

July 1976.

A very dry month, the beginning of a long drought. There was a center of dryness between Birch Lake and Stony River, and general dryness west of a line from Snowbank Lake to Tople ~~to~~ to the central St. Louis County.

Rain Events:

1. Intermediate T, 6-7 July

Afternoon, evening showers on 6 July behind Pacific front, with additional rain amounts ^{on morning of 6 July ahead of} ~~on morning of 6 July ahead of~~ frontal passage. Heaviest totals Crane Lake .76, Tower 35 .69, Ely USFSC .67, Eagle Nest .60. Least .07 at Whitefish, Finland, only .10 at Stony River.

Minor T, 7-8 July

- 2. Nighttime thunderstorms on July 7-8. Precipitation at only a few stations. Ely USFSC .38, Gunflint Lake .08, Grand Marais .01, Hibbing & a trace. Rest none.

Minor T, 8-9 July.

3. Nighttime thunderstorms on July 8-9. Heaviest amounts Cotton ^{JNE} .64, Tower .55. Least .09 at ~~Cotton City station~~ Crane Lake.

13 July.

4. Minor T, Thunderstorms broke out on afternoon of 13 July in connection with occlusion outbreak. Heaviest totals Hibbing City .52, Hibbing Airport .52, Gunflint Lake .48, Cotton JNE .47. None reported at Eagle Nest, Tower 35, Virginia, Crane Lake.

15 July.

5. Minor S, Showers fell on wee hours of 15 July ahead of cold front, and during that day from stratocumulus overcast. Heaviest totals .13 at Isabella Ranger Station, Meadow Lake, Hibbing Airport; .12 at Hoyt Lake, Gunflint Lake. None reported at Babbitt, only a trace at other stations.

476

6. Major T, ^{19 July} Heaviest rain of the month in connection with cold front arrival on the evening of the 19th. Heaviest totals Cotton City 1.42, Cotton JNE 1.38, Meadowslands 1.18. Least Isabella Ranger Station .18, only .20 at ^{Stony River and} Grand Marais and only ^{.26 at Hogt Lakes and} .35 at Babbitt.

7. Intermediate T, ^{22 July} Scattered thunderstorms with cold front on evening of 22 July. Heaviest totals Meadowslands 1.49, Cotton JNE .48, Hibbing City .31, Virginia .29. Least a trace at Eagle Nest, Babbitt, Tower **38**,

8. Major T, ^{25-26 July} Thunderstorms all day on 25 July and into wee hours of 26 July ~~as Pacific warm front moved in on 25th~~ as Pacific warm front moved in on 25th followed by cold front on wee hours of 26 July. Heaviest totals Hibbing City 1.29, Hibbing Airport 1.23, Isabella Ranger Station .68. Least .08 at Cotton JNE, only .18 at Babbitt and Meadowslands, and .19 at Ely USFSC.

9. Minor T, ^{28 July} Morning thunderstorms on 28 July. Heaviest total Hibbing City .29, Hibbing Airport .23, Fairbairn .15, Babbitt .14. None or a trace at some stations.

10. Minor T, ^{29 July} Scattered afternoon and evening showers on 29 July. Heaviest totals Gunflint Lake .47, Meadowslands .26, Crane Lake .35. None or a trace most stations.

August 1976

August 1976 was a very dry ~~year~~ about half the Cooper-Nichol Region recording less than an inch of precipitation. A ^{relative} wet maximum occurred north-south from east of Winton southward to Island Lake.

