Climate of the lower Peace River Region

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WEATHER FEATURES

Favorable for crop growth:

- Summers are very warm: the mean temperature in July is 61.2 F.
- Precipitation is low, but over half of it falls during the growing season, when plants need it and the soil is most receptive.
- Long summer days promote development and fruiting so that crops can mature within the short season.
- Low wind speeds help to minimize evaporation, and keep valuable moisture in the soil and plants.
- A stable snow cover protects roots and low plants during the cold, dry winter.

Unfavorable for crop growth and for livestock:

- Summer drought, which occurs frequently, greatly limits crop production.
- Frost in late summer and early autumn sometimes severely damages the crops.
- The long nights and bitter cold of winter cause extreme discomfort to animals and man. The sub-zero cold also prohibits the growth of many kinds of plants.
- The short growing season limits the kinds of plants that can be grown, and makes the feeding period for livestock long.

CLIMATE OF THE LOWER PEACE RIVER REGION[1]

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The lower Peace River region is a vast tract of country extending from just west of Fort Nelson southeastwardly to just beyond Fort McMurray. In the center is Fort Vermilion. The region is 200 miles wide from north to south and 500 miles long. Most of the country is quite flat, with an elevation of 1000 to 1500 feet above sea level (Figure 1). This large plain-like area is interspersed with ranges of rounded hills, whose elevation seldom exceeds 3000 feet. In the northwest are the Cameron Hills, the north center the Caribou Mountains, the south center the Buffalo Head Hills, and the east the Birch Mountains. None of these upland ranges is sufficiently pronounced to produce much effect on the climate of the region.

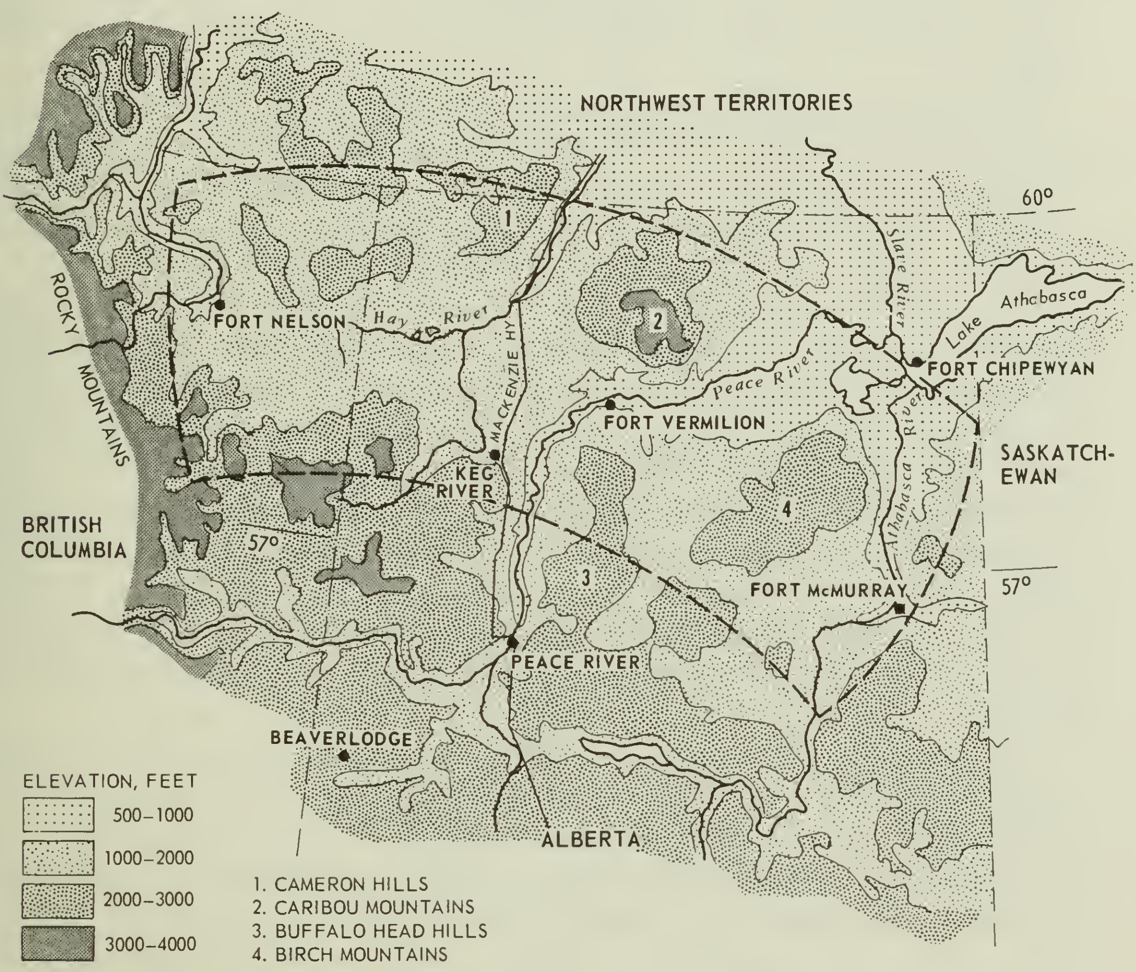

Figure 1. The lower Peace River region in northern Alberta and northeastern British Columbia.

[1]NRG No. 70-2

Although most of the region lies between 57° and 60° N latitude and is far from the influence of the warm Pacific Ocean, the area is well suited for the production of many agricultural crops. Indeed, parts of the area have a better climate than the regions farther south, partly because of the low elevation, and partly because of the long summer days that prevail when most needed for crop growth and development. It is possible to mature cucumbers, corn, tomatoes, and other warm-season crops in most years in most localities, whereas several hundred miles south, in the upper Peace River region, these crops can be grown only in very favored locations. The yields of cereal and legume seed crops compare favorably with those grown farther south (Carder, 1965a). With proper management, wheat averages 25 bushels per acre, barley 40 bushels, oats 55 bushels, flax 12 bushels, rapeseed 25 bushels, and alfalfa seed 200 pounds per acre.

About 250,000 acres of land are under cultivation in the region. Most of this is in the central part, particularly in the Fort Vermilion area. This acreage, however, is only a fraction of what could feasibly be brought under cultivation. Surveys indicate a potential of at least 6 million acres, much of which is located in the central section, but about 1 million acres are located in the western or Fort Nelson section.

In winter the region is dominated by a continental arctic air mass, which is cold and dry, but in summer more maritime air prevails, which fortunately increases chances for precipitation. In winter the storm tracks are feeble and move over the region in a northwest to southeast direction, whereas in summer they shift to the northeast and in so doing cause more air to move in from the south and west. This air, originally from the Pacific Ocean, is warmer and moister than the continental arctic air. The hot, dry continental air from the United States, prevalent south of the area and sometimes so dry that it withers vegetation, never reaches the region.

Because of the region's quite northern location, warmth in spring and fall is of high value, especially in fall when the crop is ripening. Therefore, the effects of local geographical and topographical features become significant. The slopes affording good air drainage and locations along the major rivers and lakes are definitely favorable for agriculture. Athabasca Lake, in the northeast, exerts a warming effect over a wide area. In spring its influence is reversed, because the air is chilled by melting ice. However, low temperatures in spring are not as critical as in autumn.

Meteorological data from several sources in the region were used to assess the climate. Data from Fort Nelson, Fort Vermilion, and Fort McMurray were most often used, because these three points represent the area very suitably. Records from Keg River in the south-central part and from Fort Chipewyan in the northeast were also used. These data show the climate to be very uniform for agriculture. Because the records from Fort Vermilion were the most comprehensive available, they were most often used to represent the climate of the region (Table 1). Moreover, Fort Vermilion is centrally located and much of the present and potential agricultural acreage is nearby.

