Carolina		Virginia	
	Variety	Number Of Trees	Variety	Number Of Trees	Variety	Number Of Trees	Variety	Number Of Trees	Variety	Number Of Trees
1.............	R. Delicious	595,237	McIntosh	791,219	McIntosh	672,635	R. Delicious	640,520	R. Delicious	575,432
2.............	York	403,789	R. Delicious	238,543	R. Delicious	455,806	G. Delicious	251,754	G. Delicious	299,427
3.............	G. Delicious	341,760	Cortland	94,925	Rome	335,924	Rome	159,707	York	275,356
4.............	Rome	244,453	G. Delicious	40,527	RI Greening	290,468	Stayman	64,835	Stayman	121,142
5.............	Stayman	183,058	Macoun	30,163	G. Delicious	282,442	Winesap	4,914	Winesap	103,551
6.............	Jonathan	81,232	Baldwin	18,631	Idared	263,394	Jonathan	2,875	Rome	91,289
TOTAL ALL......		2,145,658		1,365,109		3,554,996		1,173,376		1,592,706

1/ Year data pertains to: New York 1975, New England 1976, Virginia and North Carolina 1977, and Pennsylvania 1978.

PEACHES: TOTAL: NUMBER OF TREES FOR LEADING VARIETIES IN SELECTED STATES 1/

Rank	Pennsylvania		New Jersey		North Carolina		South Carolina		Virginia	
	Variety	Number Of Trees	Variety	Number Of Trees	Variety	Number Of Trees	Variety	Number Of Trees	Variety	Number Of Trees
1..............	Redhaven	111,822	Rio-Oso-Gem	174,883	Redhaven	29,028	Blake	355,764	Sunhigh	34,791
2..............	Sunhigh	95,053	Redhaven	150,877	Blake	21,643	Redglobe	289,180	Redhaven	30,519
3..............	Loring	89,712	Blake	115,076	Loring	19,865	Redhaven	233,997	Elberta	28,833
4..............	Elberta	55,271	Jerseyqueen	103,669	Candor	18,461	Coronet	199,599	Blake	27,463
5..............	Redskin	52,265	Loring	88,600	Georgia Bell	17,009	Loring	182,170	Loring	25,015
6..............	Blake	45,890	Washington	34,337	Winblo	13,788	Rio-Oso-Gem	142,827	Redskin	16,218
TOTAL ALL.......		856,842		1,035,516		279,315		3,140,185		337,643

1/ Year data pertains to: Maryland 1976, New Jersey and Virginia 1977, Pennsylvania and South Carolina 1978.

PEARS: TOTAL: NUMBER OF TREES FOR LEADING VARIETIES IN SELECTED STATES 1/

Rank	Pennsylvania		Michigan		New England		New York	
	Variety	Number Of Trees	Variety	Number Of Trees	Variety	Number Of Trees	Variety	Number Of Trees
1...............	Bartlett	83,111	Bartlett	958,887	Bosc	14,723	Bartlett	262,567
2...............	Bosc	21,021	Bosc	37,306	Bartlett	8,332	Bosc	77,729
3...............	D'Anjou	9,136	Kieffer	27,684	Clapps Fav.	1,827	Clapps Fav.	27,204
4...............	Seckel	2,987	Clapps Fav.	17,337			Seckel	8,863
5...............	Clapps Fav.	2,569	Flemish Beauty	1,711			Spartlett	4,134
6...............	Gorham	1,619	Howell	1,368			Devoe	4,068
TOTAL ALL........		127,158		1,048,562		28,170		392,285

1/ Year data pertains to: Michigan 1973, New York 1975, New England 1976, and Pennsylvania 1978.

GRAPES: TOTAL: ACRES OF VINES FOR LEADING VARIETIES IN SELECTED STATES 1/

Rank	Pennsylvania		New York		Michigan		North Carolina	
	Variety	Acreage Of Vines	Variety	Acreage Of Vines	Variety	Acreage Of Vines	Variety	Acreage Of Vines
1...............	Concord	11,751.2	Concord	27,568	Concord	15,274	Carlos	508
2...............	Catawba	914.7	Catawba	3,477	Niagara	977	Magnolia	422
3...............	Niagara	471.2	Niagara	2,355	Delaware	243	Scuppernong	288
4...............	Delaware	372.7	Delaware	2,051	Baco Noir	84	Higgins	150
5...............	Seyval Blanc	99.2	Aurora	1,727	Fredonia	71	Fry	45
TOTAL ALL........		14,271.3		42,653		16,878		1,677

1/ Year data pertains to: North Carolina and Michigan 1973, New York 1975, and Pennsylvania 1978.

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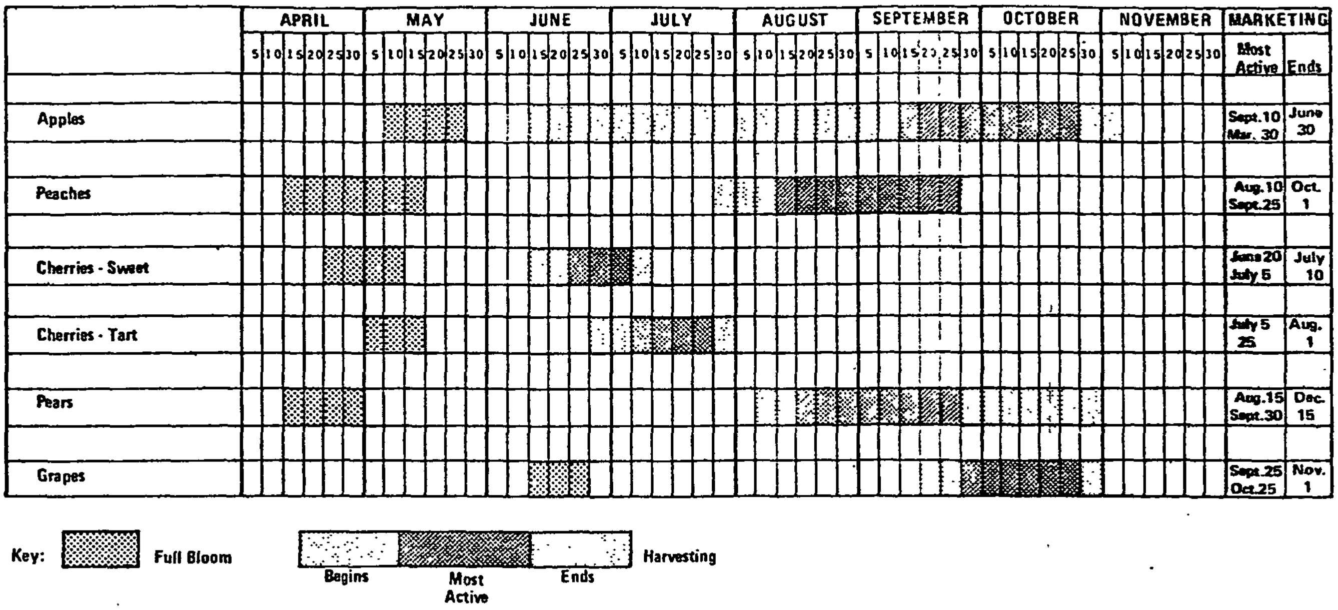
USUAL DATES OF FULL BLOOM, HARVEST AND MARKETING FOR PRINCIPAL PENNSYLVANIA FRUIT CROPS



TREE DENSITY GUIDE

DISTANCE BETWEEN TREES IN ROW (FEET)

Feet 1/	6	7	8	9	10	12	14	16	18	20	22	24	26	28	30	32	34	36
4.....	1,815	1,627	1,261	1,210	1,089	907	777	680	605	544	495	453	418	388	363	340	320	302
5.....	1,452	1,240	1,089	966	871	726	622	544	484	435	396	363	335	311	290	272	256	242
6.....	1,218	1,037	907	806	727	605	518	543	403	363	330	302	279	259	242	226	213	201
8.....	907	777	680	605	544	453	388	339	302	272	247	225	209	194	181	169	160	151
10....	726	622	544	484	435	363	311	272	242	218	207	181	167	155	145	136	128	121
12....	605	518	453	403	362	302	259	226	201	181	165	151	139	129	121	113	106	100
14....	518	444	388	345	311	259	222	194	172	155	141	129	119	111	103	97	91	86
16....	453	388	339	325	272	226	194	169	151	136	123	113	104	97	90	85	80	75
18....	403	345	302	268	242	201	172	151	134	121	110	100	93	86	80	75	70	67
20....	363	311	272	242	218	181	155	136	121	108	99	90	83	77	72	66	64	60
22....	330	282	247	220	207	165	141	123	110	99	90	82	76	70	66	61	58	55
24....	302	259	226	201	181	151	129	113	100	90	82	75	69	64	60	56	53	50
26....	279	239	209	196	167	139	119	104	93	83	76	69	64	59	55	52	49	46
28....	259	222	194	172	155	129	111	97	86	77	70	64	59	55	51	48	45	43
30....	242	207	181	161	145	121	103	90	80	72	66	60	55	51	48	45	42	40
32....	226	194	169	151	136	113	97	85	75	66	61	56	52	48	45	42	40	37
34....	213	183	160	145	128	106	91	80	70	64	58	53	49	45	42	40	37	35
36....	210	172	151	134	121	100	86	75	67	60	55	50	46	43	40	37	35	33
38....	191	164	143	127	114	95	81	71	63	57	52	47	44	40	38	35	33	31
40....	181	155	136	121	108	90	77	66	60	54	48	45	41	38	36	34	32	30
45....	161	138	121	108	96	81	69	61	54	48	44	40	37	35	32	30	28	27

NUMBER OF TREES PER ACRE FOR CORRESPONDING SPACING

1/ Distance between rows (feet).

Zurich. A member of the ORSER staff traveled to Australia and implemented the system for the Commonwealth Scientific and Industrial Research Organization. While there, he also conducted several short courses and seminars on use of the system.

Foreign users have also visited Penn State to become acquainted with the system. A planner from Italy spent several months at ORSER, generating land use maps of Rome and Milan and demonstrating that Landsat data could be used as valuable input to planning for densely populated European cities. The results of this work were presented to the UN Center for Housing and Urban Development and to several remote sensing conferences in Europe.

The ORSER system is continually expanded and refined to meet the needs of the growing number of users who are finding that its capabilities, flexibility, and portability meet their needs for timely and effective analysis of remote sensing data. Students trained on the system are highly employable and find it easy to adapt to other computerized systems of remote sensing analysis.

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ORSER PREPRINT

THE ORSER SYSTEM FOR THE ANALYSIS OF REMOTELY SENSED DIGITAL DATA[1]

Wayne L. Myers and Brian J. Turner[2]

Abstract.--The ORSER system is a comprehensive package of computer programs developed by the Office for Remote Sensing of Earth Resources (ORSER) at The Pennsylvania State University for analyzing various kinds of remotely sensed digital data. It is now probably the most widespread remote sensing computer analysis package in the world, being available at more than 28 locations in the United States and in 8 other countries. A general-purpose interface is being constructed so that information extracted by the ORSER system can be used readily to augment and update geographic information systems (GIS). Application of this capability for statewide monitoring of gypsy moth defoliation is discussed.

INTRODUCTION

Remote sensing has been used as an input to natural resource inventories long before the term "remote sensing" was coined. Such early work, however, was based entirely on aerial photography. Aerial photography from conventional aircraft offers the advantage of high resolution, making it possible to associate a high degree of location specificity with the information extracted. On the other hand, procurement of such imagery is relatively expensive and extraction of the information is a manual and somewhat subjective process. One alternative for reducing costs is to use small-scale imagery from high-flying aircraft. Information taken from small-scale airphotos is less location specific, and the extraction process becomes considerably more subjective. LANDSAT provides relatively inexpensive, broad area coverage in computer-compatible form. The computer-compatible nature of LANDSAT data makes it possible to replace slow and subjective human interpretation by more rapid and objective statistical techniques for extraction of information. LANDSAT usage has evolved as the computerized equivalent of small-scale aerial photography, with a relatively low degree of location specificity being attributed to the information extracted. LANDSAT data are, however, intrinsically quite location specific. The next step in evolution of LANDSAT usage is to take advantage of that location specificity. When this step is taken, computer analysis of remotely sensed digital data becomes a very versatile method of augmenting and updating natural resource information systems. The ORSER system has proven itself repeatedly in the traditional mode of LANDSAT analysis, and is now undergoing expansion for in-place applications.

BASIC STRUCTURE OF THE ORSER SYSTEM

The ORSER system is a comprehensive package of computer programs developed by the Office for Remote Sensing of Earth Resources (ORSER) at The Pennsylvania State University for analyzing various kinds of remotely sensed digital data. It is now possibly the most widespread remote sensing computer analysis package in the world, being available at more than 28 locations in the United States and in 8 other countries. It has the substantial advantage of being relatively easy to implement on any large general-purpose computer having a FORTRAN compiler.

The system is dynamic and continually evolving and, because of its modular construction, it can be easily updated. The preprocessing subsystem can now read data from most satellites which have collected earth resources information. Data can be merged, edge-joined, transformed in a variety of ways, and geometrically corrected. The analysis subsystem provides the user with an array of analytical programs, including both supervised and unsupervised classification procedures. The display subsystem can produce output maps for display on a wide variety of devices including line printers, cathode ray tubes, film recorders, and incremental plotters. Line data from a digitizer can be superimposed on these displays and used to delineate areas for area statistics.

[1]Paper presented at the SAF National Workshop, "In-Place Resource Inventories: Principles and Practices" [University of Maine, Orono, August 10-14, 1981].

[2]Wayne L. Myers is Associate Professor of Forest Biometrics and Brian J. Turner is Associate Professor of Forest Management and Co-Director of ORSER, The Pennsylvania State University, University Park, Pa.

The basic approach in the ORSER system is to treat channels of data as vector dimensions in hyperspace. Original channels and ancillary data of a metric nature may be recombined in various ways to produce additional "synthetic" channels. The entire vector space can undergo both Euclidean and non-Euclidean transformations. Transformation to canonical axes has proven particularly useful. Geometric registration is achieved by translation, rescaling, rotation, and rubber-sheet stretch through resampling processes. Extensive use of vector and matrix notation is made in documentation of the system.

As of this writing, the ORSER system consisting of some 35 individual programs can be purchased as FORTRAN code on magnetic tape for $3,000. Most organizations which have acquired it have had large IBM computers, although the system has also been installed on large CDC, Honeywell, and Burroughs main frames. Ease of installation has varied, depending more on the ability of the installer than on the particular computer configuration. Since all code is now in near-ANSI FORTRAN IV, the latest version should be easier to install than previous ones.

Students and short-course participants have found the system to be relatively easy to use. Typical run decks, or "stems," are shown in the "ORSER User Manual" (Turner et al. 1978). Card users can use these as a base, and teletypewriter-terminal users can call the stems for all programs from stored files and edit them. Control cards are set up as a keyword followed by appropriate parameters. In most cases, format is fixed. Defaults are used extensively. Most programs can be run successfully with only a few control cards, and users can then refine the results by modifying or adding control cards. Control cards are described in the manual, and many of them are common to several programs.

A user-friendly "front-end" to some of the most commonly used ORSER programs, called OCCULT, has been developed at NASA/Goddard Space Flight Center. It has been used extensively in their training sessions (National Aeronautics and Space Administration 1979). At Penn State, we have used our INTERACT editing system to develop a similar procedure for all programs. The role of both of these "front-ends" is to allow the user to set up a run file (JCL and control cards) in a conversational manner and submit it for batch processing. Such an interactive system, however, is not essential for operation of the ORSER system.

Typical applications of the ORSER system have dealt with land use, soils, geology, and vegetation. Typical end products have been classification maps and enhanced color images.

ORSER IN RELATION TO IN-PLACE INVENTORIES

Research on natural resource information systems at Penn State and a NASA project to monitor gypsy moth defoliation in Pennsylvania have both provided impetus for enhancing the capabilities of the ORSER system to extract location-specific information. Although the capacity to isolate and process data from polygonal areas has existed within the system for some time, it has been necessary to go through the entire analytical sequence on a polygon-by-polygon basis. This becomes quite cumbersome when the polygons are small or numerous. Furthermore, there were no provisions for subsequent compilation or logical overlay operations by polygon classes when the classes were defined in terms of attribute data. Such limitations are typical of the current state of the art in systems for analyzing remotely sensed digital data.

There are two possible avenues of approach to overcoming these limitations. One is to build the capabilities into the remote sensing system itself. Success in this endeavor would almost surely lead to a very large and complex system--much more so than the current 40,000 lines of FORTRAN code already comprising the ORSER system. Such a system would also have a rather large inertia to overcome in keeping pace with the rapidly moving technology of geographic information systems. Complexity and inertia of this order are contrary to the philosophy of design in the ORSER system. We wish to keep the system modular and retain the ability to alter one component easily without affecting the other components.

The second approach to developing the desired capabilities is to build an interface between the remote sensing analysis system and a companion geographic information system (GIS). This way the main data base containing all sorts of information is hosted and manipulated by the GIS. The remote sensing analysis system becomes one of many methods for augmenting and updating the data base. The essential feature of such an interface is the ability to summarize information extracted from the remotely sensed data for each of the geounits already defined in the GIS, and to provide these summaries in a form that can be loaded directly into the data base as an additional layer of information. The geounits can be counties, townships, forest districts, timber stands, ecotypes, sampling strata, etc. Given this linkage for one GIS, liaison with another GIS becomes mostly a problem of reformatting the geounit summaries.

This latter approach has been chosen as the method of giving the ORSER system capabilities for providing truly location-specific information from LANDSAT or other sources of remotely sensed digital data. The interface system currently being developed is called ZONAL (ZONation ALgorithms). Given a set of polygonal geounits, ZONAL will simulate the action of a raster scanner and produce a set of "pixels" for each geounit that corresponds to the pixels in the remotely sensed digital data. Instead of reflectance values, however, the ZONAL pixels will contain geounit identifiers. The geounit identifiers in the ZONAL pixels constitute the indexing information needed for compilation by geounit.

This procedure has the major advantage of not requiring modifications in either the GIS or the remote sensing analysis system. It does require the capability for accurately registering the remotely sensed data to the map base used in the GIS. It also requires the capacity to process blocks of data large enough to encompass the geounits of interest. The ORSER system has both the necessary registration capabilities and the ability to process a full LANDSAT scene.

DEVELOPMENT OF A GYPSY MOTH MONITORING SYSTEM

A proposed statewide system for monitoring gypsy moth defoliation in Pennsylvania will exercise the full capabilities of ORSER/ZONAL. Development of the prototype system is being sponsored by NASA/Goddard Space Flight Center under the direction of Mr. Darrel Williams and Dr. Lisette Dottavio, and in cooperation with ORSER at Penn State. The general structure planned for the system is as follows.

A map-registered set of LANDSAT data covering the entire State of Pennsylvania is being assembled by NASA. This initial statewide data set will be classified by NASA into forested and nonforested categories. Pixels in the forested area will be assigned a value of one and pixels in nonforested areas will be assigned a value of zero to form a binary mask that can be superimposed in multiplicative fashion on LANDSAT data collected subsequently. The reason for this binary mask is that past research at NASA/Goddard and ORSER has indicated an overlap of LANDSAT signatures between defoliated forest areas and certain features in nonforested areas. The binary mask will restrict analyses to forested areas, thus eliminating any confusion with features in nonforested areas. LANDSAT data collected subsequently will be registered to the same map base, and will thus be in registration with the binary mask.

Three different sets of geounits (polygons) will be used in the monitoring system. Counties will constitute one set of geounits. Forest districts will constitute a second set of geounits. And, units in the Pennsylvania State Forest Pest Locator Grid will comprise a third set of geounits. The system is designed to provide area statistics on moderate and severe defoliation by any of these three types of geounits, as well as changes in defoliated area from year to year.

Since gypsy moth defoliation tends to move in progressive fashion from areas affected the previous year, it should not be necessary to obtain or process LANDSAT data over the entire state every year. Data procurement and processing in any given year can be restricted to areas having likelihood of infestation as judged from occurrence in the previous year.

For this particular application, the GIS need not be very sophisticated. In fact, something as simple as SYMAP with a small "front-end" should suffice. A background information system will also be needed to handle the mask, ZONAL indexing sets, and large quantities of LANDSAT data that will be accumulated over a period of time. For this purpose, the various data sets will be partitioned and stored in a series of files. A file management subsystem is being developed to retrieve specified partitions and edge-join them into larger blocks as required.

When the monitoring system calls attention to specific geounits, currently available facilities of ORSER for handling individual polygons can be used to prepare detailed maps showing distribution or defoliation within a particular geounit.

If inclement weather makes it appear unlikely that LANDSAT data will be available over the area of interest, estimates of defoliation can still be developed from aerial observation and entered directly into the GIS. This ability to bypass LANDSAT processing and substitute information from other sources is an additional virtue of the ZONAL interface technique, as opposed to making the GIS logic an integral part of the system for processing remotely sensed data.

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Turner, B. J., D. N. Applegate, and B. F. Merembeck. 1978. Satellite and aircraft multispectral scanner digital data user manual. ORSER Technical Report 9-78, The Pennsylvania State University, University Park, Pa.

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APPLICABILITY OF SATELLITE FREEZE FORECASTING AND COLD CLIMATE MAPPING TO THE OTHER PARTS OF THE UNITED STATES

Subcontract to Michigan State University
Agriculture Experiment Station
Center for Remote Sensing
Department of Entomology
East Lansing, Michigan 48824

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ACKNOWLEDGEMENTS

This project has involved a number of MSU faculty, specialists, and students, all of whom have contributed to the process of developing and utilizing satellite imagery for applications in Michigan. The development of the various software and displays required the use of several different computing facilities at MSU including those in the Department of Entomology, the Center for Remote Sensing and the Univeristy mainframe. The project has grown through stimulation from a rather small contract. As more individuals are exposed to the system developed at MSU, additional applications are perceived and suggested. The information and displays provided by the system are currently shown at remote sensing training sessions and the technology transfer process is being extended further through these educational channels.

This report and the results contained herein, are a product of many individuals who have worked on various aspects of this project. Following is an alphabetical listing of those who have made significant contributions to the project.

John Baleja, Programmer Analyst, Center for Remote Sensing
Jon Bartholic, Associate Director, Agricultural Experiment Station
William Corcoran, Student Programmer, Department of Geography
William Enslin, Manager, Center for Remote Sensing
Stuart Gage, Associate Professor, Department of Entomology
Ardeshir Goshtasby, Graduate Research Asst. Center for Remote Sensing
David Lusch, Research Specialist, Center for Remote Sensing
James Pieronek, Systems Analyst, Department of Entomology

We also acknowledge the efforts of Liz Bartels and Rosie Spagnuolo who assisted in preparing the final report.

I. INTRODUCTION

The physiography of Michigan provides a ideal conditions to evaluate the use of GOES thermal imagery for assessing freeze events in the state. Since fruit is among the major commodities grown in Michigan and freezing temperatures can severely limit production, a frost assessment and prediction system can be a definite asset.

For example, 1981 showed that spring frosts can have a major impact on the fruit crop. This year, frosts during April destroyed a major portion of the Michigan cherry crop and were also responsible for diminishing apple production. The cherry crop was reduced by about 75% in the major growing area and apple production was reduced by up to 50%. These events exemplify the need to enhance frost prediction methods and to develop methods to analyze and assess the impact of such events.

This project has addressed some of these aspects and real progress has been made in identifying the value of using GOES thermal imagery in Michigan. The process of technology transfer is a difficult one and we appreciate the efforts of NASA and The University of Florida in this activity.

At MSU we are convinced of the utility of using satellite information to aid in the enhancement of crop production for Michigan. It should be recognized that our growth in this high technology area has been variable. Within the University it has been important to disseminate some of the technology to other units. We have been successful in moving the efforts related to this project to the Center for Remote Sensing from the Entomology Department where the project was first established. Additional state resources were allocated so that we could approach the use of thermal imagery as part of an integrated system. Hardward has been acquired and existing hardware has been used toward these developments.

We now believe that we are on the trajectory of developing an independent and integrated project which will be able to grow on its own accord. This should be truly indicative of the process of technology transfer.

It is the intent of this report to describe the progress we have made and to identify the developments relative to the tasks which were assigned. First, since a great deal of effort was placed on development of a system to process satellite imagery, an overview of the processing system will be presented. Second, GOES thermal images and several surface environmental data bases were prepared to comply with the various tasks which we were able to accomplish. These data bases were developed so that we could begin to assess the physical models developed in Florida. Third, the data bases were then analyzed to identify correlations between satellite apparent temperature patterns, and earth surface factors. Fourth, a discussion of significant freeze events in 1981 and the physical models are presented to provide our perspective on how these models could be applied in the context of the Michigan environment. Next, we felt it necessary to describe some of the difficulties we encountered in obtaining data to develop the system for Michigan.

II. MSU GOES DATA ANALYSIS SYSTEM

New data analysis and display capabilities were developed and implemented around the existing basic software system used at MSU to manage image data obtained from the GOES satellite (Figure 1).

The previous system includes a projection conversion program and several display options. GOES thermal infrared data, stored on nine-track magnetic tape by NESS, are read onto a permanent disk file on the MSU CDC Cyber 170/750 mainframe computer. These data are converted to text and transmitted to a Terak 8510 via a 1200 baud telephone connection and stored on diskette for further processing.

Once the data are available on the Terak microcomputer, they are reconverted into the original format--a 129 by 129 array of integers corresponding to infrared intensities as measured by the GOES/SMS satellite. The projection conversion program converts the satellite's perspective projection centered at 75 degrees west longitude, 0 degrees latitude, to an orthographic projection of Michigan centered at 85 degrees west longitude, 42 degrees north latitude. Although this program corrects the perspective distortion, it does not correct for drift in the satellite's position, which can introduce a registration error of 5 to 30 kilometers in a given data set. Software programs allow an operator to produce several different types of maps interactively

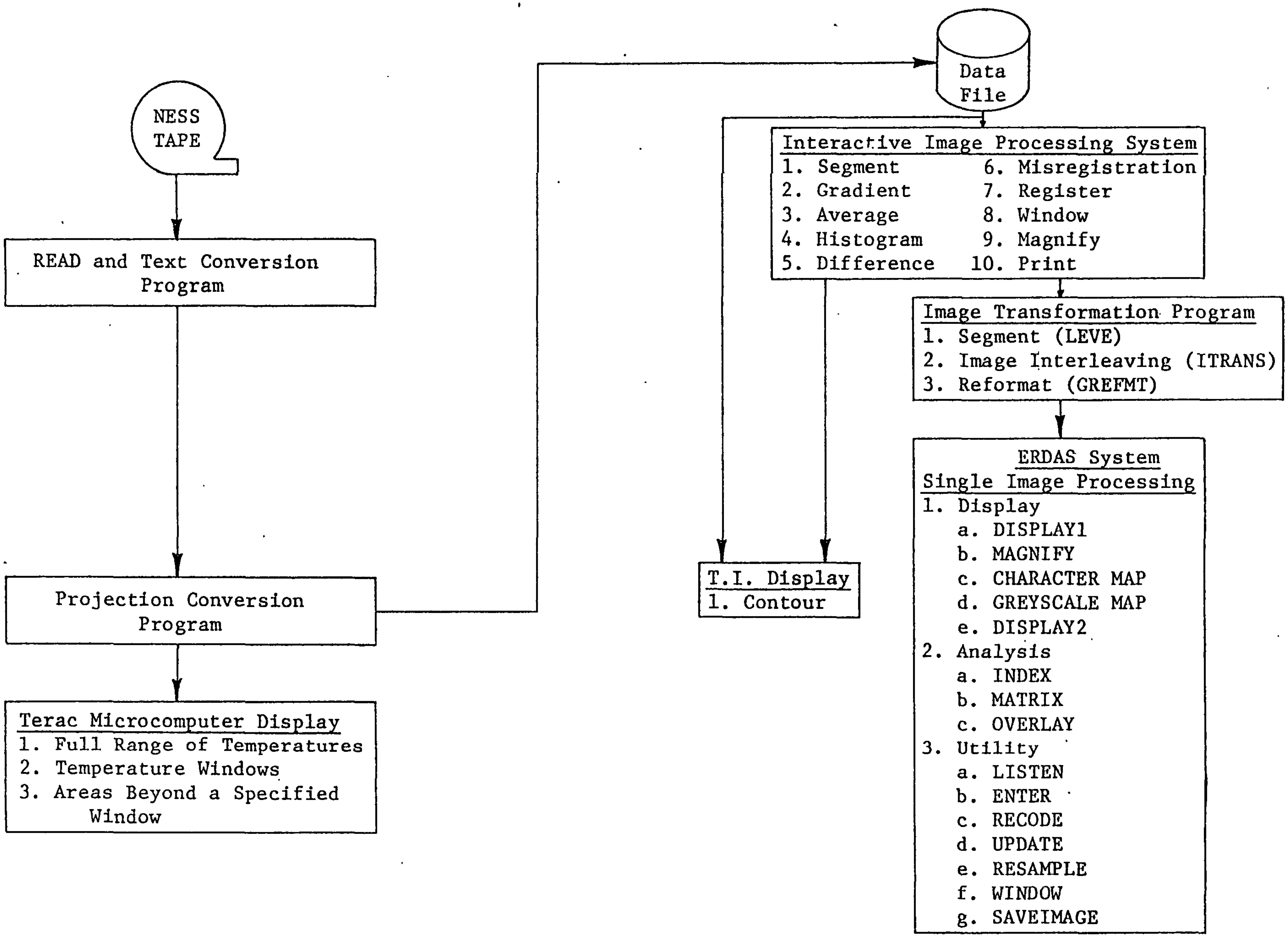


Figure 1. MSU GOES data analysis systems.

using a data value-to-temperature conversion scheme which is basically a two-part linear approximation of an exponential curve (Chen, 1979). The display program produces the following:

a. Map of full range of temperatures across Michigan.

b. Map of areas falling into a specified temperature window.

c. Map of areas with temperatures above or below a specified temperature.

All of the above temperature displays are available in degrees Fahrenheit, Celsius or Kelvin. The program operator selects the desired mapping option and the computer produces an image on either a 12 inch black-and-white video monitor with 320 by 240 on/off pixel resolution or an eight-color video monitor.

A. Interactive Image Processing System

All of the new programs access GOES data that has been transferred back onto a data file on the mainframe computer after being run through the projection conversion program.

An interactive image processing system (IIPS) was developed which contains module subprograms that perform selected operations on image data. The system resides on the Cyber 170/750 mainframe computer and is operated interactively from a terminal. The image operation routines (except for file handling and management) available are:

1) SEGMENT--segments an image into regions of specified gray levels using up to 15 threshold values.

2) GRADIENT--finds the gradient of an image by the maximum difference method. If the input image is a segmented image, the result is a contour image.

3) AVERAGE--finds the average gray level of corresponding pixels of several images.

4) HISTOGRAM--produces a histogram of data values of an image.

5) DIFFERENCE--finds the difference between the data values of pixels in two images.

6) MISREGISTRATION--finds the translational misregistration between images by using a sequential similarity detection method on gradient images of the original data.

7) REGISTER--corrects for translational misregistration through x,y shift.

8) WINDOW--will window out a portion of an image.

9) MAGNIFY--will enlarge an image to a specified magnification factor.

10) PRINT--outputs an image as gray level values on a printer.

B. The Earth Resources Data Analysis System (ERDAS)

Image data generated through the above routines can be transferred via a 1200 baud telephone connection to the ERDAS microcomputer system at the Center for Remote Sensing. One of the following image transformations, accomplished with software which resides on the Cyber 170/750, must be executed prior to data transfer:

1) SEGMENT (LEVE)--groups the Fahrenheit or Celsius temperature value into 2-16 ranges.

2) IMAGE INTERLEAVING (ITRANS)--transforms four GOES images into a band interleaved by line format file.

3) REFORMAT (GREFMT)--processes GOES image data for transfer to the ERDAS system.

A geographic information system, IMGRID2, is available on the ERDAS for the manipulation of grid-based data files. This system will display a data file on a 512 x 480 x 4 bit pixel array capable of a maximum of 16 color-coded categories. The following display, analysis and utility options are available within this GIS:

DISPLAY

1) DISPLAY1--displays a user-specified data file on the color monitor in the 512 x 480 display mode.

2) MAGNIFY--magnifies a user-specified data file on the color monitor in the 512 x 480 display mode.

3) CHARACTER MAP--prints a character overprint grey scale map of a user specified data file on the Anadex printer.

4) GREYSCALE MAP--prints a dot matrix grey scale map of any user-specified data file on the Anadex printer.

5) DISPLAY2--displays a data file that includes user-generated alpha-numeric graphics.

ANALYSIS

1) INDEX--performs a weighted summation on 2-5 variable files and outputs a new variable file.
2) OVERLAY--creates a new file by combining from 2-5 user-specified variables and taking the highest value for any grid cell from the old variables and assigning it as the new data value.
3) MATRIX--compares the occurrences between two variable files and create a new variable file of the coincidences.

UTILITY

1) LISTEN--A system communication package used primarily for mainframe to micro data transfer.
2) ENTER--Allows the user to enter data to create a new variable file.
3) RECODE--Allows the user to change or group specific values in a given variable file.
4) UPDATE--Allows the user to change the value of any data element in a given file.
5) RESAMPLE--Changes the pixel size of any user-specified image.
6) WINDOW--Creates a user-specified subimage from a larger image file.
7) SAVEIMAGE--Stores an image exactly the way it is displayed on

the RGB monitor.

C. Contour Program

The Interactive Image Processing system also transfers GOES data, via a 1200 baud telephone link, to the Texas Instrument minicomputer in the Department of Entomology. The contour program on the T.I. computer is designed to find the boundary between regions of different temperature ranges in a GOES thermal image. After the contours are found, they can be displayed either on the graphics terminal or the plotter.

The program is composed of 3 parts:

1) Thresholding, by which the image is segmented into regions of different temperature ranges which are specified by the user.
2) Contour extractor which produces contours by following the boundary between regions.
3) Plotter program which generates plotting data both for the graphics display and the plotter.

III. DATA BASES

A. Goes Data Base

Computer line printer maps were created from each of the 18 GOES images within the time frame of 3:00 p.m., June 24 to 10:00 a.m., June 25, 1979 which were available for the study. These maps display the Fahrenheit temperature value for each GOES pixel in a given scene. Based on a comparison of all of these line printer maps, the 10:00 a.m. image was selected as having the widest temperature variation for a daytime image (8:00 a.m. - 6:00 p.m.) and the 5:00 a.m. image was selected as having the widest temperature variation of the night images (8:00 p.m. - 7:00 a.m.). The 10:00 a.m. and 5:00 a.m. printer maps were hand-contoured using a 2 degree F contour interval and optimum landmass and water temperature ranges were determined. This process was necessitated by the IMGRID2 graphic information system which is limited to a maximum of 16 color-coded categories. These temperature ranges were used to process all of the GOES data sets using the segment routine on the mainframe computer.

Since the June 24-25, 1979 GOES digital tape did not contain the orbital information necessary for digital geometric correction procedures, a less accurate registration method was employed. Once the 10:00 a.m. data file was contoured and color coded via the IMGRID2 package, it required resampling since the screen pixels on the color monitor are square. Hence, the color-coded image on the monitor could not be used for "fitting" to the base map.

Initial photographic enlargement of color-coded GOES data had suggested that the average pixel size was approximately 9 x 12 km. Using this pixel aspect ratio, a line printer map of contoured (categorized in 16 classes) temperature data was created at a scale of 1:1,000,000. This map was found to be very distorted compared to the 1:1,000,000 U.S.G.S. base map of Michigan indicating that the pixel size was not 9 x 12 km. Several other aspect ratios were tried and the "best fit" was obtained with pixels which were 8 x 11 km. The 8 x 11 km grid cell was adopted for use in data capture in order to match the GOES data.

Figure 2 depicts the thermal patterns in Michigan at six selected times during the interval 3:00 p.m., June 24 to 10:00 a.m., June 25, 1979. The 3:00 p.m. (Figure 3) and 4:00 a.m. (Figure 4) data sets were selected for analysis because they approximate maximum and minimum land-surface temperature conditions, respectively.

The multitemporal analysis of the GOES data mandates that the various data sets be registered relative to one another. Two methods were used to determine and correct translational misregistration between GOES images resulting from satellite drift between acquisition times. The first method involved generating line printer maps of each GOES image, and contouring by hand the shoreline of Michigan (i.e. the maximum thermal gradient contour) on each map. These shoreline contours were used to register map pairs superimposed on a light table. The amount of misregistration between two images was simply the amount of shift (x,y), if any, between the column and row numbers of each map pair. Using the Window program on ERDAS, the GOES data files were properly registered to each other by partitioning out windowed areas specified by appropriate x-y coordinates for each image.

