# Summer Precipitation Data from Selected BLM and USGS Gaging Stations in the National Petroleum Reserve – Alaska, 2003-07

*Fish Creek gaging station, photo taken 08.04.06 by R.Kemnitz.*


by

Jeff Derry, Richard Kemnitz, Daqing Yang, Michael Lilly


November 2007


Bureau of Land Management and

North Slope Lakes Hydrologic Projects

Report No. INE/WERC 07.20

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## A report on research sponsored by:

- Bureau of Land Management

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## DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the accuracy of the data presented herein. This research was funded by the Bureau of Land Management (BLM), and Geo-Watersheds Scientific (GWS). The contents of the report do not necessarily reflect the views of policies of the BLM, GWS, or any local sponsor. This work does not constitute a standard, specification, or regulation.

The use of trade and firm names in this document is for the purpose of identification only and does not imply endorsement by the University of Alaska Fairbanks, BLM, GWS, or other project sponsors.

## CONVERSION FACTORS, UNITS, ABBREVIATIONS AND SYMBOLS

### Conversion Factors

| Multiply | By | To obtain |
|---|---|---|
| | Length | |
| inch (in) | 25.4 | millimeter (mm) |
| inch (in) | 2.54 | centimeter (cm) |
| foot (ft) | 0.3048 | meter (m) |
| mile (mi) | 1.609 | kilometer (km) |

### Units

For the purposes of this report, only English units were employed.

### Physical and Chemical Water-Quality Units:

Vertical Datum:

In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929), a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called *Sea Level Datum of 1929*.

Horizontal Datum:

The horizontal datum for all locations in this report is the North American Datum of 1983.

**Abbreviations, Acronyms, and Symbols**

| | |
|---|---|
| BLM | Bureau of Land Management |
| hr | hour |
| in | inches |
| ft | feet |
| GWS | Geo-Watersheds Scientific |
| mm | millimeters |
| NPR-A | National Petroleum Reserve - Alaska |
| QA | quality assurance |
| QC | quality control |
| UAF | University of Alaska Fairbanks |
| USGS | U.S. Geological Survey |
| WERC | Water and Environmental Research Center |
| WWW | World Wide Web |

## PROJECT COOPERATORS

This project was developed in coordination with the North Slope Lakes project, which covers a large area of the North Slope and benefits from a number of positive partnerships. All project partners contribute to the overall project objectives.

- BP Exploration (Alaska) Inc.
- Conoco Phillips Alaska (CPA)
- Geo-Watersheds Scientific
- Bureau of Land Management
- Alaska Department of Natural Resources
- The Nature Conservancy
- Northern Alaska Environmental Center
- Mineral Management Service

## ACKNOWLEDGEMENTS

Bureau of Land Management sponsored this project, including field coordination and logistics support. Additional support was provided by other project cooperators, and Geo-Watersheds Scientific (GWS), in the form of financial and in-kind match.

# Summer Precipitation Data from Selected BLM and USGS Gaging Stations in the National Petroleum Reserve – Alaska, 2003-07

## INTRODUCTION

The University of Alaska Fairbanks (UAF) Water and Environmental Research Center (WERC) and Geo-Watersheds Scientific (GWS), together with project cooperators, initiated a study in the Fall of 2002 (Phase One) to obtain baseline information about the physical and chemical characteristics of North Slope tundra lakes. The project was extended in 2005 (Phase Two) to cover a greater number of water source lakes and reservoirs and develop better understanding of lake-watershed processes related to water use and management. This project was initiated to help coordinate and support additional Bureau of Land Management (BLM) and United States Geological Survey (USGS) data collection in the National Petroleum Reserve – Alaska (NPRA) and at Umiat, Alaska. Additionally, summer precipitation data collected at selected BLM and USGS surface-water gaging sites were reviewed and summarized for public use.

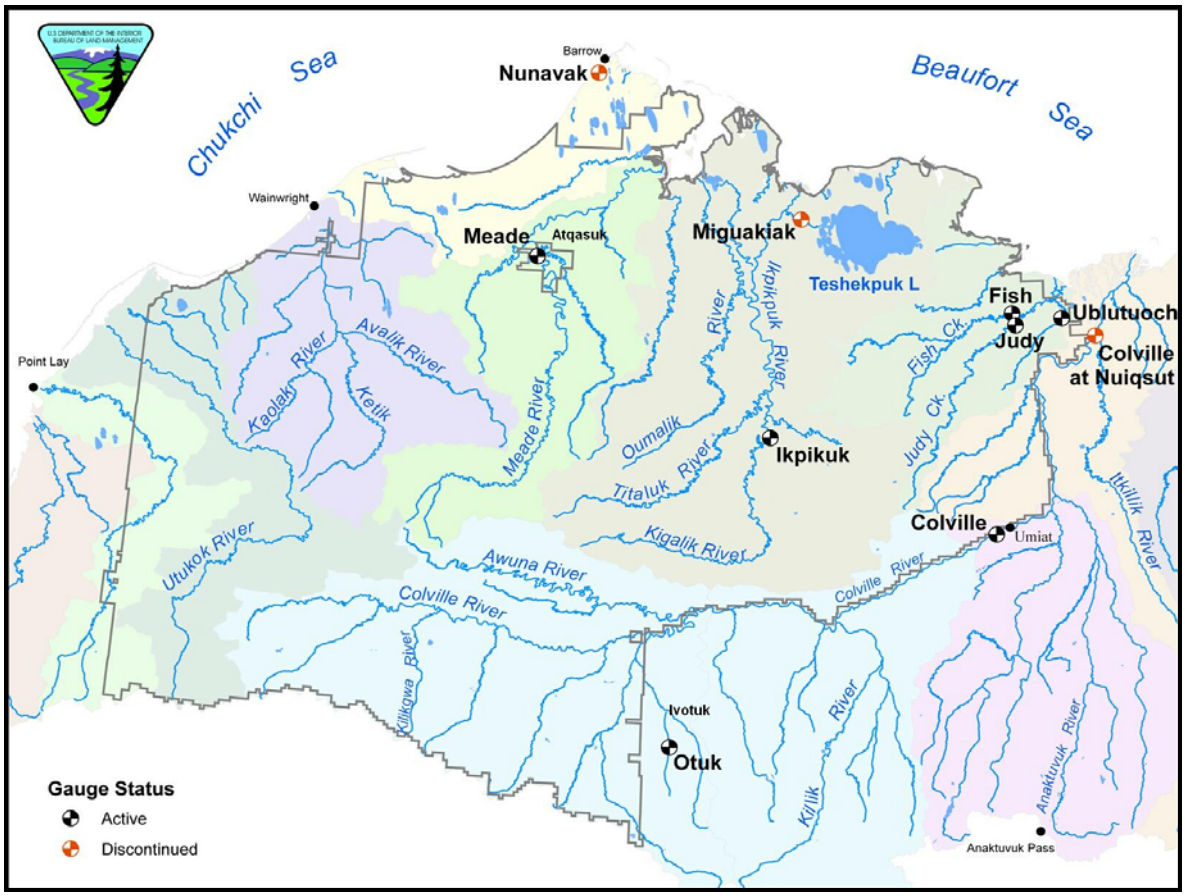


**Figure 1. Location of gaging stations in NPR-A, Alaska.**

## SITE LOCATIONS

The summer precipitation stations were located at surface-water gaging stations in NPR-A. The stations were located at the Colville River at Umiat (275 ft elevation), Ikpikpuk River below Fry Creek (100 ft elevation), and Fish Creek near Nuiqsut (50 ft elevation) (Figure 1).