Rain Events:

1. Minor T, ^{1 August} Afternoon thunderstorms, in northwesterly flow. Heavier amounts Cotton 3NE .43, Island Lake .42, ^{less than .05 elsewhere.} Most stations had none.
2. Minor R, ^{4 August} General rain on 4 August ~~in~~ in westerly flow ahead of front. Heaviest falls Meadowlands 1.24, Island Lake .65, Hibbing Airport .51. But only .02 at Grand Marais, .03 at Winton, .08 at Hoyt Lake, .10 at Babbitt, .11 at Isabella Ranger Station.
3. Minor T, ^{8-10 August} General thunderstorms from afternoon of 8 August to wee hours of 10 August. Heavier amounts Gunflint Lake .88, Isabella Ranger Station .59, Island Lake .57, Babbitt .46, Winton .42. At Tower 3S only .14.
4. Minor. Scattered showers afternoon of 11 August. Only light amounts.
5. Minor T, ^{12 August} Scattered thunderstorms afternoon of 12 August. Heavier amounts Winton .71, Tofta .50, Ely WFSO .49, Finland .41. Least trace at Hibbing Airport, Crane Lake; only .02 at Virginia.

5. Minot, ^{13 August.} Light showers afternoon of 13 August in ^{southwesterly} ~~northwesterly~~ flow.
~~Heavy~~ ^{light &} amounts.

AUG 1972

6. Minot, ^{19 August.} Scattered thunderstorms morning of 19 August. ~~Heavy~~
only very light amounts reported.

7. Minot, ^{26 August.} Scattered thunderstorms morning of 26 August behind
Pacific cold front. Heavier amounts Cotton .35,
Whiteface .25, Bremsen .20, Dead Lake .20, Cotton PNE .16,
None or a trace at some stations.

September 1976

September 1976 was the third consecutive dry month of the year. Heavier amounts centered over Birch Lake, Isabella Ranger Station, separated by dry area from Starg River to Durka River.

Precipitation Events

1. Minor T, 7-8 September.

of 7 September, ^{weakened 8 September.} Heavier amounts, ^{Gundlit Lake .26,} Babbitt .25, Virginia .22, Tower 3S .18. Least .01 at Grand Marais.

2. Minor B, 11-14 September.

General rain and drizzle with ^{2nd after} passage of cold front on morning of 13 September. Heavier totals Finland .47, Isabella Ranger Station .38, ^{Ely USFSC .37,} Hibbing City .36, Tower 3S .32. Least .07 at Grand Marais.

3. Minor S, 19-23 September.

General shower activity ^{for four days} following cold frontal passage on morning of 19 September. Heavier totals Babbitt .97, Isabella Ranger Station .73, Grand Marais .68, Tower 3S .62. ¹⁻²⁻⁷³ ~~6-27-73~~ ⁶⁻²⁷⁻⁷³

4. Minor S, ^{25-27 September} Afternoon and evening clouds on 25 September into week hours of 26 September. Heavier totals Gundlit Lake .50, Ely USFSC .28, Isabella Ranger Station .28, Eagle Nest .26, Tower 3S .26. Least .03 at Meadlands, Cotton JMT.

5. Minor. Some light drizzle on 26 September following cold front. Heavier amounts ~~at~~ Isabella Ranger Station .11, Finland .10. None reported at ~~at~~

October 1976

The fourth very dry month in a row. Slightly less dry along higher ground from Garfield Lake to Skibos.

Precipitation Events

1. Intermediate R, ^{4 October.} Most of the precipitation, ~~for the~~ month fell in connection with cold front passage, ^{early morning} of 4 October. Heavier amounts Hoyt Lakes 1.07, Babbitt .87, Meadows .87, Brimley .76, Ely WFSC .70, Minnimar .70, Cotton JNE .69, Whiteface .67, Duxie River .66, Winton .65, Kaweshiwi .60. Least .16 at Crane Lake, only .24 at Finland, .29 at Hibbing Airport.
2. Minor S, ^{7-8 October.} Snow showers, rain showers 7-8 October in cool air. Heavier totals Grand Marais .47, Crane Lake .24, Hoyt Lakes .13. ~~trace~~ ^{ONLY} .03 at Eagles Nest, Ely WFSC, Cotton JNE, Hibbing Airport. Just a trace at Meadows.
3. Minor S, ^{14-16 October.} Instability snow showers ¹⁶ 15 October. Behind Continental front passing mid-day 14 October. Heavier amounts Ely WFSC .29, Minnimar .30. Least a trace at Meadows.
4. Minor S, ^{19-22 October.} Snow and rain showers ahead and behind cold front passage ~~on~~ during day on 20 October. ~~Heavier totals~~ Crane Lake .45, ^{Babbitt .23,} Isabella Ranger Station .21, Ely WFSC .20, Winton .20, Kaweshiwi .20. Many stations reported less than .10.