Table 1. Monthly and annual weather records for Fort Vermilion (averages for the number of years of records)

	Mean temperature, F		Degree-days above		Precipitation, inches		Evaporation,† inches	Bright sunshine, hours daily	Wind, mph
	Air	Soil*	42 F	50 F	Total	Snow			
Number of years of records:	30	9	30	30	30	30	9	30	7
January	−8.9	21.0			0.84	8.2		2.2	5.5
February	−2.2	22.7			0.83	8.5		3.6	5.6
March	12.8	25.2			0.79	7.8		5.5	6.9
April	33.3	33.3	34.7	4.3	0.63	4.2		7.5	6.9
May	49.5	48.1	251.6	86.6	1.25	0.7	3.90	8.6	7.3
June	57.3	61.1	456.3	232.1	1.72	0.4	3.80	9.5	6.2
July	61.2	66.1	616.9	370.7	2.47		3.75	9.6	5.9
August	58.5	63.3	511.2	271.3	1.83		3.25	8.3	5.3
September	48.2	50.7	219.5	67.8	1.19	0.2	2.40	5.4	5.9
October	35.2	38.5	40.7	5.6	0.85	4.4		3.9	6.9
November	12.3	28.7			0.90	8.1		2.0	5.9
December	−3.2	23.6			1.01	10.0		1.0	4.7
Year	29.5	40.2	2130.9	1038.4	14.31	52.5	17.10	5.6	6.1

*Four inches below clipped grass sward.

†From 4-foot sunken tank.

HIGHLIGHTS

The lower Peace River region has a continental climate because it is situated east of the Rocky Mountains, 400 to 700 miles from the Pacific Ocean, and some 700 miles from the usually frozen Arctic Ocean. Therefore, extremes of weather are common and can be quite irregular in occurrence. From the standpoint of growing crops the greatest shortcoming is not lack of warmth, as may be supposed, but lack of moisture. Precipitation decreases north of central Alberta: the average annual precipitation at Fort Vermilion is 14.3 inches, at Beaverlodge is 18.5 inches, and at Edmonton is 17.6 inches. Also, precipitation occurs irregularly, varying at any one location from as little as 9 inches to over 20 inches. Because of continental conditions, precipitation may occur anytime, during high summer when it is much needed or in fall when not wanted at all. The amount of moisture taken up by the soil is lower than the actual rainfall because about a third of the precipitation occurs in winter, when the ground is frozen and unreceptive to water. Fortunately, this condition is relieved in the spring, when the sandy loam soil permits good percolation of snowmelt so that almost half of the winter's precipitation enters the soil for the benefit of crops.

Warmth, though usually adequate in summer for the growth of crops, can, like moisture, be quite erratic in its occurrence. The region is exposed to surges of cold air from the Arctic so that very unseasonable conditions do occasionally occur. In late summer these cold blasts sometimes bring damaging frosts. This movement of cold northern air limits the length of the growing season. However, the long summer days associated with northern latitudes stimulate most types of crop to rapid development so that a long frost-free season is not necessary for them to mature (Valle and Carder, 1962).

Although the topography of the countryside is flat, flooding is rare, mostly because of the low precipitation and the sandy, loamy, and friable soil where water can readily percolate. However, wet spells in late summer can induce poor harvest conditions, which, if prolonged, may add to the difficulties associated with snow and icing.

The severest tests for humans and livestock are the long spells of bitter cold. Fortunately winter winds are light or often absent. Storms are rare, partly because of the absence of major storm tracks across the region and the presence of forests. Serious freezing rain or ice storms seldom occur. Persistent heavy fogs are unknown, though thick morning fogs sometimes occur, particularly in the fall. During periods of extreme cold, ice fogs may form at night.

From mid-October to late April the ground is snow-covered almost continually as chinook winds are either feeble or do not occur. The snow cover benefits plant life, because the snow protects low-growing forms from the cold, and ensures that the branches and twigs of trees do not overly dry out and suffer damage as they sometimes do in areas subjected to strong chinooks. However, even feeble chinooks are welcomed by animals and man because of the warmth they bring.

Summer heat is seldom intense enough to form violent thunderstorms and so hail is rare.

Before the mid-1940's the climate tended to be warmer and moister, but since then it has been slightly cooler and precipitation has remained about the same.

AIR TEMPERATURE

Winters are cold, but summers are quite warm (Figure 2). The coldest day of the year is January 24, with a mean daily temperature of −14 F; the warmest day is July 18, with a mean of 63 F. The mean daily temperature falls below zero on December 5 and does not rise above it again until February 24. For most of July and the first 10 days of August the mean daily temperature is above 60 F. The temperature rises above freezing in mid-April and falls below it in late October. There is no January thaw as in the upper Peace River region, but instead a period of warming occurs in early February.

Mean daily maximum and minimum temperatures parallel the daily means. The daily fluctuation between the mean maximum and the mean minimum is usually greatest in summer, when the intensity of sunshine is highest.

Daily temperature extremes show that it is possible for frost to occur at almost any time of the year, except perhaps the first half of July. The period June 20 to August 10 is free from killing frosts. In January and February temperatures may drop below −60 F, whereas in late July they may soar above 95 F. Less than half the year is free from sub-zero temperatures, which may occur until the end of April and as early as mid-October. Very warm temperatures can occur in the winter: above 50 F has been recorded in January and February. The differences between daily extremes are much greater in winter than in summer. In winter, temperatures vary as much as 115 degrees, whereas in summer the maximum spread is only half this amount.

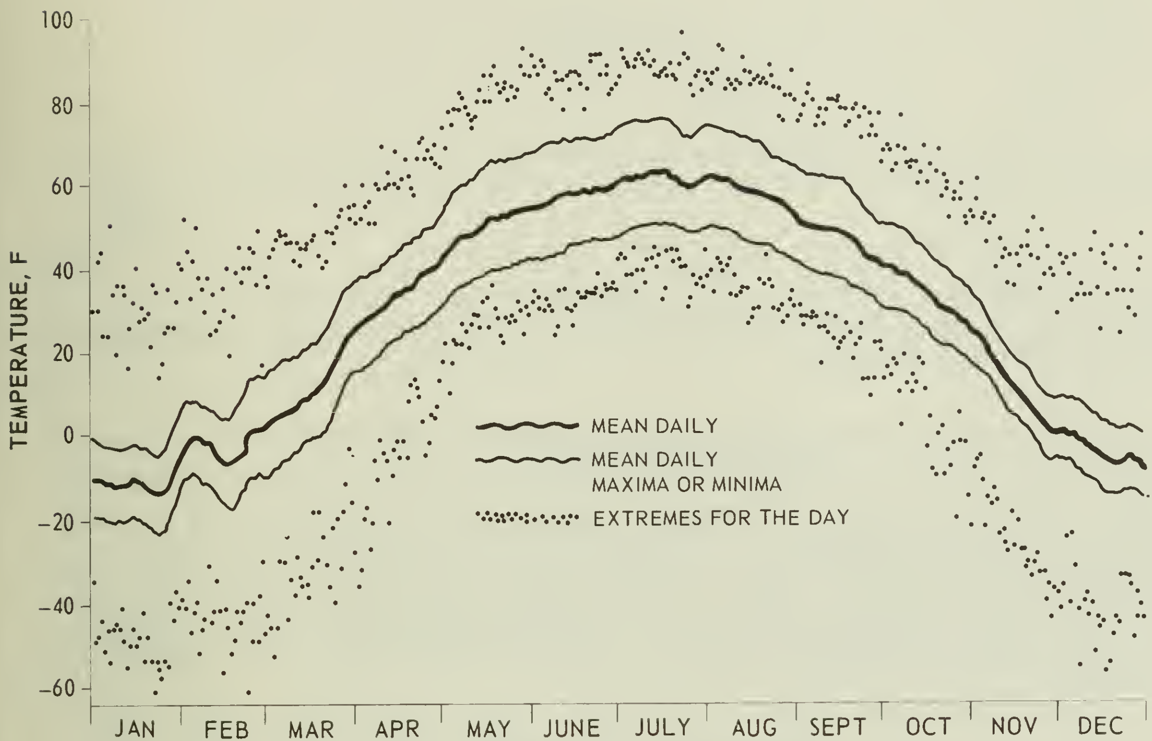

Figure 2. Daily temperatures at Fort Vermilion, 1948-67 (5-day running averages).