ORIGINAL PAGE
COLOR PHOTOGRAPH

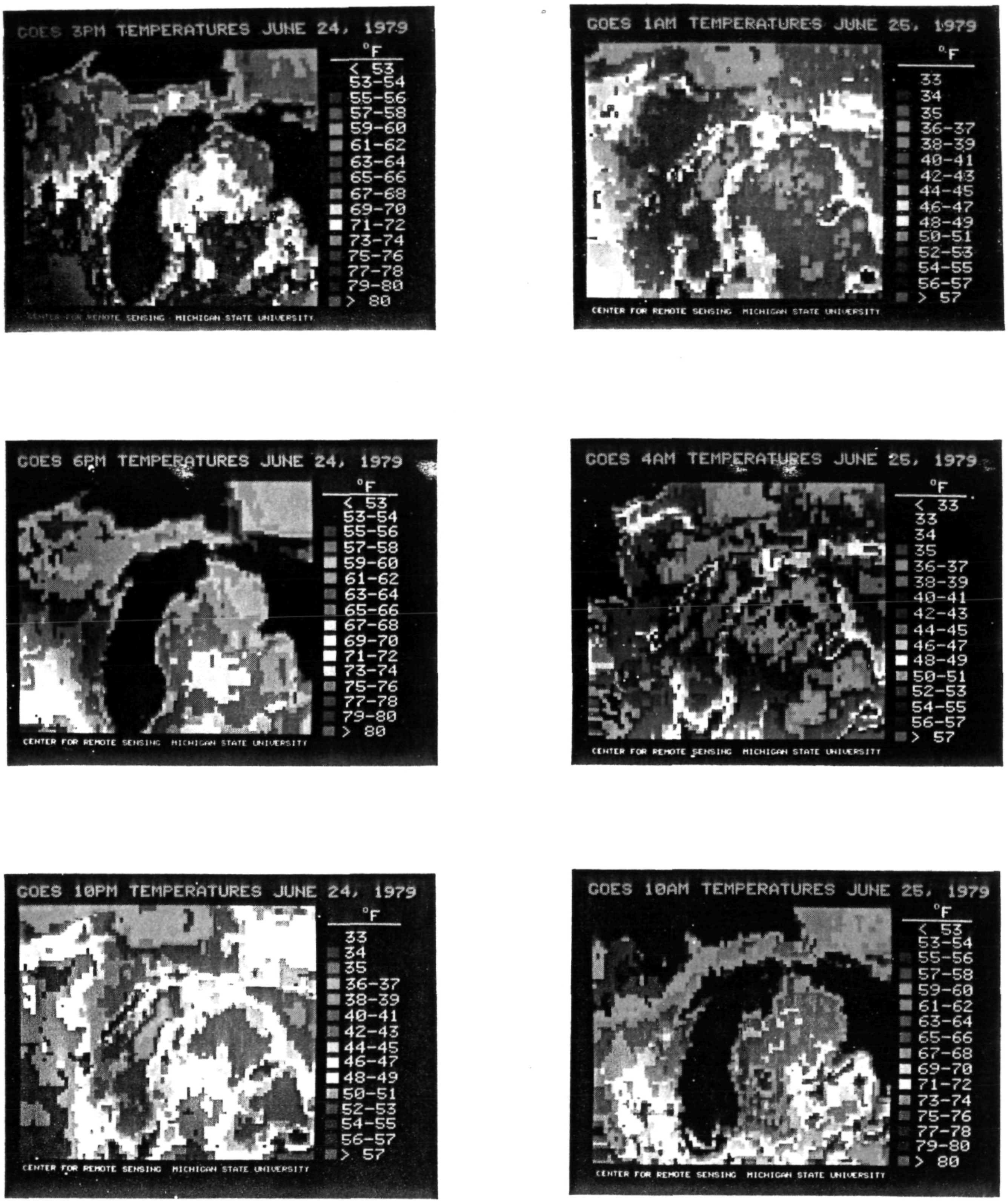


Figure 2. Color display sequence of GOES thermal data of Michigan acquired June 24-25, 1979.

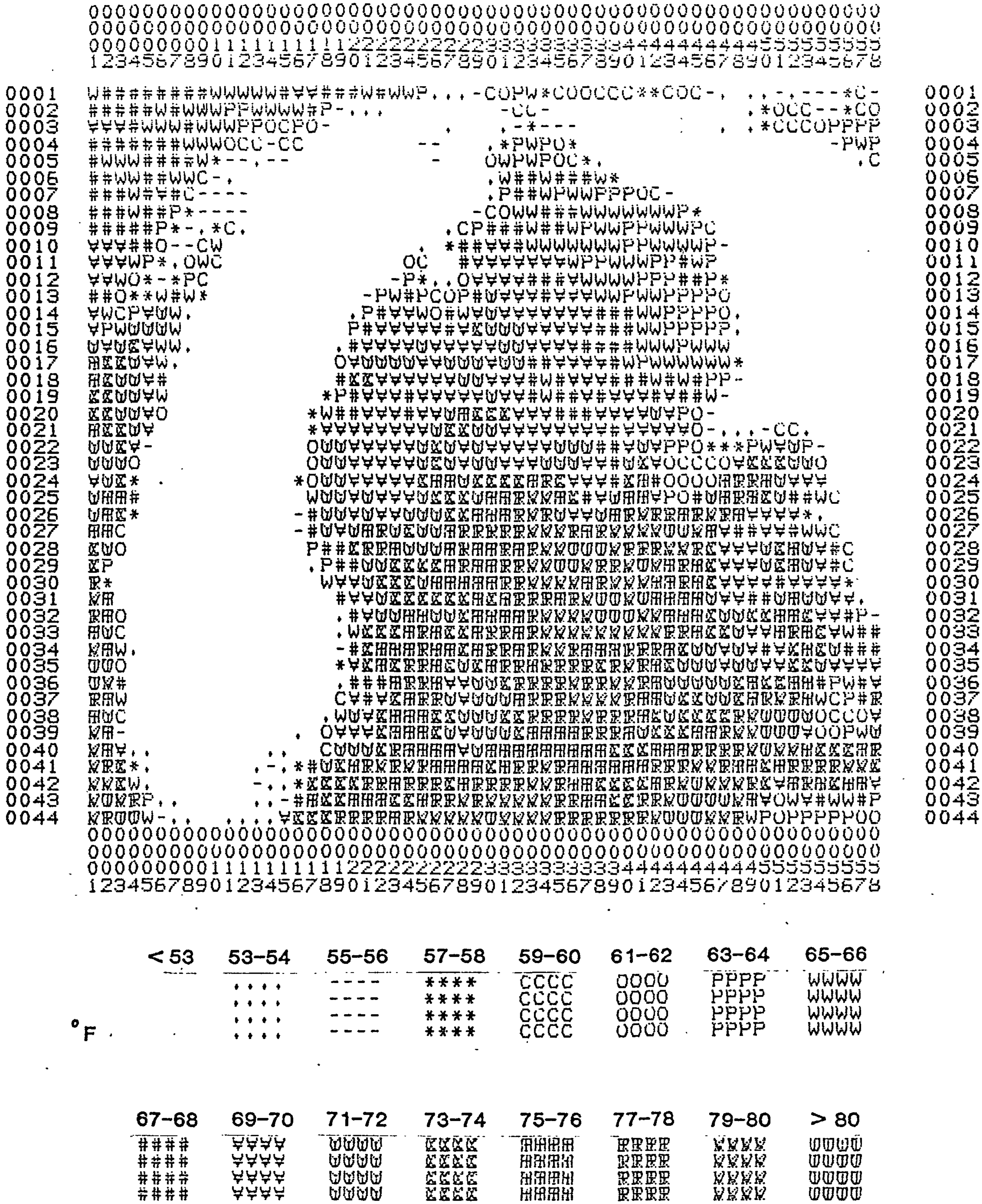


Figure 3. Line printer output of GOES pixel temperatures in Michigan from 3:00 p.m., June 24, 1979.

A second, digital method was developed which automatically determines the translational misregistration between images. The registration is accomplished using a sequential similarity detection method (Barnea & Silverman, 1972).

This method works as follows:

1) Gradient images of each GOES image are provided.
2) A search area (a subpicture) of one of the two images to be registered is selected.
3) A window area from the other image (which is smaller in size than the search area) is selected which covers (approximately) the same region on the ground as the search area.
4) The window area is shifted exhaustively over the search area and the difference between the search and the window area is computed.
5) The registration is determined by the (x,y) translation which produce the minimum difference value.

The following table shows the amount of translational corrections (x,y shift) needed to register each GOES image to the previous one in the sequence (relative shift) and to the 3:00 p.m. image (absolute shift). The 3:00 p.m. image was selected as the base because it displays the maximum thermal gradient along Michigan's coastline.

IMAGE TIME	RELATIVE SHIFT VALUE (x,y)	ABSOLUTE SHIFT VALUE (x,y)
3:00 p.m.		
4:00 p.m.	(0,0)	(0,0)
5:00 p.m.	(0,1)	(0,1)
6:00 p.m.	(0,0)	(0,1)
8:00 p.m.	(-1,0)	(-1,1)
9:00 p.m.	(0,0)	(-1,1)
10:00 p.m.	(-1,0)	(-2,1)
11:00 p.m.	(1,0)	(-2,1)
12:00 a.m.	(-1,0)	(-3,1)
1:00 a.m.	(0,0)	(-3,1)
2:00 a.m.	(0,0)	(-3,1)
4:00 a.m.	(1,0)	(-2,1)

B. Surface Environmental Data Base

Several environmental factors were selected because of their potential to significantly influence surface temperatures. These included land cover/use, local relief, percent forest land and water holding capacity in the upper three feet of soil. With the exception of statewide land cover/use information, published data were available for each of these variables.

Level I land cover/use data were photo interpreted from 1:1,000,000 scale, diazo-enhanced Landsat imagery. Seven categories were derived: urban, agriculture, deciduous forest, coniferous forest, barren land, water and wetlands. Local relief data were extracted from the very small scale (approximately 1:3 million) map in Pawling (1969). Information on the percent of land in forest was available from a 1:2.5 million map of the state (Michigan Department of Natural Resources, 1970). Data on the water holding capacity of Michigan's soils were obtained from 1:1.8 million maps of the state (Schneider and Erickson, n.d.). Although information was available for several solum depths, data for the upper three feet were selected to take into account the many two-storied soils in Michigan.

All of these maps were brought to a common scale of 1:1 million cartographically. Each factor map was registered to the 1:1 million U.S.G.S. base map of Michigan and overlaid with a computer-generated orthogonal coding grid composed of 8 x 11 km cells. Dominant factor categories were encoded in each cell and, subsequently, placed on diskette storage via direct keyboard entry on the ERDAS microcomputer. These four digital files were output to line printer hardcopy and compared for registration accuracy. Additionally, the percent forest land and land cover/use files were digitally overlaid to assess their compatibility and assist in editing the files for encoding errors. The general patterns of the four surface characteristics are discussed below.

The generalized land cover/use of Michigan's southern peninsula is shown in Figure 5. The large cell size of the encoding grid (determined by the GOES pixel dimensions), is compatable with this Level I categorization of land cover/use. Urban centers large enough to dominate this cell size occur only in the southern half of the peninsula which is dominated by agricultural land use. The two forest categories predominate in the northern half of the Lower Peninsula and water bodies sufficiently large to dominate a coding cell are also restricted to this part of the state.

The forest lands in the southern part of the state are scattered and small in extent compared to the woodlands in the northern half of the Lower Peninsula. With the exception of the Allegan State Game Area in southwestern Michigan, which is 70-95% forested, most of the woodland in southern Michigan is less than 40% forested (Figure 6). The northern Lower Peninsula, on the other hand, has at least 70% forest cover in most places. A notable exception to this generalization is the agricultural area of northwestern Michigan around Grand Traverse Bay which has less than 40% forest cover.

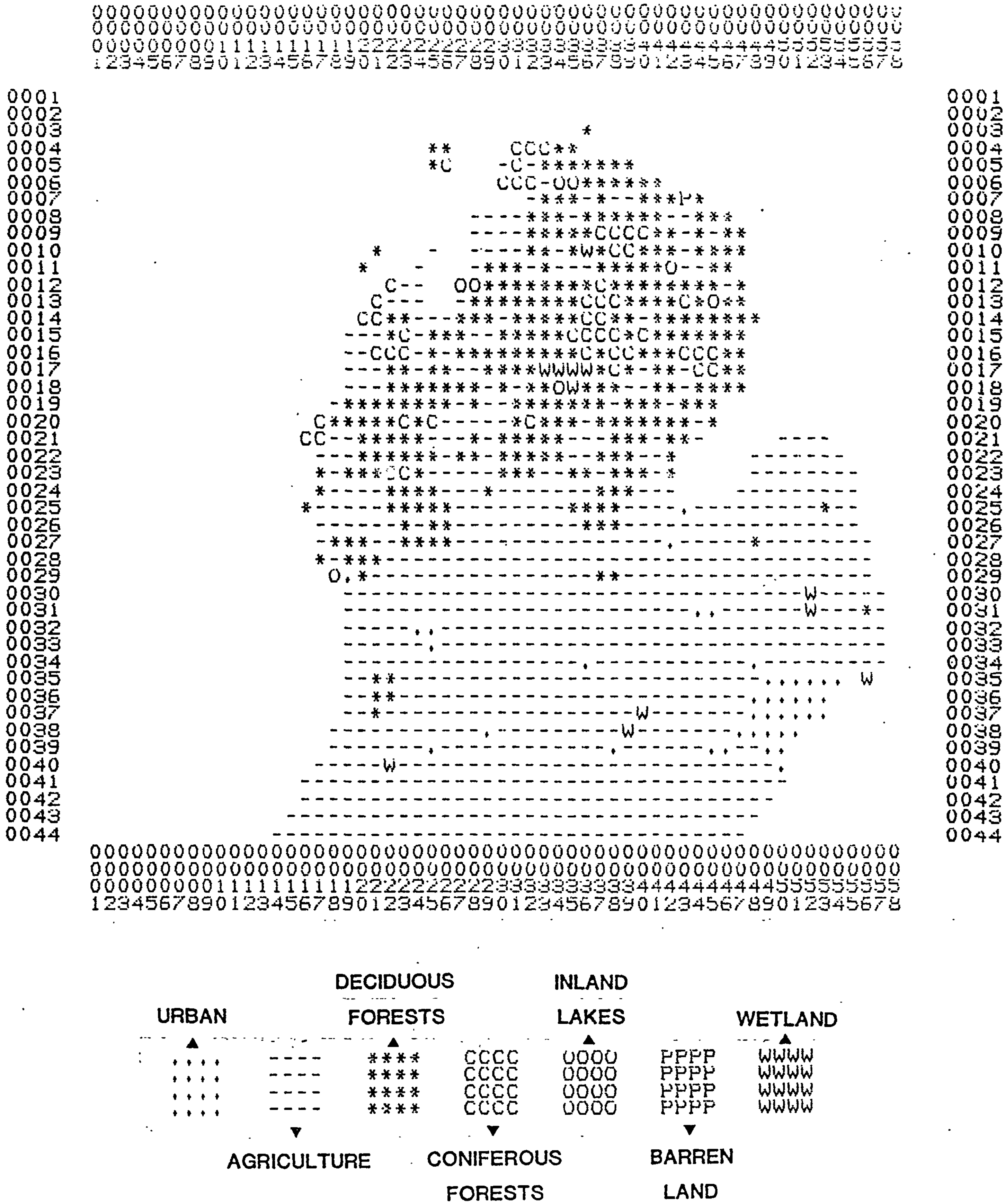
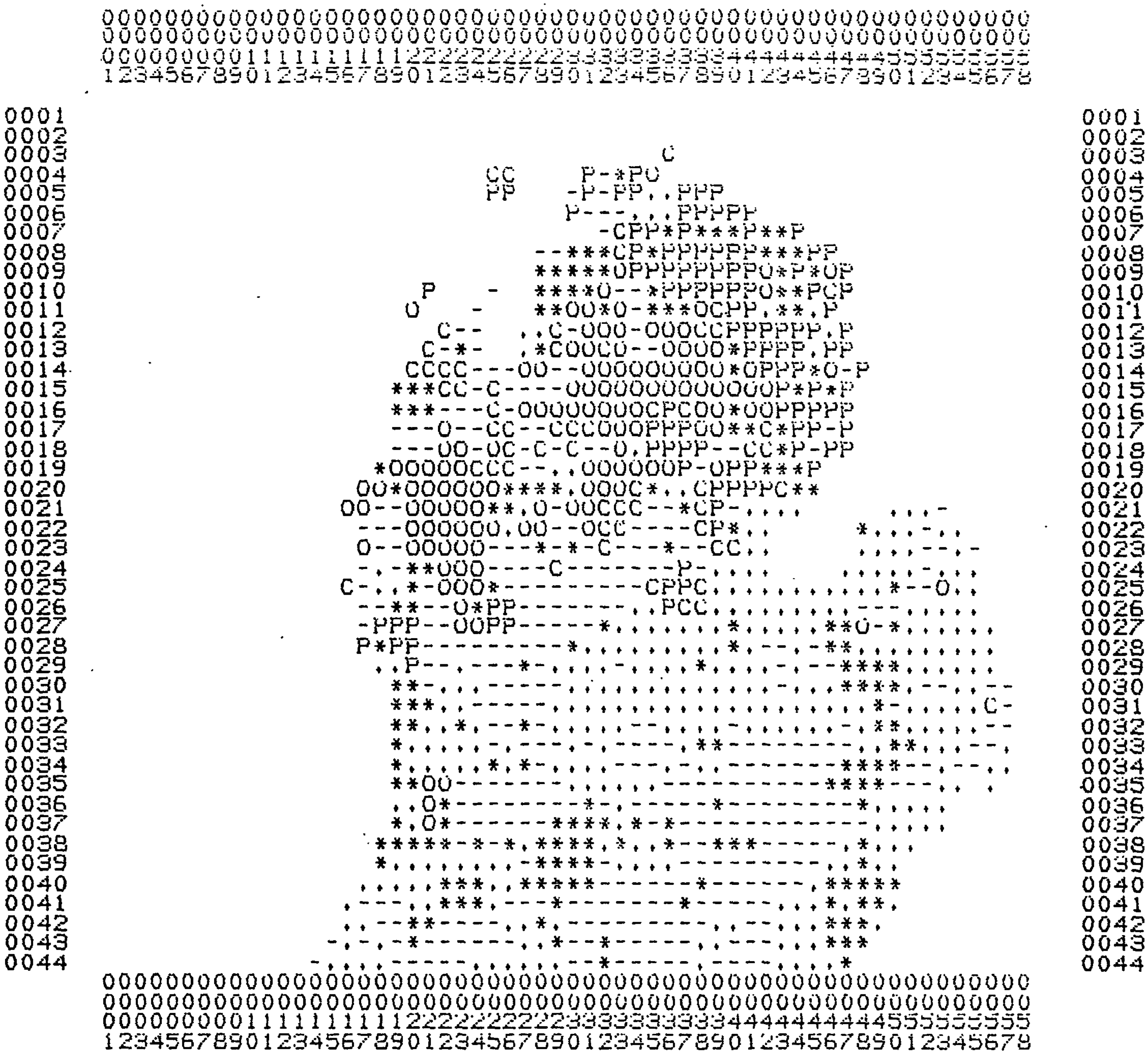


Figure 5. Land cover classification of Michigan.



0-5%	5-15%	15-40%	40-70%	70-95%	95-100%
....	----	****	CCCC	OOOO	PPPP
....	----	****	CCCC	OOOO	PPPP
....	----	****	CCCC	OOOO	PPPP
....	----	****	CCCC	OOOO	PPPP

Figure 6. Percent of land in forest for Michigan.

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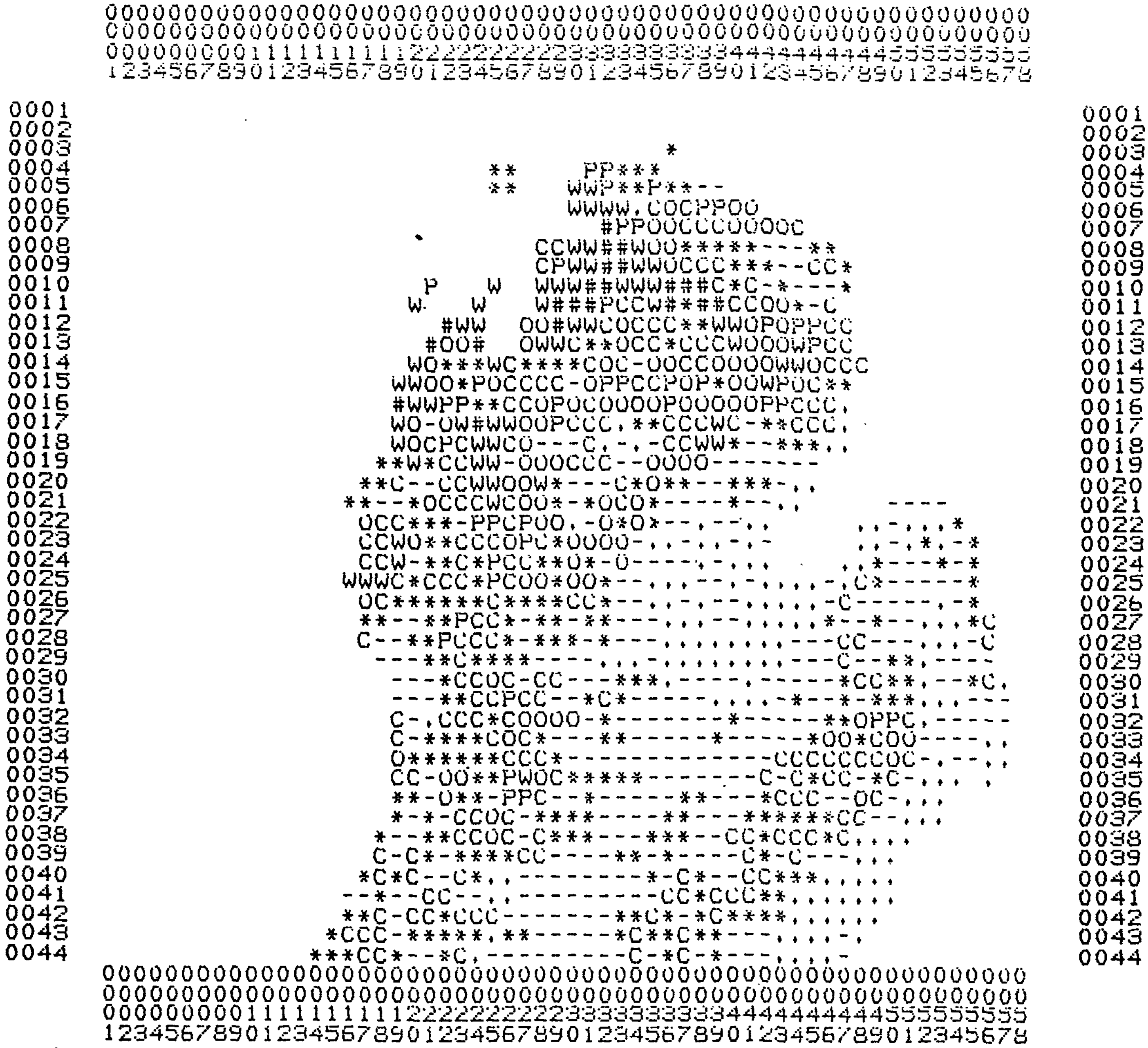
Local relief, a measure of absolute elevation difference per unit area, in the Southern Peninsula ranges from less than 49 feet per cell (GOES pixel) to more than 500 feet per cell (Figure 7). Areas of lowest relief (0-49 feet/cell) correspond to the glacial lacustrine plains around and southwest of Saginaw Bay and along the southeastern coast of the state. The narrow, linear, north-south trending area of low relief on the east side of Michigan's "thumb" correlates with the Black River Valley. A much broader zone of higher relief, up to 249 feet/cell, trends southwestward from the central "thumb" area. This more rugged topography is associated with interlobate ice-contact glacial deposits. A more diffuse zone of high relief relates to other interlobate deposits occurs in southwestern Michigan and trends northwards where it merges with the nearly ubiquitous rugged topography of the northern Lower Peninsula. The very hummocky terrain (greater than 200 ft/cell) of this part of the state results from the abrupt juxtaposition of high coastal dunes or inland morainic masses with broad flat valley-train deposits. A localized area of somewhat subdued local relief (less than 150 ft/cell) occurs in the northeastern-most part of the state.

The distribution of soil types in Michigan at the order level is characterized by the predominance of Spodosols in the northern and west-central parts of the state and Alfisols in the southern and east-central regions of the Lower Peninsula. The gross textural differences between these soil orders results in low water holding capacities for most northern Michigan soils and much higher capacities in the soils of central and southeastern



FEET/PIXEL

0-49	50-99	100-149	150-199	200-249	250-299	300-399	400-599
....	----	****	CCCC	OOOO	PPPP	WWWW	####
....	----	****	CCCC	OOOO	PPPP	WWWW	####
....	----	****	CCCC	OOOO	PPPP	WWWW	####
....	----	****	CCCC	OOOO	PPPP	WWWW	####

Figure 7. Local relief (elevation change per pixel) in Michigan.

Michigan and the "thumb" area (Figure 8). The stratified ice-contact and glaciofluvial drift of the two interlobate zones of southern Michigan produce soils of low water holding capacity as well. Each of the five areas of highest water holding capacity (greater than 20") are associated with areas of Histosols.

IV. ANALYSIS OF GOES THERMAL DATA

A. Comparison of Satellite and Weather Station Temperatures

The recorded ambient air temperatures at selected synoptic weather stations were compared to the 3:00 p.m. and 4:00 a.m. temperatures derived from GOES data as shown in Table 1. Overall, there is a good agreement between GOES pixel temperatures and recorded air temperatures. At 3:00 p.m., 63% of the GOES pixels examined agreed within ± 4 degrees F with corresponding recorded air temperature, while at 4:00 a.m., there was 88% agreement. The majority of 3:00 p.m. GOES temperature values were warmer than the 1.5m air temperatures, but at 4:00 a.m. the positive and negative departures were about equal. The nine pixels which varied by more than 4 degrees F from the synoptic station temperatures at 3:00 p.m. are all located in the southern part of the state and are circled on Figure 9. The three pixels circled on Figure 10 differed by more than 4 degrees F from the 4:00 a.m. station temperatures. The discrepancies between these two data sets are probably due to the inherent differences between thermal radiance values integrated across 88 square kilometers and point sampled ambient air temperatures, as well as the +/- 2 to 4 degrees C accuracy limitation of the VISSR thermal channel (NOAA, 1978:C2).

INCHES

3.75–6.5	6.5–9.0	9.0–10.25	10.25–11.5	11.5–15.0	15.0–20.0	>20.0
....	----	****	CCCC	OOOO	PPPP	WWWW

Figure 8. Water holding capacity of the upper 3 feet of soil in Michigan.

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Table 1. Comparison of GOES pixel temperatures with 1.5 m. air temperatures recorded at selected synoptic weather stations.

	4:00 a.m. Temp (F)		3:00 p.m. Temp (F)	
	GOES	STATION	GOES	STATION
Allegan	42-43	41	74-75	66
Alpena City	42-43	40	63-64	61
Alpena WSO	40-41	38	65-66	61
Bad Axe	40-41	38	73-74	60
Benton Harbor	46-47	46	79-80	66
Detroit WSFO	46-47	42	73-74	69
Eau Claire	44-45	42	73-74	66
Flint WSO	40-41	41	75-76	66
Grand Haven	44-45	47	67-68	63
Grand Rapids	42-43	45	74-75	72
Hart	46-47	52	61-62	61
Hesperia	40-41	41	71-72	71
Holland	44-45	41	67-68	61
Houghton Lake WSO	46-47	38	65-66	66
Lake City	38-39	37	71-72	67
Lansing WSO	40-41	39	79-80	66
Lapeer	36-37	36	67-68	65
Ludington	42-43	47	61-62	63
Muskegon WSO	44-45	42	69-70	63
Newaygo	42-43	39	71-72	71
Onaway	38-39	40	63-64	63
Paw Paw	42-43	45	73-74	73
Sandusky	38-39	41	65-66	60
Traverse City	38-39	40	65-66	63

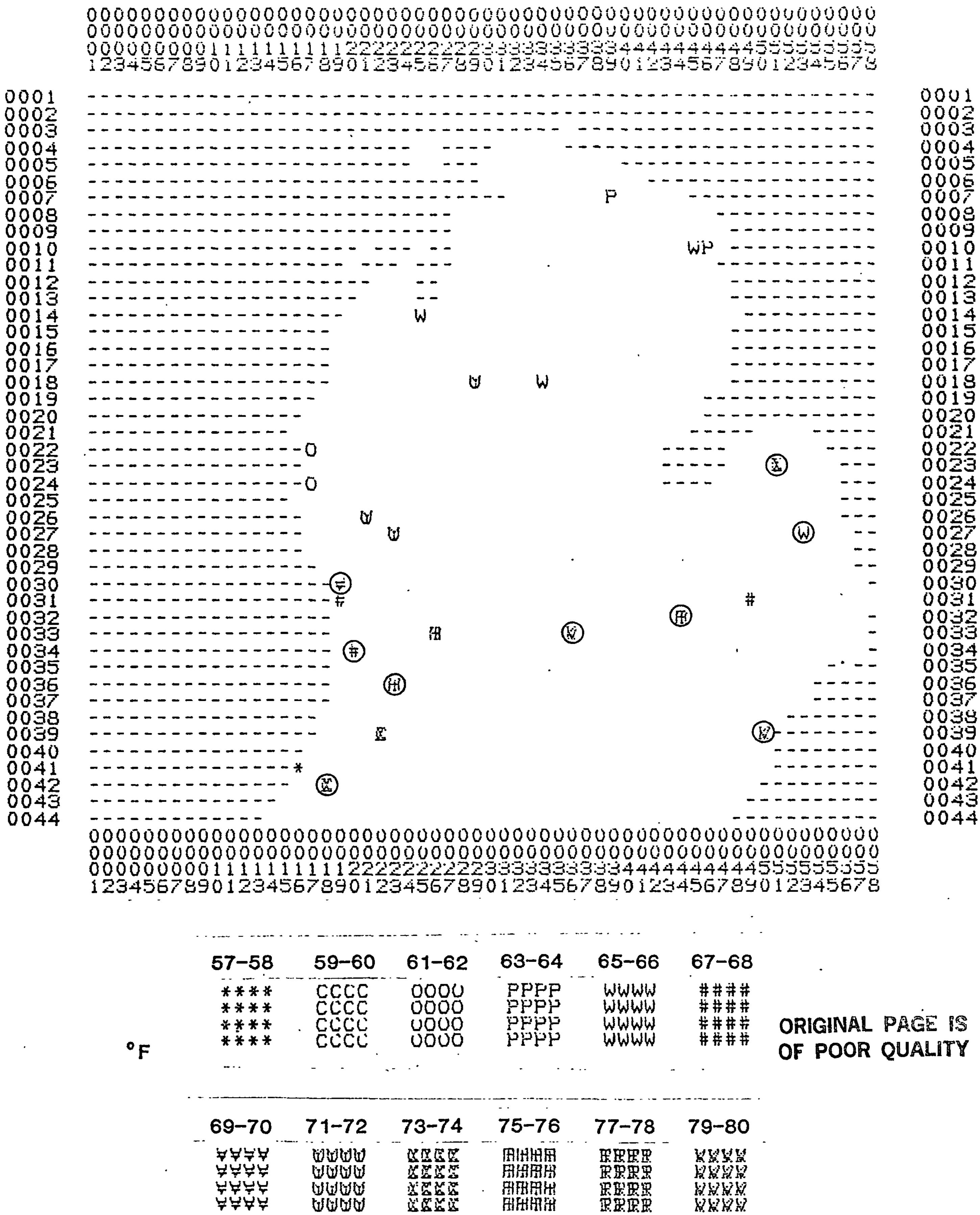
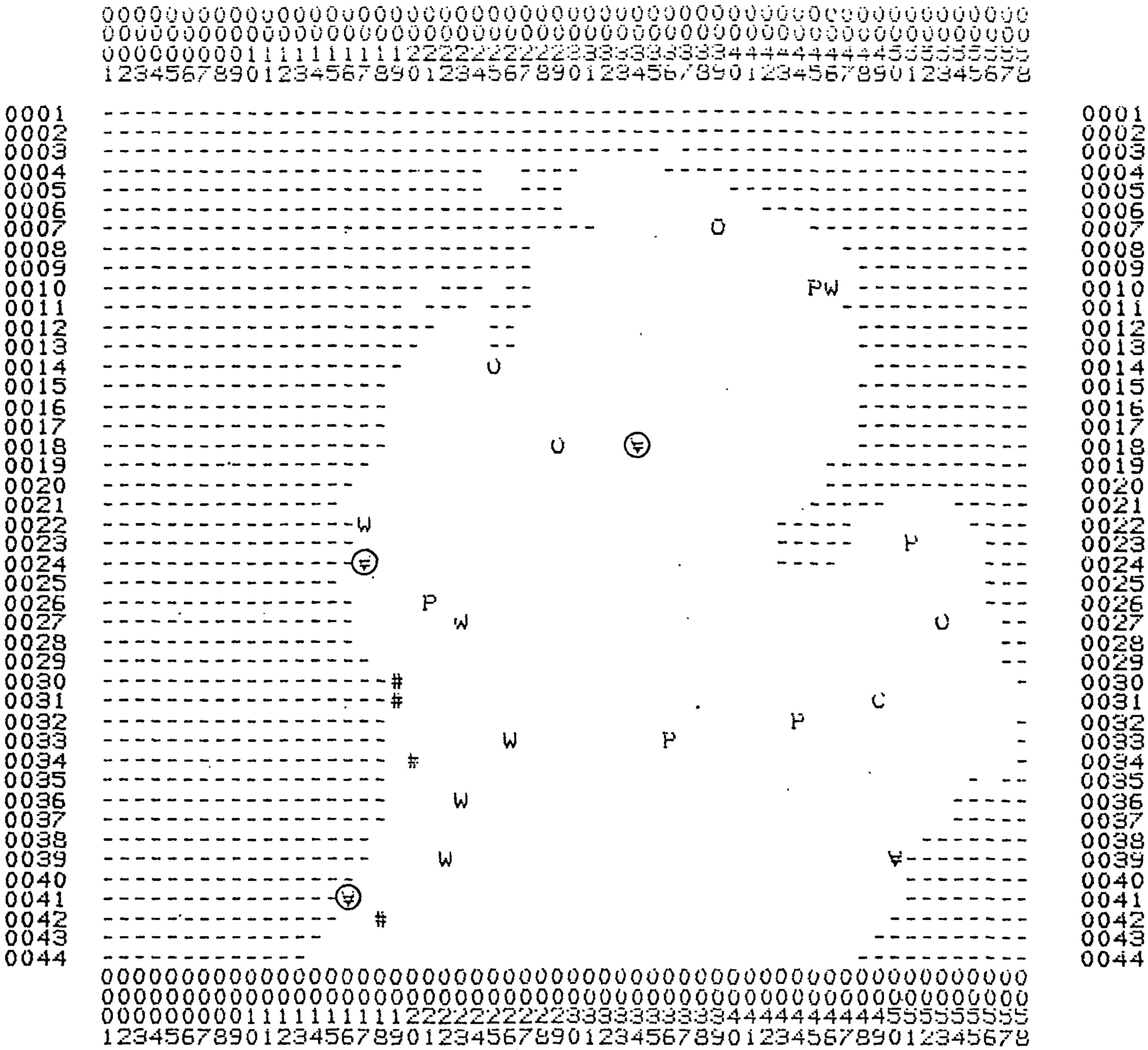


Figure 9. Apparent temperature at selected synoptic weather station sites from GOES 3:00 p.m. data for June 24, 1979 (circled pixel temperatures differed by more than 4° F. from recorded air temperatures).



°F

33	34	35	36-37	38-39	40-41	42-43	44-45	46-47	48-49
****	CCCC	OOOO	PPPP	WWWW	####	¥¥¥¥	WWWW	[illegible]	HHHH
****	CCCC	OOOO	PPPP	WWWW	####	¥¥¥¥	WWWW	[illegible]	HHHH
****	CCCC	OOOO	PPPP	WWWW	####	¥¥¥¥	WWWW	[illegible]	HHHH
****	CCCC	OOOO	PPPP	WWWW	####	¥¥¥¥	WWWW	[illegible]	HHHH

Figure 10. Apparent temperature at selected synoptic weather station sites from GOES 4:00 a.m. data for June 25, 1979 (circled pixel temperatures differed by more than 4° F. from recorded air temperatures).

B. Analysis of Apparent Temperature Patterns

Static temperature patterns at 3:00 p.m. (Figure 3) and 4:00 a.m. (Figure 4), were analyzed as well as patterns of dynamic thermal flux. An average temperature pattern image (Figure 11) was produced from GOES data acquired at 3:00 p.m., 10:00 p.m., 4:00 a.m. and 10:00 a.m., June 24-25, 1979 utilizing the Index routine of the IMGRID2 program. By subtracting 4:00 a.m. radiance values from 3:00 p.m. values using IIPS software, a temperature difference image (Figure 12) was constructed.

The correlation of temperature patterns depicted on these four GOES images with the four surface attributes encoded in the environmental data base was assessed by comparing both printer maps and color images (Figure 13) displayed on a video monitor. A brief description of the major correlations follows.