November 1976

Very much below normal precipitation for fifth month in a row. Only Ducha River reported more than .40 inches - and ~~that~~ ^{maybe is} ~~probably is~~ too high due to possible ~~blowing~~ snow blowing into the gage. All precipitation from ^{mostly} showers.

Precipitation Events

1. Minor S, 1-4 November.
Light snow showers, falling frontal passages 1 to 4 November. Heavier amounts Winton .14, Tower 35 .13, Aare Lake .12. Most stations less than .05.
2. Minor S, 9-12 November.
Light snow showers following frontal passage on 9 November. Heavier totals Minnirons .19, Island Lake .18, Tower 35 .16.
3. Minor S, 17-20 November.
Light amounts almost daily 17 November and 3 of month at most stations. Heavier totals through entire period Gurfliet Lake .18, Cotton JNE .18, Whitford .16, Brinson .16. Very light amounts at many stations.

December 1976

Sixth ~~month~~ straight month below normal precipitation.
Maximum over high ground, less along Lake Superior
and west.

Precipitation Events

1. Minor B, ^{2-4 December} Snow began ahead of Pacific warm front
on evening of 2 December. Snow lasted to arrival of
front ^{at midday 4 December} then quit or tapered off. Heavier totals
Kawishiwi .20, ^{Totke. 20,} Hoyt Lakes .17, Pit ^{at Grand Marais,} only .05 at Hibbin
Airport, Tower.
2. Minor S, ^{5-6 December} Snow began in scattered flow ~~the~~ ahead of
vorticity maximum ^{late} on evening of 5 December, lasting
through northwesterly flow during ^{dormant} 6 December into the
evening. Heavier totals Gull Lake .30, Eagle Nest .18,
Whitefore .18, Hibbin city .17. Pit only .03 at
Minnirox, .09 at Hibbin Airport.
3. Minor B, ^{9-10 December} Snow began early on 9 December ahead of Pacific
warm front, continuing to passage of continental polar cold
front late on 9 December. Heavier totals Island Lake .48,
Gull Lake .31, Only ^{.02 at Minnirox,} .04 reported at Hibbin Airport,
Grand Marais, Cotton.

Dec 1976

4. Mīnā R, ^{11 December} Light snow ahead of Paigui warm front on 11 December. Maximum .03 at Coase Lake, trace or none elsewhere.

5. Mīnā R, ^{13 December} Light snow began midmorning on 13 December ahead of Paigui warm front. Heavy totals Grand Marais .07, White .02, Hoyt Lakes .01. Trace or none elsewhere.

6. Mīnā R, ^{21-22 December} Snow ~~fell~~ in association with cold front passage ^{well hours} on 22 December. Heavy totals Grand Marais .08, Coase Lake .05, Pawa .05. Less amounts elsewhere.

7. Mīnā R, ^{24-25 December} Snow ahead of Paigui warm front passage; ^{mostly} on 24 December. Heavy totals Eagle Nest .48, Whiteface .16, Mesadawood .12. Less amounts or none elsewhere.

8. Mīnā R, ^{26-27 December} Snow on 26, 27 December in response to low passing to the ^{the} west of the Region. Heavy totals Breckin .36, Hibbin City .35, Carlton .33. Only a trace at Gungli Lake, .03 at Grand Marais,

January 1977.

This was the seventh straight month below normal precipitation in the region. All falls of snow were minor. No liquid precipitation fell. Heaviest precipitation was along the high ground parallel to the lake, as it is most of the time, with lighter totals either side.

