Alouette Project Water Use Plan

Alouette Water Temperature

Implementation Year 4

Reference: ALUMON-5

Alouette Water Temperature – 2011

Study Period: 2011

Greenbank Environmental Inc.

June 29, 2012

Alouette Water Temperature

Program No. ALUMON #5

Contract No. Q8-8630

29 June 2012

Prepared for:

BC hydro

Environmental Risk Management
6911 Southpoint Drive
Burnaby, BC
V3N 4X8

Prepared by:

GREENBANK
ENVIRONMENTAL INC.

Jeff Greenbank, RPBio.
913 Baker Drive
Coquitlam, BC
V3J 6X3

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Executive Summary

Water temperature in the Alouette River, downstream of the Alouette Dam continues to be a concern for BC Hydro, environmental agencies and stakeholders. In response to these concerns and other potential low-flow issues, BC Hydro changed the operation of the Alouette Dam by fully opening the low level outlet (LLO) in 1996 to increase the minimum flows. It has been agreed by the fisheries technical committee (FTC) that the increase in flows has improved the temperature conditions, however, uncertainties regarding the potential of high water temperature impacts remain.

To address these uncertainties, BC Hydro has commissioned a water temperature monitoring program to measure water temperatures throughout the watershed, including the reservoir, to better assess the possible range of operational changes that can be taken to mitigate for measured impacts. This Year 4 report summarizes the 2011 temperature data and provides comparisons to earlier years.

Water temperatures in the plunge pool just downstream of the Alouette Dam generally ranged from a low of about 4°C in December and January and generally increased from February with peak temperatures observed in late August and early September. Water temperatures did not reach lethal levels for salmonids. Water temperatures reached a high of 19°C to 22°C from 2000 through 2010 while temperatures in 2011 did not surpass 18°C. Weekly mean water temperatures were highest at the beginning of September when they approached 17°C at the Plunge Pool site.

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Program No. ALUMON #5

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1 Introduction

1.1 Background

Water temperature in the Alouette River, downstream of the Alouette Dam continues to be a concern for BC Hydro, environmental agencies and stakeholders. In response to these concerns and other potential low-flow issues, BC Hydro changed the operation of the Alouette Dam by fully opening the low level outlet (LLO) in 1996 to increase the minimum flows. It has been agreed by the fisheries technical committee (FTC) that the increase in flows has improved the temperature conditions, however, uncertainties regarding the extent potential of high water temperature impacts remain.

To address these uncertainties, BC Hydro has commissioned a water temperature monitoring program to measure water temperatures throughout the watershed, including the reservoir, to better assess the possible range of operational changes that can be taken to mitigate for measured impacts. This Year 4 report summarizes the 2011 temperature data and provides some comparison to earlier years. This report is preliminary and will be expanded to address all of the management questions as the program proceeds and more data is collected.

1.2 Management Questions

The FTC identified the following management questions that will be addressed by this temperature monitoring program.

1. How often are water temperature ≥25°C, the incipient lethal water temperature of most stream rearing salmonid species, including the duration of each event and the frequency of occurrence?
2. Is the duration of observed warm water event less than 1 day, thus limiting exposure to warm waters and thermal stress impacts.
3. Are warm temperature events restricted to certain sections of the river, indicating the inflow of cooler waters into the system (most likely ground water)?
4. Is the frequency and duration of warm water events such that it would promote a shift in community structure and/or reduce survival and growth of rearing juvenile salmonids, as indicated by a change in smolt numbers?
5. Given the extent of thermal stratification in the reservoir and the location of the LLO, is there an operational change that can be implemented to mitigate the occurrence of warm water events.

This report will summarize the results of the water temperature monitoring completed in 2011.

2 Methods

2.1 Field Methods

Temperature data is collected from both the Alouette Lake reservoir and Alouette River between the Alouette Dam and 224th Street in Maple Ridge, BC (Figure 1). Temperature monitoring in the reservoir is completed with a string of temperature loggers hanging off the LLO structure. The string of loggers is orientated vertically with a 2 m spacing from 124 m el. down to 114 m el. The LLO intake is located at 113 m el.