The Colville River station, which is funded entirely by the USGS (USGS site number 15875000), is located near Umiat on the Colville River Floodplain. The station lies approximately 200' from the Colville River in an area surrounded by relatively large deciduous shrubs on a tussock tundra surface (Figure 2). Minor topographic relief is seen in the area with precipitation distribution likely being influenced by orographic lifting. Additional data collected at this site includes gage height, discharge, water temperature, and air temperature. Data and information for this site can be acquired at: http://waterdata.usgs.gov/ak/nwis/uv/?site_no=15875000

The Ikpikpuk River station, USGS number 15820000, is located approximately 70 miles NW of Umiat and 250' from the Ikpikpuk River on a high bluff overlooking a bedrock riffle extending across the river. Surrounding vegetation is tussock tundra of intermediate species composition. Very little topographic relief is seen except for local drainages (Figure 3). Additional data collected at this site include gage height, discharge, water temperature, air temperature, wind speed, and wind direction. Data and information for this site can be acquired at: http://waterdata.usgs.gov/nwis/uv?15820000

The Fish Creek station, USGS number 15860000, is located approximately 20 miles west from the village of Nuiqsut. Surrounding vegetation is low laying shrubs and tussock tundra. The station is located on the left bank with little vegetation in the vicinity. There is little topographic relief except for Fish Creek approximately 100' away (Figure 4). Additional data collected at this site include gage height, discharge, water temperature, air temperature, wind speed, and wind direction. Data and information for this site can be acquired at: http://waterdata.usgs.gov/ak/nwis/uv/?site_no=15860000

**Figure 2. Colville River at Umiat.  Photo taken 06.02.07 by J. Eash.**

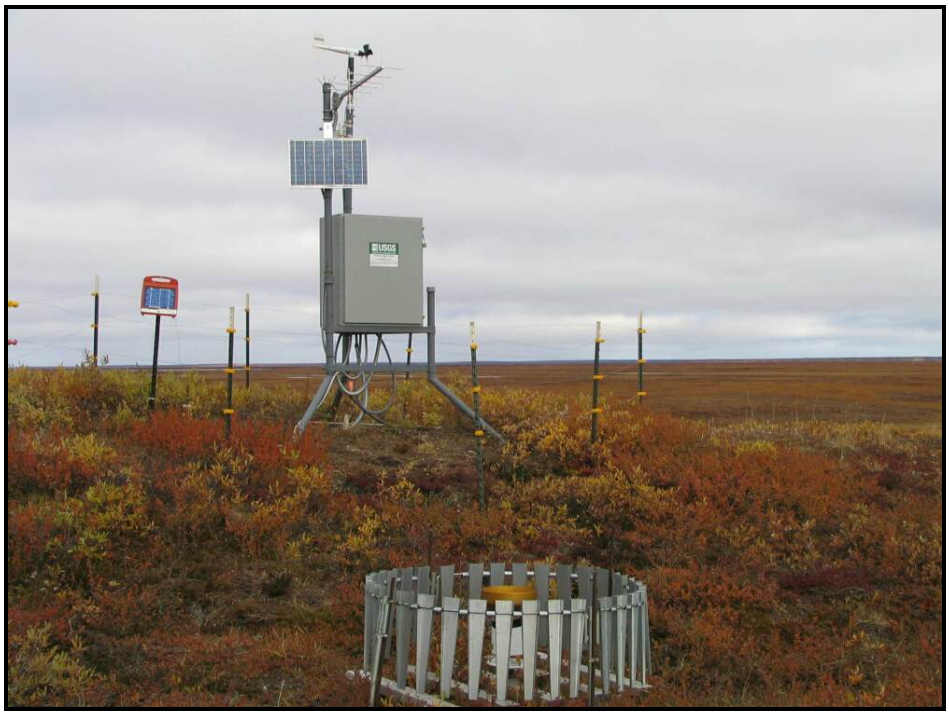


**Figure 3. Ikpikpuk River gaging station, photo taken 09.01.06 by R. Kemnitz.**

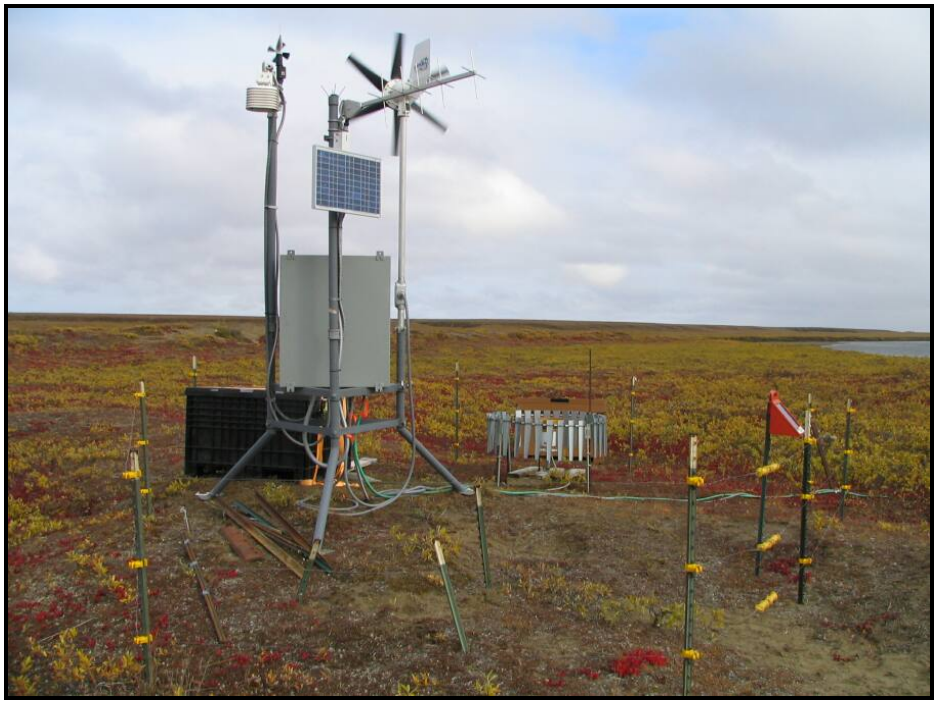

**Figure 4. Fish Creek gaging station, photo taken 08.31.06 by R. Kemnitz.**

## DATA COLLECTION METHODS

Summer precipitation values at the field sites were collected with tipping bucket gages. A summary table of gages used are listed below (Table 1). All units funnel precipitation from an orifice into a bucket mechanism that tips when filled to a calibrated level. Each tip is counted by a datalogger and recorded at either 15 minute or hourly intervals.