Precipitation Events.

1. Minor S, ^{1-3 January.} Light snow ~~in association with a cold front~~
~~was first~~ on 2-3 January. Heavier totals Keweenaw .10,
Island Lake .10. But ^{only} ~~at~~ trace at Pabst, .01 at
Minneapolis.
2. Minor S, ^{5-6 January.} Snow showers, ahead of,
6 January. Behind cold front during day on
Heavier totals Island Lake .24, Pabst .15,
Lighter amounts Cotton .01, Meadville .02, Tower .05.
3. Minor S, ^{12-14 January.} Shows brought by small scale systems 12-14
January. Heavier totals Island Lake .35, Meadville .31,
Brinson .21. ~~Less amounts~~ Only a trace at Cotton,
Gulfport Lake, Tower.
4. Minor R, ^{19 January.} Snow ~~from~~ afternoon of 19 January ahead of Pacific
warm front. Heavier totals Minneapolis .12, Hibbing City .08;
only a trace at several places.

20 January.
5. Minor S, Light snow flurries behind cold front during day of
20 January. Isabella ELC recorded .01, other places trace or
none.

22-23 January
6. Minor R/S, Snow, mostly time ahead of, behind Pacific front arriving on 23 January.
Heavier totals Bremson .27, Winton .27, Hest Lakes .23, Babbitt .23.
Smaller ~~total~~ amounts Minniray .03, Virginia .03.

27-31 January.
7. Minor S, Small systems behind frontal passage of afternoon
27 January brought scattered snow showers to end of month.
Heavier amounts Isabella ELC .11, Island Lake .06,
Hibbing Airport .06, Crane Lake .06. None ^{reported} a trace at
some places.

February 1977

~~Winter~~ Storm late in month ^{started the end} ~~long dry period~~ of the long dry period since July and ~~ended~~ began a wet period lasting for the rest of the Project. Precipitation from the storm pretty well reflected the ~~past~~ pattern for the month. Heaviest precipitation was along the high ground, the least along Lake Superior and to the west of the high ground.

Precipitation Events

1. Miroc S, 2-4 February.

Snow behind cold front passage on afternoon of

2 February. Heavier totals Minnimore .20, Tower

.15, Gunglitz Lake .15, Winton .10, Gane Lake .10. Least .01

at several places.

2. Miroc T, February.

Light snow in southern flow on 7 February. Most .06 at Isabella ELC, trace most other places.

3. Miroc R, 11-12 February.

Drizzle and fog in connection with occlusion passing over on 12 February. Heavier totals, Gunglitz Lake .15, Isabella ELC .13, Hibbing Airport .06. Only a trace at Tower, Virginia, Grand Marais.

4. Miroc S, 13 February.

Snow with return of cold front from northwest. Heavier amounts at Isabella ELC .04, ~~Winton~~ at Eagles Nest .02. None reported or a trace at most places.

5. Miroc S, 16-18 February.

Warm front followed by cold front with traces of snow to most places, with Babbitt reporting only measurable precipitation at .01.

6. Minor ^{19-20 February} S, Light snow on evening of 19 February from low clouds behind passing cold front. Heaviest fall Virginia .01, trace or none reported elsewhere.

7. Major ^{23-26 February} B) Biggest storm of the winter ~~brought~~ ~~was~~ signalled the beginning of a wet era ending the long drought that prevailed since July 1976. By far most of the precipitation falling this month occurred during this storm. Heaviest totals ^{storm} ~~at~~ ^{Finland} .86, Whiteford .81, Wake .80, Gunglitz Lake .64, Hubbin Airport .60, Tipton .60, Minninox .60. Virginia reported only .04, Brookitt .15, Hest Lakes .15.

March 1977

March 1977 was a wet month nearly everywhere in the Region, and extremely wet toward the southern Lake Superior ~~the~~ north ~~shore~~ shore. The high ground area was very wet.