DEGREE-DAYS FOR GROWTH

To determine the growing season for cool-season crops, such as wheat, peas, carrots, and many others, it is customary to calculate the number of degree-days above 42 F. For example, for a day with a mean temperature of 43 F the number of degree-days above 42 is 1; for a day with a mean of 44 F, 2; and so on. The average number of these units at Fort Vermilion per year is 2131 (Table 1), which is 189 more than at Beaverlodge. Starting slowly, the buildup of degree-days becomes rapid late in April and maintains this pace until late July, when there is a sudden falling-off, which is followed by a resurge in early August (Figure 3). Before the middle of August a precipitous decline sets in and continues to the end of September so that little warmth remains to promote any significant growth after this time. The average growing season for cool-season crops is 198 days.

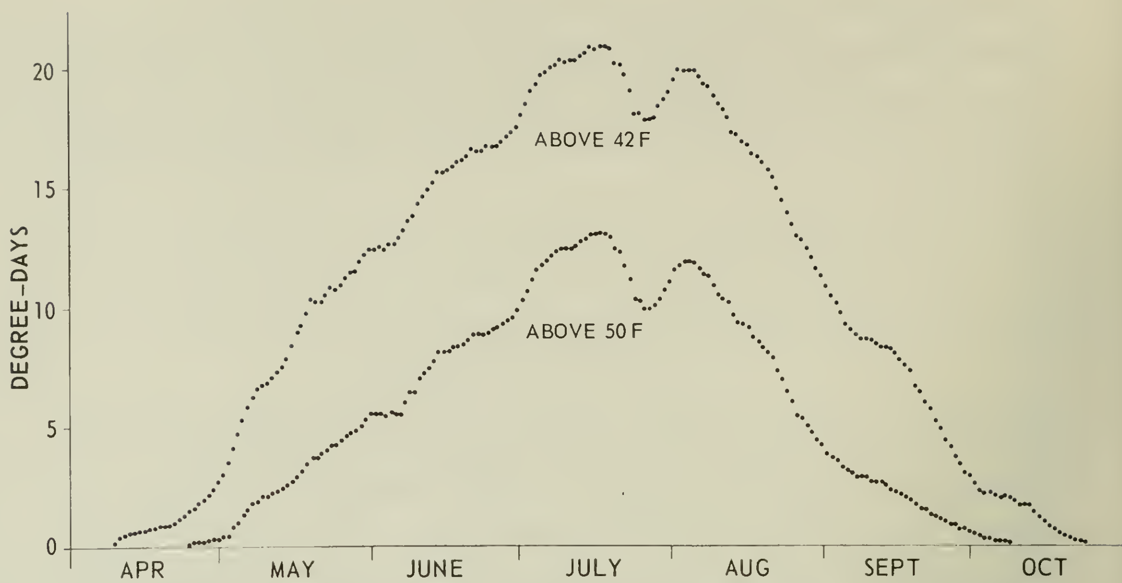

Figure 3. Average daily degree-days above 42 F and 50 F throughout the growing season, 1948-67 (5-day running averages).

For warm-season crops, such as corn, tomatoes, and beans, the base temperature usually used is 50 F. The average number of degree-days above this base each year is 1038, or 258 more than at Beaverlodge. The seasonal wax and wane of the daily sum of this type of degree-day are similar to those for cool-season crops. However, degree-days above 50 F are fewer in number, starting late in April and ending early in October. The average growing season for warm-season crops at Fort Vermilion is 168 days.

FROST-FREE PERIODS

Average periods free of frost (above 32 F) and of killing frost (above 28 F) are 82 and 112 days. In spring, the average date of the last killing frost is May 22, and the last frost June 7 (Figure 4). In fall, the average date of the first frost is August 27, and the first killing frost September 9. One year in 10, the last frost in spring is on June 28 and the first frost in fall is on August 1. The chances of frost on other dates are also shown in Figure 4.

It may be supposed that, because the Fort Vermilion district has only 82 frost-free days, the district is limited even in the production of cool-season crops. However, frost alone is not the real limiting factor; rather, it is killing frost that limits production. It has been found that crops can be produced satisfactorily in much less time in northern areas than farther south, because of the long summer days or strong photoperiodic effect in such areas. It is known, for instance, that north of about 55° latitude only 80 killing-frost-free days are needed for the successful production of cool-season crops (Carder, 1965b). However, 112 such days are available at Fort Vermilion.

Cool-season crops can withstand frost without any harm unless frost strikes them at a very vulnerable stage, such as flowering. Summer frosts in the north are

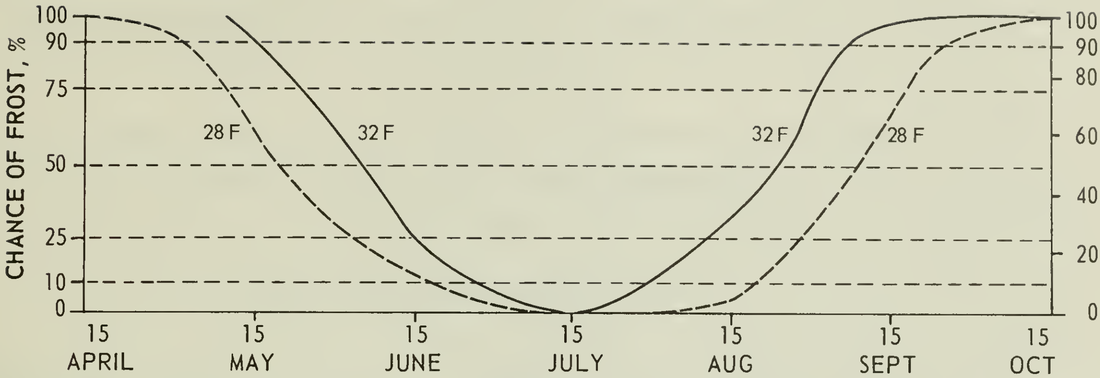

Figure 4. Chances of last frost (32 F) and of killing frost (28 F) on or after any date in spring and of first frost and killing frost on or before any date in fall, 60 years average records, 1909-68.

usually not severely damaging because of the short period of darkness in which plants are subjected to them. Therefore, frost injury is not nearly so severe as the instrument records would indicate.

SOIL TEMPERATURE

The soil temperature at Fort Vermilion rises rapidly during April and continues to rise until mid-June. From then until late August it remains fairly constant, then plunges swiftly till the end of November (Figure 5). In winter, the soil temperature does not fall below 20 F, in contrast with the air temperature, which may fall far below zero. However, in summer the soil temperature can and does exceed the air temperature by a large amount.