**Table 1. Precipitation gage specifications**

| Maker | Model | Orifice Size | Increments | Accuracy |
|---|---|---|---|---|
| Texas Electronics | TR-525M-R3 | 9.66 inch | 0.1 mm | ± 1% at 2 in/hr. |
| Texas Electronics | TR-525 USW | 8 inch | 0.01 inch | ± 1% at 1 in/hr |
| Sutron | 5600-0420 | 8 inch | 0.01 inch | ± 0.5% at 0.5 in/hr<br>± 2% at 2 in/hr |
| Novalynx | 260-2500 | 8 inch | 0.01 inch | ± 1% at 2 in/hr |

Gages sit at a height of 1.3 – 2.3 feet above ground. Since wind can cause undercatch of falling precipitation (Benning, J., and D. Yang, 2005), the precipitation gages are surrounded by

an Alter (wind) shield (Figure 5). The Alter shield encircles the tipping bucket at a height slightly higher than the top of the gage rim. The hinged metal sections are designed to negate wind effects around the gage and allow for capture of undisturbed falling precipitation. Site specific details are below:

- Colville River: Novalynx tipping bucket gage, model# 260-2500, which collects data at 15-minute increments. This site originally had a Sutron model tipping bucket, model # 5600-0420 mounted 10 feet above ground on one leg of the gaging station from June 2003 to June 2, 2007. The gage was calibrated before field installation and after removal from the gaging station. During the period 2003-2006 it was checked twice a year to verify that the funnel was clear of debris, and that the rain gage was level. USGS was not funded to QA/QC the gage during this period. On June 2, 2007 the Sutron gage was replaced with a Novalynx gage and re-installed 2 feet above ground level and surrounded by an Alter shield. USGS QA/QC procedures were initiated at this time.

- Ikpikpuk River: Novalynx tipping bucket gage, model# 260-2500 (installed May 28, 2007), which records in 15 minute intervals. From June 1, 2003 to May 28, 2007 a Texas Electronics Inc. model TR-525M-R3 tipping bucket enclosed within an Alter shield was located about 30 feet shoreward of the gaging station**.** Data were collected in millimeters and recorded at 1-hour increments. The gage was installed and calibrated by BLM before field installation in 2003 and upon removal in 2007. It was checked every visit to ensure "tips" were being recorded, that the funnel was clear of debris, and that the rain gage was level. In June 2005 the USGS took over operation of the gaging station but was not funded to QA/QC the gage during the period June 2005 to May 2007. On May 28, 2007 the Texas Electronics gage was replaced with a Novalynx gage. USGS QA/QC procedures were initiated with the calibration and installation of the Novalynx gage in 2007. On July 17, 2007 the Novalynx gage was temporarily replaced by a Texas Electronics model TR-525 USW tipping bucket gage until August 25 when the Novalynx gage was re-installed.

- Fish Creek: Sutron tipping bucket gage, model # 5600-0420 (installed June 4, 2007), which records in 15 minute intervals.. From June 9, 2003 to June 3, 2007 a Texas Electronics Inc. model TR-525M-R3 tipping bucket gage was used, where data were collected in millimeters and recorded at 1-hour increments. The gage was installed and calibrated by BLM before field installation in 2003 and upon removal in 2007. It was

checked every visit to ensure "tips" were being recorded, that the funnel was clear of debris, and that the rain gage was level. In June 2005 the USGS took over operation of the gaging station but was not funded to QA/QC the gage during the period June 2005 to May 2007. USGS QA/QC procedures were initiated in 2007. On June 4, 2007 the Texas Electronics gage was replaced with a Sutron gage. For this report, data were reviewed to remove any erroneous values and collection values were converted to English units.

Instrument programming, collection specifications, and data storage is controlled with a Sutron Model 8200 or 8210 datalogger. The Fish Creek and Ikpikpuk Creek sites record precipitation values on an hourly basis, while the Colville River gage records precipitation every 15 minutes. Time periods where data are available for the three sites are detailed in Table 2. Station data are retrieved during field visits and also transmitted hourly to the GOES west satellite where it is relayed and archived in USGS and NWS databases. This data are accessible through the USGS links provided above beginning in June 2007. Raw data files were downloaded by the USGS and were archived locally within the Anchorage Field Office.

**Figure 5. Typical precipitation gage, photo by J. Derry.**

**Table 2. Period of precipitation record collected for Colville River at Umiat, Ikpikpuk River, and Fish Creek gaging stations for the 2003-07 summers.**

| Year | Colville River | Ikpikpuk River | Fish Creek |
|---|---|---|---|
| 2003 | 6/18 - 10/13 | 6/1 - 10/13 | 6/1 - 10/10 |
| 2004 | 5/12 - 9/30 | 5/20 - 10/21 | 5/20 - 10/7 |
| 2005 | 5/19 - 10/3 | 6/5 - 10/22 | 5/25 - 9/30 |
| 2006 | 5/13 - 10/13 | 5/24 -10/15 | 5/24 - 10/19 |
| 2007 | 5/23 - 9/30 | 5/20 - 6/11, 7/18 - 10/16 | 5/26 - 10/2 |

## SELECTED RESULTS

For this report, precipitation in the form of rain is assumed to occur in the North Slope region from approximately May 15 – October 15. Snow may fall within this period and rain may fall before or after this period, nonetheless, this period captures the majority of time in which precipitation falls as rainfall and when gages are in operation.

From 2003-2007 the Colville River site saw a cumulative precipitation range from 1.75” in 2007 to 5.14” in 2003 with an average of 3.39” for the period of study (Table 3). Rain essentially begins to occur for the summer season approximately the first part of June and ends the middle part of September. The majority of precipitation falls in July (Figure 6).

From 2003 – 2007 the Ikpikpuk River site saw a cumulative precipitation range of 1.63” in 2007 to 5.90” in 2004 with an average of 3.97” for the period of study (Table 4). Rain begins to occur in early June and ends the middle part of September. The majority of precipitation does not occur consistently in any one month, usually varying between July and August, and even June in 2007 (Figure 7).

From 2003 – 2007 Fish Creek saw cumulative precipitation range of 0.87” in 2007 to 4.03” in 2003 with an average of 2.88” for the period of study (Table 5). Minor precipitation in the form of rain is seen in May, but not considerable until the latter part of June. The majority of precipitation occurs in July (Figure 8).