Temperature data loggers are located at five location on the South Alouette River between the Alouette Dam and the 224th Street bridge crossing (Table 1).

Table 1. Loggers site reference names and locations

Site Reference	Location
LLO Outlet	Directly adjacent to the LLO outlet for a direct measure of water temperature leaving the Dam.
Plunge Pool	Immediately downstream, of the Alouette Dam plunge pool approximately 50 m downstream of the LLO on the left bank of the river. The location will measure the effect of the plunge pool residence time on outflow water temperatures.
Mud Creek	On the left bank of the river just upstream of the Mud Creek confluence.
ARMS	On the left bank of the river approximately 50 m downstream of the Alco Park hatchery.
224th St	On the right bank of the river approximately 100 m upstream of the 224th Street bridge.

The temperature loggers are TidbiT V2 Temp Logger (Part # UTBI-001) manufactured by the Onset Computer Corporation. The operational temperature range of the loggers is from -20°C to 70°C in air and a maximum sustained temperature of 30°C in water. The accuracy of the loggers is 0.2°C over a range of 0 to 50°C. The loggers are set to log temperature measurements hourly at all locations.

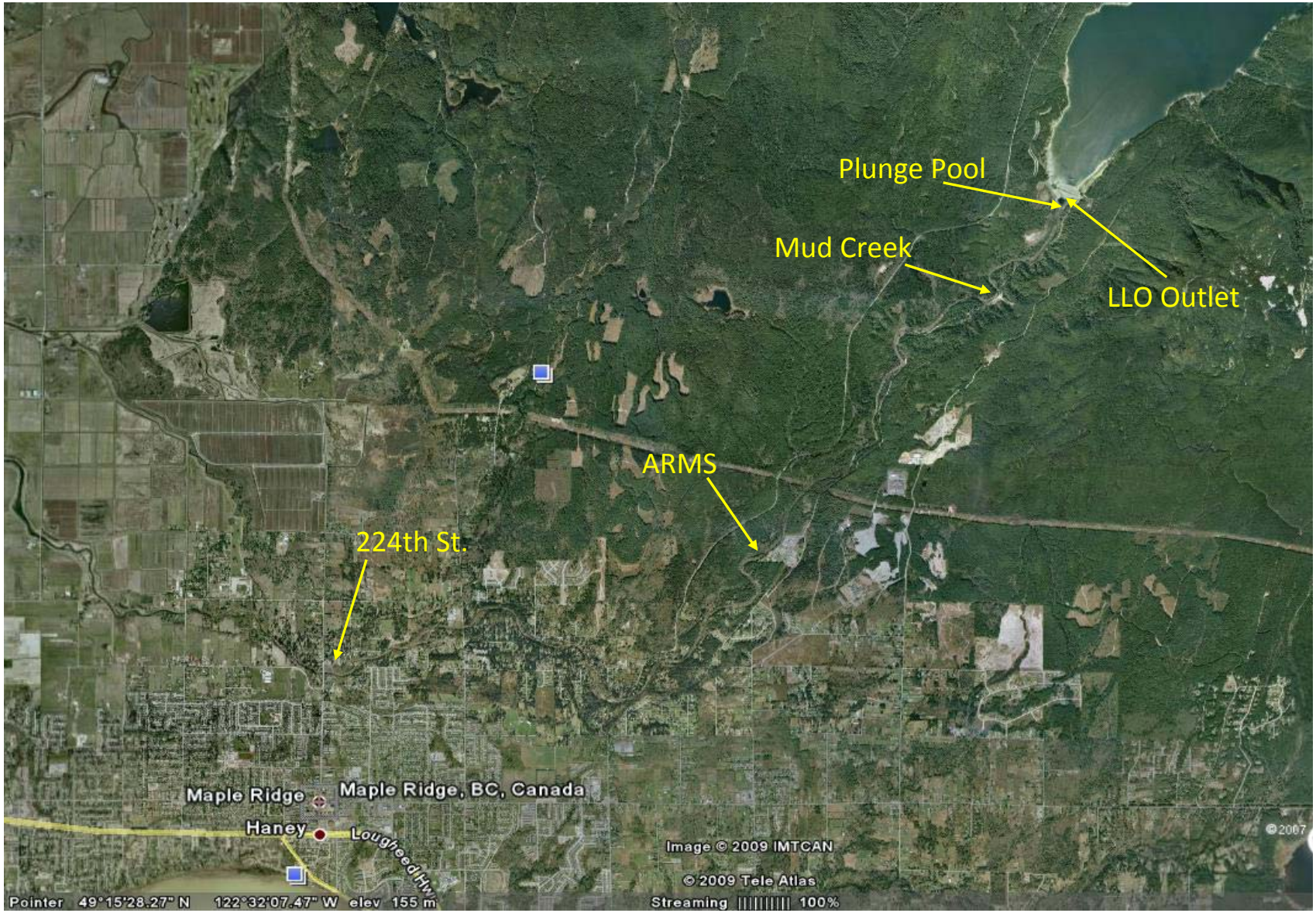

Figure 1. Location of Alouette River temperature loggers.

2.2 Data Analysis

Temperature data was provided by BC Hydro in daily mean, maximum and minimum format for data prior to 2008. For subsequent data the daily mean, maximum and minimums were calculated and plotted. Weekly means were also calculated for the summer months on the river sites.

3 Results

In 2011, daily mean water temperatures in the plunge pool just downstream of the Alouette Dam ranged from a low of about 4°C in December and January and increased from February with peak daily mean temperatures near 18 °C observed in September. Daily mean water temperatures at the Plunge Pool were lower through the summer months compared with previous years on record (Figure 2). Plots of daily mean, minimum and maximum water temperatures from the Plunge Pool site for all year are provided in Appendix 1.

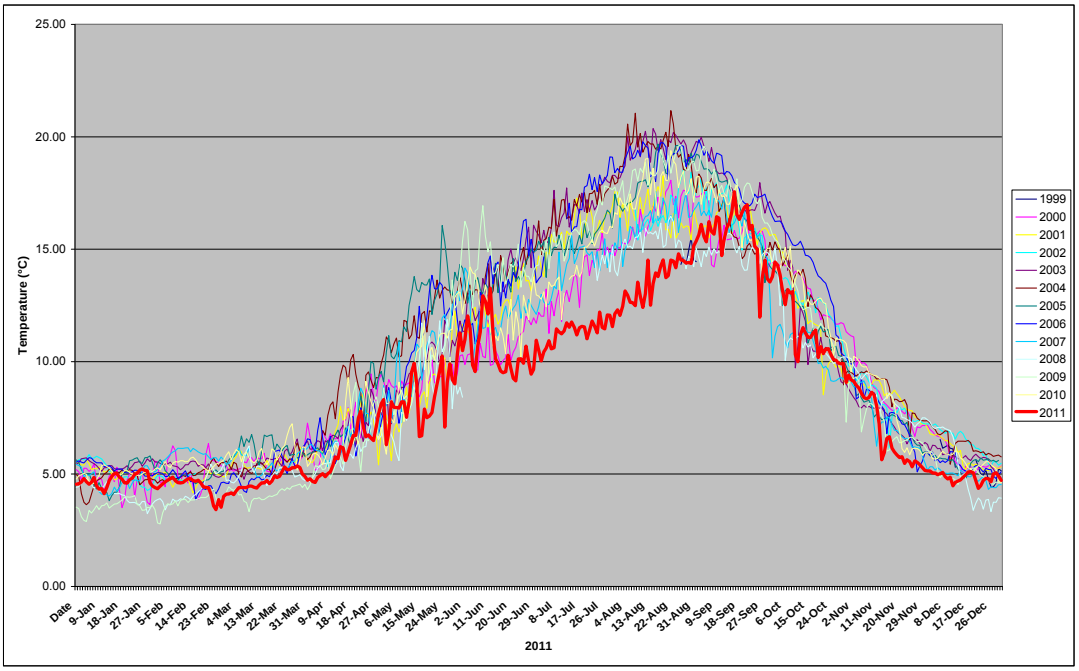

Figure 2. Mean daily water temperatures at the Plunge Pool Site for all years. Mean daily water temperatures for 2011 are shown in bold red.