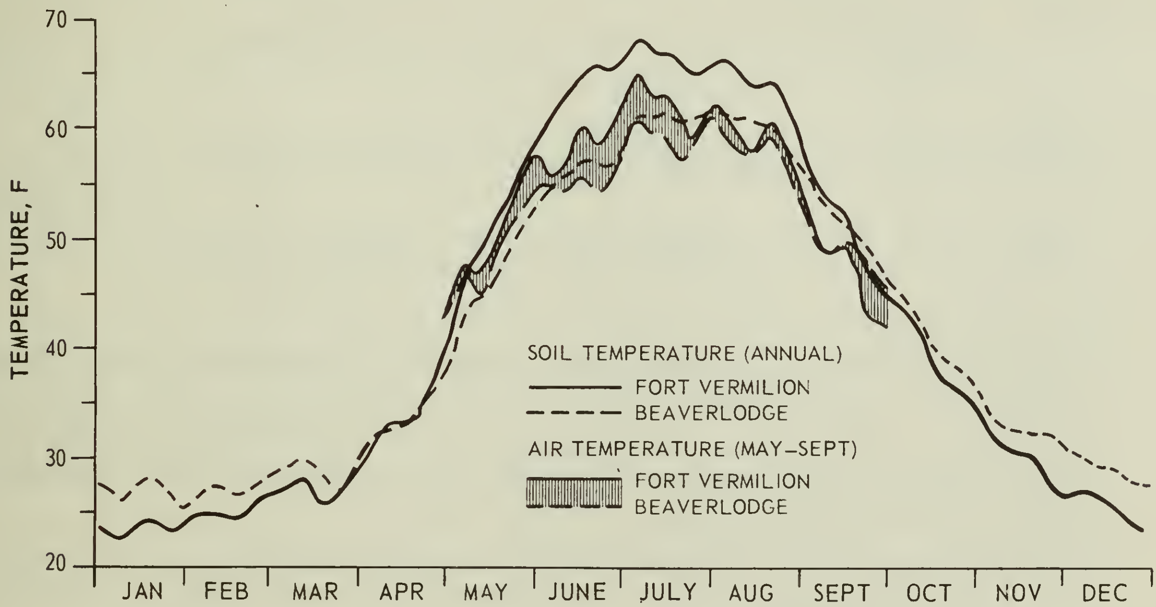

Figure 5. Comparative soil (4 inches below clipped grass sward) and air temperatures at Fort Vermilion and Beaverlodge, 1964-68 (5-day running averages).

Although the soil is colder in winter at Fort Vermilion than at Beaverlodge, it is much warmer in summer: in late June a difference of 9 degrees. Part of this summer difference is due to warmer air temperatures, but at least half is due to a "warmer" sandy type of soil.

Soil temperature fluctuates much less than air temperature, mainly because soil gains and loses heat more slowly than air. In winter, snow cover and lower intensity of sunshine also reduce fluctuations in soil temperature.

DAY LENGTH AND INSOLATION

The hours of daylight and of civillight at Fort Vermilion are 6.4 and 8.1 on December 21, and 18.4 and 21.0 on June 21 (Figure 6). Daylight is that part of the day from sunrise to sunset; civillight is that period from when the center of the sun is 6 degrees below the horizon in the morning to when it is in this position in the evening.

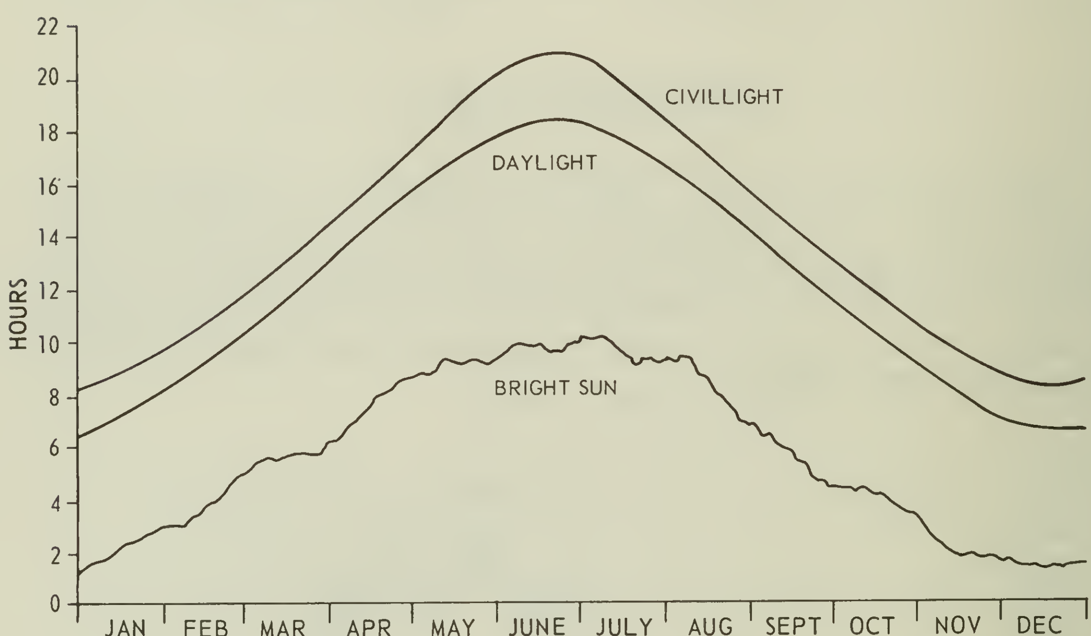

Figure 6. Daily periods of daylight and civillight throughout the year. Also insolation as represented by daily hours of bright sunshine, 1948-67 (10-day running averages).

A notably long twilight (Figure 6) is especially important in the north, because most plants respond to light intensities as low as 1 or 2 foot-candles. The intensity of light on a clear day at the beginning and close of civillight is about 1 or 2 foot-candles. Twilight is the time from sunset to the end of civillight and from the beginning of civillight to sunrise.

The average number of hours of bright sunshine each day ranges from as little as 1.3 around Christmas to 10.2 in early July (Figure 6). November, December, and January have very little sunshine, whereas May, June, and July have many hours, because the days are much longer. Actually, sunshine is more reduced in summer than in other seasons because of a slight increase in cloudiness (note the broadening of the width of band between the "daylight" and "bright sun" curves in Figure 6).

PRECIPITATION

If most of the precipitation did not occur in summer (Figure 7), few crops could be produced in the Fort Vermilion area. Distribution would be almost perfect if the maximum rainfall took place a little earlier in summer. But the rains are often too late for maximum benefit to crops. Nevertheless, distribution is excellent for land work, because the weather is dry in May at seeding time and fairly dry at harvest in late August and September.

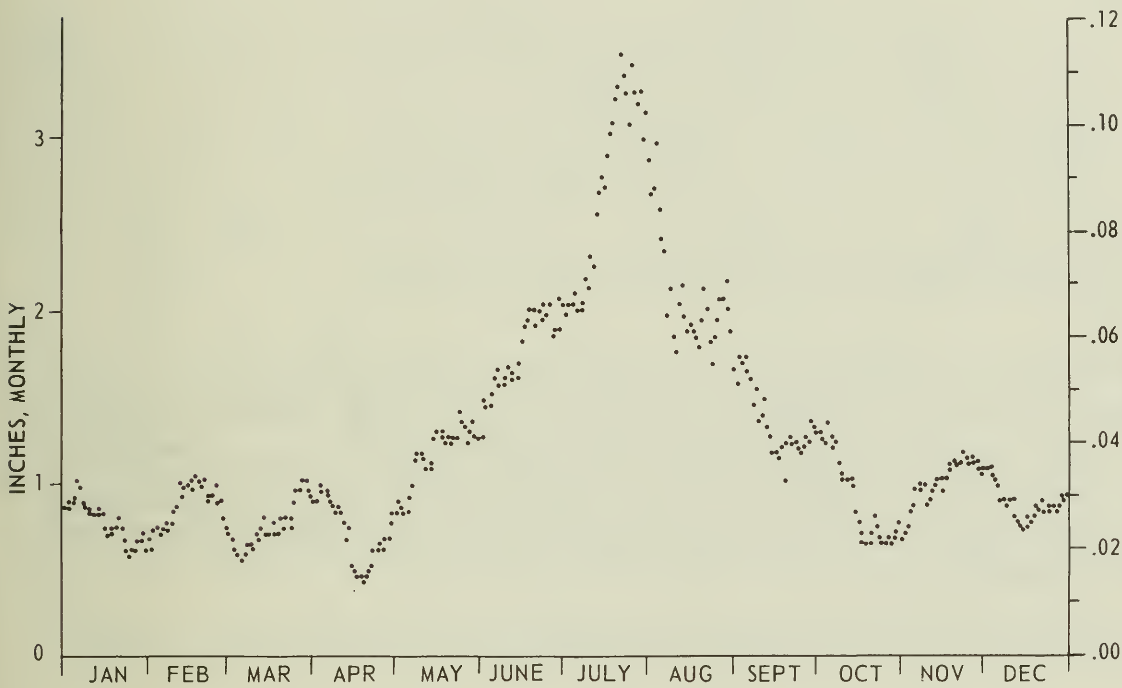

Figure 7. Average monthly and daily precipitation throughout the year, 1948-67 (10-day running averages).