Precipitation Events

1. Intermediate R., ^{3-5 March} ~~March~~ ^{large} A storm passed to the south of the Region 3-5 March, bringing snow ^{those days}. Heaviest totals Wales .70, Island Lake .6, Meadowlands .53, Eagle Nest .27, Tawa .27, Embarras .26. Least a trace at Grand Marais, .05 at Hibbing Airport.

2. Minor R., ^{9 March} ~~March~~ First rainstorm of year on 9 March with frontal passage. Heaviest total .13 at Isabella Etc; .10 at Virginia.

3. Major R. ^{11-14 March} Heavy rainstorm ^{came on northeasterly winds} as a storm center passed to the south. Heaviest totals ^{Wales 1.80} Finland 1.74, ^{Island Lake 1.73} Topte 1.70, Isabella Lake State 1.10. Lighter amounts Gore Lake .25, Embarras .46, Hibbing Airport .51, ~~at~~ Eagle Nest .60.

4. Minor S., ^{17-18 March} ~~March~~ Snow falling cold front on 17-18 March. Heaviest totals Island Lake .22, Virginia .21. Trace at Grand Marais, Winton.

April 1977

Precipitation was ~~not~~ fairly uniform over the region this month as ~~no~~ no single precipitation event dominated the month's totals.

Precipitation Events

1. Minor R, 1-2 April.
Rain, drizzle on night of 1-2 April with passage of occlusion.
Heavier totals Tower .29, Tope .10, Ely USFSC .06

2. Minor S, 6-7 April
Very light precipitation associated with passage of cold front from North-northeast on night of April 6-7. ~~Kawishew~~
~~gaze~~ Total of .02 at Minniconau, Isabella EIC, and Crane Lake, lesser amounts elsewhere, except possibly at Kawishew where gauge tripped .10 increment.

3. Minor R/S, 11-12 April
Rain showers before, behind Pacific cold front on 12 April.
Heavier totals Crane Lake .32, Breinson .23,
Isabella RS .17, Only a trace at Gunflint Lake,
Winton, and Babbitt.

4. Minor R/S, 14-15 April
~~Precipitation~~ Showers in southeasterly flow 14-15 April.
Heavier totals Tower .21, Isabella RS .10,
Cotton .08, Only a trace at Grand
Marais, .01 at Winton.

April 77

5. Intermediate ^{T, 17 April.} ^{Nighttime} Thunderstorms broke out on ^{three hours of} ~~the~~ 17 April -- the first of the season. Heavier amounts Gunflint Lake .33, Eagles Nest .32. Lesser amounts trace at Grand Marais, .08 at Ely USFSC.

6. Major ^{RT} ~~Intermediate~~, 18 April. ^{Morning and} ^{Afternoon} ^{Thunder-} showers 18 April, ^{in connection with Pacific cold front.} ~~Heavier amounts~~

~~Intermediate~~ Four days of rain, ^{and east wind} ^{18-21 April} as the Pacific cold front stalled over Lake Superior. ~~Heavier totals~~ ~~intensity of~~
Total amounts over region fairly uniform, with most ~~stations~~ ~~for~~ locations recording between .90 and 1.10 inches. Heavier totals Gunflint Lake 1.54, Firlad 1.16, Lesser totals ^{Grand Marais .56,} ^{Winton .65,} Crane Lake .67, Kaministiquia .80.

7. Minor ^{23 April} Sprinkles on 23 April from passing cloud patches. Only traces at some stations

8. Minor ^{29 April.} Light, widely scattered thunderstorms on ^{some good} afternoon of 29 April. Heavier totals Island Lake .17, Gunflint Lake .10, Whitefish .10, Meadowlands .06, Hoyt Lakes .03. None or a trace elsewhere.

Roller echoes show ^{shower cells forming just east of} ~~shower cells~~ moving from WNW to ESE, dissipates
upon reaching Lake Superior. First echoes at 1517 EST
29 April; last echo 2010 CST.