Mean daily water temperatures at the downstream sites were similar, although they appeared to be higher during the warmest summer months (Figure 3). Mean daily water temperatures are generally above 16°C during the summer months for most of the years on record (Appendix 2).

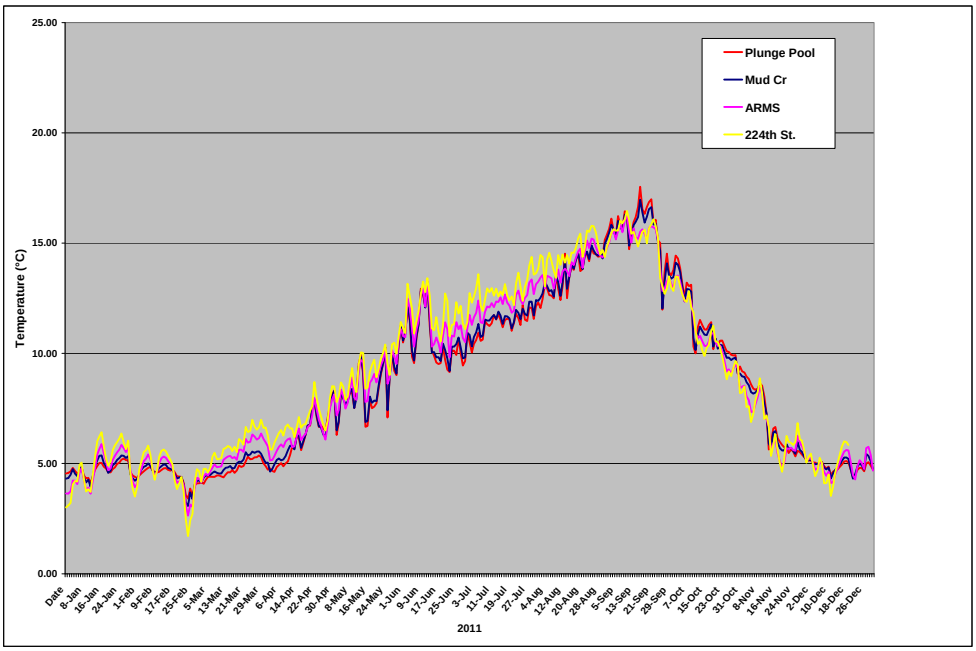

Figure 3. Mean daily water temperatures for the river sites, 2011.

A closer look at the Plunge Pool water temperatures during the warmest months of the year (July through September) shows a maximum daily temperature of 18°C in mid-September and a low of 8.0°C (Figure 4). This is cooler than temperatures observed in 2010 when maximum temperatures exceeded 20°C for 6 hours in August. Unlike most of the previous years, water temperatures did not exceed 20°C at any of the river sites in 2011. Water temperatures exceeded 18°C at the ARMS site for approximately 2 hours on September 11, 2011 which was the only observations greater than 18°C at all the river sites in 2011.