Land mass temperatures at 3:00 p.m. ranged from 53 degrees to greater than 80 degrees F (Figure 13). The warmest temperatures occurred in the central, south and southeastern parts of the state, whereas the northeast had the coolest temperatures (Figure 14). The hottest pixel temperatures (greater than 80 degrees) were detected in the Detroit metropolitan area, northwest Monroe County, northwest Shiawassee County and the northern boundary between Gratiot and Saginaw Counties (see reference map, Figure 15). These areas are in either urban or agricultural use on lands of low relief (less than 100') and high water holding capacity. Over 75% of these hot areas have relief less than 50'/pixel, a

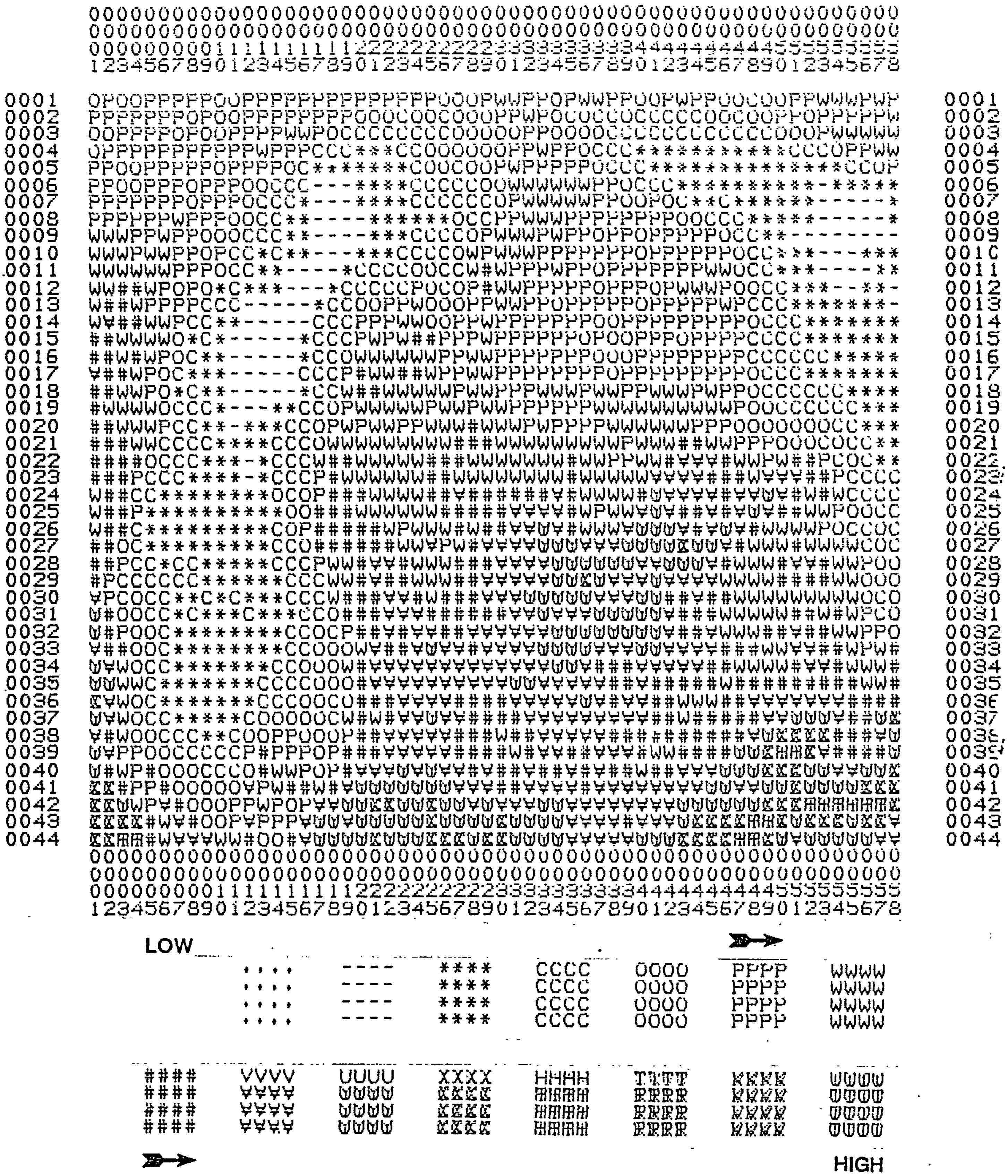


Figure 11. Average pixel temperatures derived from GOES data acquired at 3:00 p.m. and 10:00 p.m., June 24; 4:00 a.m. and 10:00 a.m., June 25, 1979.

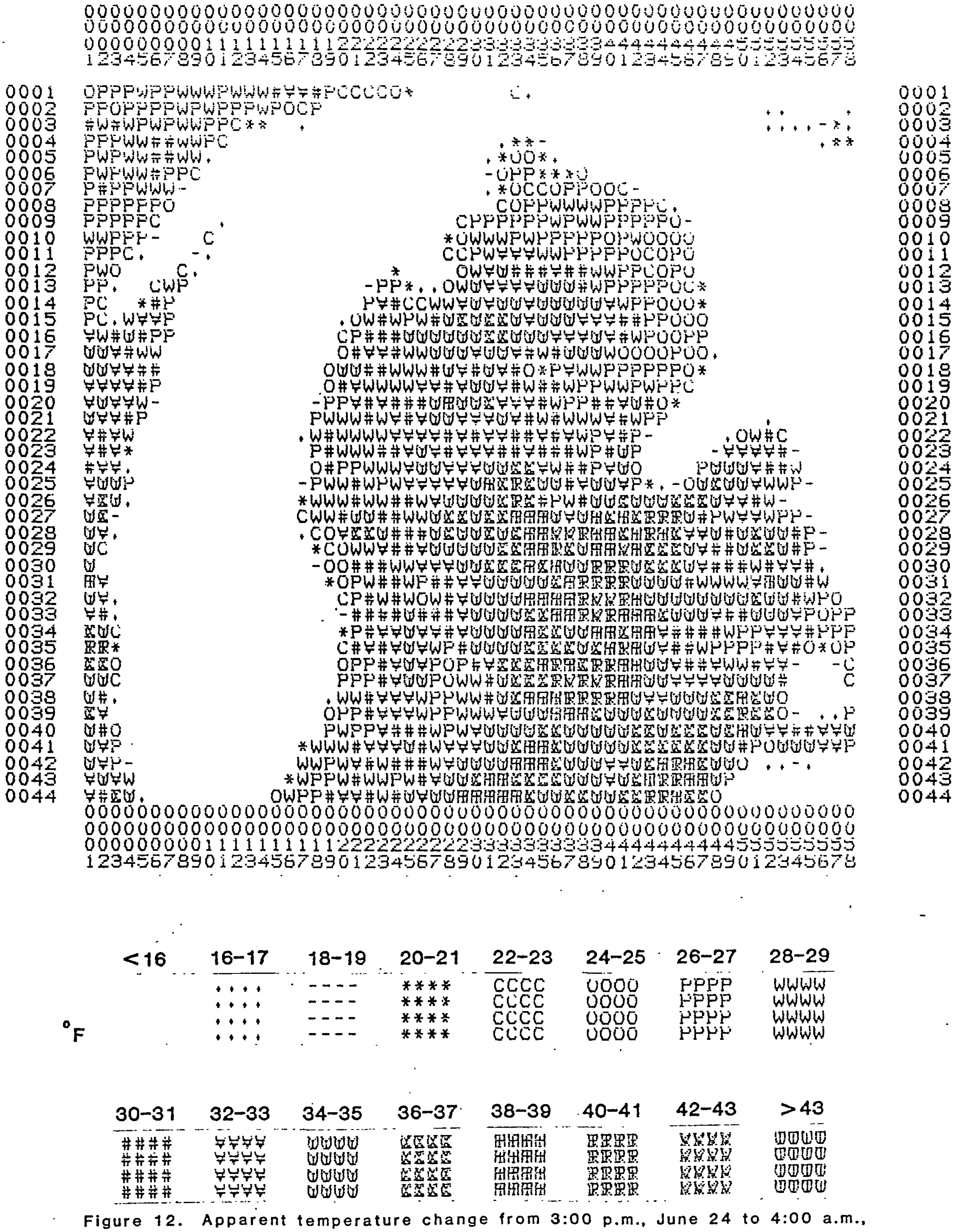


Figure 12. Apparent temperature change from 3:00 p.m., June 24 to 4:00 a.m., June 25, 1979 derived from GOES data.

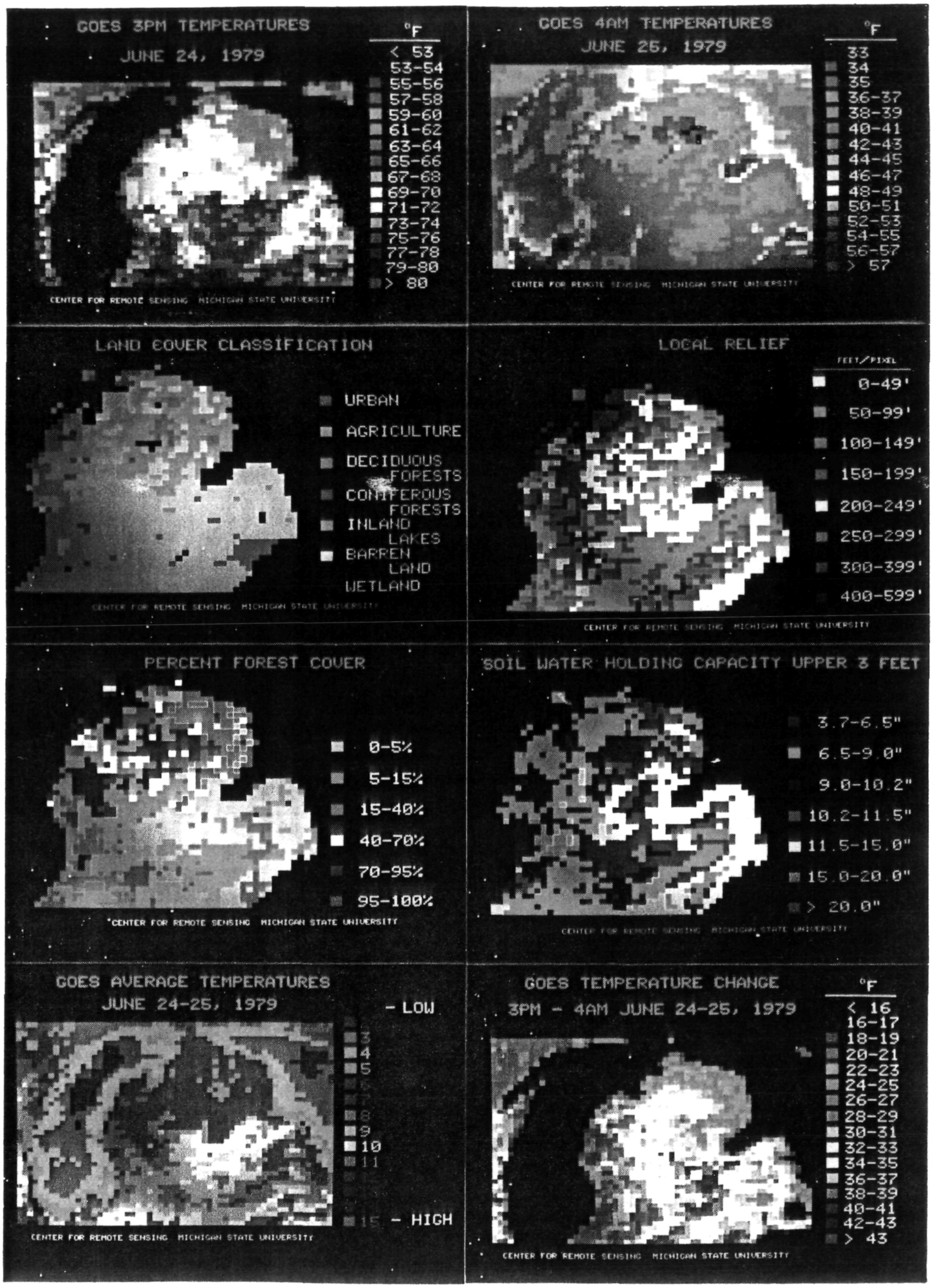


Figure 13. Comparison of GOES thermal patterns with the distributions of selected surface features in Michigan.

CCCC pixel temperatures less than 68°F.

WWWW pixel temperatures greater than 76°F.

Figure 14. Areas of minimum and maximum apparent temperatures at 3:00 p.m., June 24, 1979 from GOES thermal data.

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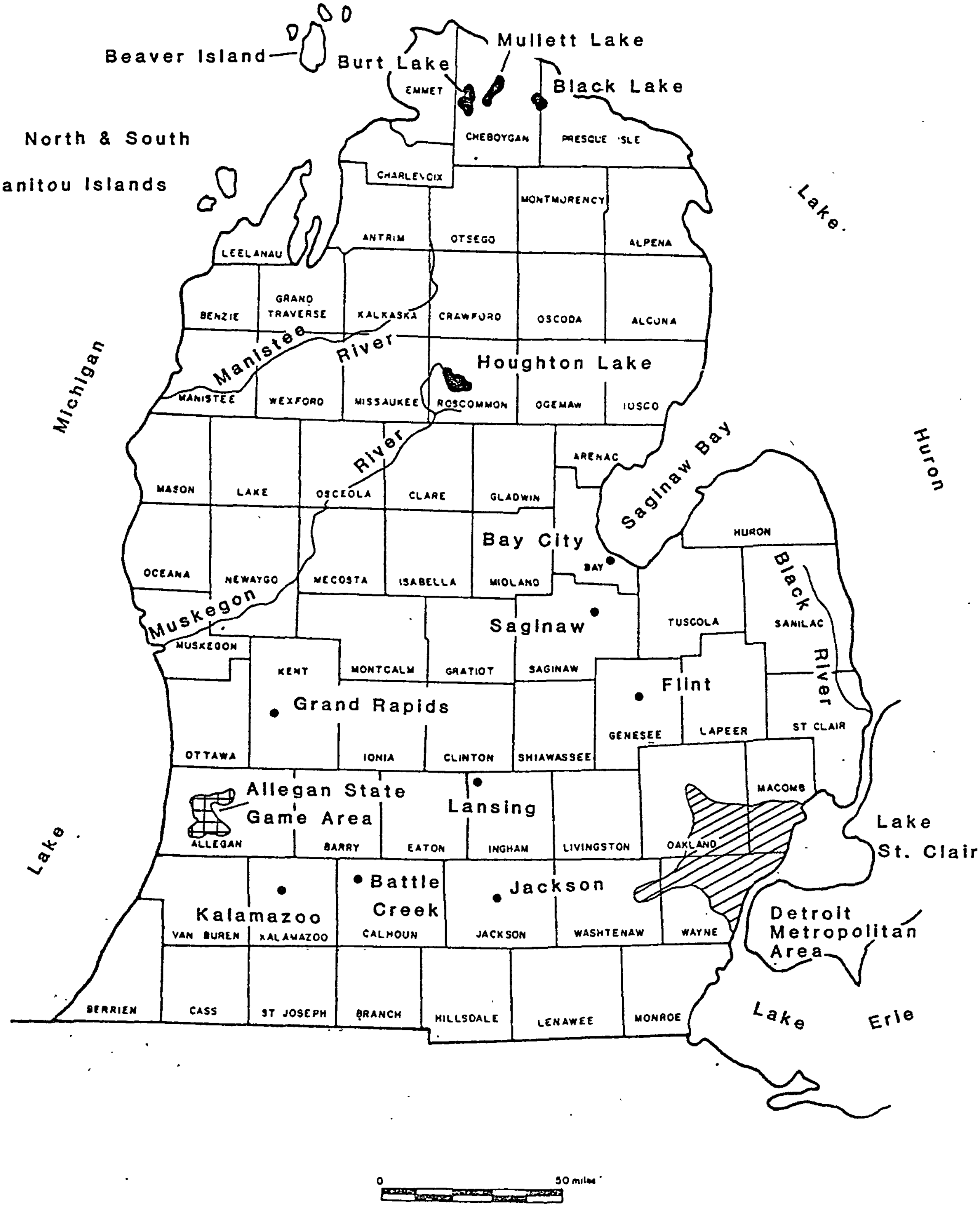

Figure 15. Reference map of Michigan showing county boundaries and selected geographic features.

water holding capacity of greater than 10.25" in the upper three feet of the soil and are less than 5% forested. Pixels with radiant temperatures greater than 76 degrees F at 3:00 p.m. (Figure 14) also correlate with urban and agricultural areas of low relief and high water holding capacity. The majority of the coolest temperatures (less than 68 degrees F) are in the forested areas of the northeastern part of Michigan where the land area is over 95% forested with a soil water holding capacity of less than 9".

The coolest (33 - 35 degrees F) and warmest (44 - 47 degrees F) pixel temperatures at 4:00 a.m. are shown in Figure 16. Cool temperatures were recorded in the north-central part of the state on a heavily forested plateau-like area of well-drained sandy soils with low water holding capacities. Within this cool region, the coldest radiant temperatures were associated with coniferous forests composed primarily of jack pine. Additionally, the effects of latitude and continentality may also contribute to the cold temperatures of this area. The linear series of cool pixels trending southwest from the Houghton Lake area corresponds with the upper Muskegon River valley and may result from cold air drainage. A similar situation in the upper Manistee River valley produced the pocket of cool temperatures south of Grand Traverse Bay in northwestern Michigan.

The warmest pixels over land at 4:00 a.m. are associated with areas of high soil water holding capacity, urban centers such as Detroit and Grand Rapids or inland lakes. Houghton Lake, for

CCCC
CCCC pixel temperatures 33° - 35° F.
CCCC
CCCC

WWWW
WWWW pixel temperatures 44° - 47° F.
WWWW
WWWW

Figure 16. Areas of minimum and maximum apparent temperatures at 4:00 a.m., June 25, 1979 from GOES thermal data.

example, had an apparent temperature as much as 10 degrees F warmer than its surroundings. The close proximity of Black, Burt, and Mullett Lakes in the northernmost part of the Lower Peninsula contributed to the warmer temperatures of the east-west trending Indian River lowland. The highest temperatures detected at 4:00 a.m. (greater than 57 degrees F) correspond to the shallow waters of Saginaw Bay, Lake St. Clair and Lake Erie (Figure 13).

The lowest average apparent temperatures (based on satellite observations at 3:00 p.m., 10:00 p.m., 4:00 a.m. and 10:00 a.m., June 24-25, 1979) are highly correlated with the deepest parts of Lakes Michigan and Huron indicating the high thermal inertia of these areas. Of the land areas, northeastern Michigan maintained the coolest average temperatures during the observation period probably as a result of its high percentage of forest land, rugged topography and low soil water holding capacities. The highest average apparent temperatures are associated with the city of Detroit and east-central Monroe county. Warm average temperatures are also found in central Michigan's Saginaw lowland which is dominated by agricultural land use, has minimal forest cover and very low local relief.

The greatest diurnal (3:00 p.m. - 4:00 a.m.) apparent temperature changes (greater than 37 degrees F) occurred primarily in the agricultural land of south central Michigan. Temperature changes of less than 28 degrees F were associated with many coastal areas, the rugged, forested northeastern part of the Lower Peninsula, the areas of numerous inland lakes in Barry and Oakland counties, and Houghton Lake and its neighboring wetlands.

C. Contouring Temperature Difference Images

Automatic machine contouring of temperature change digital files provides a valuable analysis technique which is particularly useful for studying thermal patterns and gradients. Temperature difference files record the absolute difference, pixel for pixel, between thermal data files recorded at two separate times. Thermal gradients can be studied using this technique by the repetitive display of multiple contoured images of increasing temperature thresholds. Although a detailed assessment of this technique was not undertaken, a sample data set is included herewith to illustrate this data processing capability.

A temperature difference file was prepared by calculating the absolute thermal flux between the 3:00 p.m. and 11:00 p.m. GOES data sets. This file was then thresholded at various temperature values (e.g. Figures 17-19) to display regions of different temperature change. The contours shown in Figure 17 encompass areas of more than 8 degrees F temperature change (3:00 p.m. to 11:00 p.m.) and depict the land-water interface fairly well. Note especially that Beaver and North and South Manitou Islands in northern Lake Michigan are resolved at this temperature threshold. In Figure 18, areas of more than 20 degrees F temperature difference are bounded by the contour lines. At this threshold, several inland areas are depicted which may be associated with lakes and/or wetlands. Relative to the 8 degree F

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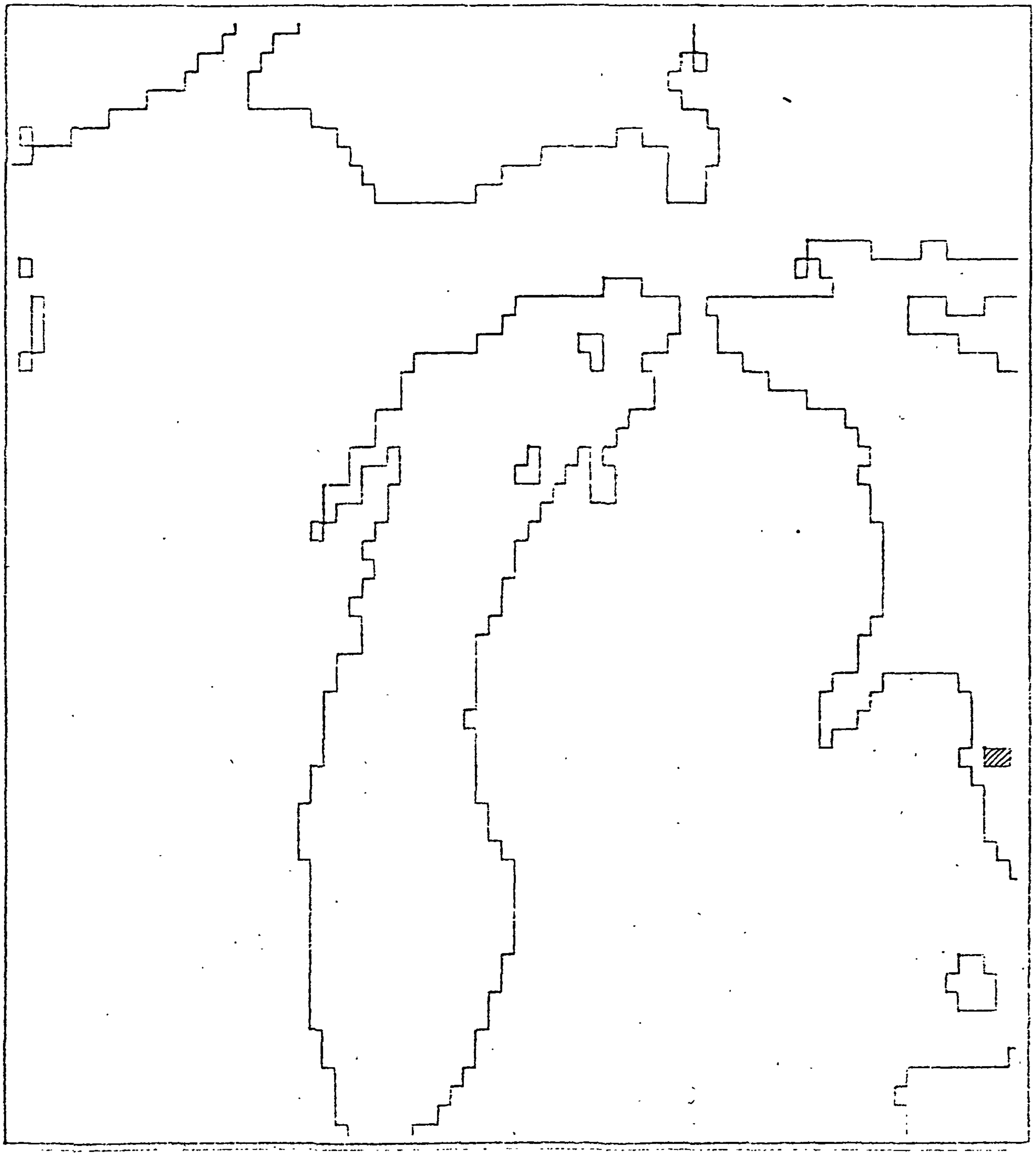

Figure 17. 8° F. temperature difference boundary from GOES thermal data acquired 3:00 p.m. and 11:00 p.m., June 24, 1979.

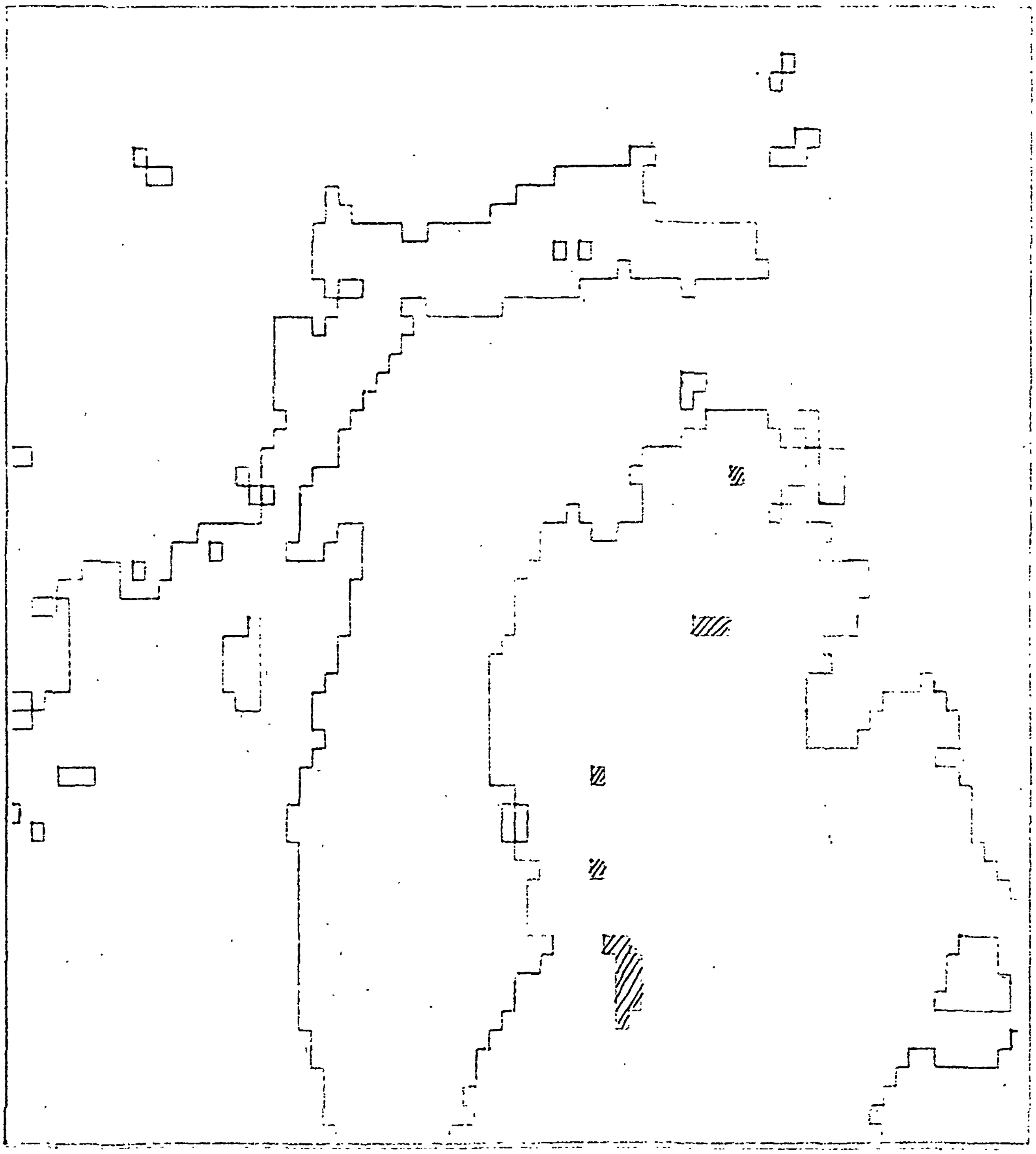

Figure 18. 20° F. temperature difference boundary from GOES thermal data acquired 3:00 p.m. and 11:00 p.m., June 24, 1979.

difference image, the more restricted areal expansion of Saginaw Bay, Lake St. Clair and Lake Erie at this 20 degree F threshold compared to Lakes Michigan and Huron indicates that these shallow water bodies are bounded by steeper thermal gradients. This condition is even more pronounced in the 24 degree F difference image (Figure 19). At this threshold, mesoscale regions of varying thermal flux become apparent within Michigan's land mass. For example, western and southwestern Michigan as a whole seems to have a higher thermal inertia than the central and southeastern parts of the state but also displays more intra-regional variability. This western region of fluctuating thermal differences can also be discriminated in the 3:00 p.m. - 4:00 a.m. temperature change image discussed previously (Figure 13).

V. SIGNIFICANT FREEZE EVENTS IN 1981

In 1981 two significant freeze events occurred during April, the most serious of which occurred on April 21. These freezes seriously affected fruit production in the state. Minimum temperatures which occurred at 61 weather stations during the two freeze events are shown on Table 2. To document the environmental change at one location, hourly data were collected at the MSU weather station.

The variables measured were:

1. Screen temperature (1.5 m)
2. Outside temperature (1.5 m)

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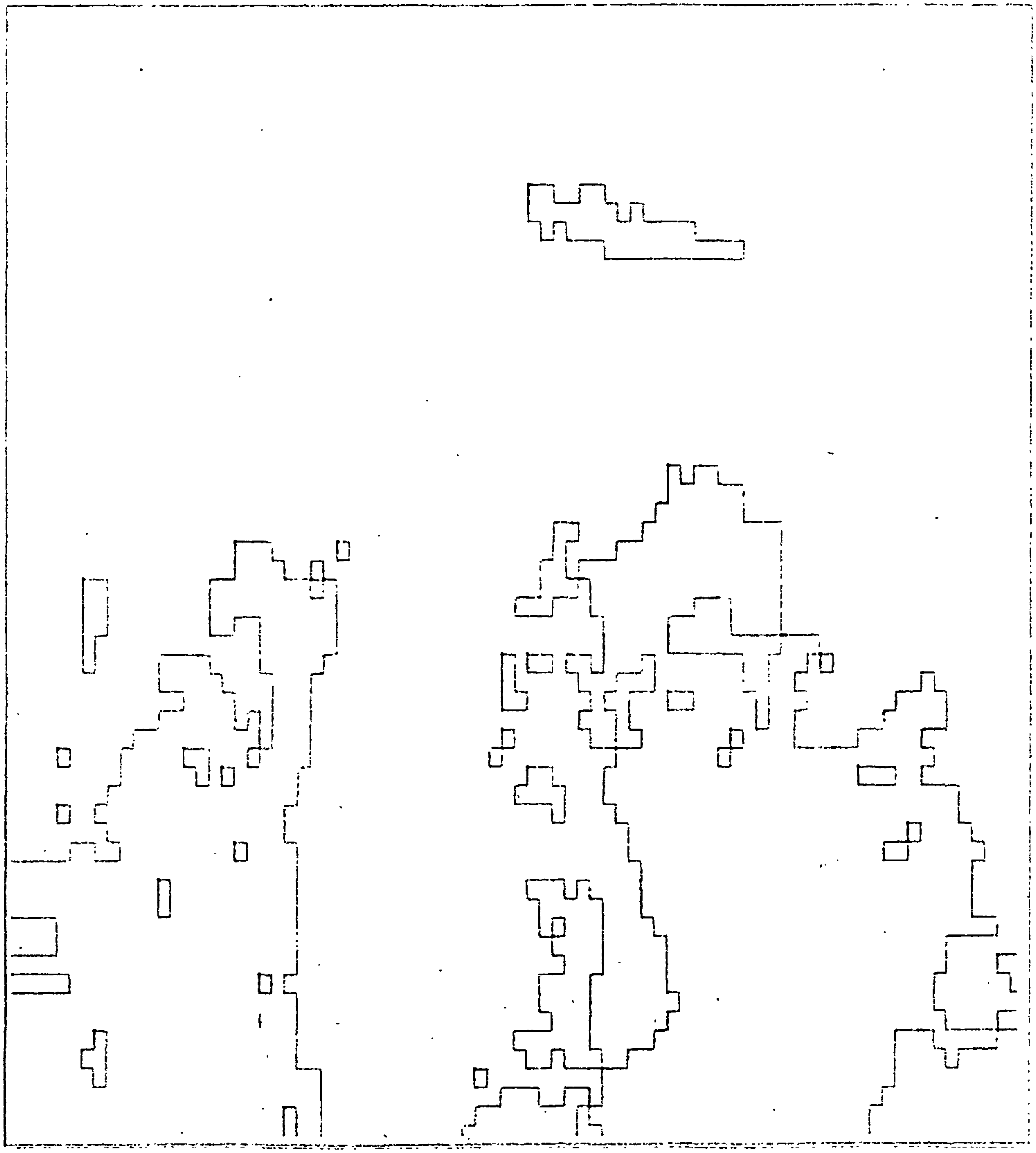

Figure 19. 24° F. temperature difference boundary from GOES thermal data acquired 3:00 p.m. and 11:00 p.m., June 24, 1979.

Table 2. Selected April minimum temperatures in Michigan (1.5m).

STATION	APRIL 15, 1981 MINIMUM	APRIL 21, 1981 MINIMUM
Alpena	23	19
Detroit	29	25
Escanaba	26	26
Flint	26	25
Grand Rapids	26	27
Houghton	22	24
Houghton Lake	23	19
Jackson	30	28
Lansing	26	24
Marquette	17	17
Muskegon	25	27
Pellston	15	16
Saginaw Airport	MM	25
Sault Ste. Marie	18	16
Traverse	21	16
Glendora	28	28
Sodus	30	28
Watervliet	28	24
Paw Paw	28	28
Grand Junction	26	24
Fenville	27	27
Coldwater	29	25
Allendale	26	29
Hudsonville	27	29
Holland	24	28
Nunica	23	25
Mears	25	25
Belding	23	26
Clarksville	25	27
Peach Ridge	25	27
Kent City	25	26
Graham Station	25	29
Edmore	20	24
Grant	23	27
Fremont	23	26
Berrien Springs	Msg.	30
MSU Horticultural Farm	25	24
Bad Axe	25	20
Bear Lake	24	20

Table 2. Con't.

STATION	APRIL 15, 1981 MINIMUM	APRIL 21, 1981 MINIMUM
Beulah	24	22
Empire	20	20
Imlay City	26	21
Kewadin	22	22
Lake City	18	16
Lake Leelanau	22	21
Lexington	26	MM
Ludington	23	22
Montrose	24	19
N.W. Horticultural	22	22
Old Mission	20	22
Ossineke	22	20
Rogers City	21	20
Saginaw Valley	22	21
Saline	26	21
Sandusky	25	23
Standish	22	19
Toledo	27	25
Unionville	26	24
Washington	30	25
Riverside	--	27
Keeler	--	27

3. Soil moisture (5 cm)

4. Relative humidity (%)

5. Light intensity (kj/m)

6. Wind velocity (mph)

An attempt made to measure radiation during this period failed due to technical problems with the device, but radiation was successfully measured during two successive spring freeze events.

Plots of each variable during the April 20-21 freeze event are shown in Figures 20-25. In conjunction with this freeze event, an attempt was made to procure GOES imagery to validate the impact of the freeze and to assist in the interpretation of the physical model and to examine the sequence of thermal events as the freeze approached. Unfortunately we were informed by NESS that we could no longer obtain GOES imagery but could only obtain GOES data from the historical archiving system at Wisconsin (see Data Access Difficulties section). This led to great disappointment and discouragement because the image processing system we developed was based on the GOES format provided by NESS. We are still hopeful that this problem can be resolved as we have spent considerable time and effort developing this component of the system.

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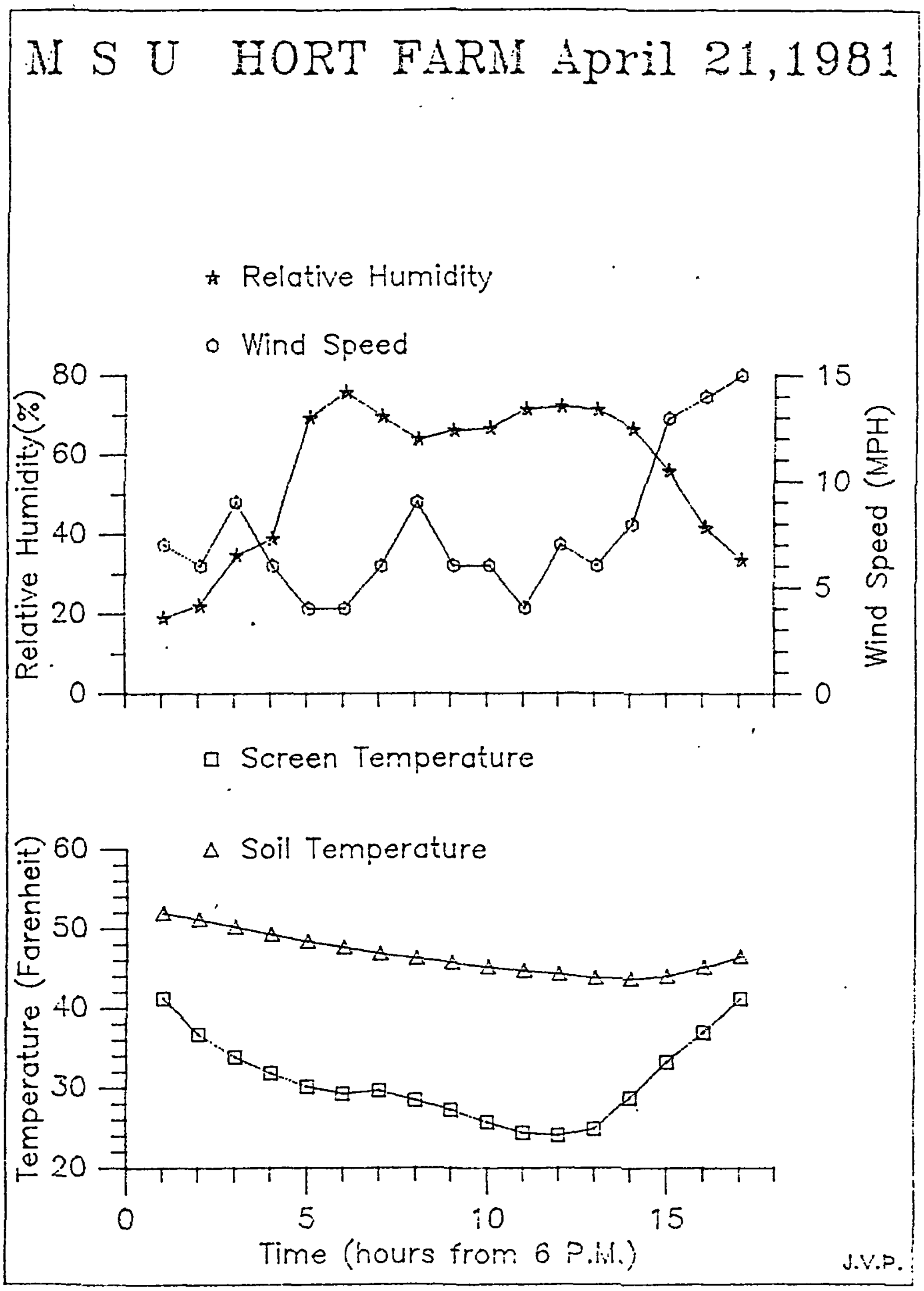

VI. PHYSICAL MODEL AND SPECIFIC TASK DISCUSSION

Task I: From data bases collected, make sample runs of the P-model and/or concept and present observations/conclusions as to results.