Winter precipitation, which is almost all snow, is rather meager. This is an advantage in an area where the total annual precipitation is only 14 inches, because much of the moisture received in winter falls on frozen ground and is lost in spring in the form of run-off water.

Because of the continental climate, the yearly amount of precipitation is very irregular and has varied over 40 years from 9.1 to 20.5 inches (Figure 8). Of more importance to crop production than the annual precipitation is the amount of rain that falls during the growing season, when the soil is receptive to it. Variation of this precipitation is even greater and a severely damaging drought may be expected to occur at least 1 year in 5.

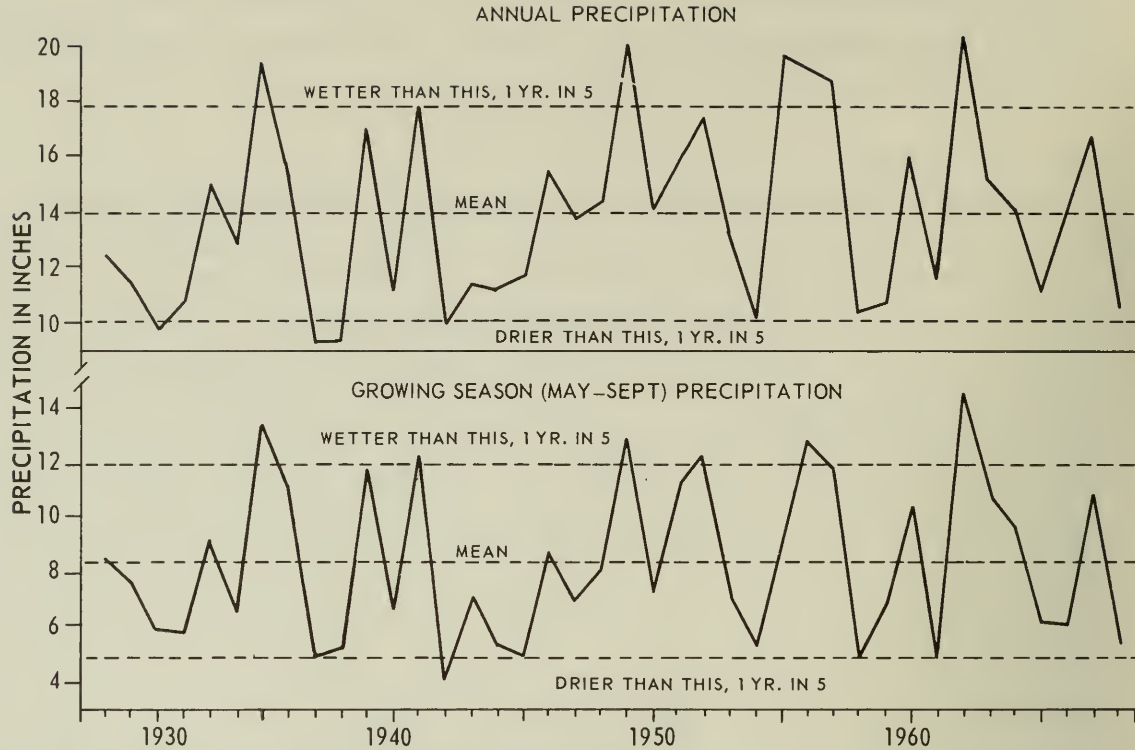

Figure 8. Annual and growing-season precipitation, 40 years, 1929-68.

In most years, snow covers the ground from early October until the end of April (Figure 9). The snow gradually gets deeper during the winter until late in March, when rapid settling and melting begin. Because Fort Vermilion is quite far from the Rocky Mountains, the chinook, the warm wind of winter, seldom produces much effect there. This is an advantage for plant life, which retains its protective snow blanket all winter.

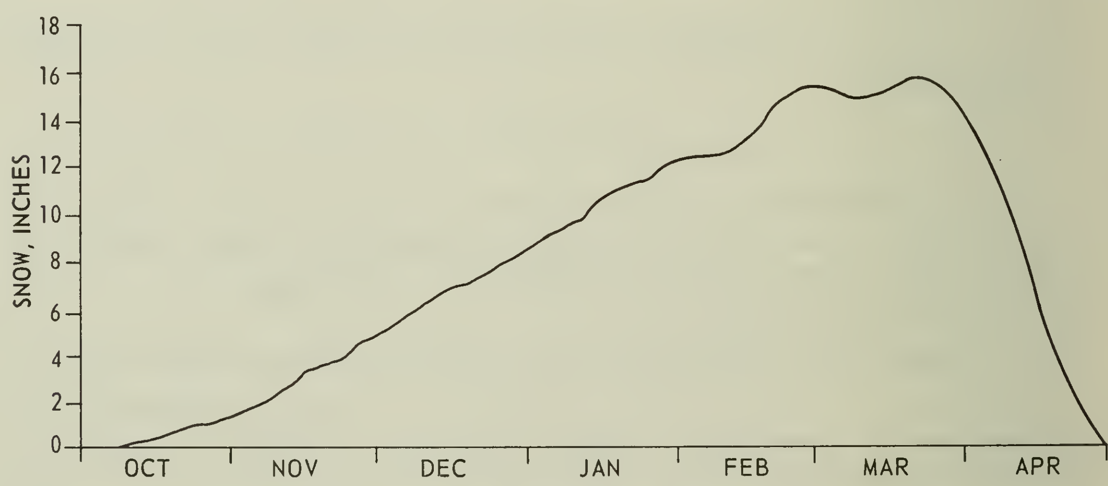

Figure 9. Average daily depth of snow throughout the winter, 1959-69 (5-day running averages).

In the middle of winter and summer the air tends to be calm, but spring and fall are windy seasons (Figure 10). May and October are the windiest months of the year. Because spring land work is done in May, proper management of the soil is needed to prevent erosion. The worst storms in winter usually occur in November and March. It is fortunate for livestock and man that the coldest months of the year are the calmest. August is usually the pleasantest month, because it is rather calm, warm, and the heaviest rains of summer are over.

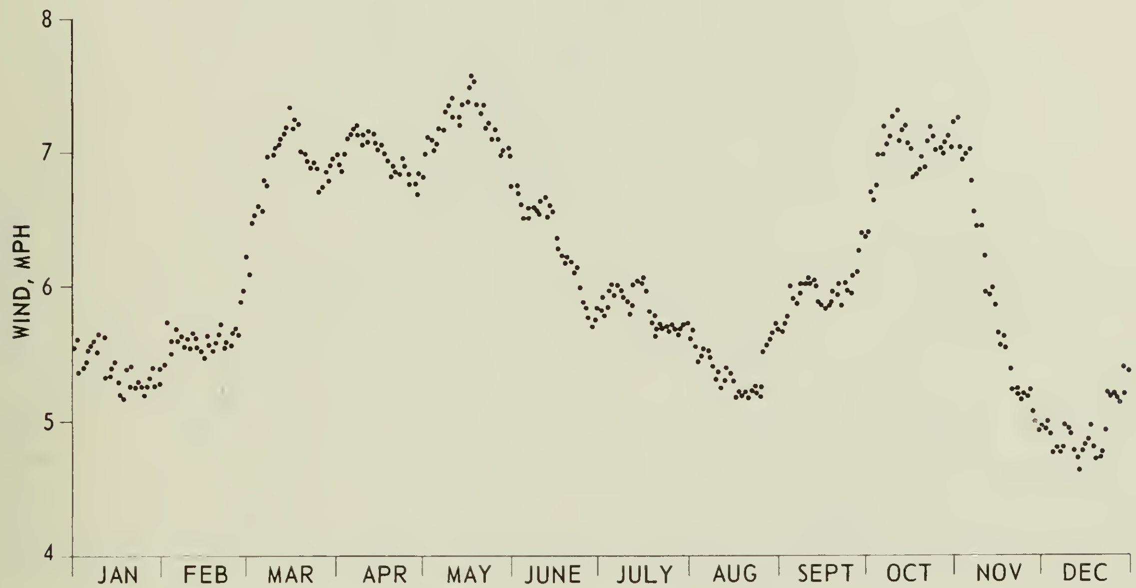

Figure 10. Average daily wind speed throughout the year, 1954-66 (10-day running averages).