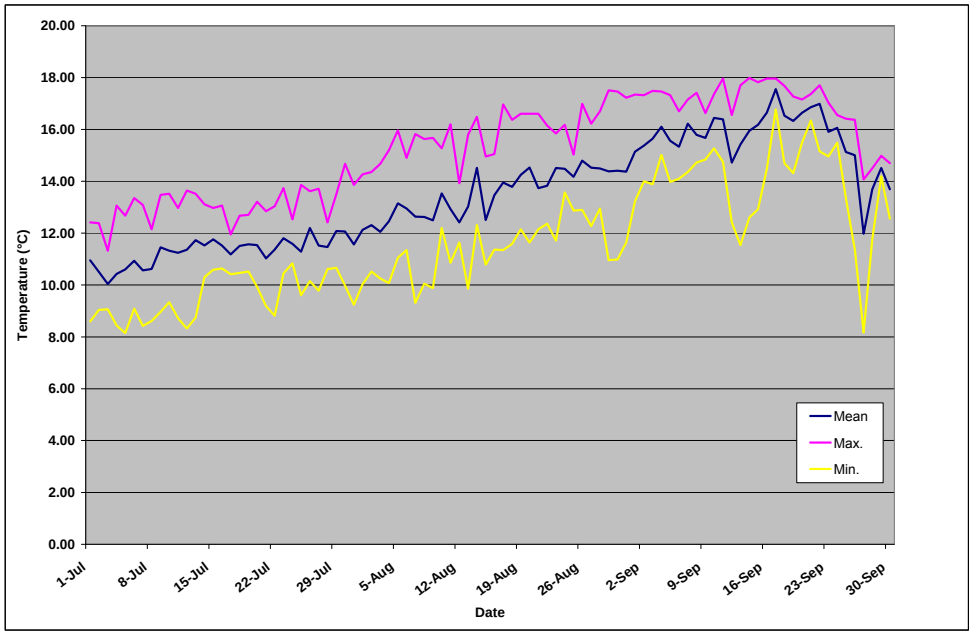

Figure 4. Mean, minimum and maximum summer water temperatures from the Plunge Pool site, 2011.

Weekly mean temperatures were calculated for all river sites. In 2011, weekly mean temperatures through the warmest months (July through September) ranged from about 11°C to near 17°C (Figure 5). Weekly mean temperatures were highest at the 224th St site in July and August while the Plunge Pool Site has the warmest weekly mean temperatures in September (Figure 5).

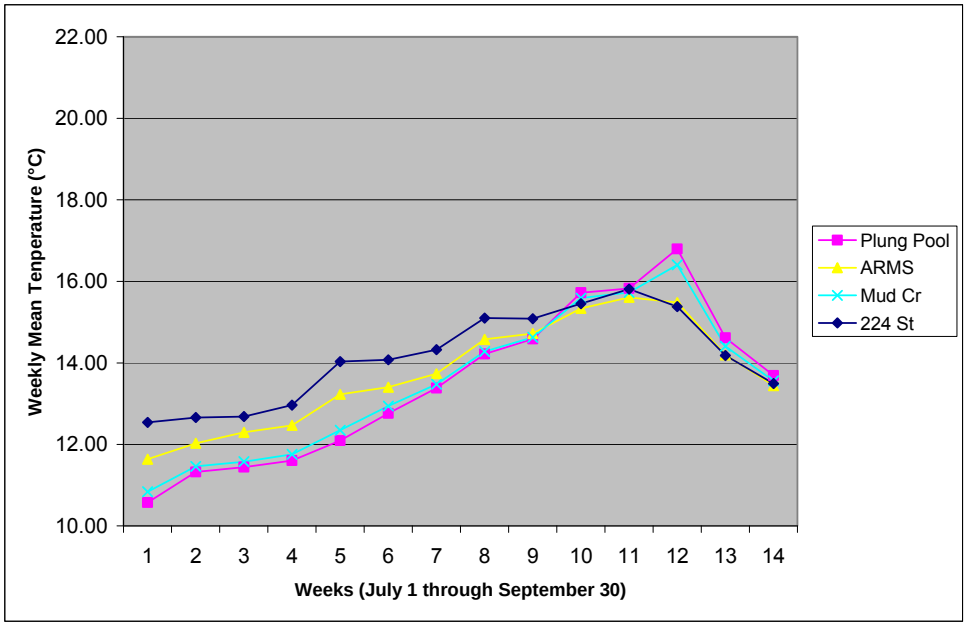

Figure 5. Weekly mean summer temperatures, July 1 to September 30, 2011.