**Table 3. Monthly summer precipitation for Colville River at Umiat gaging station for the 2003-07 summers.**

| | May | June | July | August | September | October | Total |
|---|---|---|---|---|---|---|---|
| 2003 | NA | 0.11 | 3.40 | 0.73 | 0.67 | 0.23 | 5.14 |
| 2004 | 0.12 | 0.54 | 2.04 | 0.86 | 0.61 | 0.00 | 4.05 |
| 2005 | 0.00 | 0.59 | 1.04 | 0.34 | 0.34 | 0.00 | 2.31 |
| 2006 | 0.33 | 0.60 | 1.39 | 1.13 | 0.14 | 0.09 | 3.68 |
| 2007 | 0.02 | 0.80 | 0.16 | 0.51 | 0.26 | 0.00 | 1.75 |
| Average | 0.12 | 0.53 | 1.61 | 0.71 | 0.40 | 0.06 | 3.39 |

**Table 4. Monthly summer precipitation for Ikpikpuk River gaging station for the 2003-07 summers.**

| | May | June | July | August | September | October | Total |
|---|---|---|---|---|---|---|---|
| 2003 | NA | 0.46 | 2.15 | 1.05 | 0.90 | 0.60 | 5.16 |
| 2004 | 0.44 | 1.27 | 1.64 | 1.21 | 1.32 | 0.02 | 5.90 |
| 2005 | NA | 0.29 | 0.83 | 1.19 | 0.53 | 0.15 | 2.99 |
| 2006 | 0.26 | 0.86 | 1.07 | 1.57 | 0.30 | 0.12 | 4.18 |
| 2007 | 0.00 | 0.63* | 0.10* | 0.44 | 0.46 | 0.00 | 1.63 |
| Average | 0.23 | 0.70 | 1.16 | 1.09 | 0.70 | 0.18 | 3.97 |

**Table 5. Monthly summer precipitation for Fish Creek gaging station for the 2003-07 summers.**

| | May | June | July | August | September | October | Total |
|---|---|---|---|---|---|---|---|
| 2003 | NA | 0.06 | 2.01 | 0.78 | 0.76 | 0.42 | 4.03 |
| 2004 | 0.07 | 0.42 | 1.46 | 0.64 | 0.68 | 0.12 | 3.39 |
| 2005 | 0.01 | 0.08 | 1.15 | 0.87 | 0.46 | 0.00 | 2.57 |
| 2006 | 0.09 | 0.28 | 1.50 | 1.00 | 0.20 | 0.47 | 3.54 |
| 2007 | 0.01 | 0.44 | 0.04 | 0.31 | 0.07 | 0.00 | 0.87 |
| Average | 0.05 | 0.26 | 1.23 | 0.72 | 0.43 | 0.20 | 3.13 |

**Table 6. Cumulative summer precipitation in inches for Colville River at Umiat, Ikpikpuk River, and Fish Creek gaging stations averaged over the 2003-07 summers and for the three sites.**

| | 2003 | 2004 | 2005 | 2006 | 2007 | Average |
|---|---|---|---|---|---|---|
| Colville | 5.14 | 4.05 | 2.31 | 3.68 | 1.75 | 3.39 |
| Ikpikpuk | 5.16 | 5.90 | 2.99 | 4.18 | 1.63* | 3.97 |
| Fish | 4.03 | 3.39 | 2.57 | 3.54 | 0.87 | 2.88 |
| Average | 4.78 | 4.45 | 2.62 | 3.80 | 1.42 | |

* includes an estimated 0.60 inches added to the missing period June 12 – July 17