Data to characterize the micrometeorological conditions during freezes in Michigan were collected on different spring nights. The measurements included temperature gradient, radiation, wind movement and indication of direction, dew point and soil temperature. This data has been provided to Florida for general analysis.

Our conclusions from the data are the following:

1. The radiation, which is such an important driving force in affecting minimum temperatures, fell in the same range of readings that one might expect over the peninsula of Florida during freeze conditions.

2. The temperature drops observed, although limited in number, have indicated that temperature drops were within the range that might be expected during Florida freezes.

3. Recently, a thesis in Agricultural Engineering (Levitt, 1981) has characterized the statistical types of freeze conditions which tend to verify earlier work by Van Den Brink, (1981), showing approximately 60% of Michigan freezes were radiation, and 24% were advection and 16% were due to both conditions. Again, these general characterizations which show freeze

conditions on a broad scale are similar to the types of general freeze conditions from the statistical standpoint that Florida receives.

4. Persistence of temperature differences between stations seems to exist. MOSS product analysis has been done that indicates there are good correlations between key (weather forecasting sites) locations and agricultural weather measuring locations.

5. Analysis from Phase I of field measurements with an airplane and with temperature instrumentation mounted in moving vehicles provided important data. This information showed that there is clearly cold air drainage with large temperature differences down moderate slopes. Also, the high degree of wind variability and its affect mixing the atmospheric boundary layer were experienced in Michigan as in Florida.

The main difference would be the fact that Michigan's important freezes occur in the spring. Thus, the soil heat flux might be expected to be different from Florida during fall events. Analysis of this effect would show, however, that there has to be warming periods prior to the freeze for nearly all conditions during later spring freeze events. Thus, for many of the most significant freezes, the soil would be considerably warmer than air in a manner similar to that found in Florida. The clear exception would be severe early spring freezes when frozen ground would complicate the physical model.

Task II: Give observations/conclusions as to the applicability of the S-Model and/or concept from the data bases at the two areas.

Before the data bases could even be examined, extensive geometric corrections were required. This was accomplished during Phase I. The whole system for more accurate analysis was transferred over to the ERDAS System in the Center for Remote Sensing during Phase II. The accuracy of the data was again shown to be adequate during Phase I, but during Phase II additional analysis was conducted. Figures 5 and 6 show output of various temperature ranges from the printer on the ERDAS System. Certain patterns, as well as detailed temperature information are clearly portrayed. To enhance analysis, a windowing technique was developed that located the exact GOES element with weather stations for which hourly data was collected. (Figure 8 shows systematically where these airport collecting stations were located). This technique gave us greater capability to locate exact pixels with stations. Figure 9, shows temperature differences observed for those stations at 4:00 a.m. Clearly, the accuracy is shown to be sufficiently good for dependable real time temperature information, as well as for use in developing the S-Model.

Persistence of temperature by location existed throughout the night. With the enhanced capabilities for color display, by smaller temperature increments on the ERDAS system, more detailed persistence patterns were able to be evaluated (Figure 10). This evaluation clearly showed that the coldest temperatures, for example, occurred at specific locations early in the night and continued to be the coldest temperature locations throughout the night. Thus, there was every indication that patterns would persist throughout a night.

Of extreme importance to the statistical model is the persistance of similar patterns from night to night. This would clearly be expected if the temperatures are strongly dependent on permanent surface vegetation and soil characteristics. For this analysis, a variety of data bases were digitized on the same scale as the GOES data. (See Figure 1-4). As a result of an extensive visual analysis, it is clear that the temperature patterns can be specifically related to surface features or combinations of surface features. The conclusion is that one would anticipate the patterns to be a function of surface conditions, and therefore, would persist under similar meteorological conditions.

Task III: Identify and discuss any peculiarities of the Michigan and Pennsylvania sites which might limit conclusions from being applied elsewhere in the United States as a general case.

It has become increasingly clear that there are considerable similarities between Michigan conditions and Florida conditions. The significance of the peninsula and its effect on temperatures inland have been shown to exist for both locations. The advantage in geometrically correcting data and overlaying scenes are clearly easiest when one has a temperature discontinuity as it occurs between water and land for a peninsula.

Also, Michigan has a slightly more rugged terrain, from a meteorological standpoint, than Florida. Thus, there are terrain features that have a significant impact on temperature regimes. However, many of the surface characteristics, such as bare soil, pastures, and forested areas exist in both states.

Task IV: Give recommendations as to whether the concept should be pursued further, and if so, what specific studies should be performed.

Clearly, the conceptual theme of using GOES data to aid in characterizing the thermal regimes in a state both in non-real and real time, need to be further pursued. The data proves to be very accurate, particularly during radiation freeze events and correlations of temperature patterns with general surface conditions which indicates more information could be obtained.

VII. DATA ACCESS DIFFICULTIES

It is appropriate to discuss some of the problems encountered in obtaining satellite data as it relates to the process of technology transfer. One of the objectives of our involvement with the project was to develop capabilities relative to processing GOES thermal imagery.

After considerable difficulty in obtaining the Michigan GOES imagery from NESS, we finally obtained a readable data set. A system of processing the information was developed based on the NESS format and tape characteristics. It required five or six tries to get usable information. In April 1981 a request was made to obtain data for both the freeze events that we had been anticipating. The data for April 15 was requested and sent. It, however, was not Michigan data nor did it conform to the range of data expected. The request for data for the April 21 freeze event was denied due to a change in policy and we were informed that we had to obtain the data from Wisconsin. Since we had previously attempted to obtain archived data from this source we were discouraged.

One of our objectives was to examine GOES thermal imagery over a growing season. We requested and paid for the imagery. After several months a further attempt was made to obtain the information. It finally arrived with no documentation. After many attempts to read the data on our own, we requested assistance again. Some documentation arrived but it still did not seem to help. The format provided was inadequate and the data was provided in 24 bit binary.

Since the project related directly to the access and processing of GOES imagery we were surprised at the difficulty in obtaining this information. We expected that we would be assisted rather than discouraged because we felt this was part of the technology transfer process to involve other areas of the U.S.

After these difficulties we are still convinced that our pursuit of analysis of GOES thermal imagery and its application to Michigan has been and will continue to be rewarding. We trust that NASA and NESS will recognize the problem of data availability and will strive to assist users who want to use the data to benefit a state. We look forward to future assistance in this area.

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Appendix VIII

Climate of Pennsylvania

DEPARTMENT OF COMMERCE
OCEANIC AND ATMOSPHERIC ADMINISTRATION
ENVIRONMENTAL DATA SERVICE

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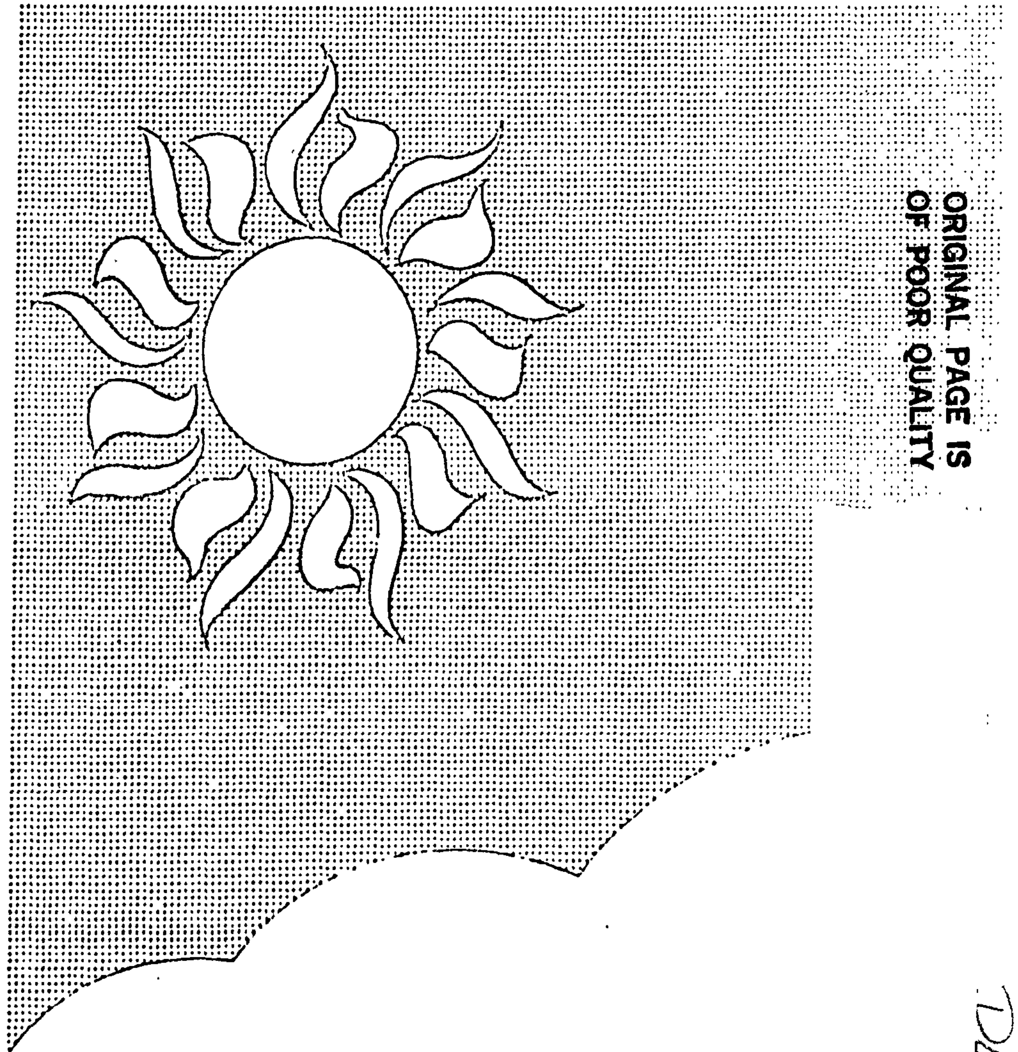
Daniel B. Mitchell
Director, National Climatic Center

CLIMATOGRAPHY OF THE UNITED STATES NO. 60

Climate of Pennsylvania



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This publication is a modified version of "Climatography of the United States, 060, Climates of the States," which was first issued by the National Oceanic and Atmospheric Administration climatologists assigned to the various States. It is one of several in the series, "Periodic Summarization of Climate," (PERSUM), prepared by the National Climatic Center (NCC) designed to provide selected climatic information of general interest to a broad spectrum of users.

The staff of the National Climatic Center expresses its thanks to those State Climatologists, who, over the years, have made significant and lasting contributions toward the development of this very useful series. Some additions and deletions to the earlier issues have been made in the interest of standardization, and to reflect current programs within the NCC.

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CLIMATE OF PENNSYLVANIA

INTRODUCTION

This publication consists of a narrative that describes some of the principal climatic features and a number of climatological summaries for stations in various geographic regions of the State. The detailed information presented should be sufficient for general use; however, some users may require additional information.

The National Climatic Center (NCC) located in Asheville, NC is authorized to perform special services for other government agencies and for private clients at the expense of the requester. The amount charged in all cases is intended solely to defray the expenses incurred by the government in satisfying such specific requests to the best of its ability. It is essential that requesters furnish the NCC with a precise statement describing the problem so that a mutual understanding of the specifica'ons is reached.

Unpublished climatological summaries have been prepared for a wide variety of users to fit specific applications. These include wind and temperature studies at airports, heating and cooling degree day information for energy studies, and many others. Tabulations produced as by-products of major projects often contain information useful for unrelated special problems. A copy of each tabulation on file at the Center may be obtained for the cost of duplication.

The Means and Extremes of meteorological variables in the Climatography of the U.S. No.20 series are recorded by observers in the cooperative network. The Normals, Means and Extremes in the Local Climatological Data, annuals are computed from observations taken by National Weather Service personnel who are generally located at airports.

ORIGINAL PAGE IS OF POOR QUALITY

CLIMATE OF PENNSYLVANIA

TOPOGRAPHIC FEATURES - The erratic course of the Delaware River is the only natural boundary of Pennsylvania. All others are arbitrary boundaies that do not conform to physical features. Notable contrasts in topography, climate, and soils exist. Within this 45,126-square-mile area lies a great variety of physical land forms of which the most notable is the Appalachian Mountain system composed of two ranges; the Blue Ridge and the Allegheny. These mountains divide the Commonwealth into three major topographical sections. In addition, two plains areas of relatively small size also exist, one in the southeast and the other in the northwest.

In the extreme southeast is the Coastal Plain situated along the Delaware River and covering an area 50 miles long and 10 miles wide. The land is low, flat, and poorly drained, but has been improved for industrial and commercial use because of its proximity to ocean transportation via the Delaware River. Philadelphia lies almost in the center of this area.

Bordering the Coast. Plain and extending 60 to 80 miles northwest to the Blue Ridge is the Piedmont Plateau, with elevations ranging from 100 to 500 feet and including rolling or undulating uplands, low hills, fertile valleys, and well drained soils. These features, combined with the prevailing climate, have aided this area in becoming the leading agricultural section of the State. Good pastures, productive land, and short distances to markets have resulted in dairy farming becoming one of the leading agricultural activities. Another activity is the growing of fruit, primarily apples and peaches. Gentle hillside slopes provide an excellent place for fruit trees, as cold air drainage helps to prevent unseasonable freezing temperatures on these slightly elevated lands. The area has many orchards, with Adams County leading all others within the region in the production of apples. The climate and soils in the Lancaster County area are especially well suited for the growing of cigar leaf tobacco, as is pointed up by the fact that Pennsylvania is the leading producer of cigar leaf of any type in the Nation.

Just northwest of the Piedmont and between the Blue Ridge and Allegheny Mountains is the Ridge and Valley Region, in which forested ridges alternate with fertile and extensively farmed valleys. Vegetables, grown primarily for canning, are the leading crop. This has led to a well developed canning industry, which is concentrated in the middle Susquehanna Valley. The Ridge and Valley Province is 80 to 100 miles wide and characterized by parallel ridges and valleys oriented northeast-southwest. The mountain ridges vary from 1,300 and 1,600 feet above sea level, with local relief 600 to 700 feet.

North and west of the Ridge and Valley Region and extending to the New York and Ohio borders is the area known as the Allegheny Plateau. This is the largest natural division of the State and occupies more than half the area. It is crossed by many deep narrow valleys and drained by the Delaware, Susquehanna, Allegheny, and Monongahela River systems. Elevations are generally 1,000 to 2,000 feet; however, some mountain peaks extend to 3,000 feet. The area is heavily wooded and among the most rugged in the State. Numerous lakes and swamps characterize this once glaciated area, creating a very picturesque landscape; this is particularly outstanding in the more northerly counties. The combination of lakes and forests at elevations high enough to keep summer temperatures comfortable and its location close to heavily populated cities have made the Pocono Mountain area a leading tourist and recreational center.

Bordering Lake Erie is a narrow 40-mile strip of flat, rich land three to four miles wide called the Lake Erie Plain. Fine alluvial soils and favorable climate permit intensive vegetable and fruit cultivation, which is typical of the much larger area surrounding Lake Erie.

Eastern and central Pennsylvania drain into the Atlantic Ocean, while the western portion of the State lies in the Ohio River Basin, except for the Lake Erie Plain in the northwest, which is drained by a number of small streams into Lake Erie. The Delaware River, which forms the eastern boundary, drains the eastern portion and flows into Delaware Bay. The Susquehanna River drains the central portion and flows into Chesapeake Bay. In the western portion, the Allegheny and the Monongahela Rivers have their confluence at Pittsburgh to form the Ohio River.

Floods may occur during any month of the year in Pennsylvania, although they occur with greater frequency in the spring months of March and April. They may result from heavy rains during any season. Generally, the most widespread flooding occurs during the winter and spring when associated with heavy rains, or heavy rains combined with snowmelt. Serious local flooding sometimes results from ice jams during the spring thaw. Heavy local thunderstorm rains cause severe flash flooding in many areas. Storms of tropical origin sometimes deposit flood-producing rains, especially in the eastern portion of the State.

Floods may be expected at least once in most years. For instance, flood stage at Pittsburgh is exceeded on the average of 1.3 times per year, based on the long-term record. However, floods of notable severity and magnitude for the State occur about once in eight years.

GENERAL CLIMATIC FEATURES - Pennsylvania is generally considered to have a humid continental type of climate, but the varied physiographic features have a marked effect on the weather and climate of the various sections within the State. The prevailing westerly winds carry most of the weather disturbances that affect Pennsylvania from the interior of the continent, so that the Atlantic Ocean has only limited influence upon the climate of the State. Coastal storms do, at times, affect the day-to-day weather, especially in eastern sections. It is here that storms of tropical origin have the greatest effect within the State, causing floods in some instances.

Throughout the State temperatures generally remain between 0° and 100°F and average from near 47°F annually in the north-central mountains to 57°F annually in the extreme southeast. The highest temperature of record in Pennsylvania of 111°F was observed at Phoenixville July 9 and 10, 1936, while the record low of -42°F occurred at Smethport January 5, 1904.

Summers are generally warm, averaging about 68°F along Lake Erie to 74°F in southeastern counties. High temperatures, 90°F or above, occur on an average of 10 to 20 days per year in most sections; but occasionally southeastern localities may experience a season with as many as 30 days, while the extreme northwest averages as few as four days annually. Only rarely does a summer pass without excessive temperatures being reported somewhere in the State. However, there are places such as immediately adjacent to Lake Erie and at some higher elevations where readings of 100°F have never been recorded. Daily temperatures during the warm season usually have a range of about 20°F over much of the State, while the daily range in winter is several degrees less. During the coldest months temperatures average near the freezing point with daily minimum readings sometimes near 0°F or below. Freezing temperatures occur on the average of 100 or more days annually with the greatest number of occurrences in mountainous regions. Records show that freezing temperatures have occurred somewhere in the State during all months of the year and below 0°F readings from November to April, inclusive.

Precipitation is fairly evenly distributed throughout the year. Annual amounts generally range between 34 to 52 inches, while the majority of places receive 38 to 46 inches. Greatest amounts usually occur in spring and summer months, while February is the driest month, having about two inches less than the wettest months. Precipitation tends to be somewhat greater in eastern sections due primarily to coastal storms which occasionally frequent the area. During the warm season these storms bring heavy rain, while in winter heavy snow or a mixture of rain and snow may be produced. Thunderstorms, which average between 30 to 35 per year, are concentrated in the warm months and are responsible for most of the summertime rainfall, which averages from 11 inches in the northwest to 13 inches in the east. Occasionally dry spells may develop and persist for several months during which time monthly precipitation may total less than one-quarter inch. These periods almost never affect all sections of the State at the same time, nor are they confined to any particular season of the year. Winter precipitation is usually three to four inches less than summer rainfall and is produced most frequently from northeastward-moving storms. When temperatures are low enough these storms sometimes cause heavy snow which may accumulate to 20 inches or more. Annual snowfall ranges between wide limits from year to year and place to place. Some years are quite light as snowfall may total less than ten inches while other years may produce upwards to 100 inches, mostly in northern and mountainous areas. Annual snowfall averages from about 20 inches in the extreme southeast to 90 inches in parts of McKean County. Measurable snow generally occurs between November 20 and March 15, although snow has been observed as early as the beginning of October and as late as May, especially in northern counties. Greatest monthly amounts usually fall in December and January; however, greatest amounts from individual storms generally occur in March as the moisture supply increases with the annual march of temperature.

As mentioned earlier, hurricanes or low pressure systems with a tropical origin seldom affect the State. Damages as a result of hurricane winds are rare and usually confined to extreme eastern portions. However, nature's most violent storm, the tornado, does occur in Pennsylvania. At least one tornado has been noted in almost all counties since the advent of severe storms records in 1854. On the average, six or seven tornadoes are observed annually in Pennsylvania, and the State ranks 27th nationally. June is the month of highest frequency, followed closely by July and August. Principal areas of tornado concentration are in the extreme northwest, the Southwest Plateau, and the Southeastern Piedmont. The frequency in the latter area is the highest in the State per square mile, similar to what is observed in portions of the Midwestern United States. Many of the tornadoes in Pennsylvania have caused relatively minor damages. However, several have claimed lives and dealt severe local economic setbacks. The most destructive activity occurred June 23, 1944, when three tornadoes raked the southwestern portion of the Commonwealth, killing 45 persons, injuring another 362, and causing over $2 million in property damage.

More detailed information is given for each of the four rather distinct climatic areas of the state.

THE SOUTHEASTERN COASTAL PLAIN AND PIEDMONT PLATEAU - In this region the summers are long and at times uncomfortably hot. Daily temperatures reach 90°F or above on the average of 25 days during the summer season; however, readings of 100°F or above are comparatively rare. From about July 1 to the middle of September this area occasionally experiences uncomfortably warm periods, four to five days to a week in length, during which light wind movement and high relative humidity make conditions oppressive. In general, the winters are comparatively mild, with an average of less than 100 days with minimum temperatures below the freezing point. Temperatures 0°F or lower occur at Philadelphia, on an average, one winter in four, and at Harrisburg one in three. The freeze-free season averages 170 to 200 days.

Average annual precipitation in the area ranges from about 30 inches in the lower Susquehanna Valley to about 46 in Chester County. Under the influence of an occasional severe coastal storm, a normal month's rainfall, or more, may occur within a period of 48 hours. The average seasonal snowfall is about 30 inches, and fields are ordinarily snow covered about one-third of the time during the winter season.

THE RIDGE AND VALLEY PROVINCE - This region does not have a true mountain type of climate, but it does have many of the characteristics of such a climate. The mountain-and-valley influence on the air movements causes somewhat greater temperature extremes than are experienced in the southeastern part of the State where the modifying coastal and Chesapeake Bay influence hold them relatively constant, and the daily range of temperature increases somewhat under the valley influences.

The effects of nocturnal radiation in the valleys and the tendency for cool air masses to flow down them at night result in a shortening of the growing season by causing freezes later in spring and earlier in fall than would otherwise occur. The growing (freeze-free) season in this section is longest in the middle Susquehanna Valley, where it averages about 165 days, and shortest in Schuylkill and Carbon Counties, averaging less than 130 days.

The annual precipitation in this area has a mean value of three or four inches more than in the southeastern part of the State, but its geographic distribution is less uniform. The mountain ridges are high enough to have some deflecting influence on general storm winds, while summer showers and thunderstorms are often shunted up the valleys.

Seasonal snowfall of the Ridge and Valley Province varies considerably within short distances. It is greatest in Somerset County, averaging 88 inches in the vicinity of Somerset, and least in Huntingdon, Mifflin, and Juniata Counties, averaging about 37 inches.

THE ALLEGHENY PLATEAU - This region has a continental type of climate, with changeable temperatures and more frequent precipitation than other parts of the State. In the more northerly sections the influence of latitude, together with higher elevation and radiation conditions, serve to make this the coldest area in the State. Occasionally, winter minimum temperatures are severe. The daily temperature range is fairly large, averaging about 20° in midwinter and 26° in midsummer. In the southern counties the daily temperature range is a few degrees higher and the same may be said of the normal annual range. Because of the rugged topography the freeze-free season is variable, ranging between 130 days in the north to 175 days in the south.

Annual precipitation has a mean of about 41 inches, ranging from less than 35 inches in the northern parts of Tioga and Bradford Counties to more than 45 inches in parts of Crawford, Warren, and Wayne Counties. The seasonal snowfall averages 54 inches in northern areas, while southern sections receive several inches less. Fields are normally snow covered three-fourths of the time during the winter season. With rapidly flowing streams in the Ohio Drainage system (except the Monongahela), it is fortunate that this part of the State is not subject to torrential rains such as sometimes occur along the Atlantic slope. Although average annual precipitation is about equal to that for the State as a whole, it usually occurs in smaller amounts at more frequent intervals; 24-hour rains exceeding 2.5 inches are comparatively rare.

THE LAKE ERIE PLAIN - This region has a unique and agriculturally advantageous climate typical of the coastal areas surrounding much of the Great Lakes. Both in spring and autumn the lake water exerts a retarding influence on the temperature regime and the freeze-free season is extended about 45 days. In the autumn this prevents early freezing temperatures, which is a critical factor in the growing of fruit and vegetables.

Annual precipitation totals about 34.5 inches, which is fairly evenly distributed throughout the year. Snowfall exceeds 54 inches per year, with heavy snows sometimes experienced late in April.

STATIONS IN THE CURRENT SERIES OF CLIMATOGRAPHY OF THE U.S. NO. 20:

PENNSYLVANIA	PERIOD	LAT. (N)	LONG. (W)	ELEV. (FT.)
Carlisle	1951-74	40°13'	77°12'	465
Chambersburg 1 ESE	1951-74	39°56'	77°38'	640
Claysville 3 W	1951-70	40°07'	80°28'	1000
Donora 1 SW	1951-74	40°10'	79°52'	762
Ephrata	1951-74	40°10'	76°10'	485
Franklin	1951-74	41°23'	79°49'	987
Gettysburg	1951-74	39°50'	77°14'	500
Holtwood	1951-74	39°50'	76°20'	187
Jamestown 2 NW	1951-74	41°30'	80°28'	1050
Johnstown	1951-74	40°20'	78°55'	1214
Lawrenceville	1951-73	42°00'	77°08'	1000
Marcus Hook	1951-74	39°49'	75°25'	12
Montrose	1951-74	41°50'	75°52'	1560
Phoenixville 1 E	1951-74	40°07'	75°30'	105
Port Clinton	1951-74	40°35'	76°02'	450
Reading 3 N	1951-72	40°22'	75°56'	270
Ridgway	1951-74	41°25'	78°45'	1360
State College	1951-74	40°48'	77°52'	1170
Stroudsburg	1951-74	41°00'	75°11'	480
Towanda 1 ESE	1951-74	41°45'	76°25'	745
Warren	1951-74	41°51'	79°08'	1280
York 3 SSW Pump Sta	1951-74	39°55'	76°45'	390

STATIONS FOR WHICH LOCAL CLIMATOLOGICAL DATA, ANNUAL, IS PREPARED:

PENNSYLVANIA	PERIOD	LAT. (N)	LONG. (W)	ELEV. (FT.)
Allentown	1976	40°39'	75°26'	387
Avoca	1976	41°20'	75°44'	930
Erie	1976	42°05'	80°11'	731
Harrisburg	1976	40°13'	76°51'	338
Philadelphia	1976	39°53'	75°15'	5
Pittsburgh AP	1976	40°30'	80°13'	1137
Pittsburgh Fed. Bldg.	1976	40°27'	80°00'	747
Williamsport	1976	41°15'	76°55'	524

CLIMATOLOGICAL SUMMARY

CARLISLE, PA — 1951 - 1974 — 40° [illegible] N — 77° 12' W — 468 FT.

Month	Temperature (°F): Means, Extremes, Mean number of days; Precipitation totals (inches): Snow, Sleet; Mean number of days
JAN	[illegible]
FEB	[illegible]
MAR	[illegible]
APR	[illegible]
MAY	[illegible]
JUN	[illegible]
JULY	[illegible]
AUG	[illegible]
SEPT	[illegible]
OCT	[illegible]
NOV	[illegible]
DEC	[illegible]
YEAR	[illegible]

CHAMBERSBURG 1 ESE, PA — 1951 - 1974 — 39° [illegible] N — 77° 38' W — 640 FT.

Month	Temperature (°F): Means, Extremes, Mean number of days; Precipitation totals (inches): Snow, Sleet; Mean number of days
JAN	[illegible]
FEB	[illegible]
MAR	[illegible]
APR	[illegible]
MAY	[illegible]
JUN	[illegible]
JULY	[illegible]
AUG	[illegible]
SEPT	[illegible]
OCT	[illegible]
NOV	[illegible]
DEC	[illegible]
YEAR	[illegible]

CLAYSVILLE 3 W, PA — 1951 - 1970 — 40° [illegible] N — 80° 28' W — 1000 FT.

Month	Temperature (°F): Means, Extremes, Mean number of days; Precipitation totals (inches): Snow, Sleet; Mean number of days
JAN	[illegible]
FEB	[illegible]
MAR	[illegible]
APR	[illegible]
MAY	[illegible]
JUN	[illegible]
JULY	[illegible]
AUG	[illegible]
SEPT	[illegible]
OCT	[illegible]
NOV	[illegible]
DEC	[illegible]
YEAR	[illegible]

* ALSO ON EARLIER DATES

CLIMATOLOGICAL SUMMARY

DONORA 1 SW, PA — 1951 - 1974 — 40° 10' N — 79° 52' W — 762 FT.

Month	Temp. Means: Daily Maximum	Daily Minimum	Monthly	Extremes: Record Highest	Year	Day	Record Lowest	Year	Day	Mean No. of Days Max: 90° and above	32° and below	Min: 32° and below	0° and below	Precip. Mean	Greatest Monthly	Year	Greatest Daily	Year	Day	Snow, Sleet: Mean	Maximum Monthly	Year	Greatest Depth	Year	Day	Mean No. of Days: .10 or more	.50 or more	1.00 or more
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
JULY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
SEPT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
YEAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

EPHRATA, PA — 1951 - 1974 — 40° 10' N — 76° 10' W — 489 FT.

Month	Temp. Means: Daily Maximum	Daily Minimum	Monthly	Extremes: Record Highest	Year	Day	Record Lowest	Year	Day	Mean No. of Days Max: 90° and above	32° and below	Min: 32° and below	0° and below	Precip. Mean	Greatest Monthly	Year	Greatest Daily	Year	Day	Snow, Sleet: Mean	Maximum Monthly	Year	Greatest Depth	Year	Day	Mean No. of Days: .10 or more	.50 or more	1.00 or more
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
JULY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
SEPT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
YEAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

FRANKLIN, PA — 1951 - 1974 — 41° 23' N — 79° 49' W — 987 FT.

Month	Temp. Means: Daily Maximum	Daily Minimum	Monthly	Extremes: Record Highest	Year	Day	Record Lowest	Year	Day	Mean No. of Days Max: 90° and above	32° and below	Min: 32° and below	0° and below	Precip. Mean	Greatest Monthly	Year	Greatest Daily	Year	Day	Snow, Sleet: Mean	Maximum Monthly	Year	Greatest Depth	Year	Day	Mean No. of Days: .10 or more	.50 or more	1.00 or more
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
JULY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
SEPT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
YEAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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OF POOR QUALITY

CLIMATOLOGICAL SUMMARY

GETTYSBURG, PA — 1931 - 1974 — 39° 50' N — 77° 14' W — 500 FT.

MONTH	Temperature (°F) Means: Daily Maximum	Daily Minimum	Monthly	Extremes: Record Highest	Year	Day	Record Lowest	Year	Day	Mean Number of Days: Max 90° and above	Max 32° and below	Min 32° and below	Min 0° and below	Precipitation Totals (Inches): Mean	Greatest Monthly	Year	Greatest Daily	Year	Day	Snow, Sleet: Mean	Maximum Monthly	Year	Greatest Depth	Year	Day	Mean Number of Days: .10 or more	.50 or more	1.00 or more
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JULY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEPT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
YEAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	SEP [illegible]	[illegible]	[illegible]	DEC [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

HOLTWOOD, PA — 1931 - 1974 — 39° 50' N — 76° 20' W — 187 FT.

MONTH	Temperature (°F) Means: Daily Maximum	Daily Minimum	Monthly	Extremes: Record Highest	Year	Day	Record Lowest	Year	Day	Mean Number of Days: Max 90° and above	Max 32° and below	Min 32° and below	Min 0° and below	Precipitation Totals (Inches): Mean	Greatest Monthly	Year	Greatest Daily	Year	Day	Snow, Sleet: Mean	Maximum Monthly	Year	Greatest Depth	Year	Day	Mean Number of Days: .10 or more	.50 or more	1.00 or more
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JULY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEPT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
YEAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

JAMESTOWN 2 NW, PA — 1931 - 1974 — 41° [illegible] N — [illegible] W — 1030 FT.

MONTH	Temperature (°F) Means: Daily Maximum	Daily Minimum	Monthly	Extremes: Record Highest	Year	Day	Record Lowest	Year	Day	Mean Number of Days: Max 90° and above	Max 32° and below	Min 32° and below	Min 0° and below	Precipitation Totals (Inches): Mean	Greatest Monthly	Year	Greatest Daily	Year	Day	Snow, Sleet: Mean	Maximum Monthly	Year	Greatest Depth	Year	Day	Mean Number of Days: .10 or more	.50 or more	1.00 or more
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JULY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEPT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
YEAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

* ALSO ON EARLIER DATES

CLIMATOLOGICAL SUMMARY

JOHNSTOWN, PA — 1951 - 1974 — 40° 20' N — 78° 55' W — 1214 FT.

MONTH	TEMPERATURE (°F): MEANS (DAILY MAXIMUM, DAILY MINIMUM, MONTHLY)	EXTREMES (RECORD HIGHEST, YEAR, DAY, RECORD LOWEST, YEAR, DAY)	MEAN NUMBER OF DAYS (MAX, MIN)	PRECIPITATION TOTALS (INCHES): MEAN, GREATEST MONTHLY, YEAR, GREATEST DAILY, YEAR, DAY	SNOW, SLEET (MEAN, MAXIMUM MONTHLY, YEAR, GREATEST DEPTH, YEAR, DAY)	MEAN NUMBER OF DAYS
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JULY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEPT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
YEAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

LAWRENCEVILLE, PA — 1951 - 1973 — 42° 00' N — 77° 08' W — 1000 FT.

MONTH	TEMPERATURE (°F): MEANS (DAILY MAXIMUM, DAILY MINIMUM, MONTHLY)	EXTREMES (RECORD HIGHEST, YEAR, DAY, RECORD LOWEST, YEAR, DAY)	MEAN NUMBER OF DAYS (MAX, MIN)	PRECIPITATION TOTALS (INCHES): MEAN, GREATEST MONTHLY, YEAR, GREATEST DAILY, YEAR, DAY	SNOW, SLEET (MEAN, MAXIMUM MONTHLY, YEAR, GREATEST DEPTH, YEAR, DAY)	MEAN NUMBER OF DAYS
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JULY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEPT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
YEAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

MARCUS HOOK, PA — 1951 - 1974 — 39° 49' N — 75° 25' W — 12 FT.

MONTH	TEMPERATURE (°F): MEANS (DAILY MAXIMUM, DAILY MINIMUM, MONTHLY)	EXTREMES (RECORD HIGHEST, YEAR, DAY, RECORD LOWEST, YEAR, DAY)	MEAN NUMBER OF DAYS (MAX, MIN)	PRECIPITATION TOTALS (INCHES): MEAN, GREATEST MONTHLY, YEAR, GREATEST DAILY, YEAR, DAY	SNOW, SLEET (MEAN, MAXIMUM MONTHLY, YEAR, GREATEST DEPTH, YEAR, DAY)	MEAN NUMBER OF DAYS
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JULY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEPT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
YEAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

* ALSO ON EARLIER DATES

CLIMATOLOGICAL SUMMARY

MONTROSE, PA 1951 - 1974 41° 50' N 75° 52' W 1580 FT.

MONTH	Temperature (°F) Means: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Day	Record lowest	Year	Day	Mean number of days Max: 90° and above	32° and below	Min: 32° and below	0° and below	Precipitation totals (inches): Mean	Greatest monthly	Year	Greatest daily	Year	Day	Snow, sleet: Mean	Maximum monthly	Year	Greatest depth	Year	Day	Mean number of days: .10 or more	.50 or more	1.00 or more
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JULY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
YEAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PHOENIXVILLE 1 E, PA 1951 - 1974 40° 07' N 75° 30' W 105 FT.

MONTH	Temperature (°F) Means: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Day	Record lowest	Year	Day	Mean number of days Max: 90° and above	32° and below	Min: 32° and below	0° and below	Precipitation totals (inches): Mean	Greatest monthly	Year	Greatest daily	Year	Day	Snow, sleet: Mean	Maximum monthly	Year	Greatest depth	Year	Day	Mean number of days: .10 or more	.50 or more	1.00 or more
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JULY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
YEAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PORT CLINTON, PA 1951 - 1974 40° 35' N 76° 02' W 450 FT.

MONTH	Temperature (°F) Means: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Day	Record lowest	Year	Day	Mean number of days Max: 90° and above	32° and below	Min: 32° and below	0° and below	Precipitation totals (inches): Mean	Greatest monthly	Year	Greatest daily	Year	Day	Snow, sleet: Mean	Maximum monthly	Year	Greatest depth	Year	Day	Mean number of days: .10 or more	.50 or more	1.00 or more
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JULY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
YEAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

* ALSO ON EARLIER DATES

CLIMATOLOGICAL SUMMARY

READING 3 N, PA 1951 - 1972 40° 22' N 75° 58' W 270 FT.