The most persistent and strongest winds come from the northwest (Figure 11). Southeast winds are next most frequent, whereas northeast, east, and southwest winds are fairly common. True northerly or southerly winds are rare and light.

Northwest winds prevail in all seasons except summer, whereas southeast winds slacken in winter. Southwest winds are strong in summer and weak in winter. Easterly winds are weakest in July, but occur in all seasons.

Although winds of the region are seldom violent, every opportunity should be used and every effort made to reduce them over cropped land. Strong winds will dry up much valuable moisture, which otherwise would be used for crop growth. Winds also damage crop foliage, and abrase, lift, and carry away rich topsoil. Local winds can be reduced by shelterbelts, either naturally grown or planted. Good shelterbelts will reduce airflow downwind for a distance of at least 30 times their height (Harris and Carder, 1969).

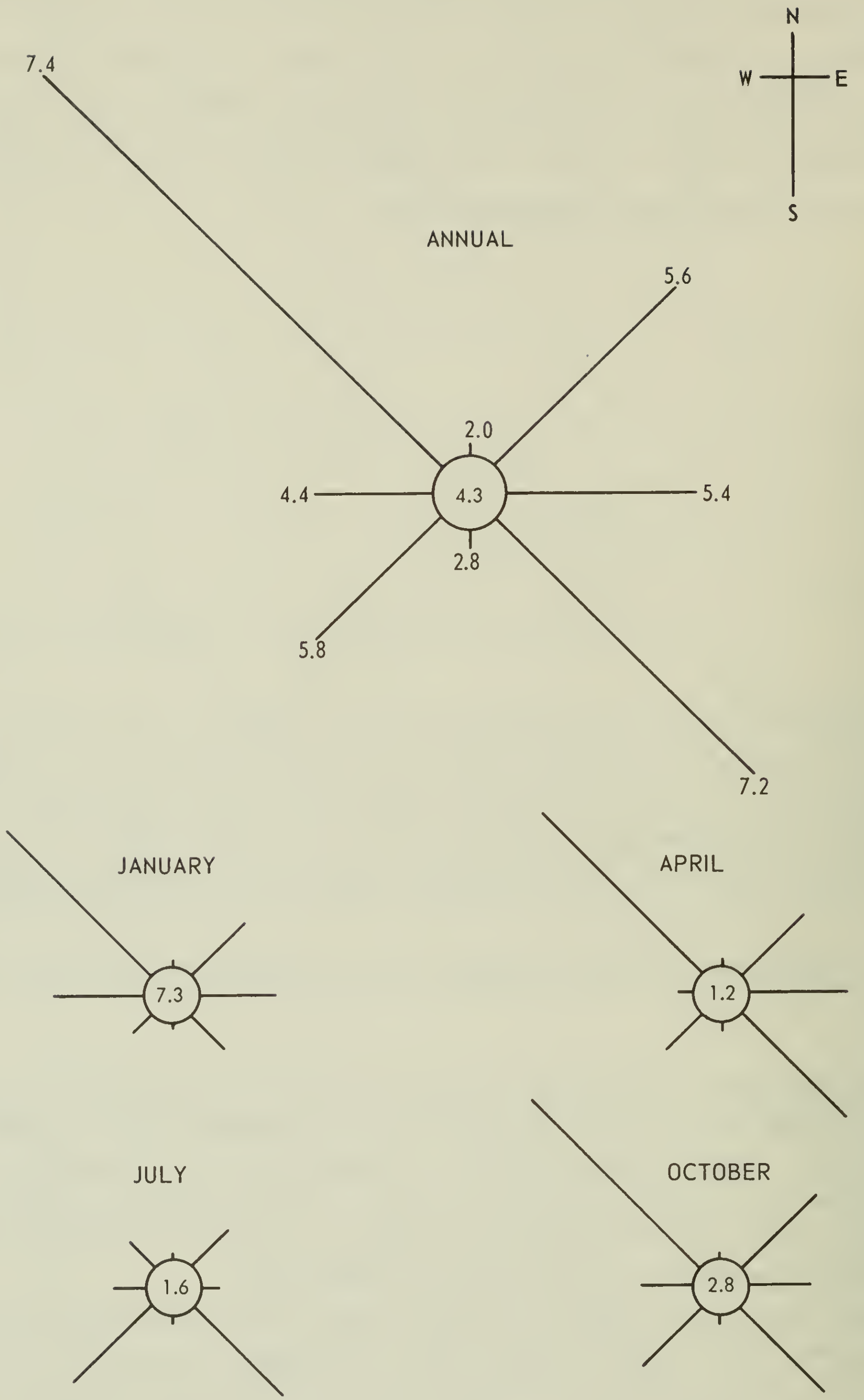

Figure 11. Average wind values for the year and for the months representative of the seasons, 1954-66. Length of ray: total run-of-wind. Number at end of ray: average wind speed, mph. Number in circle: percentage of period calm.

EVAPORATION

The rate of evaporation is fairly low. Evaporation during the growing season, May to September, at Fort Vermilion is 17.1 inches (Table 1), at Beaverlodge is 21.9 inches, and in the open plains of southern Saskatchewan is 30 inches.

Moisture loss by evaporation is closely related to amounts of wind, rain, and warmth received. Therefore, moisture loss is greatest in May, when winds are high, rainfall is low, and temperatures are moderate, and in June, when winds remain brisk, rainfall has not reached a maximum, and temperatures are quite high (Figures 2, 7, 10, and 12). Lessening winds and a great increase in rainfall depress the evaporation in July. Although precipitation is lower in August and September, evaporation is reduced still more by a combination of low wind velocity and dropping temperatures.

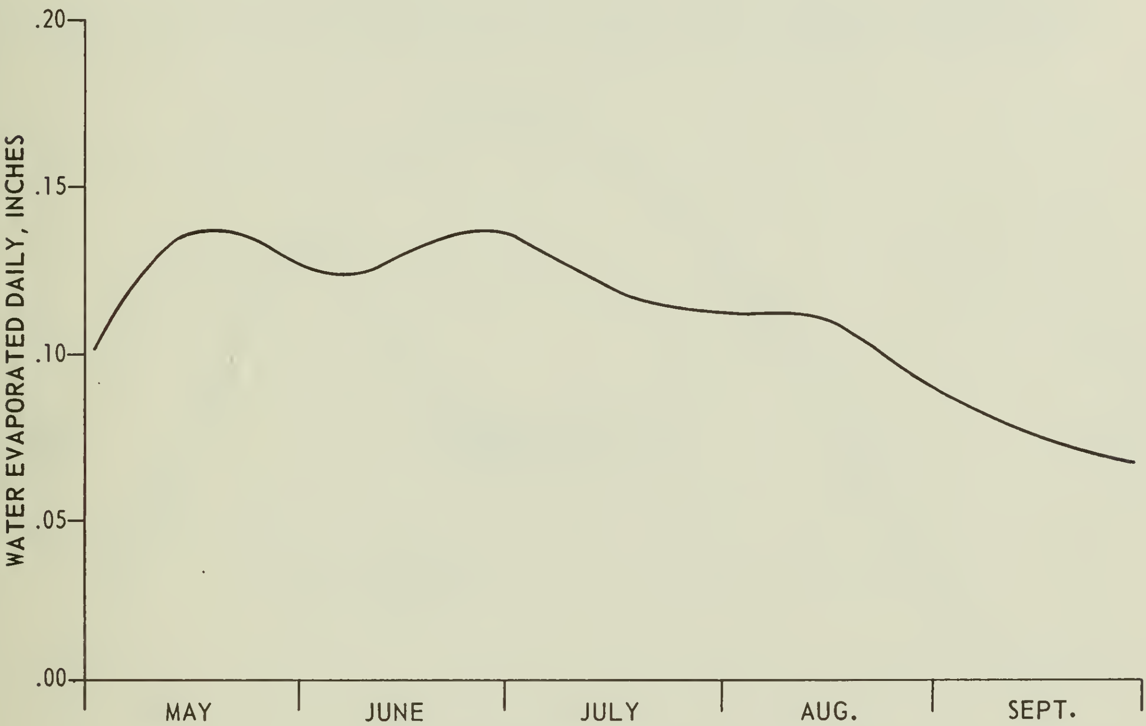

Figure 12. Trend of evaporation during the summer months. Mean of 9 years (10-day running averages).