Apr 17 /
Cleveland

S. Louis Kline,

Precipitation Events

In current meteorological practice, precipitation is measured daily at ~~the~~ a ^{the same} ~~fixed~~ time ~~that the precipitation~~ every day, although the time of observation varies from station to station. However, precipitation occurs in association with ^{eastward-moving} regions of general low atmospheric pressure ~~systems~~, which may have a transit time on the order of days. Thus, many observations of rainfall occur while it is still raining, and the total rainfall occurring during the storm in progress is cut into segments. With different observation times at the various stations, ~~storm~~ ^{daily} rainfall totals ^{may} become very confusing to relate to storm totals.

Further, the eastward-moving regions of general low atmospheric pressure have various structures to them. They may contain ¹ warm fronts, cold fronts, mesoscale thunderstorm systems, vorticity ~~and~~ ^{convergence} maxima, and sharp systems induced by differential advection of air from different regions. Between these features small regions of high pressure ^{& descending air} may cause precipitation to cease at times while the general low pressure system passes over.

1. The ^{general} reader need not understand the structure of low pressure ^{systems}, the point is that structures exist within them, causing precipitation to ~~start~~ stop and start, ^{sometimes} ~~stop~~ several or more times.

The purpose of this section is several-fold. The main purpose is to identify the precipitation events that occurred during the main part of the Copper-Nickel Project, from 1 June 1976 to 31 December 1977. ~~Described is the overall rainfall pattern for~~ to establish what happened precipitation-wise ~~and~~ ~~connection with other studies~~

Another purpose is to enable the reader to gain a deeper understanding of the precipitation regime in the Region. The general patterns remains the same from one year to the next, although the intensities of the precipitation systems may vary. Reading of this section should familiarize the reader with what "goes on" precipitation-wise. Yet another purpose is to enable users of the information to relate what may have happened to flora, fauna, leaching processes, etc. as a result of the precipitation patterns and intensities. ~~Reader may~~

Finally, a purpose is to provide ^{a guide} ~~information~~ that might be useful for any further studies.

The section is arranged by months. Following a description of the total rainfall distribution for each month, each rain event is described as follows:

1. ^{Intensity & event.} Whether an event is

a minor, intermediate, major, or very major event. A minor event is one in which very little precipitation fell -- ~~not to be very useful to~~ not enough to have much impact on most ~~surface~~ applications.

An intermediate event is one which has substantial precipitation totals to impact, ^{at least numerous} ~~many~~ applications.

A major event is one which has an impact on a great many applications, and generally requires at least one inch ^(2.54 cm) at one of the stations, or alternatively, the better part of an inch at many stations.

A very major event is one which patterns 2 or more inches of rain at several stations and/or nearly that much almost everywhere in the Region. The events are numbered in order, and the ^{event} intensity described after the event number.

2. The ~~type~~ ^{types} of rain event. The events are described as follows:

T - Basically thunderstorm-produced precipitation

S - Basically ^{convective} showers not from thunderstorms

R - Basically widespread general rains not from convective activity, in plain language, general rainstorms or general snowstorms.

In some cases, the events may be a combination of the above. In these cases, the event types are listed, ^{in the judgement of the authors,} in order of their contribution to the rainfall total.

3. The day on which the event occurred

4. A description of the event with the heavier totals and the lesser totals of the various stations reporting. In ^{a few} ~~some~~ cases, values from some stations were not included because of inapplicability (such as event gauges) or possible observer error.

Nearly every ~~precipitation~~ precipitation occurrence in the Copper-Nichel region during the period is included herein, including some observed on the radar which passed between the ground-based observing stations. There were a few instances of traces of rain reported that are not included. Some of these are likely due to observer error, while others are due to a few sprinkles from isolated clouds.

~~Also, in the~~

In reading this section, the reader may wish
to consult the monthly precipitation maps, the
daily precipitation record, ^{and} the radar echo ~~track~~^{track}
charts, ~~and the~~