MONTH	TEMPERATURE (°F) MEANS: DAILY MAXIMUM	DAILY MINIMUM	MONTHLY	EXTREMES: RECORD HIGHEST	YEAR	DAY	RECORD LOWEST	YEAR	DAY	MEAN NUMBER OF DAYS: MAX 90° AND ABOVE	MAX 32° AND BELOW	MIN 32° AND BELOW	MIN 0° AND BELOW	PRECIPITATION TOTALS (INCHES): MEAN	GREATEST MONTHLY	YEAR	GREATEST DAILY	YEAR	DAY	SNOW, SLEET: MEAN	MAXIMUM MONTHLY	YEAR	GREATEST DEPTH	YEAR	DAY	MEAN NUMBER OF DAYS: .10 OR MORE	.50 OR MORE	1.00 OR MORE
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JULY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEPT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
YEAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

RIDGWAY, PA 1951 - 1974 41° 25' N 78° 43' W 1360 FT.

MONTH	TEMPERATURE (°F) MEANS: DAILY MAXIMUM	DAILY MINIMUM	MONTHLY	EXTREMES: RECORD HIGHEST	YEAR	DAY	RECORD LOWEST	YEAR	DAY	MEAN NUMBER OF DAYS: MAX 90° AND ABOVE	MAX 32° AND BELOW	MIN 32° AND BELOW	MIN 0° AND BELOW	PRECIPITATION TOTALS (INCHES): MEAN	GREATEST MONTHLY	YEAR	GREATEST DAILY	YEAR	DAY	SNOW, SLEET: MEAN	MAXIMUM MONTHLY	YEAR	GREATEST DEPTH	YEAR	DAY	MEAN NUMBER OF DAYS: .10 OR MORE	.50 OR MORE	1.00 OR MORE
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JULY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEPT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
YEAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

STATE COLLEGE, PA 1951 - 1974 40° 48' N 77° 52' W 1170 FT.

MONTH	TEMPERATURE (°F) MEANS: DAILY MAXIMUM	DAILY MINIMUM	MONTHLY	EXTREMES: RECORD HIGHEST	YEAR	DAY	RECORD LOWEST	YEAR	DAY	MEAN NUMBER OF DAYS: MAX 90° AND ABOVE	MAX 32° AND BELOW	MIN 32° AND BELOW	MIN 0° AND BELOW	PRECIPITATION TOTALS (INCHES): MEAN	GREATEST MONTHLY	YEAR	GREATEST DAILY	YEAR	DAY	SNOW, SLEET: MEAN	MAXIMUM MONTHLY	YEAR	GREATEST DEPTH	YEAR	DAY	MEAN NUMBER OF DAYS: .10 OR MORE	.50 OR MORE	1.00 OR MORE
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JULY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEPT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
YEAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CLIMATOLOGICAL SUMMARY

STROUDSBURG, PA 1951 - 1974 41° 0[illegible]' N 75° 1[illegible]' W 480 FT.

Month	Temperature (°F)	Precipitation totals (inches)
JAN	[illegible]	[illegible]
FEB	[illegible]	[illegible]
MAR	[illegible]	[illegible]
APR	[illegible]	[illegible]
MAY	[illegible]	[illegible]
JUN	[illegible]	[illegible]
JULY	[illegible]	[illegible]
AUG	[illegible]	[illegible]
SEPT	[illegible]	[illegible]
OCT	[illegible]	[illegible]
NOV	[illegible]	[illegible]
DEC	[illegible]	[illegible]
YEAR	[illegible]	[illegible]

TOWANDA 1 ESE, PA 1951 - 1974 41° 4[illegible]' N 76° 2[illegible]' W 745 FT.

Month	Temperature (°F)	Precipitation totals (inches)
JAN	[illegible]	[illegible]
FEB	[illegible]	[illegible]
MAR	[illegible]	[illegible]
APR	[illegible]	[illegible]
MAY	[illegible]	[illegible]
JUN	[illegible]	[illegible]
JULY	[illegible]	[illegible]
AUG	[illegible]	[illegible]
SEPT	[illegible]	[illegible]
OCT	[illegible]	[illegible]
NOV	[illegible]	[illegible]
DEC	[illegible]	[illegible]
YEAR	[illegible]	[illegible]

WARREN, PA 1951 - 1974 41° [illegible] 79° [illegible] 1[illegible]0 FT.

Month	Temperature (°F)	Precipitation totals (inches)
JAN	[illegible]	[illegible]
FEB	[illegible]	[illegible]
MAR	[illegible]	[illegible]
APR	[illegible]	[illegible]
MAY	[illegible]	[illegible]
JUN	[illegible]	[illegible]
JULY	[illegible]	[illegible]
AUG	[illegible]	[illegible]
SEPT	[illegible]	[illegible]
OCT	[illegible]	[illegible]
NOV	[illegible]	[illegible]
DEC	[illegible]	[illegible]
YEAR	[illegible]	[illegible]

* ALSO ON EARLIER DATES

CLIMATOLOGICAL SUMMARY

YORK 3 SSW PUMP STA, PA 1951 - 1974 39° 55' N 76° 43' W 390 FT.

MONTH	Temperature: Means			Temperature: Extremes						Mean number of days				Precipitation totals (inches)						Snow, sleet						Mean number of days		
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
JULY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
SEPT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
YEAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

* [illegible]

NORMALS, MEANS, AND EXTREMES

ALLENTOWN, PA ALLENTOWN-BETHLEHEM-EASTON AP EASTERN 40° 39' N 75° 26' W 387 FT. 1976

[illegible]

[illegible]

17

AVOCA, PA WILKES-BARRE-SCRANTON AP EASTERN 41° 20' N 75° 44' W 930 FT. 1976

[illegible]

[illegible]

[illegible]

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OF POOR QUALITY

NORMALS, MEANS, AND EXTREMES

ERIE, PA — ERIE INTERNATIONAL AIRPORT — EASTERN — 42° 05' N — 80° 11' W — 731 FT. — 1976

[illegible]	[illegible]

[illegible]

81

HARRISBURG, PA — CAPITAL CITY AIRPORT — EASTERN — 40° 13' N — 76° 51' W — 335 FT. — 1976

[illegible]	[illegible]

[illegible]

NORMALS, MEANS, AND EXTREMES

PHILADELPHIA PA — INTERNATIONAL AIRPORT — EASTERN — 39° 53' N — 75° 15' W — 5 FT. — 1976

[illegible]

[illegible]

PITTSBURGH, PA — GREATER PITTSBURGH INTL AP — EASTERN — 40° 30' N — 80° 13' W — 1137 FT. — 1976

[illegible]

[illegible]

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NORMALS, MEANS, AND EXTREMES

PITTSBURGH, PA FEDERAL BUILDING EASTERN 40° 27' N 80° 00' W 747 FT. 1978

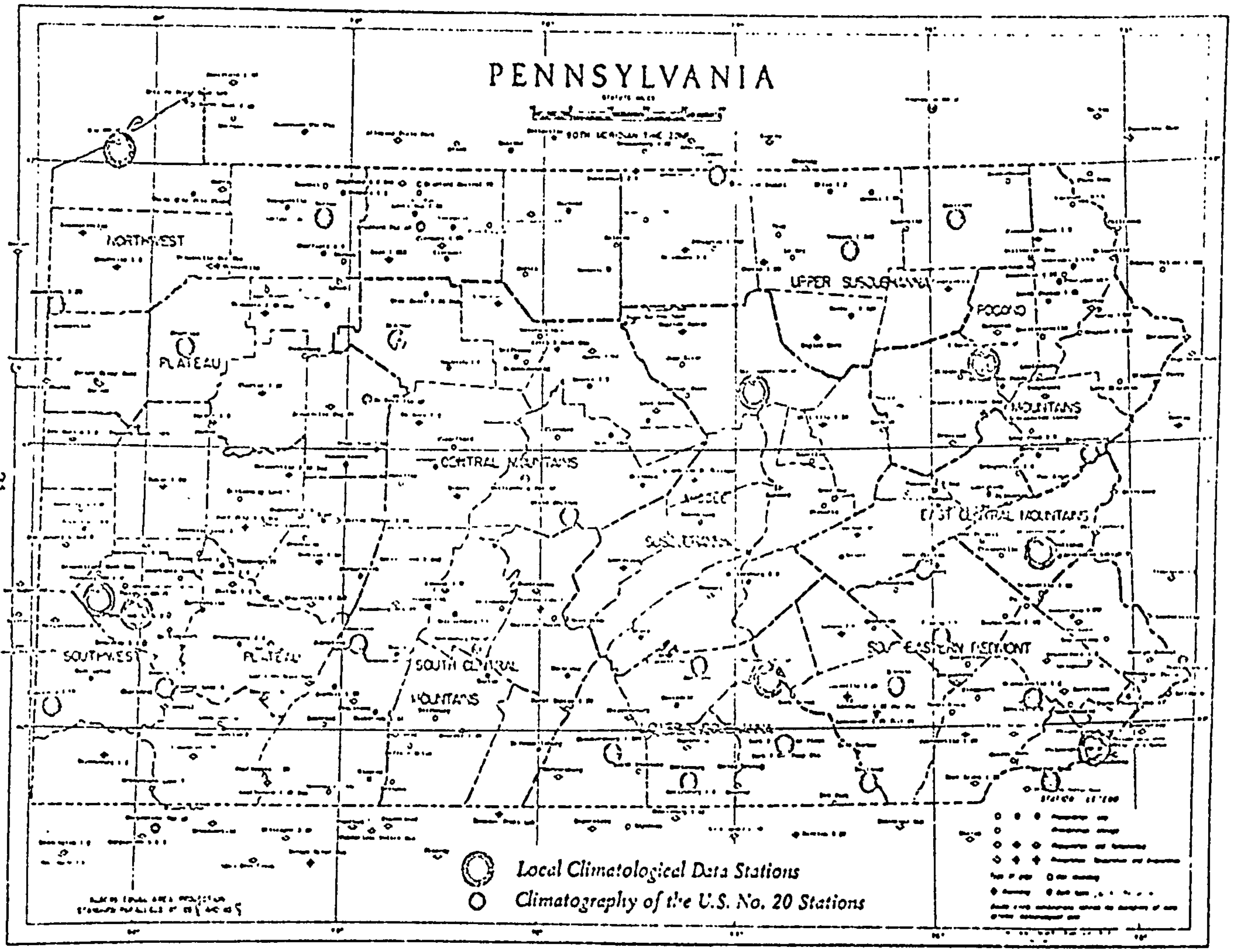
[illegible]

[illegible]

WILLIAMSPORT, PA WILLIAMSPORT-LYCOMING AP EASTERN 41° 15' N 76° 55' W 524 FT. 1978

[illegible]

[illegible]


PENNSYLVANIA
NORTHWEST
PLATEAU
UPPER SUSQUEHANNA
POCONO
MOUNTAINS
CENTRAL MOUNTAINS
EAST CENTRAL MOUNTAINS
SOUTHEASTERN PIEDMONT
SOUTHWEST
PLATEAU
SOUTH CENTRAL
MOUNTAINS
Local Climatological Data Stations
Climatography of the U.S. No. 20 Stations

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Appendix IX

The Office for Remote Sensing of Earth Resources

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P. 4

THE OFFICE FOR REMOTE SENSING OF EARTH RESOURCES
Institute for Research on Land and Water Resources
The Pennsylvania State University

The Office for Remote Sensing of Earth Resources (ORSER), is an interdisciplinary group, established in 1970 for the purpose of participating in projects involving the use of remotely-sensed data of earth resources. Investigators involved in ORSER research projects have been from the fields of agronomy, anthropology, civil engineering, computer science, electrical engineering, forestry, geology, geophysics, hydrology, meteorology, plant pathology, pattern recognition, regional planning, and soils. A problems-oriented, rather than a discipline-oriented, approach is taken in the completion of tasks, in order that associates from various disciplines may work together toward a common goal.

ORSER has directed most of its efforts toward processing, analysis, and interpretation of multispectral remotely-sensed data, most of which have been supplied by NASA in both imagery and digital format. Photo-interpretation has been a vital part of the overall analytical process, but emphasis has been on the use of digital computer algorithms for data processing. The end product of a project is typically a computer map showing various environmental and land use characteristics of data points in the analyzed scenes.

Using the IBM 370/3033 Processor at the University Computation Center, ORSER has developed an extensive digital data processing system, employing FORTRAN IV source language, remote job entry (RJE), and an interactive management and editing system (INTERACT). Statistical information, pattern recognition routines, and a variety of analyses of remotely-sensed data can be produced. Portability and computation cost efficiency have been emphasized throughout.

The ORSER facilities include a Ramtek color TV display system and a Tektronix 4010 remote graphic terminal with associated cathode ray tube (CRT) display, hard copy unit, and digitizing graphic tablet. Three additional terminals (one portable) are available, as well as a complete Datacolor image enhancement system. The laboratory also includes a Map-o-Graph unit and a Bausch and Lomb Zoom transferscope, along with Zoom 70 and 95R stereoscope systems, a microfilm reader, a Diazo printer and developer, and a variety of portable stereoscopes and light tables. All staff members have access to a Saltzman projector in the Department of Geosciences and a completely equipped photogrammetry and photointerpretation laboratory, including a Kelsh plotter, in the Department of Civil Engineering.

From 1972 through 1975, ORSER interpreted MSS data from ERTS-1 (now Landsat-1), on a NASA-funded project. The general objectives were to ascertain the usefulness of these data, to develop interpretation techniques, to apply remote sensing techniques to regional resource management problems, to provide student training in remote sensing, and to evaluate the effectiveness of interdisciplinary research and university-industry related research. Specific objectives were met in the fields of digital processing and pattern recognition, inventory of natural resources and land use, geology and hydrology, and environmental quality.

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Since 1973, the data processing system developed during the course of the above project, has been continually refined and expanded. Recent developments include the capability to handle entire Landsat scenes and to merge these scenes with a variety of ancillary data. With the system implemented on the IBM 370/3033, NASA's Goddard Space Flight Center and other users as far away as California have access by long-distance telephone lines to a sophisticated data analysis package for generating thematic maps suitable for a large variety of applications.

To assist these users, ORSER has conducted several short courses in remote sensing techniques. One of these, for planners from cities across the United States, was sponsored by Goddard Space Flight Center. Several course participants have since obtained terminals of their own in order to use the ORSER system to assist them with planning and mapping problems. Follow-up courses have been periodically held at Goddard Space Flight Center, providing further information in the use of remote sensing technology as well as giving users the opportunity to share methods they had developed while applying the ORSER system to their individual planning problems.

The various thematic maps which can be generated from Landsat, Skylab, and aircraft data using the ORSER system have both general and specific uses. For example, 17 watersheds were mapped for the Susquehanna River Basin Commission. These maps showed generalized categories of land use and were designed to assist in predicting the extent and quality of runoff from drainage basins. Projects involving the generation of maps on specific themes have included mapping of saline seeps in Montana and strip mines in Pennsylvania. A current project, funded in part by the Pennsylvania Department of Environmental Resources, is aimed towards mapping gypsy moth damage from Landsat data and incorporating ancillary geographic and related data, with a view toward creating a comprehensive data base for Pennsylvania.

The system has been used with aircraft scanner digital data to map floodplains, housing developments, power plants, and other small scale features. Funding for these and other projects has come from a variety of sources, including NASA, the U.S. Army Corps of Engineers, several regional planning commissions, and assorted private corporations. Aerial photographs have been digitized to develop an automatic system for photoanalysis of specific features. One such project, conducted in cooperation with the Department of Anthropology at Penn State and the Environmental Remote Sensing Center at the University of Wisconsin, involved digitization and analysis of photographs from Central Mexico. Soil tones and related features were mapped to trace ancient canals and settlements near Mexico City. Current projects involve Heat Capacity Mapping Mission (HCMM) and Seasat data.

The ORSER software is frequently sold for implementation at other locations. This has been done for universities and private corporations in the United States, as well as for several foreign agencies, such as EURATOM (an interdisciplinary working group in the European Common Market), the Indian Institute of Technology, the Norwegian Water Resources and Electricity Board, and the Geographic Institute of the University of

Appendix 2a

MSU Test of P-Model

Table 2 is a copy of the output of P-model evaluation (JDAY 126 = Oct. 6-7). Period denotes the length of the prediction. The column headed by PRED is the actual prediction of the 1.5m air temperature. The OBSVD column is the observed value and the error is the difference between the observed and the predicted value with a positive value indicating a high prediction.

Table 3 contains a histogram indicating the nature of the distribution of the error about the mean error. The statistics of the analysis of the errors follows in that table.

Figure 1 presents the analysis graphically.

The following items were prepared by Mr. Robert Dillon, Programmer I, IFAS/Climatology from information he received by phone from one of Dr. Stewart Gage's technicians on October 1, 1981 (see Table 1). Mr. Dillon ran the key station data from MSU through the P-model to obtain these results.

TABLE 1

KEYSITE # 1 (THL) JULIAN DAY: 126 YEAR: 1981

TIME	SOIL	10CM SOIL	50CM SOIL	1.5M AIR	3.0M AIR	9.0M AIR	DEW POINT	WIND SPEED	WIND DIRCT	NET RADTN	REF VOLTG
18.0	0.0	0.0	0.0	50.5	51.0	0.0	0.0	0.0	0.0	-.078	0.000
19.0	0.0	0.0	0.0	48.7	47.9	0.0	0.0	0.0	0.0	-.078	0.000
20.0	0.0	0.0	0.0	44.8	43.0	0.0	0.0	0.0	0.0	-.078	0.000
21.0	0.0	0.0	0.0	41.5	40.7	0.0	0.0	0.0	0.0	-.078	0.000
22.0	0.0	0.0	0.0	39.7	38.6	0.0	0.0	0.0	0.0	-.078	0.000
23.0	0.0	0.0	0.0	36.1	34.9	0.0	0.0	0.0	0.0	-.078	0.000
0.0	0.0	0.0	0.0	33.3	33.1	0.0	0.0	0.0	0.0	-.078	0.000
1.0	0.0	0.0	0.0	33.9	32.7	0.0	0.0	0.0	0.0	-.078	0.000
2.0	0.0	0.0	0.0	33.1	31.6	0.0	0.0	0.0	0.0	-.078	0.000
3.0	0.0	0.0	0.0	31.8	30.8	0.0	0.0	0.0	0.0	-.078	0.000
4.0	0.0	0.0	0.0	30.4	29.7	0.0	0.0	0.0	0.0	-.078	0.000
5.0	0.0	0.0	0.0	29.4	29.8	0.0	0.0	0.0	0.0	-.078	0.000
6.0	0.0	0.0	0.0	29.4	31.0	0.0	0.0	0.0	0.0	-.078	0.000
7.0	0.0	0.0	0.0	36.6	39.0	0.0	0.0	0.0	0.0	-.078	0.000

Table 1. Data received from MSU in appropriate format for input to P-Model. 0.0 indicates missing data.

Table 2. Copy of output from P-model run indicating the detail of each of the 55 error calculations.

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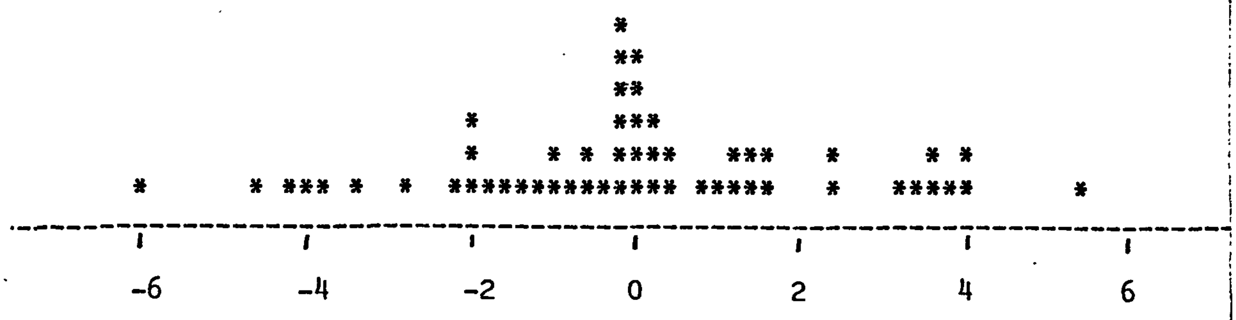
PMODL ANALYSIS Table 2.

YEAR	JDAY	STATION	HOUR	PERIOD	PRED	OBSVD	ERROR
1981	126	MICHIGAN	2100	1	42.9	41.5	1.4
1981	126	MICHIGAN	2200	2	41.3	39.6	1.7
1981	126	MICHIGAN	2300	3	39.9	36.0	3.9
1981	126	MICHIGAN	0	4	38.6	33.2	5.4
1981	126	MICHIGAN	100	5	37.4	33.8	3.6
1981	126	MICHIGAN	200	6	36.3	33.0	3.3
1981	126	MICHIGAN	300	7	35.3	31.7	3.6
1981	126	MICHIGAN	400	8	34.3	30.3	4.0
1981	126	MICHIGAN	500	9	33.4	29.3	4.0
1981	126	MICHIGAN	600	10	32.5	29.3	3.1
1981	126	MICHIGAN	2200	1	39.1	39.6	-.5
1981	126	MICHIGAN	2300	2	37.3	36.0	1.2
1981	126	MICHIGAN	0	3	35.6	33.2	2.4
1981	126	MICHIGAN	100	4	34.1	33.8	.3
1981	126	MICHIGAN	200	5	32.8	33.0	-.2
1981	126	MICHIGAN	300	6	31.5	31.7	-.2
1981	126	MICHIGAN	400	7	30.3	30.3	.0
1981	126	MICHIGAN	500	8	29.2	29.3	-.1
1981	126	MICHIGAN	600	9	28.2	29.3	-1.2
1981	126	MICHIGAN	2300	1	37.4	36.0	1.4
1981	126	MICHIGAN	0	2	35.7	33.2	2.5
1981	126	MICHIGAN	100	3	34.1	33.8	.3
1981	126	MICHIGAN	200	4	32.7	33.0	-.3
1981	126	MICHIGAN	300	5	31.5	31.7	-.2
1981	126	MICHIGAN	400	6	30.3	30.3	.0
1981	126	MICHIGAN	500	7	29.2	29.3	-.1
1981	126	MICHIGAN	600	8	28.2	29.3	-1.1
1981	126	MICHIGAN	0	1	34.0	33.2	.8
1981	126	MICHIGAN	100	2	32.4	33.8	-1.4
1981	126	MICHIGAN	200	3	31.0	33.0	-2.0
1981	126	MICHIGAN	300	4	29.7	31.7	-2.0
1981	126	MICHIGAN	400	5	28.4	30.3	-1.9
1981	126	MICHIGAN	500	6	27.2	29.3	-2.1
1981	126	MICHIGAN	600	7	26.0	29.3	-3.3
1981	126	MICHIGAN	100	1	30.9	33.8	-2.9
1981	126	MICHIGAN	200	2	29.2	33.0	-3.8
1981	126	MICHIGAN	300	3	27.6	31.7	-4.1
1981	126	MICHIGAN	400	4	26.1	30.3	-4.2
1981	126	MICHIGAN	500	5	24.7	29.3	-4.7
1981	126	MICHIGAN	600	6	23.3	29.3	-6.1
1981	126	MICHIGAN	200	1	32.5	33.0	-.5
1981	126	MICHIGAN	300	2	31.5	31.7	-.2
1981	126	MICHIGAN	400	3	30.6	30.3	.3
1981	126	MICHIGAN	500	4	29.8	29.3	.4
1981	126	MICHIGAN	600	5	29.0	29.3	-.3
1981	126	MICHIGAN	300	1	32.0	31.7	.3
1981	126	MICHIGAN	400	2	31.5	30.3	1.1
1981	126	MICHIGAN	500	3	30.9	29.3	1.6
1981	126	MICHIGAN	600	4	30.4	29.3	1.0
1981	126	MICHIGAN	400	1	30.2	30.3	-.1
1981	126	MICHIGAN	500	2	29.2	29.3	-.1
1981	126	MICHIGAN	600	3	28.3	29.3	-1.0
1981	126	MICHIGAN	500	1	28.6	29.3	-.8
1981	126	MICHIGAN	600	2	27.4	29.3	-1.9
1981	126	MICHIGAN	600	1	27.7	29.3	-1.7

Table 3.



PMODL ERROR HISTOGRAM
(DEGREES FAHRENHEIT)

POPULATION = 55

MEAN ERROR = -.024

STND. DEV. = 2.374

Table 3. Statistics from P-model analyses, MSU test, May 6-7, 1981.

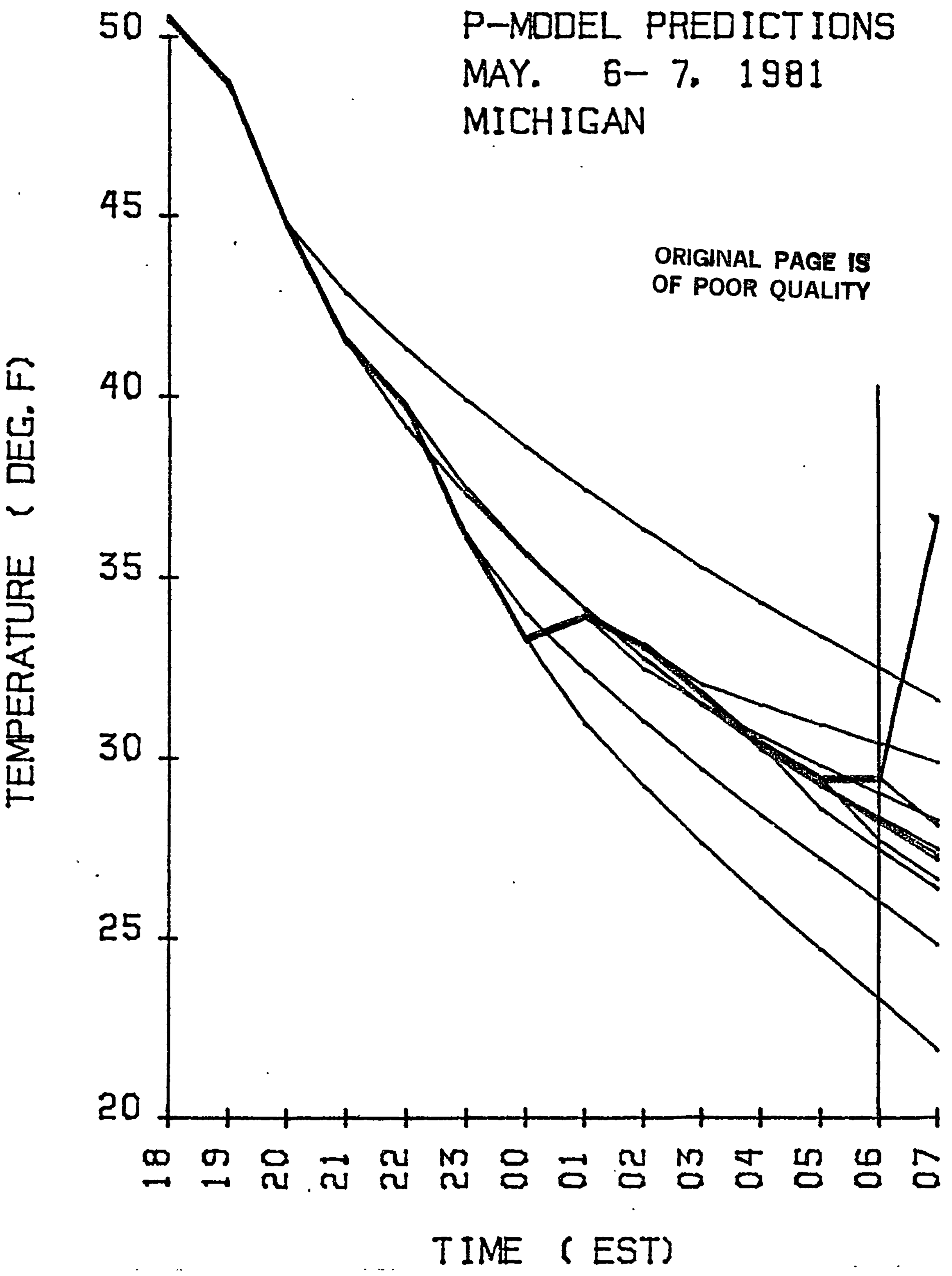


Figure 1. Results of P-model run on data submitted by the Michigan subcontractor. The thicker trace follows the 1.5 meter air temperature at the site while the thin lines trace out the P-model predictions for the remainder of the night beginning at the hour that they depart from the thicker (observed) trace. The vertical line at 6AM marks the point at which the analysis of the P-model performance was stopped because it is obvious the sun came up prior to the 0700 observations.

APPENDIX 2 B

M S U

Michigan State University

Report

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APPENDIX 3

Temperature Distribution accross Nittany Valley, Pennsylvania, during Three Typical Spring Frosts.

J. David Martsolf

Reprinted from Science in Agriculture 18(2):2-3

Penn. Stat Agr. Expr. Station, 1971.

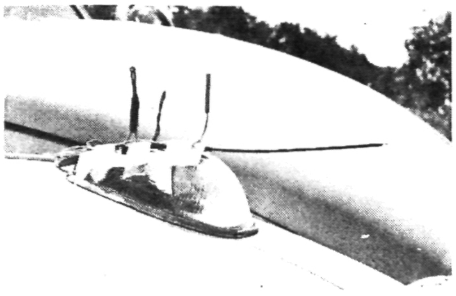


FIGURE 1. *Four thermistors mounted in tandem on a vehicle fender. From left to right, an uncoated disc, an epoxy-coated bead, a bead set in a stainless steel cylinder, and a small uncoated thermistor.*

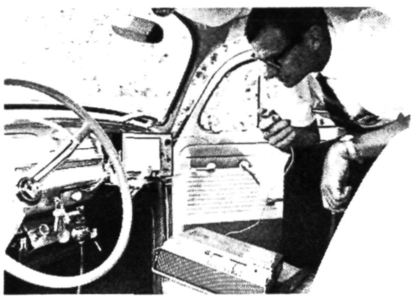
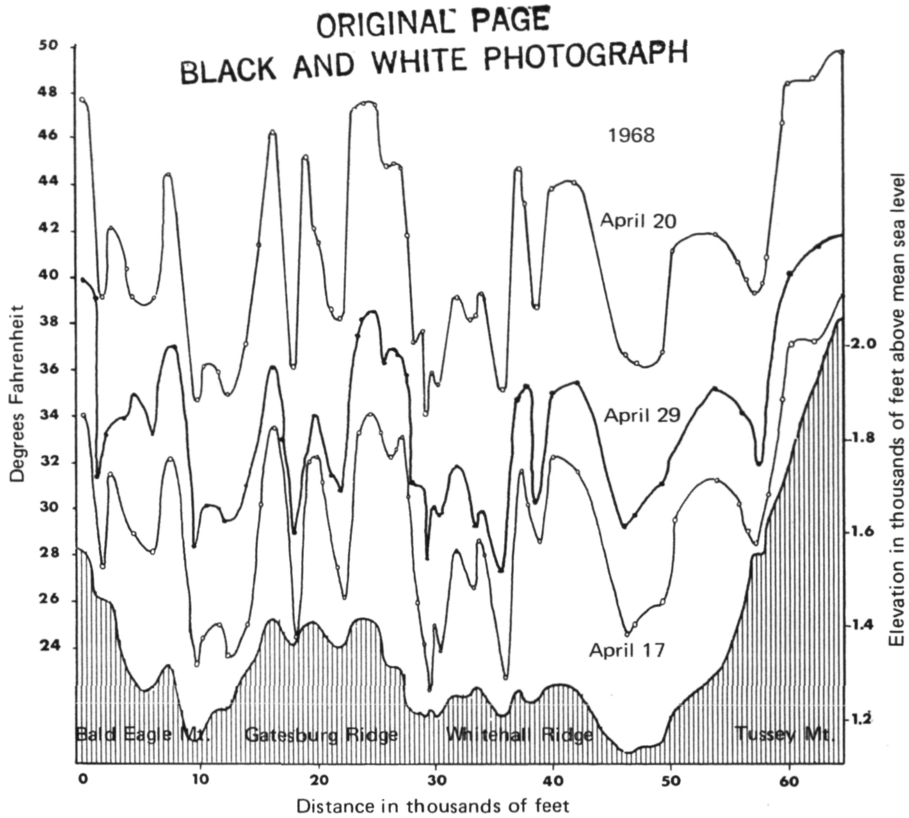


FIGURE 3. *The meter of a thermistor thermometer is temporarily mounted on the glove compartment lid with an extension of the vehicle's instrument lighting system in front of the meter for a light. It is advisable to have either a tape recorder or a passenger to record the observations.*

FIGURE 2. *Temperatures observed on three radiant frost nights, near dawn, indicating very similar patterns, from where Route 322 crosses Bald Eagle Mountain to where Route 26 crosses Mount Tussey through Nittany Valley near State College. Thermal belts along the slopes are outstanding features quite important in site selection.*



Thermistor thermometer useful horticultural tool

J. David Martsolf, *Associate Professor of Agricultural Climatology*

The thermistor thermometer has been found to be a useful tool in at least three horticultural production practices: (1) site selection, (2) sensing temperature inversion strengths and (3) sensing fruit-blossom temperatures. A thermistor is a temperature-sensitive resistor, a few are pictured in Figure 1. The resistance to current flow decreases as the temperature of the thermistor increases. The relatively small size of the thermistor minimizes disruption of the environment by its presence.

The best method of frost protection is undoubtedly good site selection. Traverses of the Nittany Valley in Central Pennsylvania using thermistor thermometers have revealed that up to 18° Fahrenheit differences in temperatures occur between the warmest and coldest locations in the valley of typical radiation frost nights near dawn. The mean increase in temperature with elevation of the site above the floor of the cold air drainage basin was 3.4° F. per 100 feet of elevation. Thermal belts on the slopes of ridges and knolls are readily mapped by this technique, Figure 2. The same instruments have sensed temperature inversion strengths between 5 feet and 50 feet heights in local orchards to be on the order of 6° to 8° F. in the early morning with rapid decay as dawn approaches.

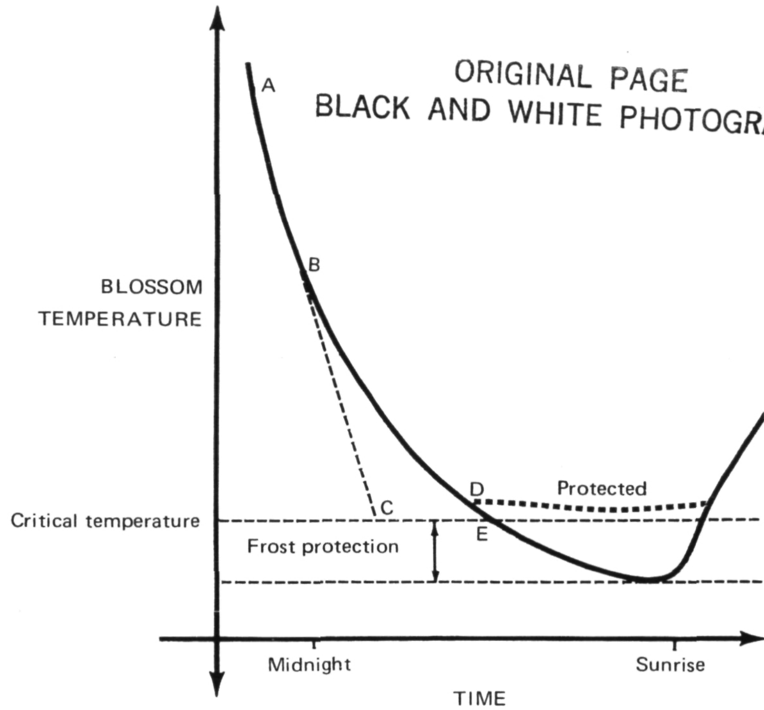
Air temperature in the close vicinity of fruit-tree blossoms has been sensed easily and compared with more conventional observations using liquid-in-glass thermometers mounted in nearby shelters. In large mature trees the air temperatures up near the blossoms were found to be 1° to 2° F. warmer than the shelter temperatures at the time the decisions were being made to light heaters. This knowledge resulted in both a saving of the crop and fuel oil.

Thermistors help in site selection—The thermistor thermometer, mounted on a vehicle, provides a technique of sensing temperature differences between potential horticultural sites by direct comparison. Figures 1 and 3 indicate a method of using a thermistor thermometer on a vehicle to measure air temperature. The readings are made while the vehicle is in forward motion to avoid sensing the heat from the vehicle's engine. Such observations express the average temperature of a column of air through which the vehicle has just moved, even more desirable information than that from a thermometer in one location.

To make comparisons between two horticultural sites, having one of known productivity and one of undetermined frost hazard, begin at one site and go to the other and then return to the first. Assume that the temperature at the first site was changing at a constant rate

FIGURE 4. *A 50 foot tower for monitoring temperature inversion, showing the vehicle at the base of the tower where wires connected to thermistors on the tower are momentarily plugged into a meter in the vehicle to sense air temperatures at various levels on the tower. With practice, the observer can make his notations and drive away from the tower before the effect of the vehicle on temperature readings becomes noticeable.*

FIGURE 5. *An idealized diagram showing the decrease in blossom temperature with time on a typical radiant frost night. (1) The trend from time A to time B will erroneously predict that the critical temperature of the blossom will be reached at time C. (2) The goal of the protection plan is to modify the blossom temperature so that it follows the dashed line from time D until sunrise rather than falling below the critical temperature at time E. (3) The minimum value of frost protection required is the number of degrees indicated by the double-headed arrow.*



and was probably at the mean of the two observations at the time the observation at the second site was being made. This is a defendable assumption near dawn of radiant frost nights, the time of interest, since the temperature change with time is both small and predictable.