Precipitation in the lower Peace River region is low, and so it is a great advantage that evaporation is also low. Also, because most cool-season crops develop faster in the long northern days, the crops are able to economize on water (Carder and Hennig, 1966). For these two reasons the northern plains are able to support a more profuse vegetation than those farther south, even though the amount of precipitation may be no greater.

However, low evaporation in August and September can be harmful to crops. Harvesting is often delayed by heavy night dews or light rains, which dampen unharvested ripe field crops.

REGIONAL CLIMATES

There are fundamental differences between the climates of the lower and the upper Peace River regions. The most important difference is that, although summers are slightly warmer in the northern region, winters are much colder. There is also a difference in the moisture regime. The lower Peace River region is generally drier, because there is less precipitation during all seasons of the year. This disparity, however, is narrowed by the fact that the rate of evaporation is less in northern areas as a result of the great reduction in windiness. Another climatic difference is the longer summer days in the north, which cause many kinds of plants to develop rapidly, ripen early, and thereby fit into the shorter growing season available to them.

Despite the vastness of the lower Peace River region, the climate throughout is very uniform. At three widely separated locations, the annual mean temperature is almost identical (Figure 13). The amount and distribution of precipitation are more

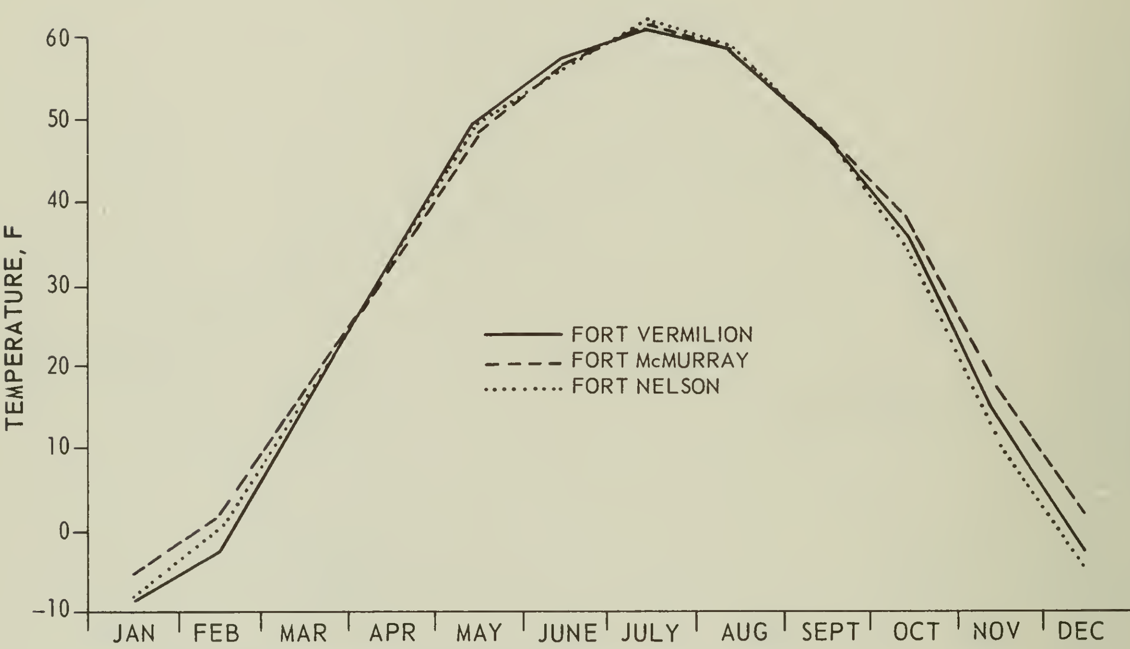

Figure 13. Mean air temperature, 30 years, 1938-67.

favorable in the west and east than at Fort Vermilion, near the center of the region (Figure 14). The Fort Nelson area is particularly favored, because it receives a higher June rainfall, which relieves the almost ever-present menace of early summer drought. In late summer and fall the Fort McMurray area receives somewhat more rain, which may increase harvesting difficulties.

The Fort Nelson area is less windy (Figure 15). This is shown by the ability of tall trees to thrive and to slow down the wind. Reduced wind, of course, adds to the already more favorable moisture balance of the area. The fact that trees grow more luxuriantly there than elsewhere in the region, particularly in the central part, increases land-clearing costs, which are a deterrent to agricultural development.

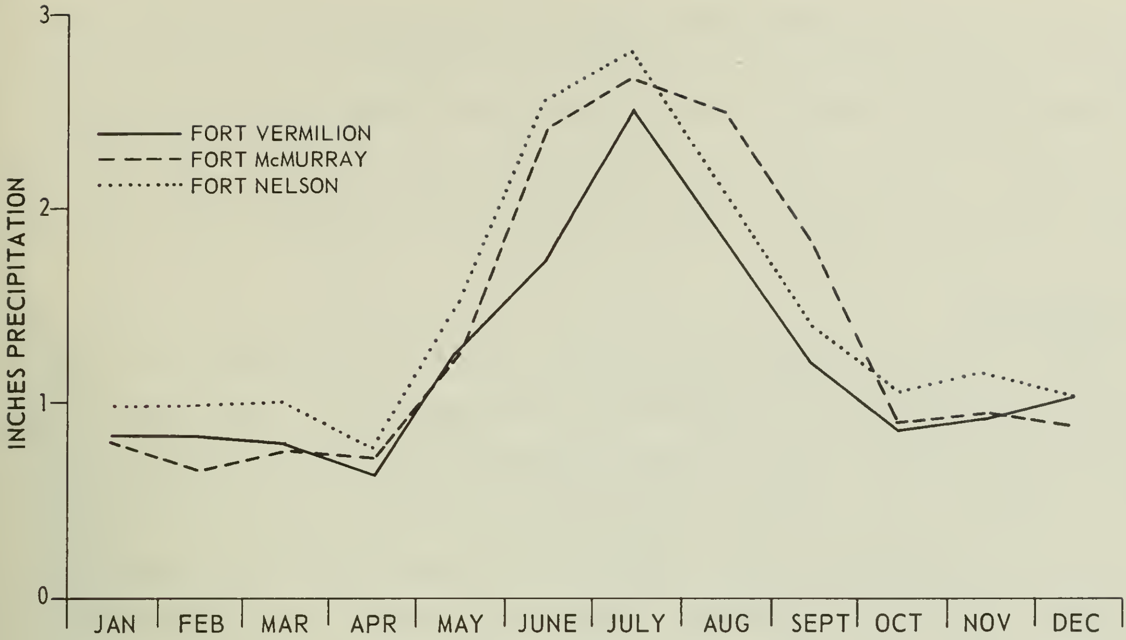

Figure 14. Mean monthly precipitation, 30 years, 1938-67.