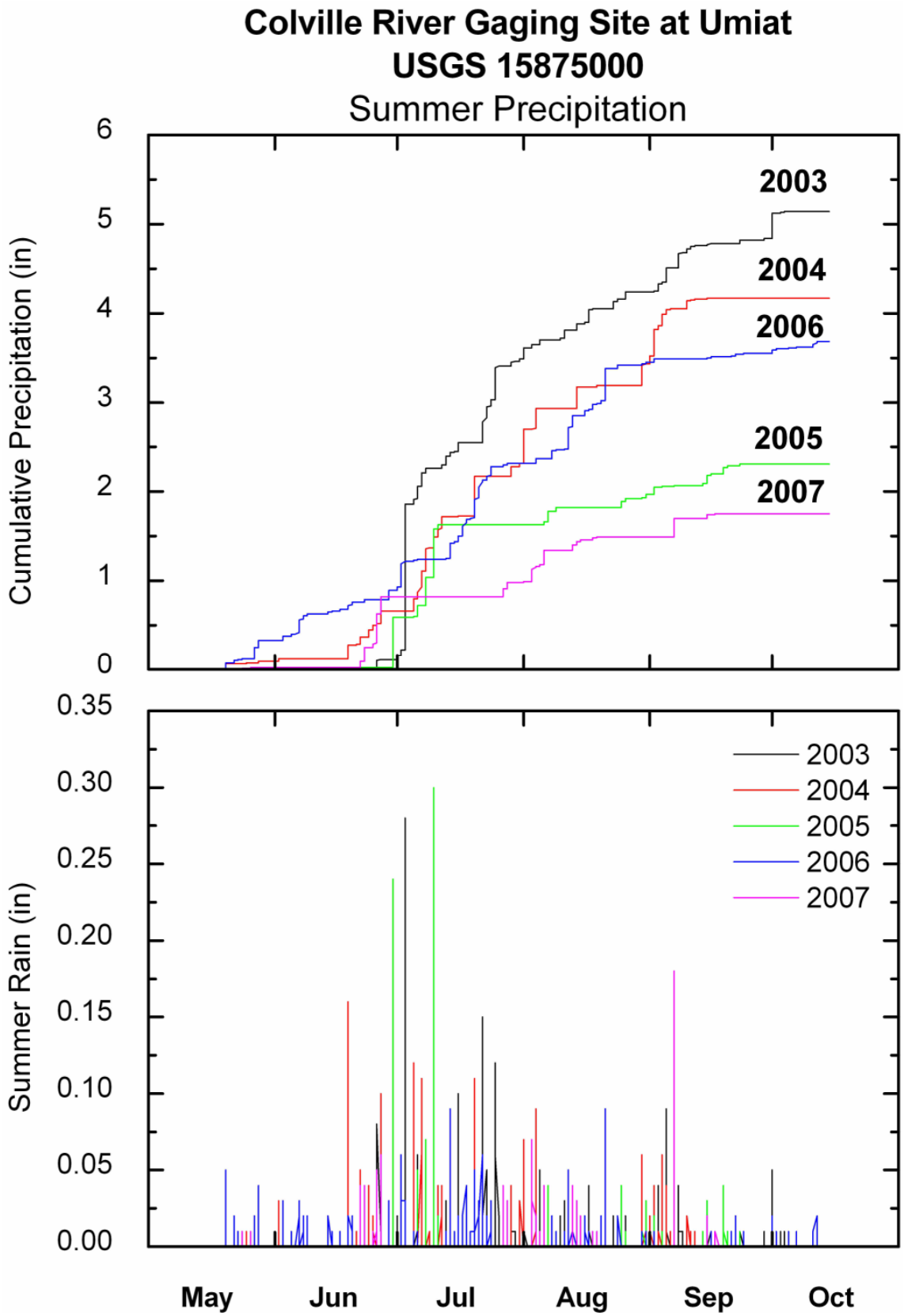


**Figure 6**. **2003-07 summer daily and cumulative precipitation for the Colville River at Umiat gaging station.**

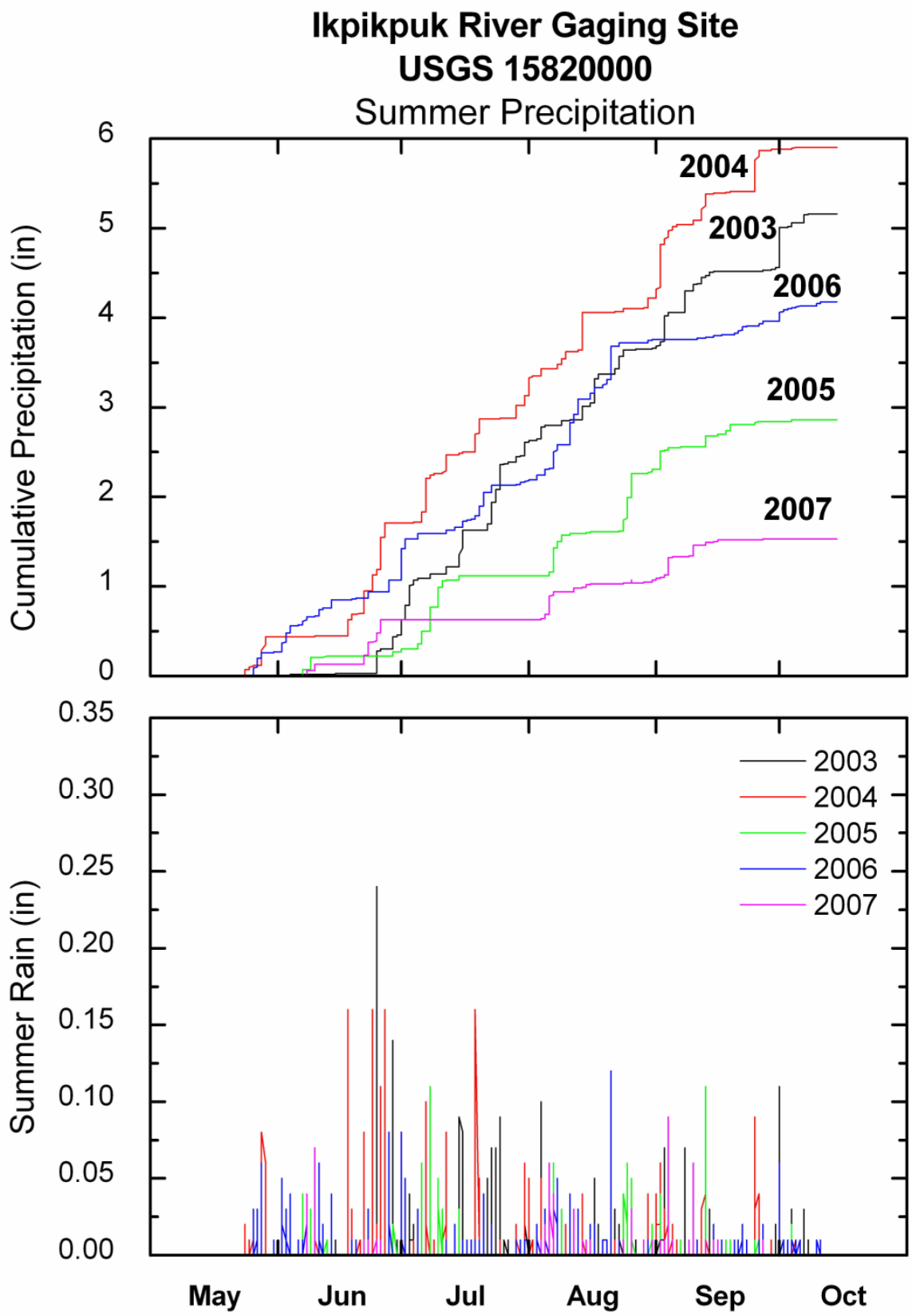


**Figure 7. 2003-07 summer daily and cumulative precipitation for the Ikpikpuk River gaging station.**

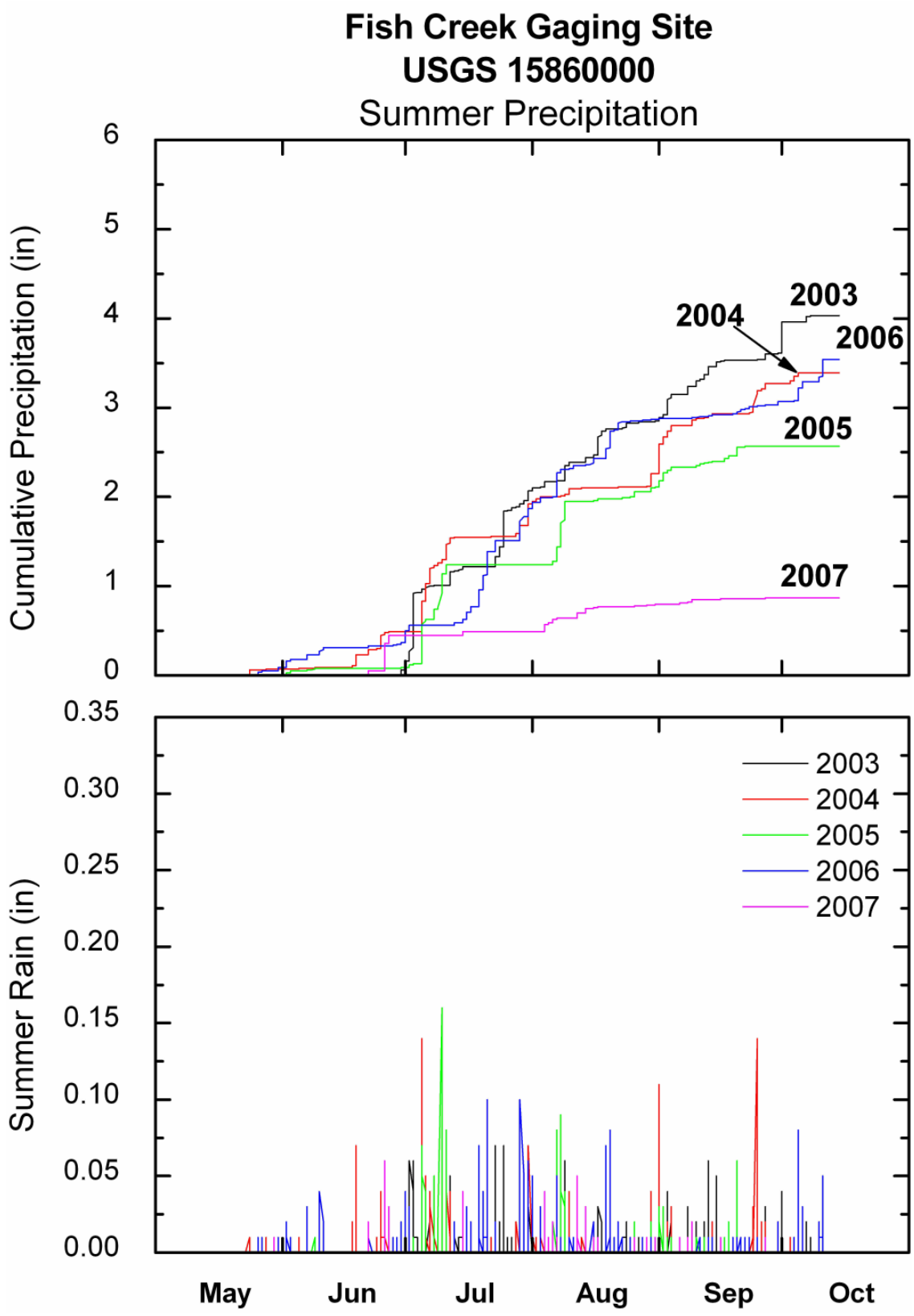


**Figure 8. 2003-07 summer daily and cumulative precipitation for the Fish Creek gaging station.**

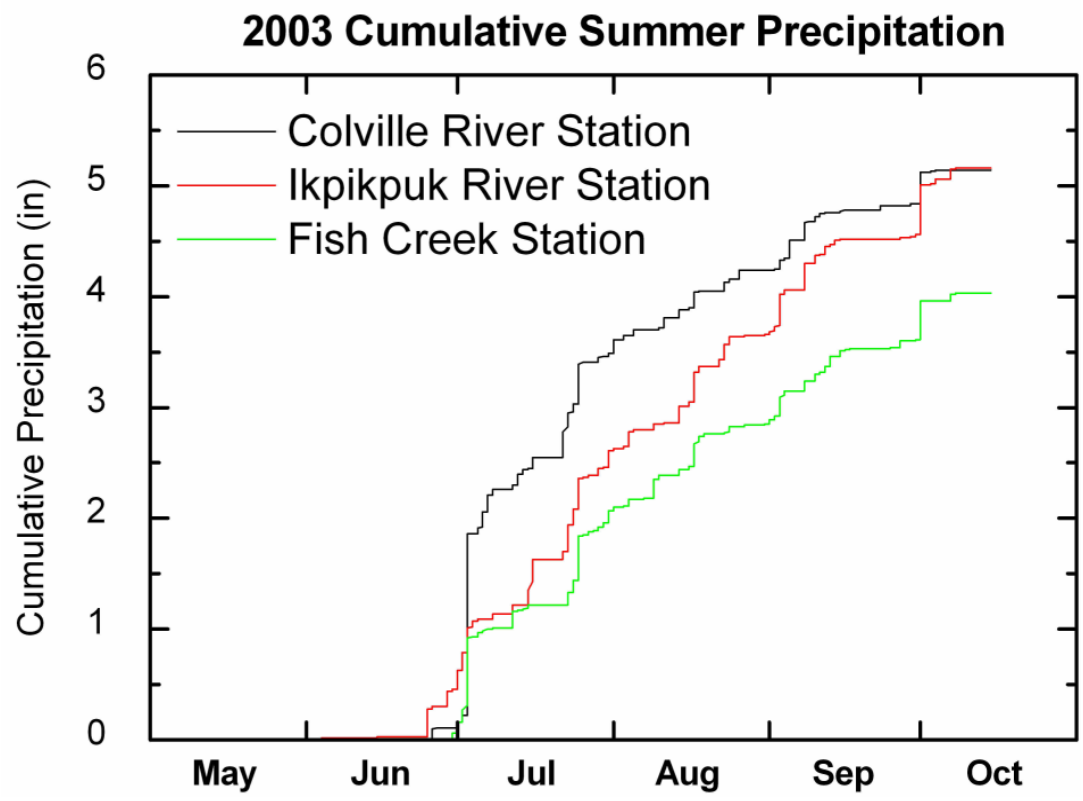


**Figure 9. 2003 annual cumulative precipitation comparisons between the three gaging stations.**

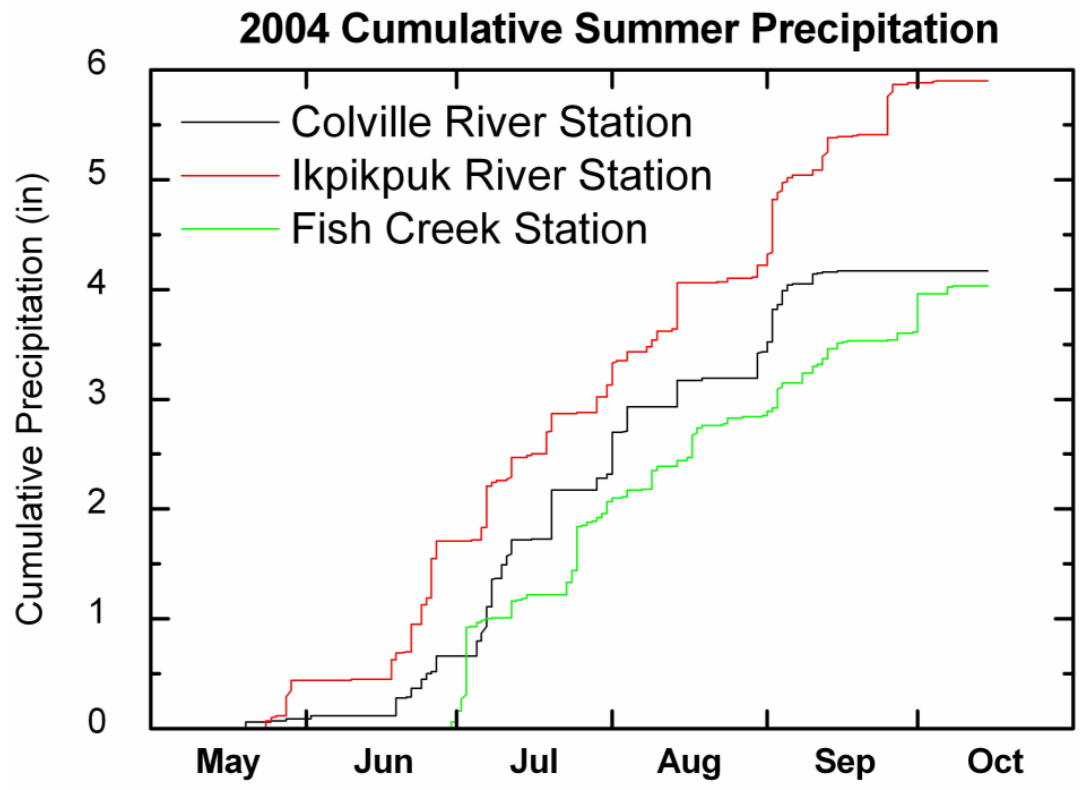


**Figure 10. 2004 annual cumulative precipitation comparisons between the three gaging stations.**

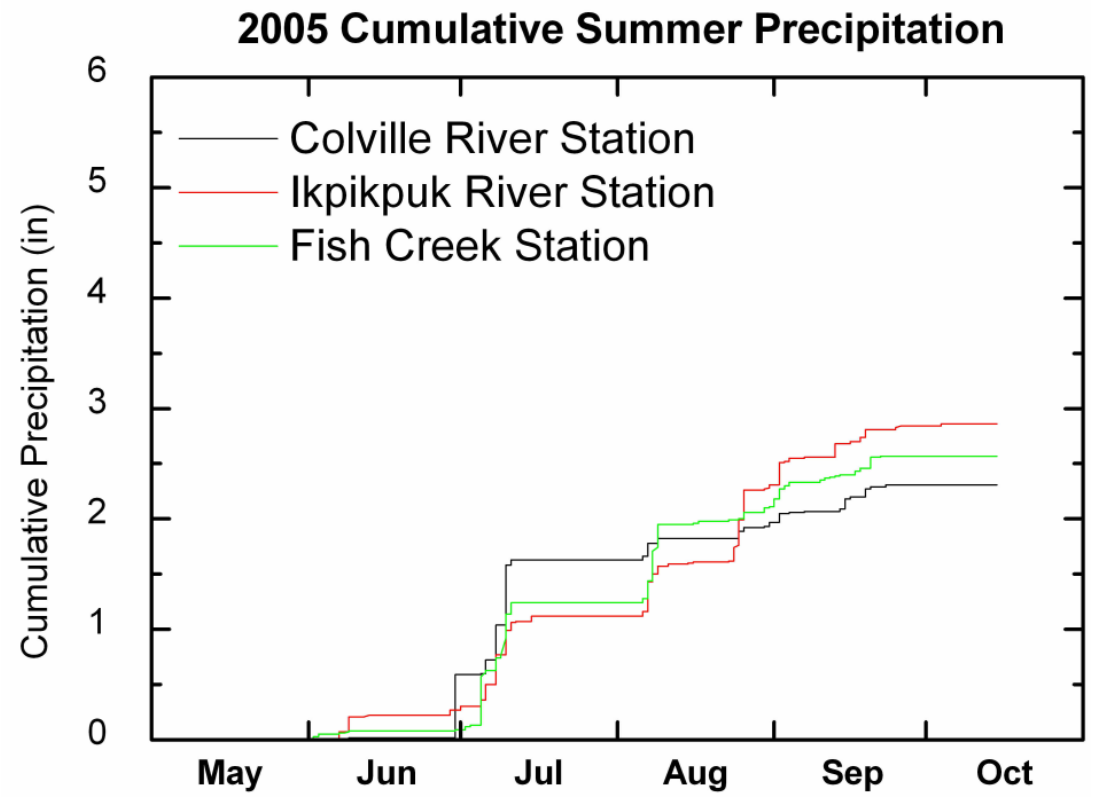


**Figure 11. 2005 annual cumulative precipitation comparisons between the three gaging stations**

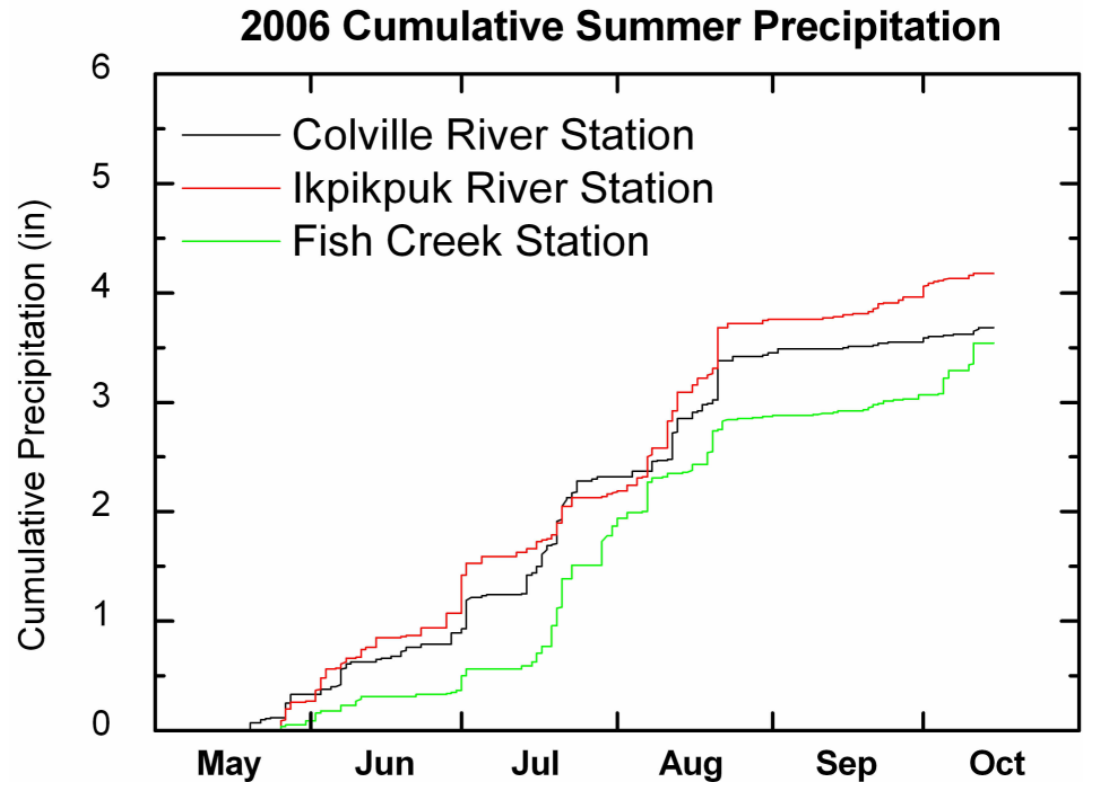


**Figure 12. 2006 annual cumulative precipitation comparisons between the three gaging stations.**

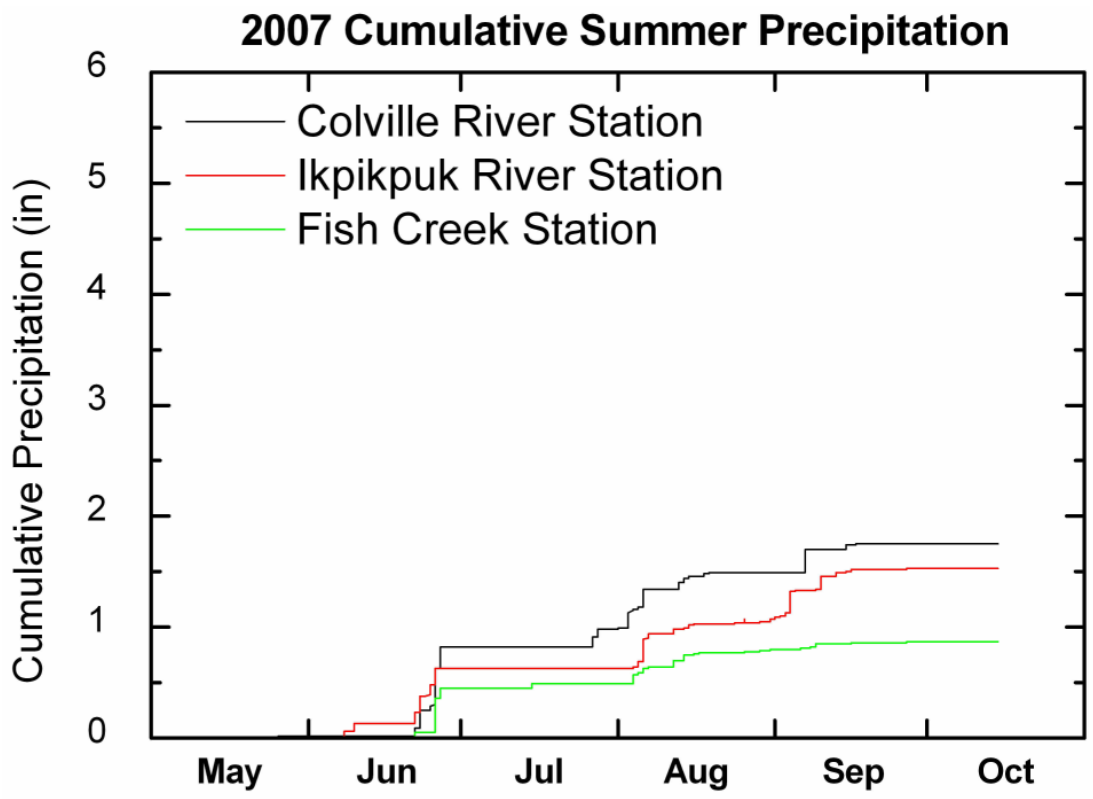


**Figure 13. 2007 annual cumulative precipitation comparisons between the three gaging stations.**

## SUMMARY

Precipitation, in the form of rain, is measured at the Colville River at Umiat, Ikpikpuk River, and Fish Creek gaging stations and summarized for the time period 2003-2007. The Colville and Ikpikpuk River gages are located within the Arctic Foothills climate zone while the Fish Creek gage is located in the Arctic Inland climate zone (Zhang, 1996). Data for this report were reviewed for erroneous and missing data as well as units of measure converted from metric to inches.