Thermistors gauge temperature inversion strengths—The difference in air temperature between a reference height near the ground, say at 5 feet, and a warmer location well above the ground, possibly at 50 feet, is termed inversion strength. Knowledge of this inversion strength is necessary to predict realistically the possible effects of various frost protection methods at the disposal of growers. In general, the greater the inversion strength, the greater the possibility of the grower modifying blossom temperatures with heating devices, wind machines, or a combination of the two. Figure 4 illustrates a method of using a meter mounted in a vehicle to quickly read thermistors mounted on a stationary inversion tower located in an orchard. An alternative method is to place the inexpensive tower out of the traffic pattern of the row by running it up through a tree. In this case the distribution of temperature within the tree is more directly indicated. The studies indicated that a 6° to 8° F. inversion strength is typical in the University orchard location near the time when firing would begin. Inversions of less than 2° or more than 10° were rare.

Blossom temperature estimator unique application—Quite typically the grower uses liquid-in-glass thermometers to calibrate temperatures. The success of this method rests on the grower's ability to decide when his blossoms are in danger of being damaged, using knowledge of the air temperature some 5 feet above the ground. The thermistor thermometer offers a more direct solution to the problem by placing the sensor in the immediate vicinity of the blossoms to increase the possibility that a good estimate of their temperature is obtained. Figure 5 describes the decision-making process diagramatically.

Small bead thermistors were intertwined with the blossoms of large apple, peach, and cherry trees in the University orchards during the past two frost seasons. Several observations indicated that blossom temperatures were most often from 1° to 2° F. *above* the sheltered liquid-in-glass thermometers nearby. No thermistor readings were lower than thermometer readings and none were over 5° higher. The additional information resulted in delaying the lighting of fires several times. This resulted in no further crop loss but a definite savings in fuel. The thermistor thermometer promises to take some of the guess work out of decisions regarding lighting of orchard heaters.

Experiences with both "homemade" and several commercially produced thermistor thermometers have unfolded knowledge of some sources as well as some characteristics of the instruments. The author will be happy to share this knowledge upon request.

APPENDIX 4

A SATELLITE FROST FORECASTING SYSTEM FOR FLORIDA

Presented to:

The Workshop on Applications of Weather Data to Agriculture and Forest Production[1]

Anaheim, CA
March 30-31, 1981

[1]Funded by: National Science Foundation
Sponsored by: American Meteorological Society

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A SATELLITE FROST FORECASTING SYSTEM FOR FLORIDA

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Institute of Food and Agricultural Science
University of Florida

INTRODUCTION

The first of two minicomputers that are the main components of the Satellite Frost Forecast System (SFFS) was delivered in July of 1977 (Bartholic, 1977). SFFS has evolved appreciably since then (Woods, 1977; Sutherland and Bartholic, 1977; Bartholic and Sutherland, 1978; Woods, 1979; Sutherland, et al., 1979; Martsolf, 1979, 1980a,b,c,d; Gaby, 1980; Sutherland, 1980; Barnett, et al., 1980). A geostationary operational environmental satellite (GOES) system provides the satellite data [SMS-2 (synchronous meteorological satellite) a prototype for the GOES became the operational `east bird´ at 75 W in April of 1980; Schnapf, 1980]. This past frost season, 80-81, marked the fourth winter in the development of SFFS. The freeze of January 12-14, 1981, was documented by the system and increasing interest in potential of such systems (Brandli, 1981). Two major changes took place during these four years of development. One is that the satellite data is now acquired digitally (from NOAA/NWS in Suitland, MD; see fig. 1), rather than by redigitizing the GOES-Tap transmissions. Secondly, the data acquisition has been automated, i.e. the computers are programmed to operate the system with little, if any, operator intervention.

THE CURRENT SYSTEM

1. Computers

Figure 1 describes SFFS in block diagram as it was operated during the 1980-81 frost season. The system is operated by one of two minicomputers which acquires the data necessary to form the SFFS products automatically. A NASA-owned computer located at the NOAA/NWS Weather Forecast Office (WFO) at Ruskin, Florida, served as the main computer

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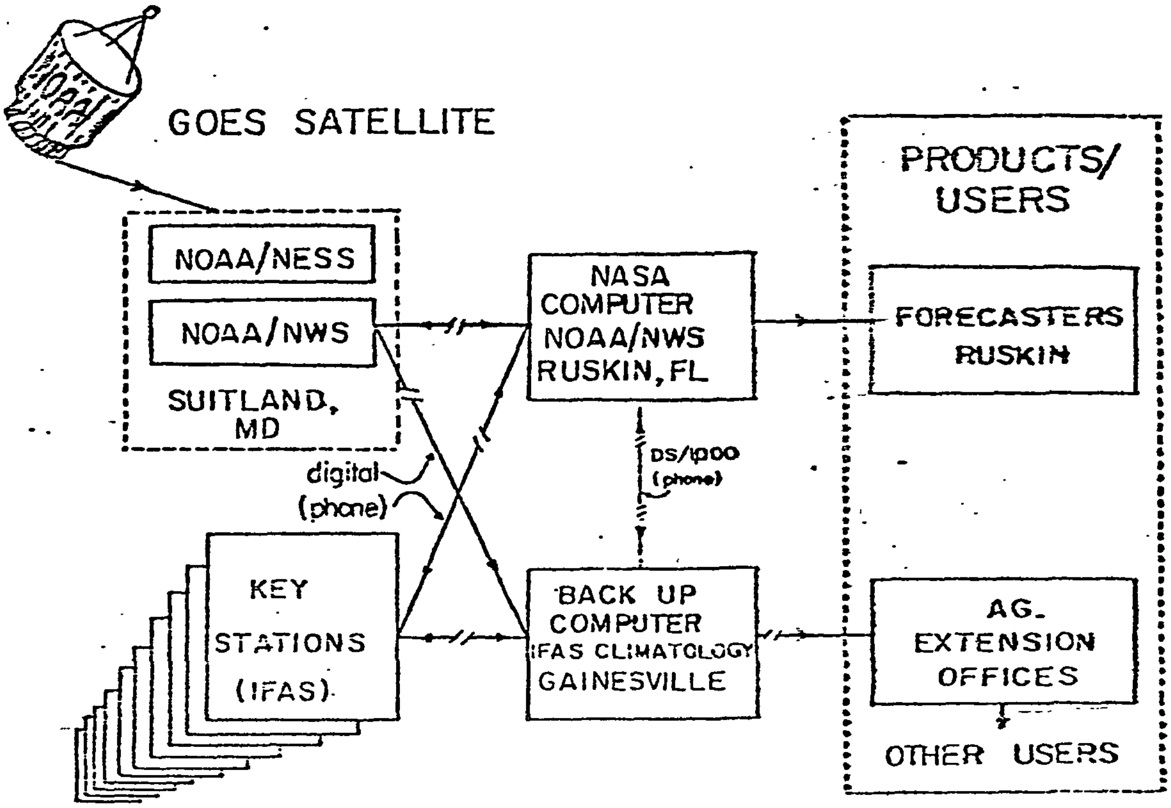

Fig. 1. Block diagram of SFFS indicating satellite digital data acquisition by phone link with NOAA/NWS-NESS in Suitland and links with 10 automated weather stations in Florida, the two computers linked by DS/1000 (a distributed system) that automate the acquisitions and process the data into products for forecasters at Ruskin, FL and for other users through Agriculture Extension offices.

with a similar machine located in the Climatology Laboratory of the Fruit Crops Department, IFAS, University of Florida, Gainesville, Florida, serving as a back-up machine.

The minicomputers are Hewlett-Packards (HP Series 1000) having RTE-IVB operating systems, and connected as a distributed system (DS/1000). The Ruskin machine is a model 2112 with 192 Kbytes of memory and accessing a 15 Mbyte disc (HP Mdl. 7905). The Gainesville machine is a model 2113 with 256 Kbytes of memory and accessing 2 each 5 Mbyte discs (HP mdl. 7900) with a third to be added in the near future. Both systems are controlled through CRT terminals (HP 2645A's) and store data on magnetic tape (800 BPI, HP Mdl 7970B). The major products are displayed on 15 inch Conrac Red-Green-Blue (RGB) Monitors, i.e. color TV displays. Automated use of telephone connections, both 300 and 1200 Baud is accomplished through a Vadic multiple chassis housing both auto-dialers and modems (Mdls 801, 305, 3415).

2. Satellite Data Link

Initially, GOESTAP analog data arriving at Ruskin WFO via Miami was redigitized to provide the satellite data input to SFFS, but planning to obtain the digital data was in progress during the first year of development (Bartholic, 1977).

During the third frost season, the development of a special driver made computer-to-computer communication between the SFFS HP's and NOAA/NWS's IBM's possible. SFFS auto dials a Vadic 3467 modem at NOAA/NWS (supplied by SFFS at first but now by NWS) in Suitland. Upon connection the SFFS computer interrogates a particular storage queue assigned by Mr. Arthur Bedient, Chief, Automation Div., NOAA/NWS. Previous to this step an NWS batch-mode program must have interrogated a large disc file (4 ea Mbyte discs) known as the VISSR Data Base (VDB; VISSR = Visible Infrared Spin-Scan Radiometer) via an IBM 360/195 (NOAA uses 2 with a third as a back-up) to select the Florida sector from the entire hemisphere of infrared data and pass it into SFFS's queue. The VDB must contain the particular VISSR data for the hour in question for the NWS program to be successful.

The VDB is filled by a batch-mode program on the IBM 360 that passes the satellite data from 22 Mbyte staging disks located in Wing 1 of FOB-4 near the 7-m dish antennae. Collecting the stretched VISSR data by antenna and processing it into the VDB are operations under NOAA/NESS jurisdiction (Waters and Green, 1979). Building the output

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queues for clients such as SFFS, i.e. the Florida Sector, is a responsibility of NOAA/NWS. During the 1980-81 frost season the staging disks sustained head crashes during a period when GTE was on strike and the VDB had to be filled by manually transferring 9-track 1600 BPI magnetic tapes from the VISSR Ingest Computers (GTE IS1000's) to transports serving the IBM 360's. Therefore, during the 80-81 frost season SFFS was successful in acquiring the sectorized satellite data in only 63% of its attempts. When the data were acquired, it was often 4 to 6 hours delayed during the early evening when the system is dependent on timely data to make convincing forecasts. Since the staging disks have been repaired and the data are transferred automatically (but by batch-processing) to the VDB, the reliability of map presence has not greatly increased nor has the delay decreased. Consequently, direct access to the satellite has been investigated. Sufficient insight was developed to suggest that the reception of the stretched VISSR data by large numbers of users was the dissemination method envisioned by the satellite's designers. Progress toward the procurement of an antenna system will be reported under a later section.

3. Automated Weather Stations

Initially these ground stations were manned by volunteers (in most cases). There were a dozen key stations selected to represent peninsular Florida in locations in which volunteers could be obtained to read and report the sensings. At the beginning of the third frost season 10 remaining stations were automated by the addition of microprocessors manufactured by Darcom.

The microprocessor controlled data acquisition systems that automate the key stations are Darcom model D303's. They are capable of interrogating up to 8 analog channels and totalizing on 2 additional six-digit electronic counters. These pulse counters can be remotely set to average the inputs over 7.5, 15, 30, or 60 minute intervals. They can be programmed to reveal the total as well as the rate over the selected time interval. These units were designed for, and have been extensively used by, gas line companies to monitor flow through pipelines by telephone. They have a built-in modem that for its cost handles the telephone communications very well. The Darcom Remote Terminal Units (RTU), as they are termed, are used at the key stations to accumulate counts from light chopper anemometers, and to scan 6 levels of thermistor sensed temperatures, a net pyrradiometer, and a reference voltage (see fig. 2).

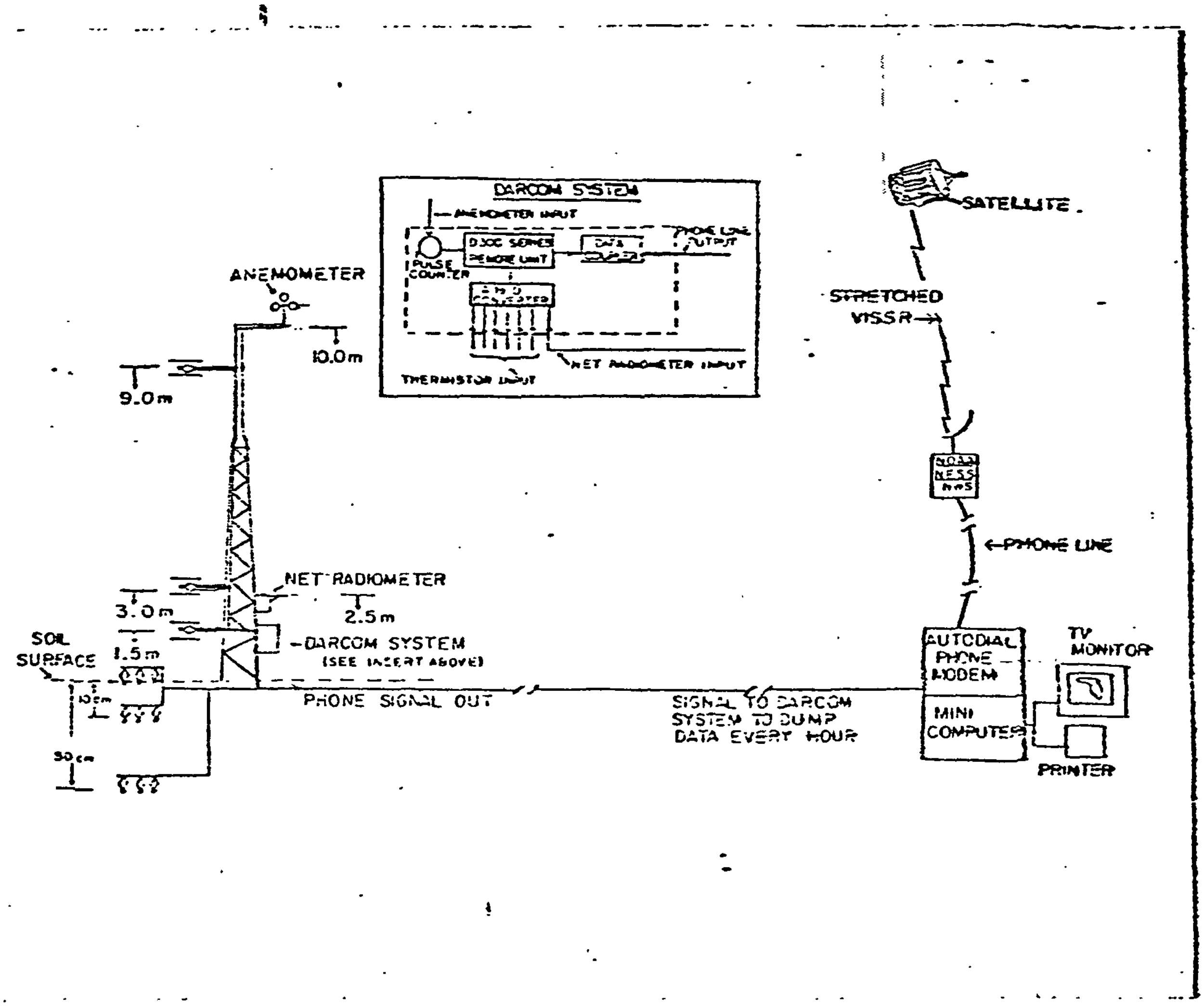

Fig. 2. Diagram of SFFS showing data acquisition links and featuring details of automated link with 10 surface weather stations scattered over peninsular Florida.

Table 1. List of key stations serving SFFS indicating their location and affiliation.

No.	Station	Location	Affiliation
1	Tallahassee	Airport	NWS
2	Jacksonville	Airport	NWS
3	Gainesville	Horticultural Unit 5 miles NW of Gainesville	IFAS/Fruit Crops
4	Tavares	Agr. Extension Center Rural, SW of Tavares	IFAS/Extension
5	Ruskin	Site of	NWS
6	Arcadia	Radio Station	Private
7	West Palm Beach	Airport	NWS
8	Belleglade	Branch Experiment Station	IFAS/AEC
9	Immokalee	Branch Experiment Station	IFAS/AEC
10	Homestead	Branch Experiment Station	IFAS/AEC

During a frost night they are scanned once per hour by one of the SFFS HP's by a fairly elaborate software package that checks to see if the station has been successfully interrogated. If not the computers tries to call the key station several additional times (a variable set by the operator) and then if unsuccessful, uses a substitution table or prearranged calculation to substitute information, while leaving a message for the operation that such a substitution has been necessary. This past frost season the key station data was acquired on 95% of the tries with most of the failures caused by chance phone line routing that resulted in very noisy lines. Regular voice grade lines are employed for these interrogations.

Seven phone companies are involved in providing the service. While these companies are required by law to provide similar service from place to place, experience with troubleshooting problems has revealed a variety of attitudes and policies regarding such service. For example, a problem developed when the Ruskin system began to interrogate the key stations (the Gainesville system had handled them during the development stage). Apparently, problems with crank calls in the Tampa Bay area had caused the phone company to hold lines open when one party hung up while the other held long enough for a trace. The procedure treated our Darcoms as a crank caller and prevented the system from completing additional calls until the rather long timeout occurred. A software change in our procedure corrected the problem relatively easily after it was isolated. But tracing problems through phone companies can not only be time consuming but quite frustrating.

Figure 2 diagrams the instrumentation on the key stations, the microprocessor controlled data acquisition system automating the station and the acquisition links that the SFFS uses to acquire the ground weather data and the satellite data used to construct the output products.

Initially, the key stations used thermocouples (copper-constantan for temperature measurement) but when they were automated in 1979, a switch to locally available thermistors (Atkins Technical, Gainesville, FL; Type 3) was made. To reduce cost, the bare thermistor beads were purchased and encased in epoxy. In 1980 the procedure was modified to increase the time constant of the sensor and its spatial integrating character by potting it in a 3.2 in length, 1/4 in diameter copper tube. The air temperature probes (3 each at 1.5m, 3.0m and 9.0m) are shielded by circular painted plywood shields (5in. dia., 1/4 in. thick) on both top and bottom. The sensor and the shields are horizontal with about 1.2 inch clearance between the shields where the natural airflow aspirates the copper-clad thermistor sensor. The same sensor configuration is used for 3 ea soil temperature measurements (surface, 10cm and 50cm in depth) except that three sensors are connected in series and enclosed in a 10 inch long copper tube to provide better spatial integration. The location of these thermistor sensors is indicated in Figure 2 but the indication of a bead thermocouple junction is an unfortunate carryover in the diagram from the first two years of SFFS operation when the manually operated key stations utilized thermocouples. Please recall that these stations are designed to operate at night only. Their purpose is more to demonstrate the procedure than to be accepted as a solution to an automated weather station for multiple uses.

The anemometer at each key station is 10 meters high. It is a Gill 3-cup light-chopper anemometer (Model 12202D, R. M. Young) which has been modified to avoid spurious counts from light scattered around the shutter and to effect a more reliable interface with the Darcom counting circuitry. Major changes involve the substitution of a GE silicon/Darlington Photo detector (Type L- 14-F1) and a IR Emitter (Type LED-55B). Currently the averaging period for the wind data is one hour but the Darcom has options for shorter periods. A shorter period is likely to be utilized in the future.

The measurement of net radiation at the key stations remains a troublesome problem. Early in the development of the key stations, shielded net pyrradiometers (Swissteco's) were used at 4 of the key stations. Covers (removable shields) were used to protect the polyethylene domes during non-frost periods but the need to manually remove and replace these was inconsistent with the automated concept. Properly maintained, the Swissteco's are excellent instruments but without such maintenance their outputs are less convincing. This past season an attempt was made to substitute ventilated net pyrradiometers that were on hand but in need of refurbishment. Delays and errors in the refurbishment process by the current vendor of the Gier-Dunkle type ventilated net radiometer precluded their use during the frost season. Tests with the delayed instruments have resulted in their return to the factory. If the ventilated net radiometers fail to provide sufficiently reliable sensings of the net radiant loss from the surface, there are several contingency plans under consideration. Several involve the development of a simple sensor that will in effect detect the presence of clouds or very moist atmospheric conditions. Others involve the use of the infrared satellite data.

4. System Products

The primary product of SFFS are a series of color-coded maps, often termed thermal maps, displayed on the Conrac color monitors located in Gainesville (the development system) and in Ruskin (the operational system). These products fall into two categories: observed maps and predicted maps. A scheduling program provides the operator with an opportunity to exercise options by modifying instructions when initiating SFFS operation. Once started (scheduled) SFFS operates on previous instructions, unless there are changes. Normally, one observed map and three predicted maps are displayed as the generating programs complete their construction during each hour of the system's operation. The scheduling program looks in an answer file for its instructions concerning the options. For example, the rather broad range of temperatures from 13 F to 50 F is often chosen for the initial thermal map display to assure complete coverage of the data. The operator then has the opportunity to request the system to refine the temperature resolution of the display by requesting a narrower temperature range.

In addition to flexibility in the temperature range per color, the operator has options in the type of presentation, e.g. split screen permitting comparison of two thermal maps side by side, or the enlargement of a particular portion of the screen (see figures 3 and 4). With a little practice the user can slice the temperature range into appropriate increments that reveal isotherms of temperatures near critical values in the forecast or for plant damage.

The big freeze of January 13-14, 1981, revealed that secondary products from the system were also in demand. Figure 5 is a copy of the printout of the so-called "symbols map." A translation table has been added that permits the

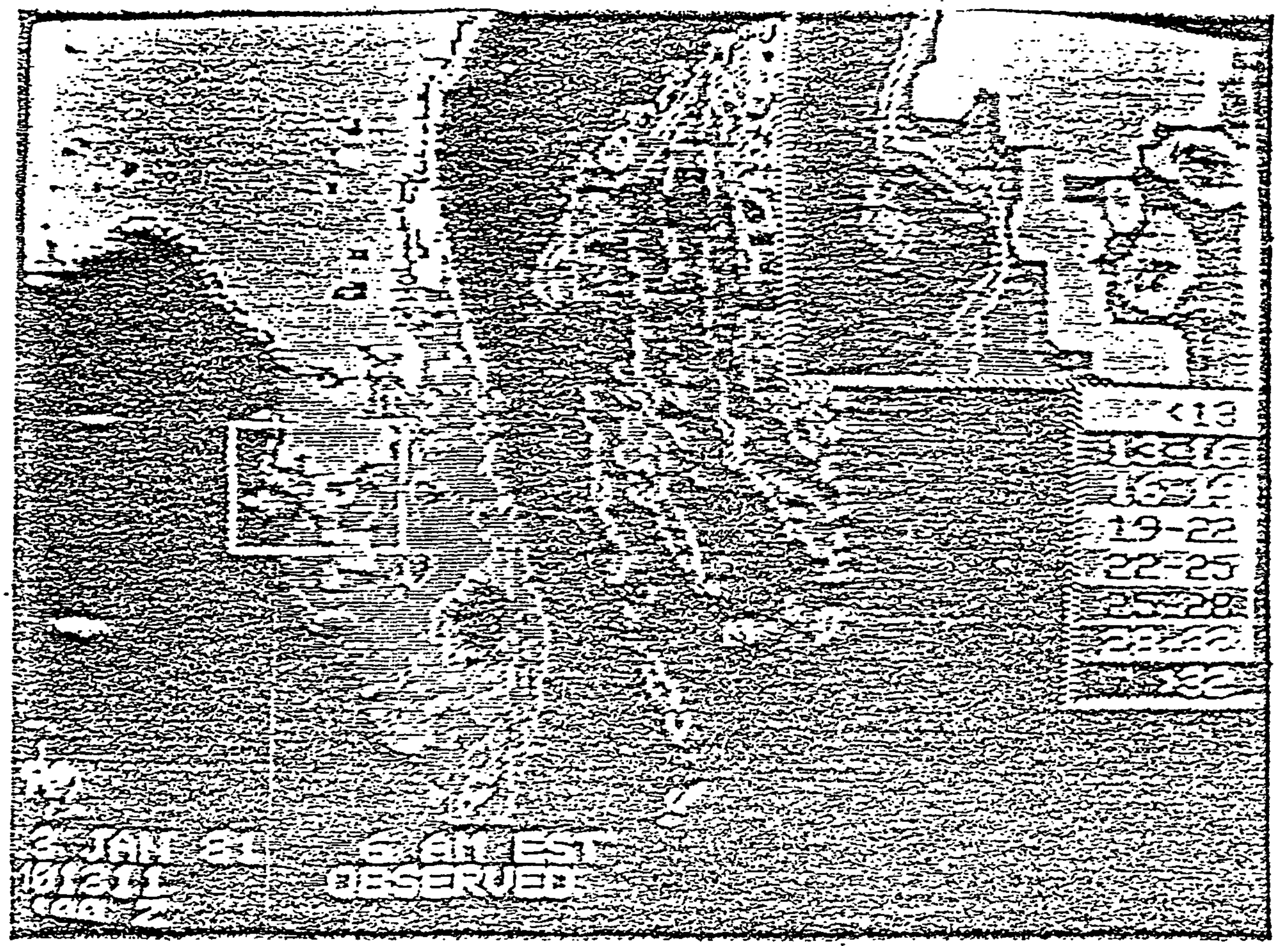

Fig. 3. Black-and-white print of the color-coded thermal map that is the primary product of SFFS. This view demonstrates the enlargement capability available to the operator through which he is able to control both the size of the box (multiplication factor) and its location on the peninsula.

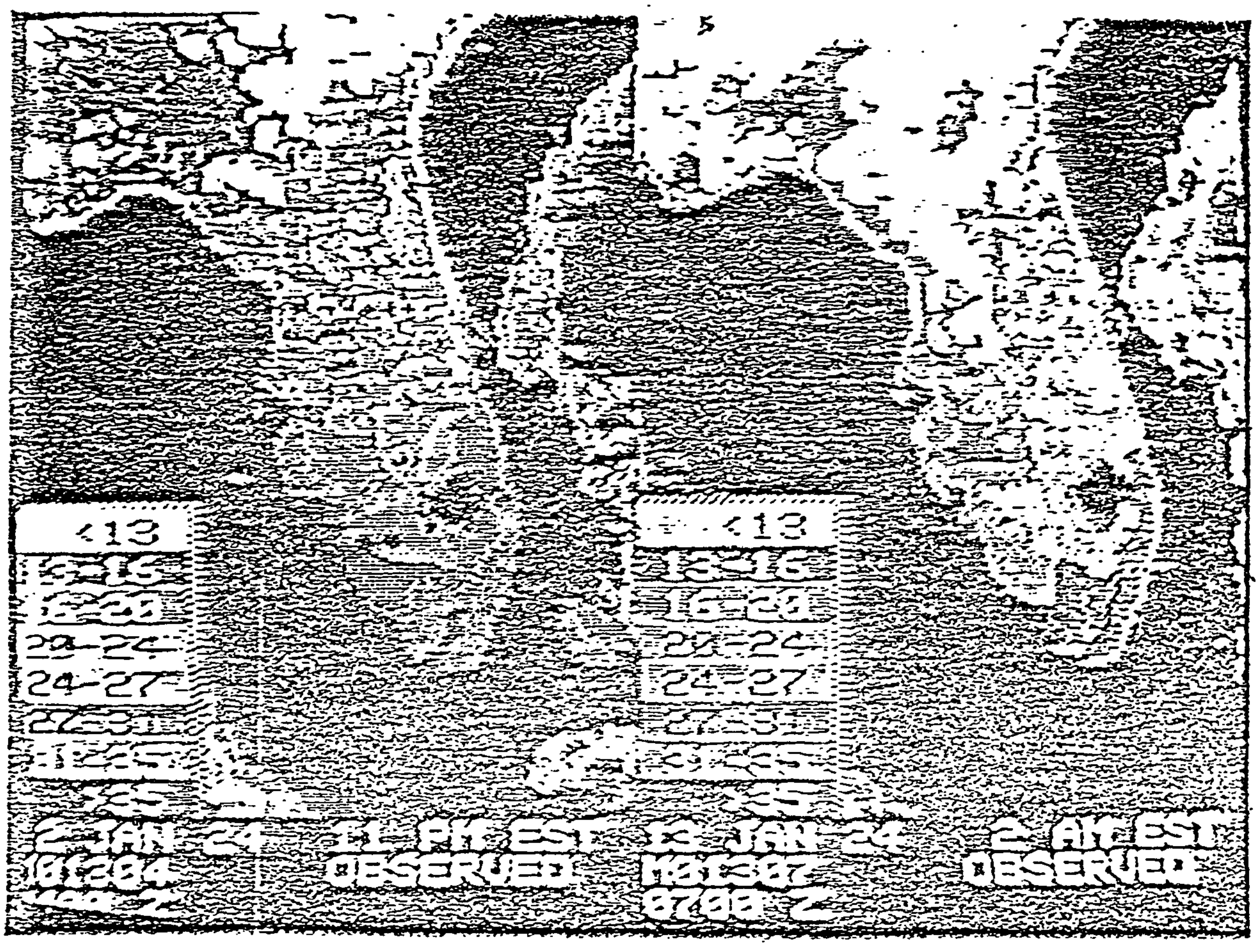

Fig. 4. Black-and-white representation of the color SFFS product demonstrating the split screen option. The operator may bring up for comparison any previously archived map for a side-by-side view of the thermal pattern similarity.

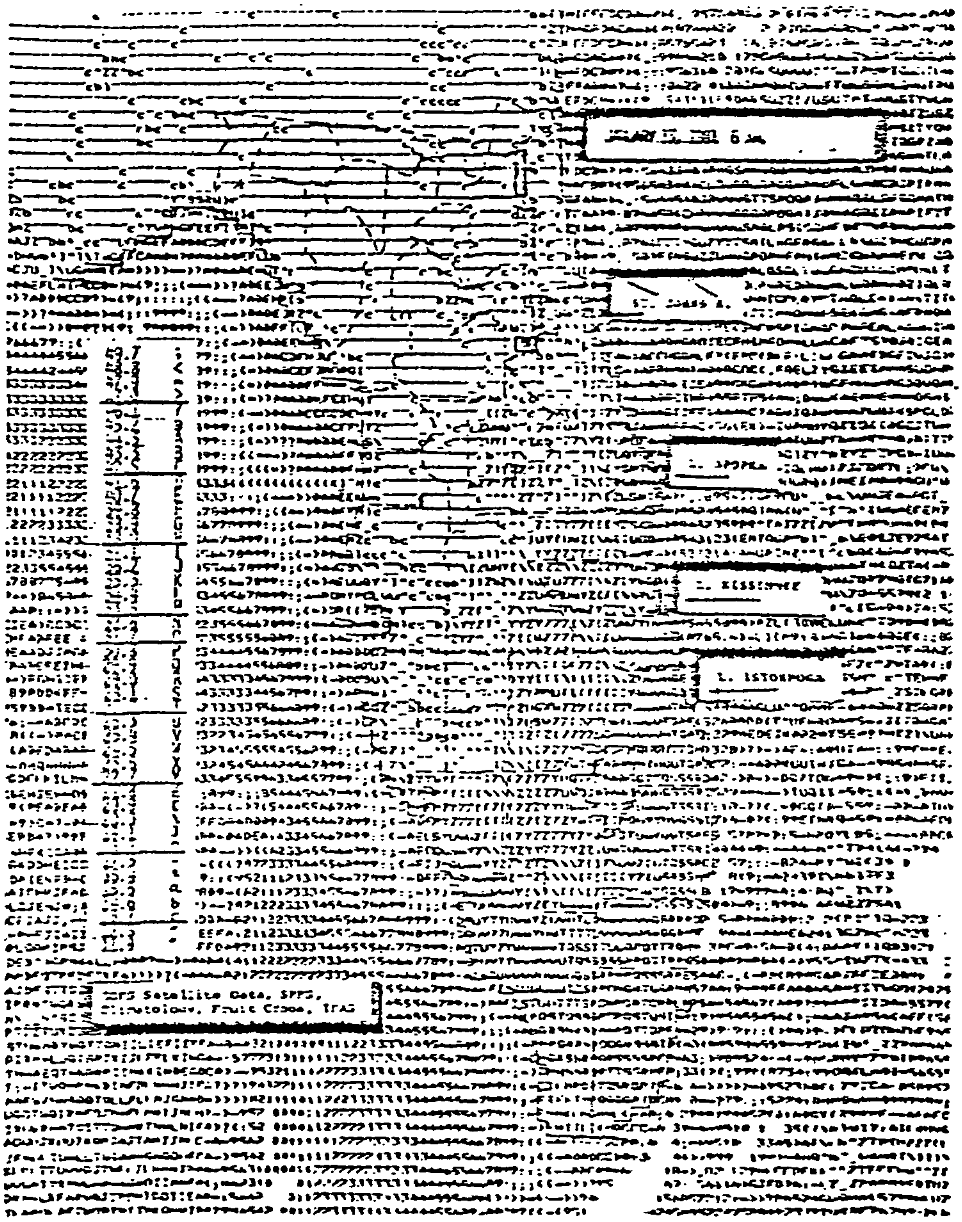

Fig. 5. A reduction (size) of the symbols map; a product of SFFS that become popular just after the big freeze (see date/time on map). The translation table on left margin permits the user to determine the temperature of any 5 km. by 5 km. pixel of interest. Users found this product much easier to archive than the color product viewed on a TV screen. Such maps were communicated from APPLE II to APPLE II for display in color.

Table 2. Printout of SFFS key station data for 1.5m air temperature for the indicated dates.

JAN. 12-13, 1981
1.5m air temperature (rounded to nearest degree F)

	18	19	20	21	22	23	00	01	02	03	04	05	06	07
Tallahassee	28	26	24	18	14	13	16	14	11	10	10	8	7	7
Jacksonville	27	24	17	20	18	13	16	15	13	9	13	13	11	11
Gainesville	30	26	20	19	18	16	14	14	13	12	11	10	10	9
Tavares	37	35	32	23	23	27	18	28	17	22	21	14	15	18
Ruskin	38	36	36	34	32	30	28	27	26	24	22	21	21	20
Arcadia	33	30	28	27	22	19	18	18	16	18	16	18	17	17
West Palm Beach	42	41	38	36	35	34	34	34	33	32	31	30	30	30
Belle Glade	40	39	37	37	36	36	35	35	35	34	34	33	33	32
Immokalee	36	35	32	36	31	29	27	23	22	22	22	20	20	20
Homestead	40	38	39	38	36	35	33	31	31	31	29	29	29	29

JAN. 13-14, 1981
1.5m air temperature (rounded to nearest degree F)

	18	19	20	21	22	23	00	01	02	03	04	05	06	07
Tallahassee	44	45	34	22	27	25	22	23	23	28	32	34	37	32
Jacksonville	39	30	30	34	19	31	30	29	29	29	29	28	27	28
Gainesville	38	35	33	28	22	20	20	20	20	20	20	20	21	27
Tavares	34	33	37	34	31	25	22	24	19	20	21	22	22	23
Ruskin	39	35	34	31	30	29	27	27	27	26	27	27	28	19
Arcadia	39	41	37	29	28	27	22	22	21	20	19	18	19	20
West Palm Beach	47	47	46	44	43	41	41	39	38	40	40	37	37	37
Belle Glade	41	38	38	36	35	32	33	33	33	33	31	30	30	31
Immokalee	42	37	34	31	28	27	31	30	27	26	28	28	30	30
Homestead	44	39	41	42	41	41	40	40	40	38	39	36	39	40

SFFS Key Station Codes:

TLH - Tallahassee
JAX - Jacksonville
GNV - Gainesville
TAV - Tavares
TBW - Ruskin

ARC - Arcadia
PBI - West Palm Beach
BLG - Belle Glade
IMK - Immokalee
HST - Homestead

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user to translate the symbols in a particular area into temperatures. The map can be easily reproduced in quantity and many of these have been used by decision makers in the areas of crop transportation, processing, futures, etc. A detail that becomes apparent in viewing this map is that differentiation of temperatures ceases below 12.8 F. This is an arbitrary limitation that results from the necessity of assigning a symbol set to temperature values in order to easily move them through the NOAA/NWS program and into the SFFS queue in Suitland. The raw data covers a much broader temperature range, i.e. -110 C to 568 C. covered by 256 counts.

Another secondary product of the system that was found quite useful after a damaging freeze was the printout of the 1.5m temperatures from the key stations. These data are available faster than those from minimum-temperature thermograph networks. The product is easily reproduced and inexpensively duplicated for mass dissemination (see Table 2).

5. Models Construct Predictions

Two models operate in series to produce the predicted products. The first, known as P-model, is an energy budget model requiring as inputs data from the key stations and estimated or observed dew points from the SFFS operator. The P-model has been published (Sutherland, 1980) and discussed in the literature (Shaw, 1981; Sutherland, 1981). Only a brief summary is made here.

The "P" in P-model stands for predictive as well as physical. The model outputs 1.5m air-temperature forecasts for the remainder of the night, i.e. up to 7AM the following morning. These forecasts are printed out in tabular form along with the previously observed 1.5m air temperatures at the key station for the operators to view at the system printer. The forecasters use these as part of the input information they have available to make their frost warnings for various areas of the state.

Currently the P-model requires 3 consecutive hours of key station to produce forecasts for subsequent hours. So the forecasts begin 3 hours after the system begins operation, often at 9PM EST. Each hour the system upgrades the forecasts for the remainder of the night using the most recent 3-hour sequence of input data.