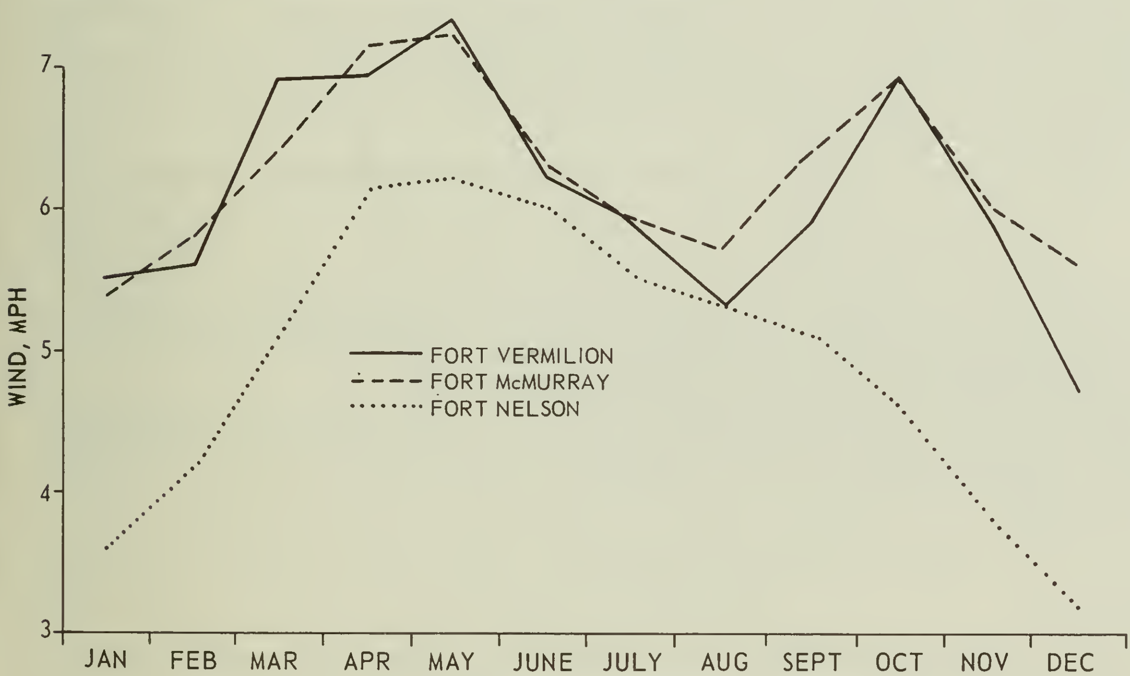

Figure 15. Mean monthly wind speed, 7 years, 1961-67.

CLIMATIC ABERRATIONS

Climate, like weather, changes, but the change in climate happens much more slowly (Carder, 1962). For this reason, in the preparation of this publication records over 30 years old were seldom used. At Fort Vermilion 60 years of records are available, and even during this period there have been changes in the climate

(Edmonds and Anderson, 1959). However, once an exceptional event has occurred, there is some chance of it recurring.

Because of the continental nature of the region's climate, weather extremes occur frequently. Occasionally such extremes persist for weeks and even months. In fact, the longer a certain pattern exists, the more persistent it becomes. Therefore, a whole summer may be rainless, or an entire winter snowy and cold.

Unusual Winters

At Fort Vermilion the fall and winter of 1933-34 stand out for extreme and rapid variations of weather. On October 8 a record high of 80 F was reached, but by October 30 the Peace River was frozen over and 7 inches of snow blanketed the area. The weather in November was most erratic. At one time the roads were so full of snow that sleighing was almost impossible, yet later that month the ice on the river broke and the river ran full and open, but not for long. On November 28 temperatures tumbled and continued downward for several weeks. On New Year's Eve the temperature plunged to −73 F. The country was wrapped in thick fog, and livestock suffered intensely from the cold.

The cold wave broke in the middle of January, but not before establishing the coldest period on record. For 37 days the temperature remained below zero and averaged a comfortable −29 F. Between 1909 and 1969 fifteen other below-zero periods of over 20 days duration were recorded, but none remained so long nor reached such low temperatures.

In 1943-44, another kind of winter occurred: an exceptionally mild and open one. The temperature dropped below zero on only 12 days and below −20 F on only 5 nights. Temperatures for November, December, and January were consistently 10 to 20 degrees above normal. Snowfall was unusually light, and fields were bare for long periods in December and January. Wagons were used instead of sleighs until mid-March, when the first real snowstorm fell.

Mild and open winters often occur. Out of 60 winters, 18 recorded maximum daily temperatures above zero for periods of at least 30 days between November and February.

Snowstorms

Only 10 snowstorms with 10 or more inches of snow have been recorded at Fort Vermilion since 1909, and 9 of them were since 1940.

The three heaviest storms were in April 1955, October 1957, and April 1966, with 27, 24, and 21 inches of snow, respectively. These storms were accompanied by winds of 10 to 20 mph and temperatures of 28 F to 32 F. The snowfall in April and October is usually about 4 inches. Apparently, exceptional snowfalls do not occur in the middle of winter.

Snow is not unknown in September and May, but none has been recorded in June, July, or August. An errant snowstorm fell on the area on September 22-23, 1924, and covered the region with 9 inches of wet snow. Temperatures of 32 F to

34 F slowly melted the snow, and stooked sheaves became saturated with water. Threshing was delayed until the end of October. May snowstorms have never caused any damage to crops; sometimes they are an asset, because of the moisture they contain.

Growing-season Weather

In 60 years, 18 summers received less than 3 inches of rain during the crucial months of June and July. Such low rainfall resulted in very poor crop yields, but there were exceptions. In 1947 good crops were produced with only 3 inches of rain in June-July, because the rain fell at the right time and in beneficial amounts. However, in 1936, yields from grain crops were low, even with a June-July rainfall of 5 inches, and stands of grain were thin with very little stooling as a result of early drought. Forage crops, however, produced well.

Frost is a common occurrence during the growing season. Nevertheless, crops are not damaged by frost as often as the weather data might indicate. The amount of damage is related not only to the temperature, but also to the length of time that crops are exposed to frost, and to their stage of development when the frost occurs. Therefore, even one or two sharp frosts before May 20 may have very little effect on the yield of cereal crops, because new growth can be initiated by buds that are still underground at the time of frost. However, a light frost, such as that of July 8, 1968, can cause total loss in localized areas. This frost struck during the flowering stage of wheat and destroyed the pollen. The plants continued to grow vigorously, but with large heads consisting of chaff.

Rainstorms

Rainfall is usually limited to less than 1 inch in any 24 hours. In 60 years, 53 days have been recorded with a rainfall of more than 1 inch. The greatest amount of rain that fell in any one day, 2.36 inches, was on May 19, 1941. There have been only three other times when over 2 inches of rain fell in a single day: 2.07 inches on August 17, 1924; 2.17 inches on July 26, 1957; and 2.04 inches on June 26, 1962.

One of the most intense rainstorms in the Fort Vermilion area occurred on the afternoon of July 15, 1962, when 1.12 inches of rain fell in 2 hours. The rain was accompanied by a rare but very majestic thunderstorm.

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REFERENCES

Carder, A. C. 1962. Climatic trends in the Beaverlodge area. Can. J. Plant Sci. 42:698-706.

Carder, A. C. 1965a. Climate of the Upper Peace River region. Can. Dep. Agr. Publ. 1224. 19 p.

Carder, A. C. 1965b. Northwestern Canada's climate: Its effect on crop growth and development. Agr. Inst. Rev. 20(3):20-22.

Carder, A. C., and A. M. F. Hennig. 1966. Soil moisture regimes under summerfallow, wheat and red fescue in the Upper Peace River region. Agr. Meteorol. 3:311-331.

Edmonds, T. C., and C. H. Anderson. 1959. Note on climatic trends in the Lower Peace River region of northern Alberta. Can. J. Plant Sci. 40:204-206.

Harris, R. E., and A. C. Carder. 1969. Shelterbelts for the Peace River region. Can. Dep. Agr. Publ. 1384. 21 p.

Valle, O., and A. C. Carder. 1962. Comparison of the climate at Tikkurila, Finland, and at Beaverlodge, Alberta, Canada, with particular reference to the growth and development of cereal crops. Acta Agr. Fenn. 100:1-31.

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