The three sites are similar in terms of annual trends (Table 5) as well as average precipitation totals for the period of review, with Fish Creek having an average of 2.88”, Colville 3.39”, and Ikpikpuk 3.97”. All three stations saw a relatively wet season in 2003 and 2004. Likewise, a very dry season in 2007 was seen with stations reporting less than half of the average precipitation from 2003-2007. Annual comparisons of cumulative precipitation are plotted on Figures 9-13 for each year 2003-07.

The Ikpikpuk gage had a malfunction from June 12 to July 17, 2007. In order to use monthly and annual data for the Ikpikpuk River gage for 2007 estimates were made for the precipitation which was not recorded. Estimates are likely to bring monthly totals within .1 inch of actual rainfall. An estimated value of .5 inches was added to the .13 inches already recorded in June at the Ikpikpuk River and an estimated value of .1 inch was added to the 0.00 inch recorded for the rest of July. Estimates were based on the nearest gages at Atqasuk, Fish Creek and the Colville River. In June Atqasuk recorded .41 inches, Fish Ck recorded .44 inches and Colville 0.80 inches. In July Atqasuk recorded .09 inches, Fish Ck recorded .04 inches and Colville 0.16 inches.

Data from the three locations reveal similarities in terms of the timing and amount of rainfall in the NPRA. All three sites (averaged over five years) received the highest rainfall in July, with August being a close second. Both June and September rainfall totals for all gages typically consisted of less than 2/3 of the average August rainfall. In July 2007 all three sites had less than 10% the monthly norms for July.

Summer precipitation data are crucial for successful basin-wide water balance estimations and hydrological modeling for runoff estimation of both gaged and ungaged watersheds. Tipping bucket precipitation from three locations in the NPRA from 2003-2007 summarized in this document demonstrate the temporal and spatial variability of summer rainfall in the NPRA. These results need to be integrated into regional precipitation studies which include additional stations within and adjacent to NPR-A.

## REFERENCES

Zhang, T., Osterkamp, T.E., and Stamnes, K. 1996. Some characteristics of the climate in Northern Alaska, U.S.A. *Arct. Alp. Res.*, 28, 10 pages.

Benning, J., and D. Yang, 2005: Adjustment of daily precipitation data at Barrow and Nome Alaska for 1995-2001, Arctic, Antarctic and Alpine Research, 37 (3), 267-283 [ pdf ] .

# APPENDIX

## OTHER NEARBY PRECIPITATION COLLECTION STATIONS

Additional precipitation data collected within and nearby NPR-A were collected at the following locations:

Atqasuk: USGS gaging station on the Meade River (2007 – present)
http://waterdata.usgs.gov/ak/nwis/uv/?site_no=15803000

Atqasuk and Barrow: Atmospheric Radiation Measurement (ARM) Program funded by the U.S. Department of Energy (DOE) collected precipitation data, http://dq.arm.gov/cgi-bin/dqmenu.pl

Ivotuk: UAF established two meteorological sites as part of the Arctic Transitions in the Land-Atmosphere System (ATLAS) (1998 – 2006).
http://www.uaf.edu/water/projects/atlas/ivotuk/met2/met2.html

Ivotuk: San Diego State University (SDSU) as part of the Global Change Research Group (GCRG) has collected precipitation data at Ivotuk (2003 – present), Atqasuk (1998, 2003-present), Barrow (1997-98, 2001-present) http://fs.sdsu.edu/gcrg/data.php

NSL sites: UAFWS1, UAFWS2, UAFWS3, UAFWS4 and L9817 also have precipitation collected from 2006 – 2008. http://www.colville-watershed.org/stations/stations.shtml

USGS Global Terrestrial network for permafrost (GTN-P): Fish Creek, Umiat, Koluktak, Drew point, Inigok. Contact Gary Clow: clow@usgs.gov

Other NOAA sites with precipitation data;
Umiat Airport, formerly identified as PAUM (METAR-TAF)
Barrow, Nuiqsut, Wainwright: Automated Surface Observing System (ASOS)
Atqasuk: Automated Weather Sensor System (AWSS)
Anaktuvuk Pass and Pt. Lay: Automated Weather Observing System (AWOS)
Alpine and Kuparuk: Supplemental Aviation Weather Reporting Station (SAWRS)