The second model, called the S-model, requires the output of the P-model and the satellite data to produce

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forecasted satellite maps. The "S" stands for space, statistical and satellite. It must build a precited satellite view, a thermal map, from the predicted temperature at 10 locations into temperatures for each of the 8 km by 8 km pixels within the borders of the peninsula. A matrix of coefficients relates the predicted key station temperatures to pixels surrounding the key station. These coefficients have been developed from previous freezes. The operator has as an option the set of coefficients that he or she wishes to employ.

THE FUTURE SYSTEM

1. Direct Down-link Antenna System

Experience with SFFS over its 4 years of development has provided users and potential users of the system products numerous opportunities to voice their concern for both the speed and the reliability of the delivery of the products. If the system products are to influence decisions concerning the commitment of energy to heating, wind machines, irrigation pumps and combinations of these, the information must be available to the decision maker as early as possible.

The NOAA/NESS-NWS communication route in Suitland through which the system has received its satellite data during the 79-80 and 80-81 frost season does not rapidly communicate the satellite data. At least two batch operations in the computer-controlled data transmission are involved. The channel has been classed as a special project rather than an operational effort. During the 80-81 frost season SFFS received approximately 63% of the satellite data that it attempted to acquire. When the staging disks were brought back on line in March at NOAA/NESS in Suitland, the reliability of map acquisition failed to increase. IFAS/UF had little choice but to attempt to directly link to the satellite by antenna (fig. 6). At the time of this report all the components indicated in Figure 6 are available or on order except for the demodulator and the bit stream synchronizer. If arrangements can be made for these two components and all the components are functional when delivered, the antenna should be feeding satellite data to SFFS by December 1, 1981.

2. Communication of SFFS Products to Additional Users

The primary user of SFFS output is the forecaster. The NOAA/NWS forecaster is expected to incorporate SFFS information into his frost warnings and communicate these to

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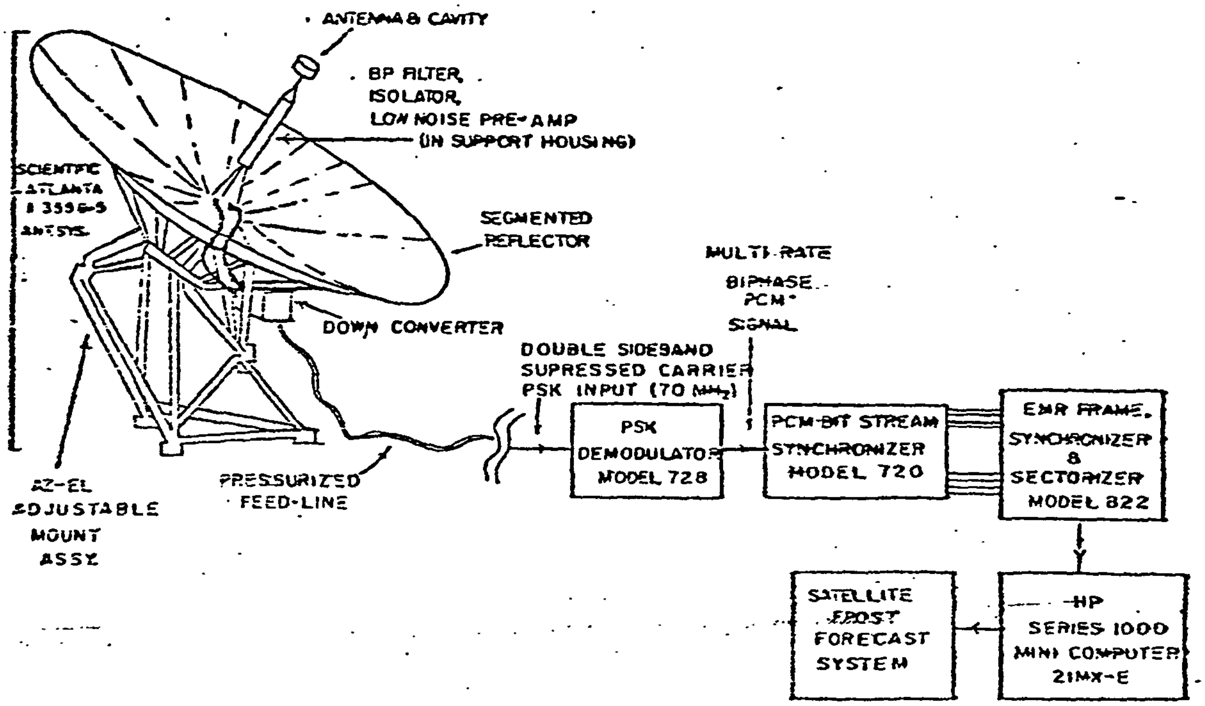

GOES STRETCHED VISSR DATA DOWNLINK

Fig. 6. Proposed antenna system for SFFS permitting direct access to digital data. Portions of this system are on order at the time of this report.

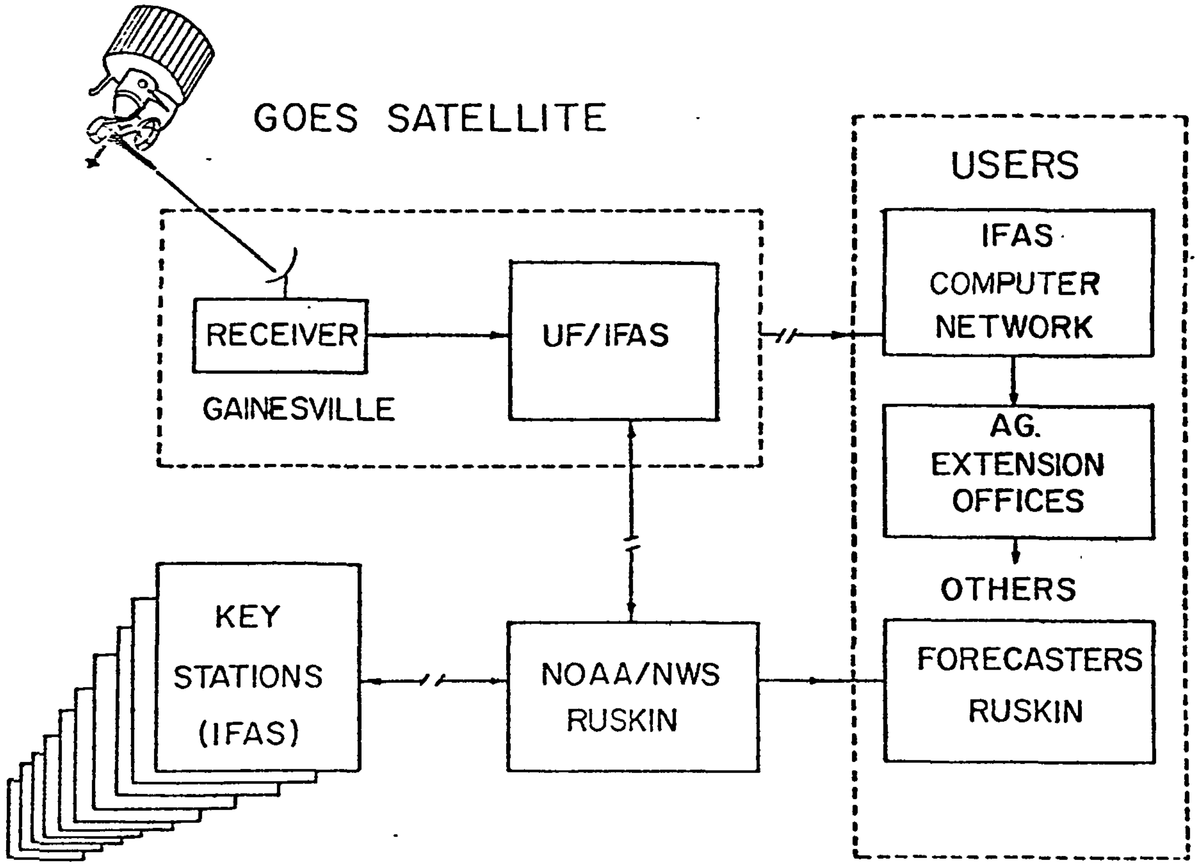

Fig. 7. Block diagram of SFFS when the antenna at UF/Gainesville (Fig. 7) becomes operational. Dissemination of SFFS products is expected to rely heavily on the IFAS computer network that is expected to link the county extension offices with the main campus of UF. Compare with Figure 1.

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users through the normal communication channels that NOAA/NWS has developed over years of service to its clientel. This has occurred during the developmental period, and is expected to continue independently of the presence of the antenna (fig. 7).

Additional users of SFFS information include all other consumers showing interest in receiving the information. During the 80-81 frost season, two county extension offices (one in Polk County and the other in Lake County) received the thermal maps by an APPLE II computer link with the Gainesville minicomputer. This was an experimental link in anticipation of the communication link that is expected to occur via the new IFAS Computer System in coming years. Growers, media, processors, etc. are expected to arrange to connect with the county computers or terminals to view thermal maps, as well as to obtain other system products through the cooperative extension service. This plan does not preclude dissemination of SFFS products from the Ruskin portion of the system as well.

SUMMARY

During 4 years of development, the Satellite Frost Forecast System has undergone significant change. From a system that initially depended upn the redigitizing of the analog GOESTAP data, it has retooled to operate with direct digital data from Suitland, MD, and is in the process of incorporating a direct link with the stretched VISSR data from the GOES satellite by antenna. The system began with manual (verbal) communications of ground truth (surface weather observations) and graduated to automated interrogation of ten key stations. Data from these two data bases (IR from GOES and air and soil temperature, wind and net radiation from key stations) are used to produce both observed and predicted satellite views of the temperature patterns over peninsular Florida. These color products, as well as some black-and-white documentation of the data acquired, are communicated not only to NWS forecasters but are expected to go to additional users through computerized communication channels developing in the Florida Cooperative Extension Service.

ACKNOWLEDGEMENTS

Both IFAS/UF and NASA (Contracts NAS10-9168 and NAS10-9892) have funded SFFS development with NOAA/NWS cooperating. Dr. Jon F. Bartholic served as the principal investigator (PI) during the first 1.5 years before becoming an Assistant Director at Michigan State University, Agricultural Experiment Station. Dr. John F. Gerber served as interim PI for a period of approximately one year and continues to support the work from his position as IFAS Grants Office Director. Dr. Michael J. Burke, Department Chairman, Dr. Ellen Chen, Post Doctorate Fellow, and Mr. James G. Georg, Consultant Meteorologist have provided leadership as well. Dr. James M. Dodge, NASA/HQ, Mr. U. Reed Barnett, Jr., and Mr. Frank W. Horn, Jr., both of NASA/KSC have coordinated NASA's support to the development. Mr. Frederick C. Crosby of NOAA/NWS has coordinated NOAA's cooperation and provided operational testing of SFFS at the Ruskin WFO. Mr. Ferris G. Johnson, Jr. has coordinated the software development with recent programming support from Mr. Fred D. Stephens, Mr. Steven E. Lasley, Mr. Robert A. Dillon and Mr. Bogdan Pelszynski. Mr. Eugene H. Hannah and Mr. Michael P. Baker have developed the key station instrumentation and the latter has responsibility for the antenna system. Mrs. Alice E. Grimes has coordinated secretarial and bookkeeping activities with aid from Miss Cindy M. Weygant and Miss Nancy S. Guzman. Of the many who have contributed to SFFS development only those who constitute the very recent team effort have been named.

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APPENDIX 5

Japan Manuscript

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GAINESVILLE, FLORIDA 32611

October 2, 1981

Secretariat
1981 International Citrus Congress
c/o The Japan Association for
Advancement of Phyto-Regulators
1-26-6 Taito,
Taito-ku,
Tokyo 110, JAPAN

Dear Sir,

Enclosed please find the paper for presentation at the 1981 International Citrus Congress entitled, "A Weather Satellite System for Observing, Forecasting, and Displaying Cold Temperatures for Citrus Producing Areas". I apologize for getting this to you a few days late.

We will be replacing the copies of Figures 7 and 10 with photographs of the appropriate size.

Please do not hesitate to contact me if you have any questions. Thank you very much.

Sincerely,

John F. Gerber

John F. Gerber
Director, IFAS Grants

JFG.jdg
Enclosure

A Weather Satellite System for Observing, Forecasting, and Displaying Cold Temperatures for Citrus Producing Areas[1]

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Additional index words: Remote sensing, Microcomputers, Micrometeorology, Mesoclimatology.

Abstract. Thermal, infrared data are acquired from the NOAA geostationary satellite at 75°W. The data are processed by a minicomputer which generates a false-colored, thermal image geometrically arranged to represent citrus growing areas in Florida, USA. Spacial resolution is limited to about 8 Km^2 and thermal resolution at about 1°C. These data are available normally within one hour of observation. A library of software programs is used to manipulate the data and to forecast the expected temperatures for the rest of the night. The data can also be transmitted to local users over telephone lines and displayed with small microcomputers and television sets. The system operates under the control of the minicomputer which initiates the action to acquire the data, generates the thermal data arrays, and estimates future temperatures. The data are compared with automated ground truth stations to verify and improve both the observed and predicted data. The system was designed to assist weather forecasters, county extension staff, and citrus growers.

Forecasting and observing minimum temperatures for citrus producing areas is difficult because citrus growers need precision of $\pm$ 1°C. This precision is especially important if temperatures are expected to reach lethal thresholds (7). Forecast of low temperatures are verified by the minimum temperature observed at official sites in standard exposures.[2] These sites are limited in number and each may be choosen to represent an area of several 100 square Km. Forecast scoring is based upon the differences between the forecast and the observation. The predictions are for geographic regions or zones of 100's to 1000's of Km^2 and for official sites.

Citrus growers correlate the expected temperature in their orchard to the forecast for the region or zone. This correlation is based upon ambient temperatures observed in the orchard coupled with years of experience using both objective and subjective techniques.

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[1]Received for publication . Florida Agricultural Experiment Station Journal Series No. . Support for this work was provided by NASA contracts NAS10-9168 and NAS10-9892. Cooperation of NWS/NOAA was greatly appreciated.

[2]Standard exposures are with glass and alcohol minimum indicating thermometers exposed either in Standard Cotton Region Shelters or in Standard Fruit Forecast Shelters used by the USA, National Weather Service

Changes in policies of the weather forecasting services, in funding, in personnel, in observation sites, in urban development, and perhaps climate changes due to land use tend to confound and change the correlation between the observed and predicted temperature at official sites and zones and the observed orchard temperature. This tends to confuse and frustrate the citrus grower.

Areal temperature measurement and forecasts could improve the services to growers, but at prohibitive expense for an intense observational network. The preparation and dissemination of verbal or written forecasts in such detail would be impractical if not impossible.

Areal measurement and display of surface temperatures in real time sensed by weather satellites provide a technique to meet many of the needs of citrus growers for temperature information. The satellites are in place and are used for a multitude of purposes - cloud movement, storm tracking, wind fields, etc. Use for horticultural purposes is simply the exploitation of this existent technology and equipment.

Satellite Observation of Surface Temperature

The weather satellite data referred to are from the IR (Infrared) 10.5 to 12.6u radiometric teloscopes on the Geostationary Operational Environmental Satellite (GOES) (Fig. 1) series. These satellites are located at 75°W latitude, at an orbital height near 36,000 Km above the earth. They operate 24 hours per day, producing areal surface IR data for the entire hemisphere once each half hour. The satellite were launched by the NASA (National Aeronautic and Space Administration (NOAA). They are spin oriented and equipped with visible and infrared radiometers, VISSR described by Abbot (1). The IR sensors view the earth through a telescope which sweeps an 8 Km wide path across Florida from West to East. Analog data from the sensors are digitized to 256 levels by the National Environmental Satellite Service (NESS) of NOAA producing a temperature resolution of 0.5°C, and a spacial resolution of 8 Km x 8 Km for 4 Km^2 pixels. Over 3000 pixels are required to represent the State of Florida. This is equivalent to a surface temperature observational network 8 Km apart in the North-South and East-West direction. An entire earth frame consist of 1821 sweeps, (1821 resolutions of the satellite) and requires 18 minutes.

The data from the satellite are telementered to an earth station at Wallops Island, Virginia, USA, they are navigated and geometrically corrected for view angle distortion, changes in the satellite spin axis and retransmitted to the satellite for dissemination to users.

The satellite observed temperatures represent the integrated areal temperature for each 8 Km by 8 Km pixel. The pixels view a fixed geographic position on the surface and which does not move or change due to surface development. Drift and shift due to satellite orbital changes, and digitization cause movement of one unit even if adequate navigational data are supplied and properly used.

The data from the satellite can be transformed into a graphic representation of a plan map of the region. (Fig. 2). Image enhancement techniques are used to transform the shape into an almost exact outline of the geographic boundaries of Florida. Either colors, gray scales, or symbols (letters, numbers, etc.) can be used to represent classes of temperature by different colors because of ease in optical assimilation of the data. Thus, surface temperature patterns representing physiographic areas are portrayed as colored pixels on a color monitor representing the entire State of Florida. This includes all of the citrus and other horticultural producing regions. At a glance the observer can view temperature distribution, patterns, changes in boundaries for the entire state.

The surface temperatures as observed by the satellite have been repeatedly verified by ground truth transects (5,8), by automated surface stations, and by minimum temperature thermometers in both orchards and official sites (8,9) (Fig. 3). The thermal patterns which emerge have been found to be presistent for weeks and nights and have been used to do retrospective agroclimatic studies (4). They can be used as a basis for delineating forecast regions with specified thermal homogenity.

The satellite observational data is nominally available one hour after observation which is satisfactory for now cast of temperature as a weather element. Since the entire area is represented there is no interpolation. Forecasts made for expected changes in each pixel can be used to produce a similar false-colored thermal image of Florida for the entire nocturnal cold period. A physical cooling model (6,11) is used to predict temperature changes for 10 key locations using both satellite and surface weather element data (wind, net radiation, soil temperature, surface air profile temperatures). The 10 key stations were correlated with individual pixels to produce a map of the entire state.

Both the observational data and the forecast data can be communicated over telephone lines as digital data to inexpensive microcomputers. Selection of appropriate microcomputers such as the Apple II Plus[3] can be used to generate the false-colored thermal images on conventional home color television sets. (Fig. 4).

The system is called the Satellite Freeze Forecast System (SFFS). It was developed by the University of Florida in cooperation with NASA and NOAA. It is a highly flexible system which uses high technology (mini and microcomputers), existent satellite resources and a library of software application programs.

Most fruit and citrus growing regions of the world are viewed by GOES Weather Satellites (10). The SFFS system could be used with some modification in most citrus and fruit growing regions of the world.

In addition to low temperature freeze observation and forecasts other applications could include, chilling hour accumulation, climate data collection, and observations, high temperature stress, cloud pattern, storm tracks, rainfall (indirectly from cloudtop temperatures), etc. SFFS presently is limited to surface temperatures during clear weather. Microwave radiometry will eventually permit temperature measurement through clouds, and the Vertical Atmospheric Sounders (VAS) are already on board some satellites. The polar orbiting satellite (NOAA Series) could be used to provide high resolution IR (1 Km^2) but only 4 to 6 times per day.

Description of SFFS

The SFFS system (Fig. 5) consists of (1) the GOES satellite, (2) a minicomputer system, (3) automated surface weather stations, (4) communication links and, (5) software programs. A complete description of the system was made by Martsolf (8).

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[3]The name Apple, Apple computer and the Apple symbol are registered trademarks of Apple Computer, Inc. Their use in this manuscript are for illustrative purposes only and does not constitute endorsement.

The GOES satellites are spin oriented and stabilized weather satellites launched by NASA and operated by NOAA. Nominal location of the satellites used is 75°W longitude above the equator at 36,000 Km above the earths surface. The IR and visual data accumulated by the satellite during a scan of the earth disk are transmitted to the surface at high baud rates (gigahertz). These raw data must be navigated to proper earth orientation because the satellite progresses in orbit, the orbit is not perfectly circular, or oriented latitudinally and the spin axis orientation shifts. In addition, to the navigation, the data are geometrically corrected for view angle. The navigated, corrected data and the navigation information are retransmitted to the satellite and rebroadcast to various users.

The NESS acquires these data and routes them to NWS/IBM 360 computer which removes a sector representing Florida and places it in computer quere.

Two Hewlett Packard 1000 series minicomputer systems make up the heart of the SFFS. (Fig. 6). One system is located at the NWS office in Ruskin, Florida, USA. The other computer is located in the Department of Fruit Crops at the University of Florida which is the development system and is also used for backup. The two computers are linked with a distributed, real time operating system (RTE-IVB and DS/1000). Both computers are equipped with tape drives, hard disks, communication modems and a color red-green-blue monitor. These computers via software and hardware control the digital telephone communications and acquire the satellite and key station data automatically.

Ten automated, microprocessor controlled weather stations are used to observe, store and furnish weather data over telephone links (Fig. 7). The microprocessor package (Darcom model D303's) was not designed for weather purposes, but has been a satisfactory, low cost method of observing and acquiring wind, temperature, humidity and radiation data. The package includes a dial-up modem which dumps data to the minicomputer when called with the proper security codes. Tampering with the stations sets flags to avoid spurious data.

The communications links consists of standard, voice grade telephone lines. The minicomputers are equipped with auto dialers and 1200 and 300 baud rate modems. Software programs control the communications. The NWS satellite data is acquired over a 1200 baud link. The software programs repeats the call if a connection is not made. The 10 key stations are dialed automatically over the 300 baud link. Since the data set from the key stations is msall the slower baud rates do not constitute a problem. The satellite data requires 3.25 minutes to transfer a thermal data set. Each key station requires 45 seconds to transfer data. These stations are interrogated hourly. Three attempts are made to acquire the data. During the past season (1980-81) data from the key stations were acquired 96% of the time.

Software programs are responsible for the coordination and operation of the entire SFFS. They control the data acquisition communication and product generation. The satellite IR data are scaled, arranged in class intervals and color assigned. The data are used to create an observed, false-colored thermal image of Florida with the time and date and a color temperature key. (Fig. 2). The range of temperatures and the colors assigned can be changed by the operator to isolate certain temperature ranges. Eight temperature color classes can be used. Enlargement of a specified area is made by positioning a white rectangular outline over the image. The enlargement is variable (2x to 9x). The enlarged rectangle appears in the upper right hand corner of the display. (Fig. 8). Two thermal maps can be displayed simultaneously on a split screen (Fig. 9). The observed thermal maps are nominally available one hour after observations, however, this could be sooner if satellite data were available more rapidly.

Predicted thermal maps of Florida are produced by the software. Data from the satellite and the key stations are used with a physical cooling model to estimate the minimum and hourly temperatures for the entire night. These data are correlated with pixel temperatures and the key station temperatures to produce a false-colored thermal map of Florida. If red-green-blue color monitor is not available a standard (NTSC) color television signal is produced which can be viewed on a home television receiver. The data can be printed as hard copy (Fig. 10) using symbols because the system is not limited to 8 thermal levels.

A summary of the 10 key stations is printed as acquired (Table 1) so the measured weather elements are recorded and updated immediately. These data are valuable to verify the satellite observational data and for planning and mangement purposes following cold weather.

The software library includes programs for evaluation and analysis of the data. Temperature difference maps, cooling rates and persistent cold areas can be obtained from the software. The operator has control of the SFFS through the keyboard software and can intervene or can allow the system to operate automatically.

Future Developments

The SFFS was designed to assist weather forecasters, extension specialists, extension agents and growers. A pilot effort is underway to transmit the thermal images to county extension offices. The commercial television signal could be communicated, but would require costly coxial cable or microwave links and would not allow local manipulation of the product. Software programs have been developed to use microcomputers (Apple-II Plus) to acquire the thermal and weather data over telephone lines and display the thermal maps on home color television sets. This has been successfully demonstrated in the 1980-81 cold season. This network will be expanded to 5 counties, communication rates will be enhanced (300 baud to 1200 baud) and additional software developed. The present microcomputers have color compatibility limitations but the products are of acceptable quality.

A direct satellite antenna link will be tested during the 1981-82 cold season. This link will intercept the stretched VISSR data and reduce the time delays in processing and sectorizing by NESS and NWS. In addition, it may reduce expensive long distance telephone lines. The main advantage would be more timely data. The problems of handling the data stream with the present minicomputer system are a major part of the present testing program. Additional software and hardware may be required.

A two year study of the applicability of SFFS to other regions is nearing completion. The preliminary indications are encouraging and lead us to conclude that SFFS may be useful at higher latitudes in areas with high topographic relief.

During the severe freezes in January 1981 in Florida, the satellite observed temperatures were lower than expected. Subsequent examination of surface data and of specific location in identified pixels tend to be in agreement ($\pm$ 1°C) with surface observations. These data combined work done by our colleague Dr. E. Chen (3,4) indicate that satellite data have excellent potential for delineation of agroclimate zones and for the identification of persistent cold and warm locations.

The thermal inertia of the earths surface is closely related to the maximum and minimum temperatures. Diurnal satellite observations should permit the estimation and mapping of the thermal inertia classes of the surface and charges caused by rainfall, foliage, cultivation, etc. These data could significantly assist the forecasters skills and estimates of departures from climatic norms.

As forecasters develop skill in using SFFS, forecast scores and verification could become more closely tied to forecasts and observed temperatures for specific regions and areas, as delineated by SFFS thermal images. Coupled with satellite defined climatic zones in important citrus producing regions the SFFS should assist in the development of more meaningful and accurate temperature observations, warnings and forecasts for citrus and other horticultural producers.

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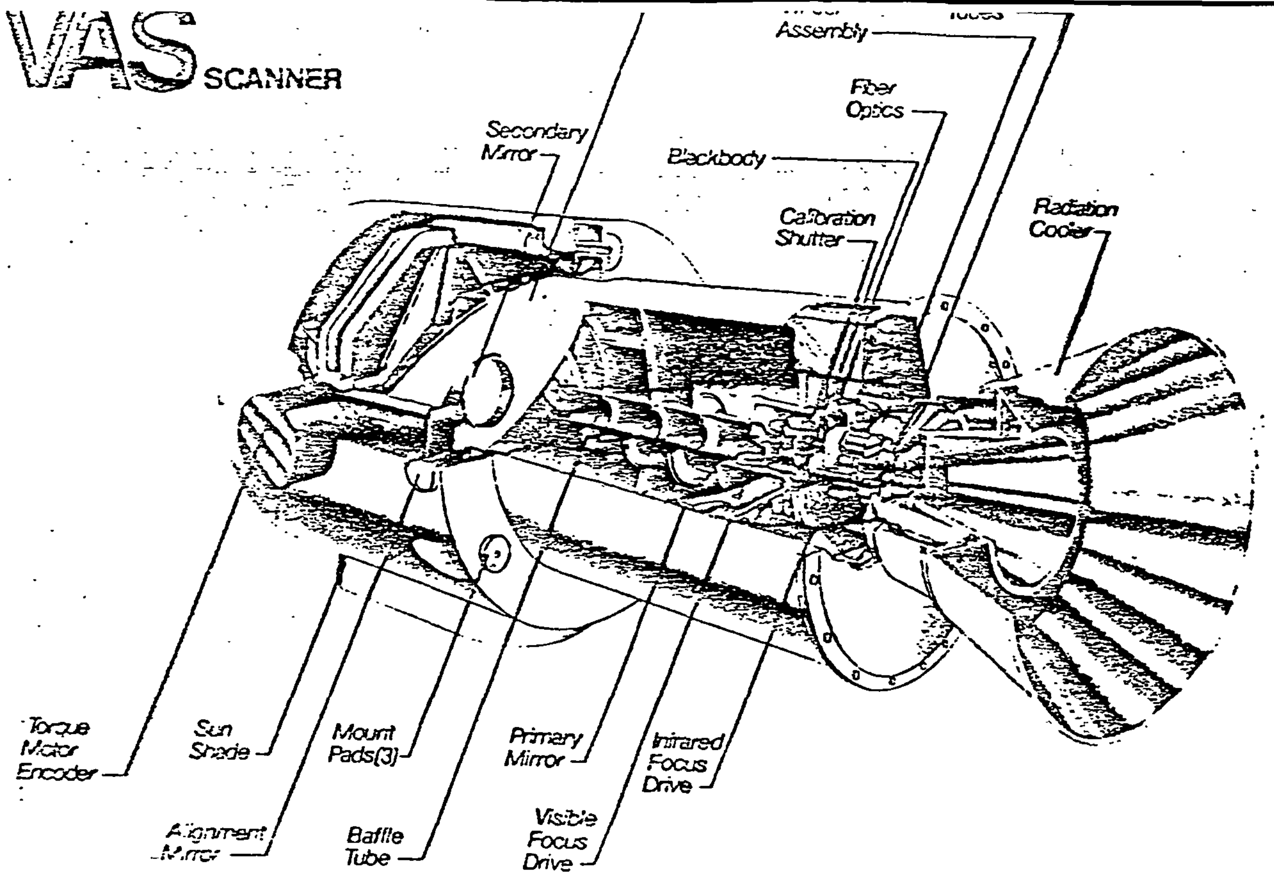

Fig. 1. Is a line drawing of the GOES-D satellite presently in geosynchronous orbit over the equator at 75°W latitude. Orbital height is 36,000 Km above the surface. The satellite is spin stabilized. The infrared data from the satellite is used by SFFS to produce a false-colored thermal image of Florida.

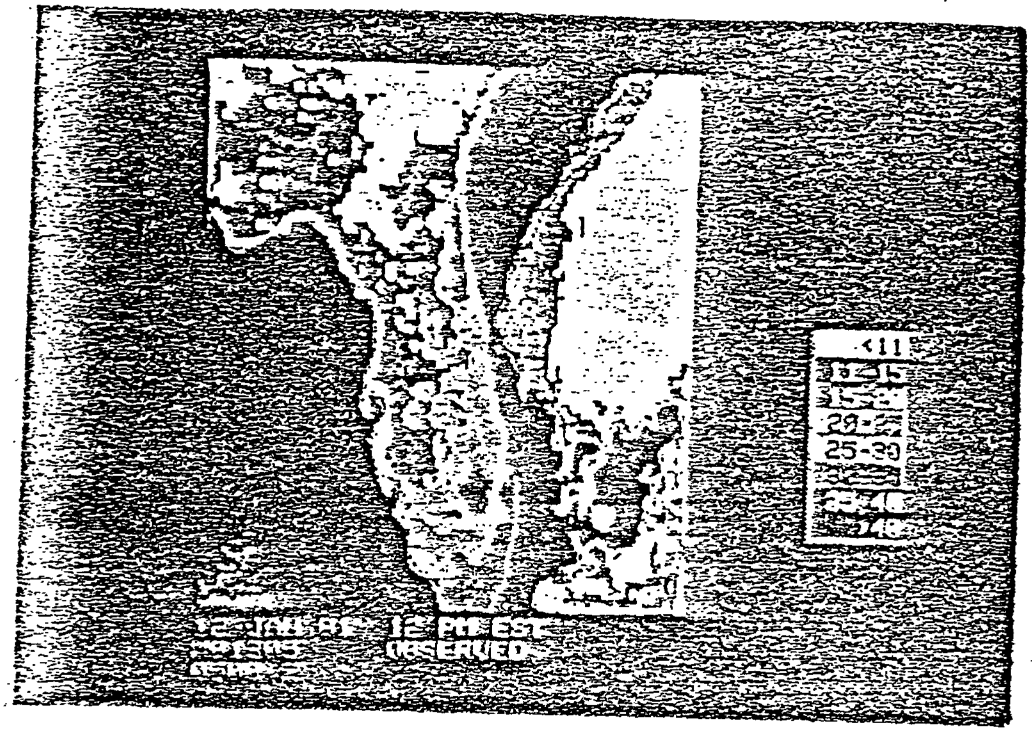

Fig. 2. A photograph of a geometrical image of Florida created from infrared data from the GOES-D satellite. The boundary outlines are derived from thermal discounties between the ocean and gulf waters and the land. The temperature classes are displayed in color on a video monitor.

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JANUARY 13, 1981 6:00 A.M.

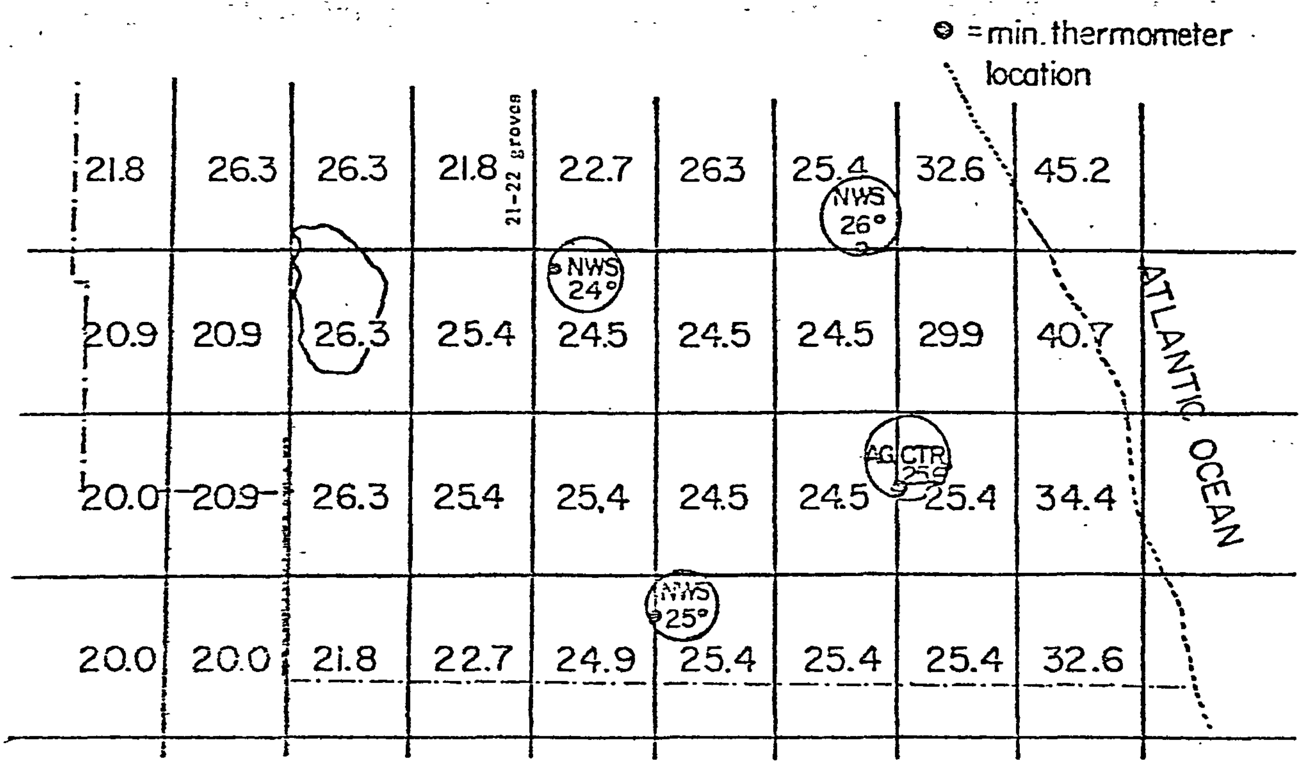

Fig. 3. A comparison of observed temperature from satellite data pixels (rectangular outlines) and surface shelter (1.5M) height exposures (Circled numbers).

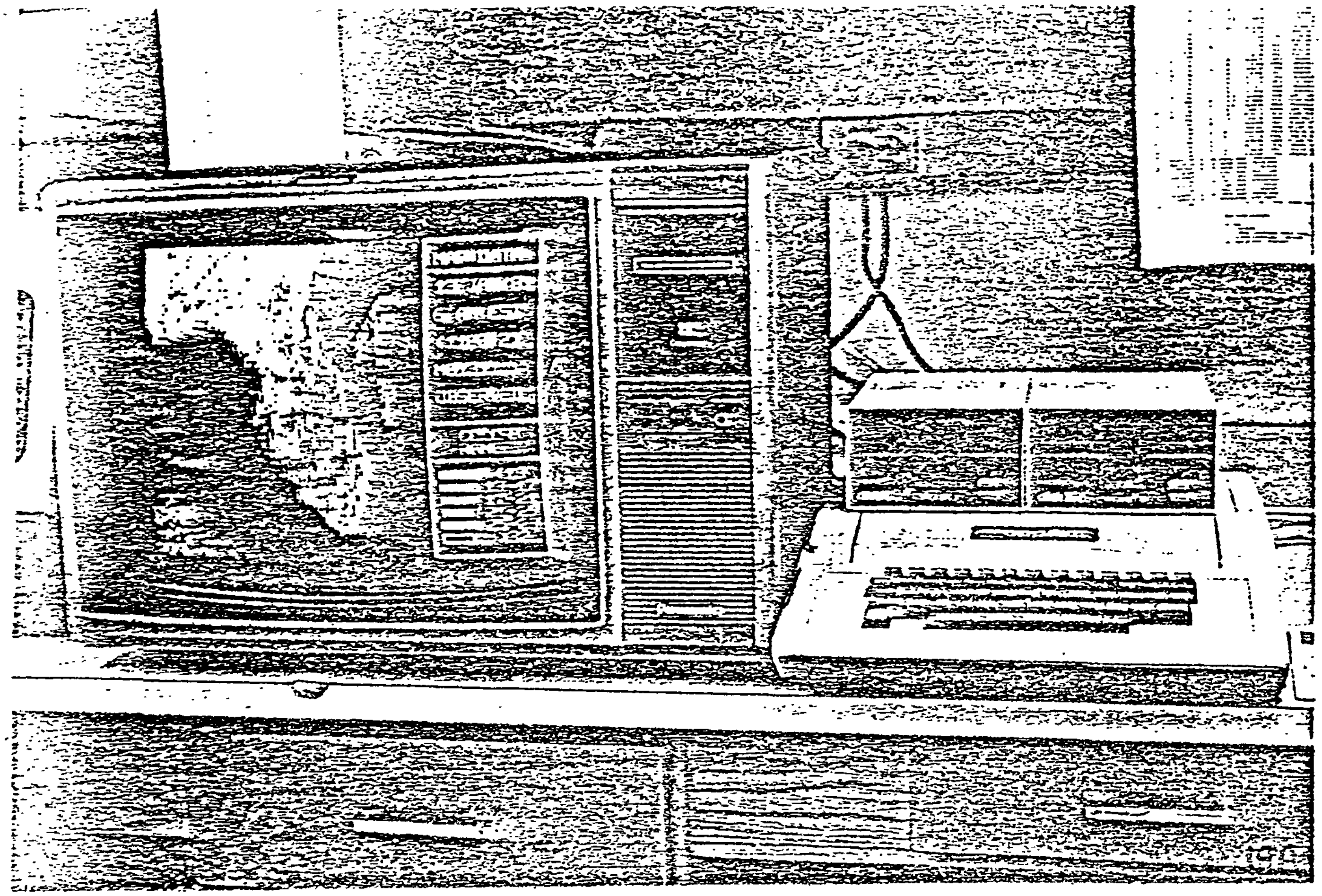

Fig. 4. A photograph of an Apple microcomputer, disk drive and television monitor used to display the false-colored thermal images in county extension offices. The data is transferred from the SFFS computers to the microcomputers by telephone lines.

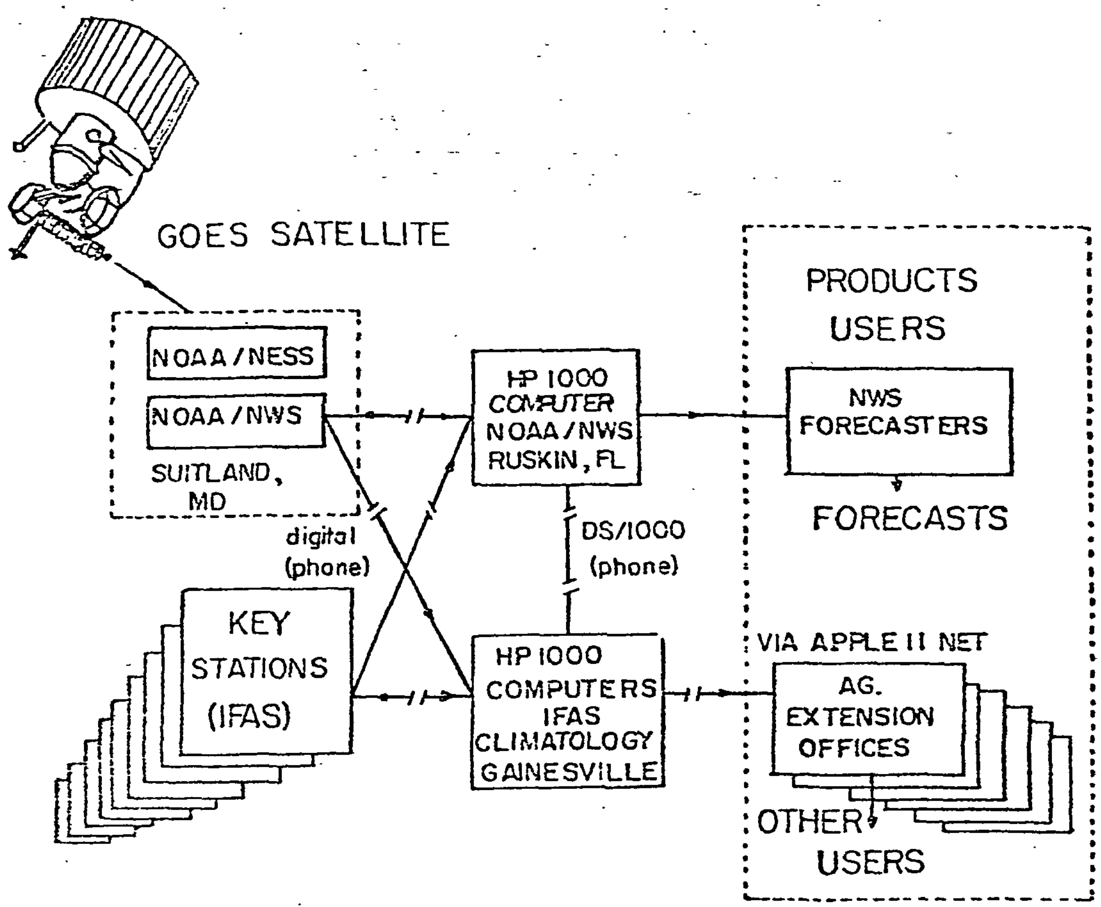

Fig. 5. A black diagram of the Satellite Freeze Forecast System (SFFS).

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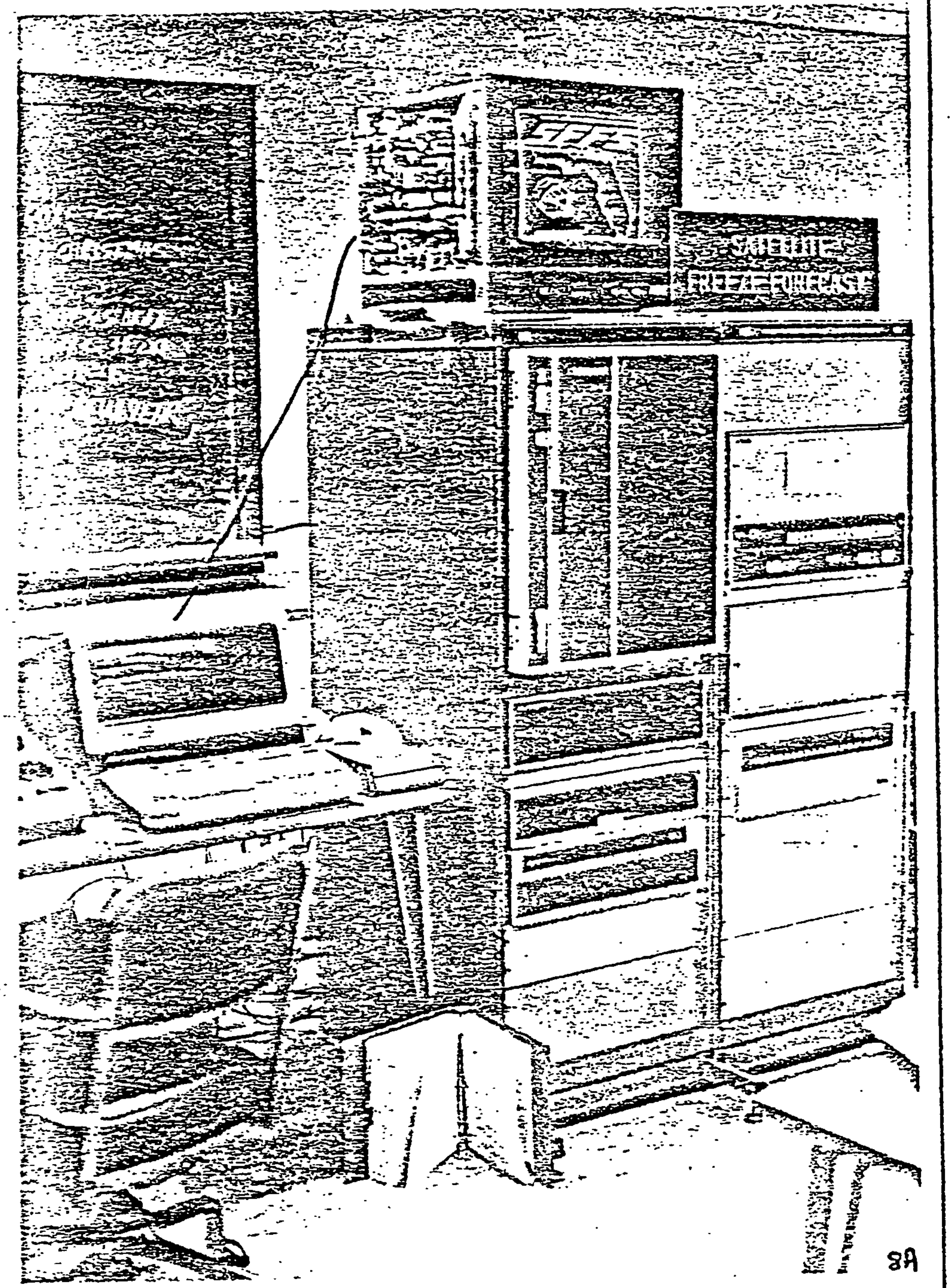

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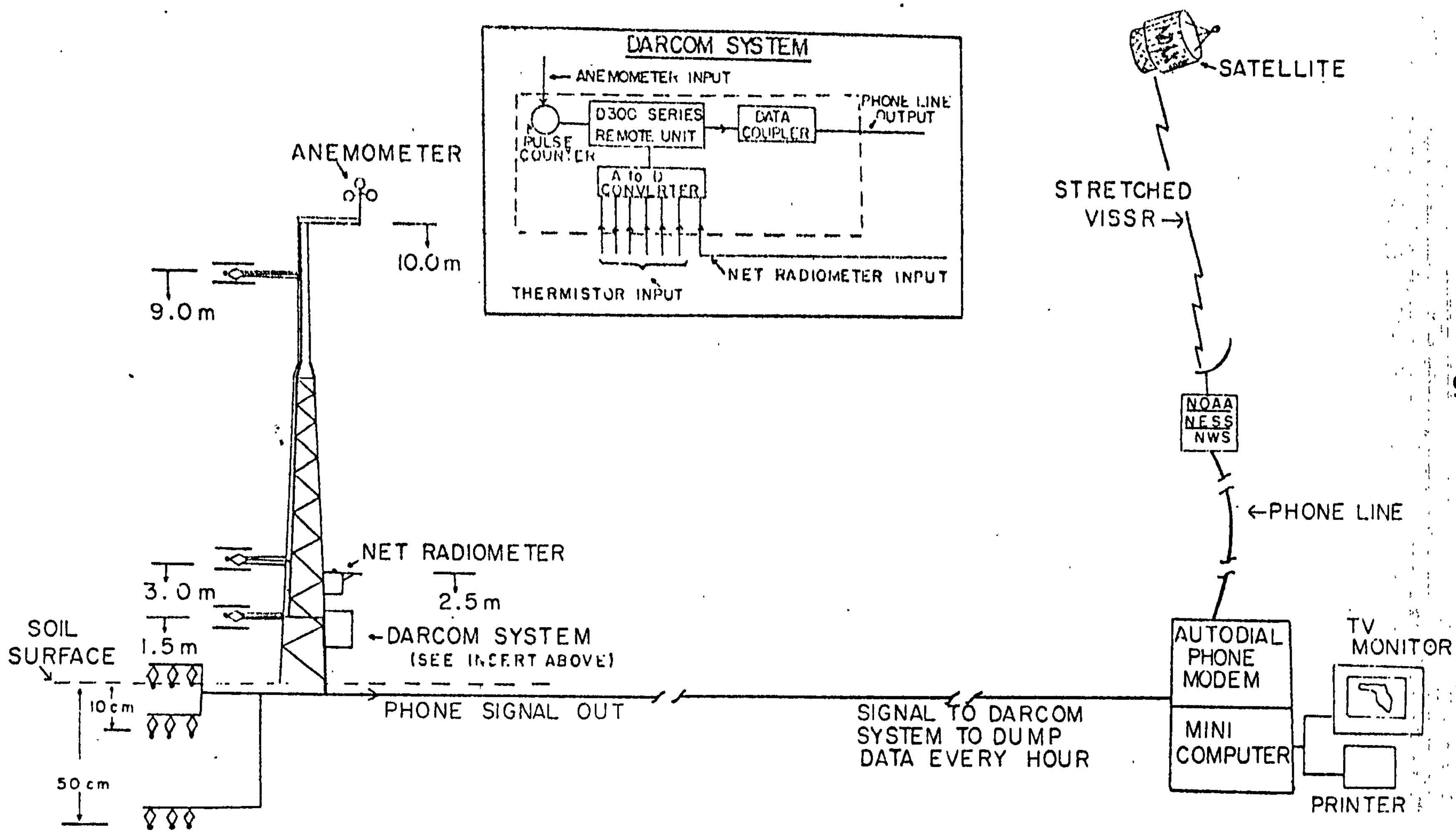
Fig. 6. Satellite Freeze Forecast System Hewlett Packard 1000 series minicomputer.


DARCOM SYSTEM
ANEMOMETER INPUT
PULSE COUNTER
D30C SERIES REMOTE UNIT
DATA COUPLER
PHONE LINE OUTPUT
A to D CONVERTER
THERMISTOR INPUT
NET RADIOMETER INPUT
ANEMOMETER
10.0 m
9.0 m
NET RADIOMETER
3.0 m
2.5 m
SOIL SURFACE
1.5 m
DARCOM SYSTEM
(SEE INSERT ABOVE)
10 cm
50 cm
PHONE SIGNAL OUT
SIGNAL TO DARCOM SYSTEM TO DUMP DATA EVERY HOUR
SATELLITE
STRETCHED VISSR
NOAA
NESS
NWS
PHONE LINE
AUTODIAL PHONE MODEM
MINI COMPUTER
TV MONITOR
PRINTER

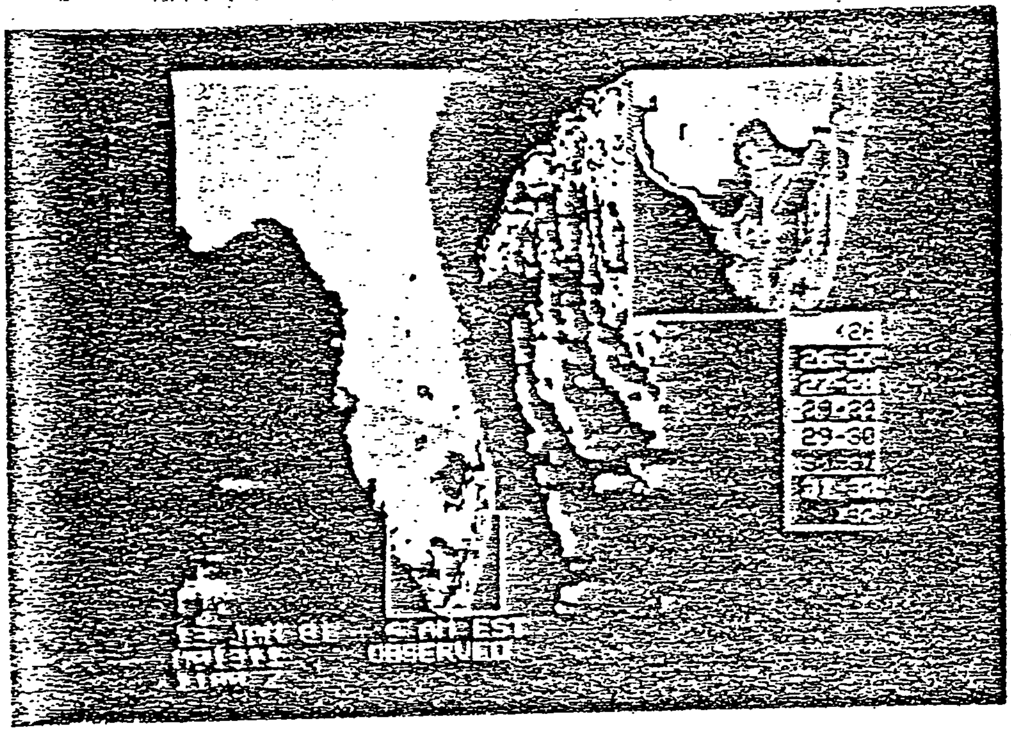


Fig. 8. A false-colored thermal image of Florida with an enlargement of section enclosed by the white rectangular outline displayed in the upper right hand corner. Note: the resolution of individual pixels is unchanged, but visual resolution is enhanced.

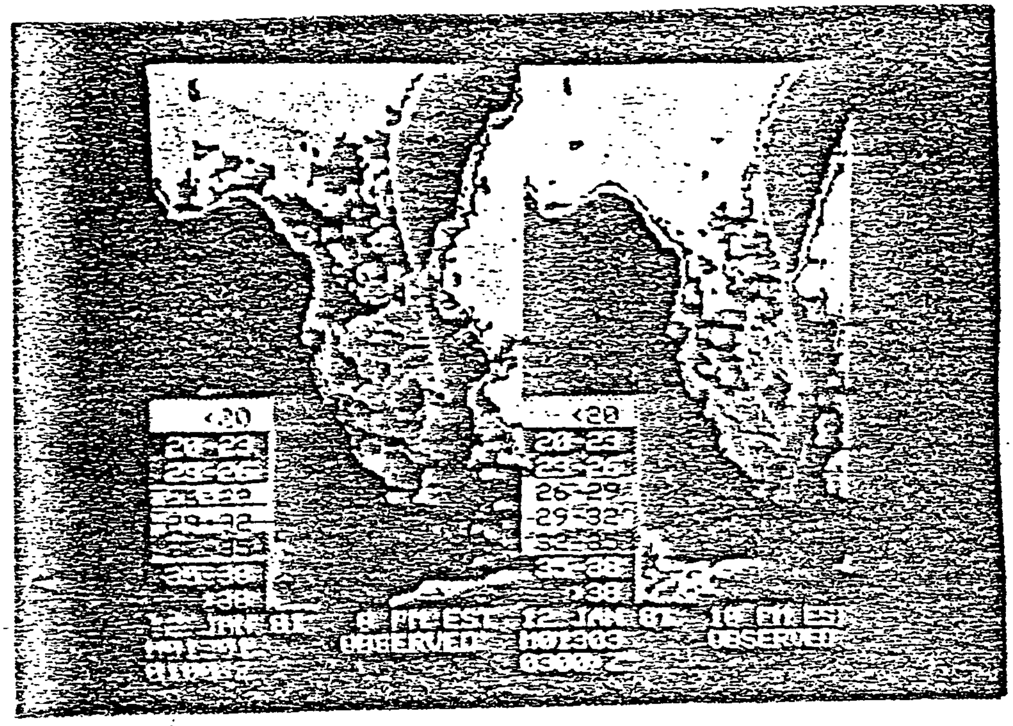
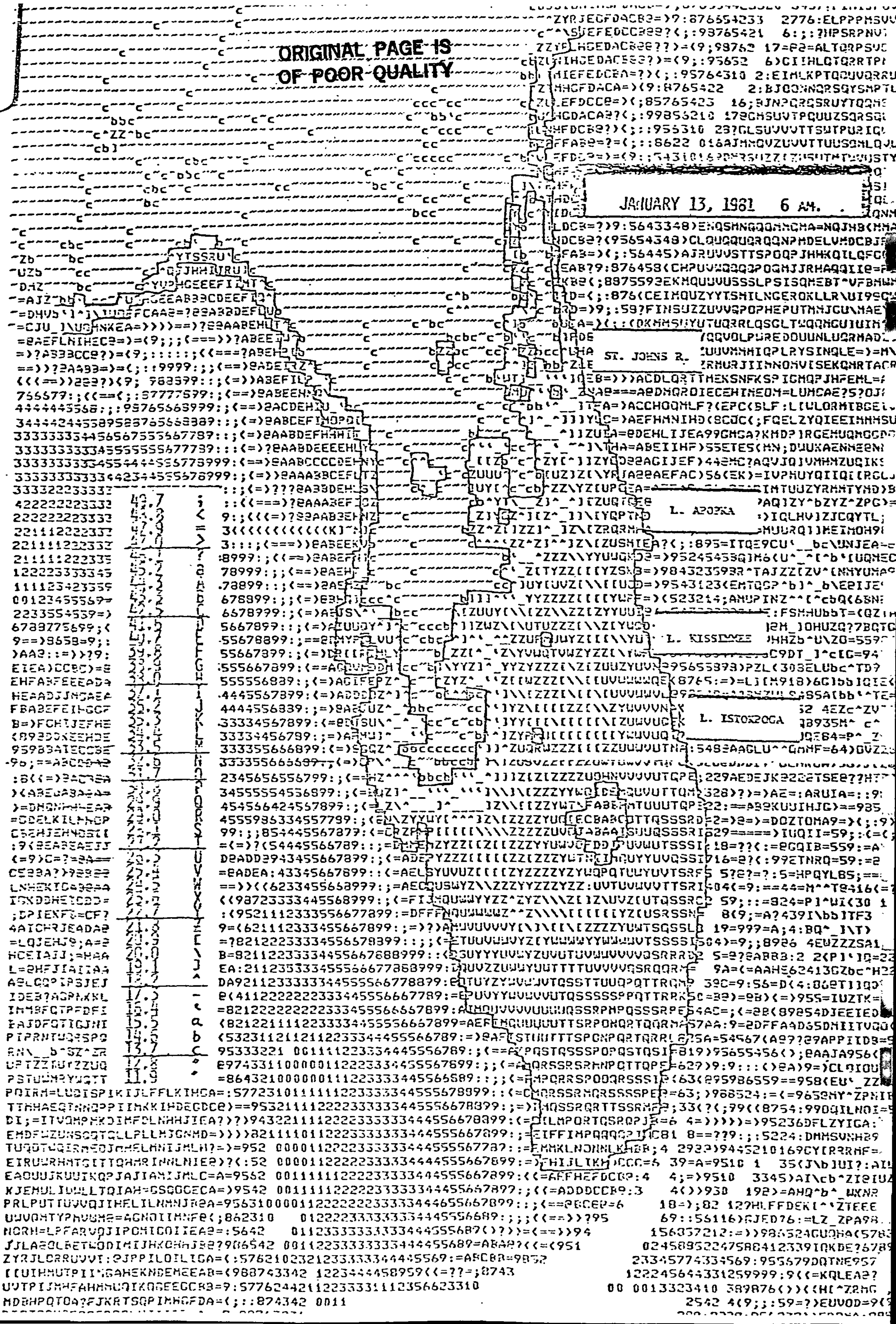


Fig. 9. False colored images of Florida from 8 and 10 PM EST (20:00 and 22:00) displayed simultaneously to portray rates of cooling and changes in cold areas.


JANUARY 13, 1981 6 AM.
ST. JOHNS R.
L. APOPKA
L. KISSIMMEE
L. ISTOKPOGA

JAN. 12-13, 1981
1.5m air temperature (rounded to nearest degree F)

	18	19	20	21	22	23	00	01	02	03	04	05	06	07
Tallahassee	28	26	24	18	14	13	16	14	11	10	10	8	7	7
Jacksonville	27	24	17	20	18	13	16	15	13	9	13	13	11	11
Gainesville	30	26	20	19	18	16	14	14	13	12	11	10	10	9
Tavares	37	35	32	23	23	27	18	28	17	22	21	14	15	18
Ruskin	38	36	36	34	32	30	28	27	26	24	22	21	21	20
Arcadia	33	30	28	27	22	19	18	18	16	18	16	18	17	17
West Palm Beach	42	41	38	36	35	34	34	34	33	32	31	30	30	30
Belle Glade	40	39	37	37	36	36	35	35	35	34	34	33	33	32
Immokalee	36	35	32	36	31	29	27	23	22	22	22	20	20	20
Homestead	40	38	39	38	36	35	33	31	31	31	29	29	29	29

JAN. 13-14, 1981
1.5m air temperature (rounded to nearest degree F)

	18	19	20	21	22	23	00	01	02	03	04	05	06	07
Tallahassee	44	45	34	22	27	25	22	23	23	28	32	34	37	32
Jacksonville	39	30	30	34	19	31	30	29	29	29	29	28	27	28
Gainesville	38	35	33	28	22	20	20	20	20	20	20	20	21	27
Tavares	34	33	37	34	31	25	22	24	19	20	21	22	22	23
Ruskin	39	35	34	31	30	29	27	27	27	26	27	27	28	19
Arcadia	39	41	37	29	28	27	22	22	21	20	19	18	19	20
West Palm Beach	47	47	46	44	43	41	41	39	38	40	40	37	37	37
Belle Glade	41	38	38	36	35	32	33	33	33	33	31	30	30	31
Immokalee	42	37	34	31	28	27	31	30	27	26	28	28	30	30
Homestead	44	39	41	42	41	41	40	40	40	38	39	36	39	40

Table 1. Hourly air temperatures collected from the ten key stations by the SFFS computer and printed immediately.

OMIT TO END

APPENDIX 6

THE PENNSYLVANIA STATE UNIVERSITY
249 AGRICULTURAL ENGINEERING BUILDING
UNIVERSITY PARK, PENNSYLVANIA 16802

College of Agriculture
and
College of Engineering
Department of Agricultural Engineering

October 6, 1981

Dr. J. D. Martsolf
University of Florida
Institute of Food and
Agricultural Science
2121 HS/PF
Gainesville, Florida 32611

Dear Dave:

I am writing a letter to clarify a few points which we had discussed during our session in Gainesville last week. I personally thought that we had a very productive meeting relative to the conclusion of work on Phase II of the satellite freeze forecast project in which we have been involved.

As I have indicated to you several times over the past two years, I had much reservation relative to the possibility of using satellite freeze forecast technology in mountainous regions such as Pennsylvania. As was evident, I assume, by the final report which I sent you and by our lengthly discussions during the time that I was in Gainesville I have certainly altered this opinion. I do, in fact, now feel very hopeful that this technology can be successfully applied to Pennsylvania as well as other states in the Northeast region of the United States. There are a number of developments which have indicated the possibility of applying this technology to Pennsylvania and surrounding area fruit growers.

As we have discussed, there is considerable interest at this institution in the development of a computerized information dissemination network for use by both county extension offices and by individual fruit growers and farmers. This network will lend itself very well to the transfer of technology and predictions arising from satellite forecast methods.

Work which you had previously conducted while at The Pennsylvania State University and which has been referred to in the final composite report for this project has indicated extreme temperature variations over a traverse of about 18° Fahr. These variations were again supported by studies which were conducted in Pennsylvania during Phase I of the current project. These studies have all shown that there is, in fact, a very significant temperature variation with topological changes. Even with these variations, however, it has been possible to very accurately predict night time temperatures for one particular station such as was used in Phase II of this project.

At the present time, I am attempting to gather resources sufficient to allow a proposal for additional research in the area of application of satellite freeze forecast technology. The most pressing need, in my opinion, is to use a minimum of three climatological stations for gathering data needed for input to the P-model. By gathering such information from these three stations and making predictions at various locations in the state of Pennsylvania, a further analysis of the applicability of the P-model will be possible. It is also believed feasible to attempt to adjust the model for topological and climatic histories for these stations. It would be possible to obtain some of the climatological data needed from archived records, but the total inputs which would be desirable for the P-model are not available to the best of my knowledge.

Having either used archive or newly collected data and obtained a new set of predictions for the P-model, the next step for the project would be to provide a technique for real time application of said P-model or an alternate form of forecasting.

As I discussed with you while in Gainesville, presumably The Pennsylvania State University might be very much interested in attempting to procure real time satellite data from the down-link capability for stationary satellite data acquisition which you are developing at the University of Florida. This information could be sectorized and transmitted to Pennsylvania on a contractual arrangement if agreeable with your organization. Having obtained in a timely fashion the appropriate satellite data, the P-model would be run in Pennsylvania and forecasts made readily available to fruit growers through an information distribution network which is concurrently being developed.

In order for this scheme to be feasible, it is necessary that cooperation does exist between The Pennsylvania State University and the University of Florida. We would very much like to explore a method by which it would be possible for us to obtain a listing and/or magnetic tape of the P-model in the form currently being used at the University of Florida. In addition, we would also like to explore the probable cost for obtaining real time sectorized data from the stationary satellites once your antenna system and data reduction capability is operational.

Attached to this letter, I have indicated the resources which are available at The Pennsylvania State University for coming to bear with this problem. We will actively explore the possibility of submitting a proposal for continuation of this work. I would welcome any suggestions you may have in that regard. We are very anxious to cooperate with the University of Florida in this respect in any way possible.

Once again, I feel we have had a very productive project and am quite encouraged by the success which has been shown by Phase II of the freeze forecast technology research. I look forward to cooperating with you once again in the future and hope that we can identify some mechanism by which this research may be continued.

Sincerely yours,

Terry

C. T. Morrow
Assoc. Prof.

CTM/ds

cc: H. V. Walton

Attachment

SATELLITE FROST FORECAST TECHNOLOGY

APPLIED TO PENNSYLVANIA

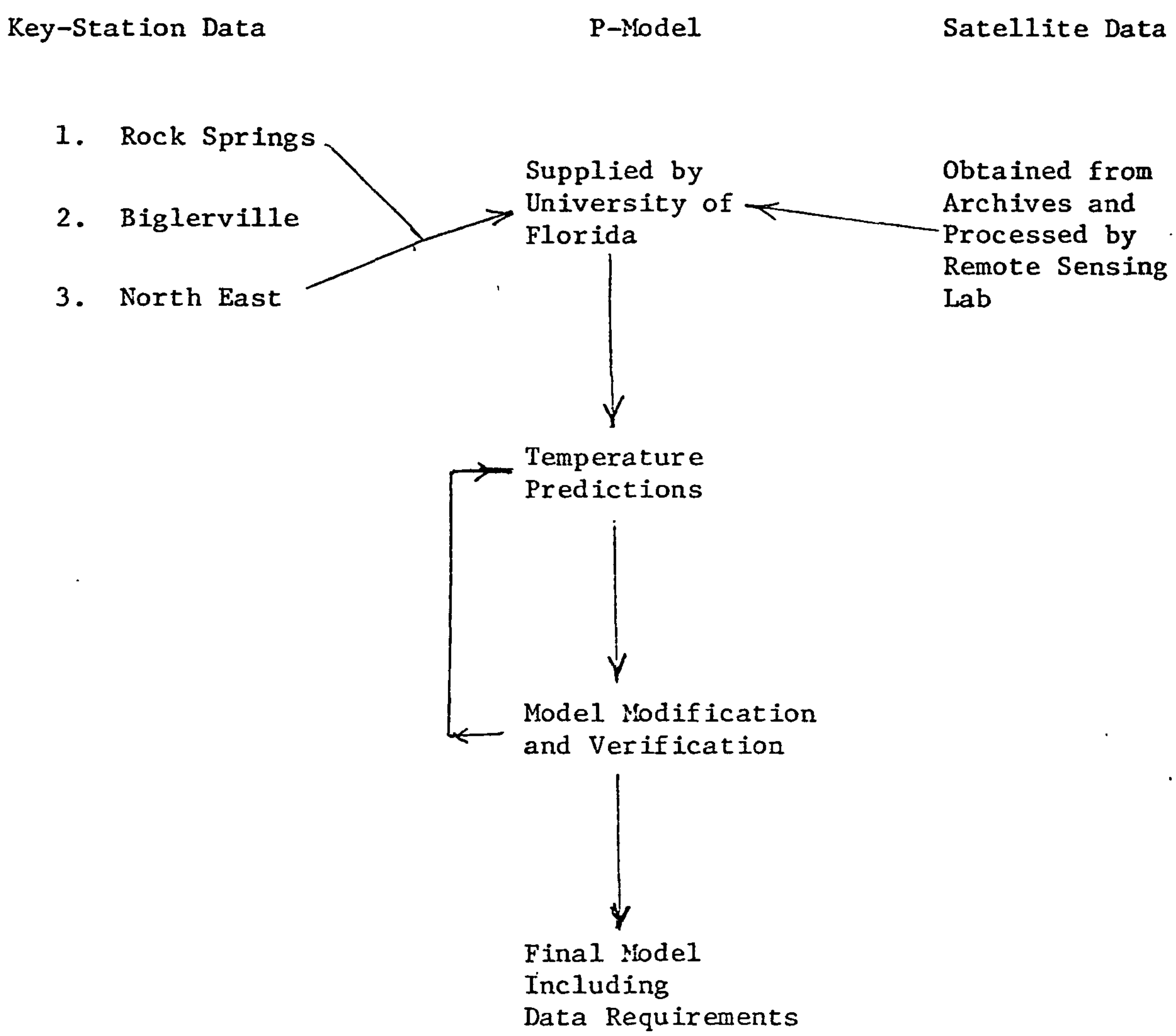
FOR MULTI-TASK AGRICULTURAL FORECASTING

I. Research Team

Name	Credentials	Specialty	Departmental Affiliation	Location
C. Morrow	Ph.D, P.E.	Engineering Team Leader	Agricultural Engineering	University Park
J. Russo	Ph.D	Climatology	Horticulture	University Park
C. Ritter	Ph.D	Pomology Extension	Horticulture	University Park
G. Hussey	Ph.D	Computers Information Network	College of Agriculture	University Park
G. Petersen	Ph.D	Remote Sensing Soil Genesis	Remote Sensing Lab, Agronomy	University Park
T. Carlson	Ph.D	Meteorology Remote Sensing	Meteorology Remote Sen. Lab	University Park
D. Thomson	Ph.D	Meteorology Instrumentation	Meteorology	University Park
G. Greene, II	Ph.D	Pomologist	Horticulture	Biglervill PA
G. Jubb, Jr.	Ph.D	Entomologist	Entomology	North East PA
S. Pennypacker	Ph.D	Plant Pathologist	Plant Pathologist	University Park

SATELLITE FROST FORECAST TECHNOLOGY
APPLIED TO PENNSYLVANIA
FOR MULTI-TASK AGRICULTURAL FORECASTING

II. Information Transfer for Phase I (Model Adaptation)



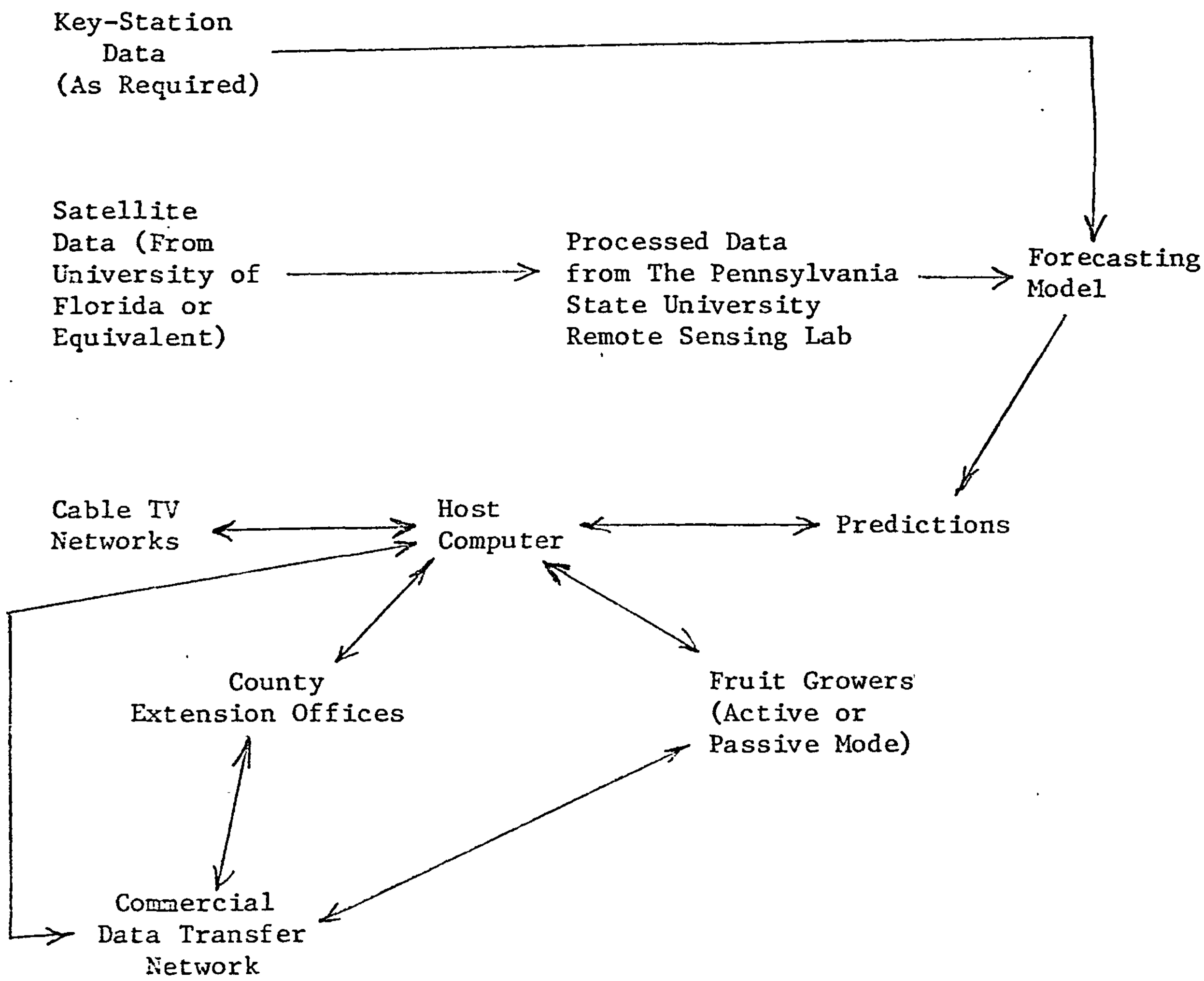
Note: Similar procedures to be followed for integrated pest management and similar applications.

SATELLITE FROST FORECAST TECHNOLOGY

APPLIED TO PENNSYLVANIA

FOR MULTI-TASK AGRICULTURAL FORECASTING

III. Real-Time Forecasting System



Note: Exact nature of outward links from host computer will be finalized during the course of the research project.