Reservoir water temperature is measured at the LLO outlet structure from 124 m elevation to 114 m elevation with loggers placed at 2 m intervals. The LLO intake gate draws water from 113 m el. Mean daily water temperatures are very similar through all depths in the winter months while differences by depth become most pronounced in late August when the highest water temperatures are observed (Figure 6). Daily mean, maximum and minimum water temperatures for each elevation 2011 are provided in Appendix 3.

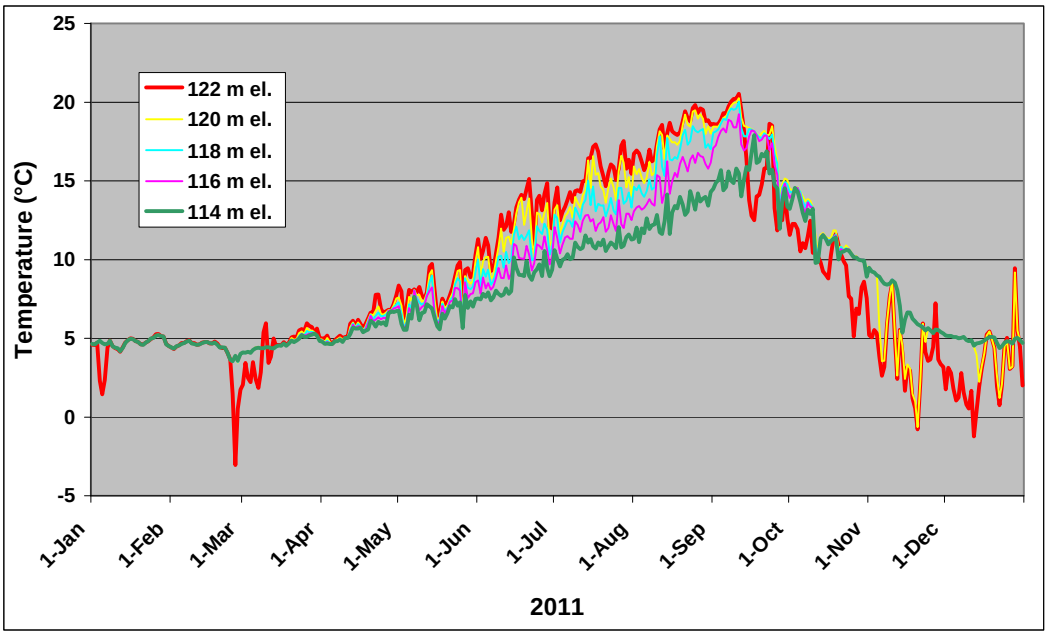

Figure 6. Daily mean water temperatures from the Alouette Dam LLO structure, 2011. The 124 m el. data is not shown since it was above the water elevation for this period.

4 Discussion

The highest water temperatures were observed in late August and early September in the Alouette River in 2011. Of the salmonid species present, these temperatures potentially impact summer rearing coho and steelhead as well as resident trout species. Adult sockeye returning in July may also encounter water temperatures above their optimum range. We have illustrated the interactions between life history stage and water temperature for coho, sockeye and steelhead in Appendix 4.

For coho, we found that the daily maximum water temperatures approached the upper sustained temperature range for juveniles in August 2011. Lethal temperatures were not approached. For sockeye adults, we found that the optimum temperature range was surpassed in the beginning of July during the anticipated migration period but the upper sustained or avoidance temperature was not approached. Water temperatures are within the optimum range for adult sockeye near the beginning of the migration which is important to ensure river entry or migration is not delayed. Temperatures for juvenile sockeye during outmigration were below or within the optimum range. Steelhead are within the optimum temperature range for adult migration and incubation. Water temperatures were within or below the optimum range for juveniles surpassed in 2011.

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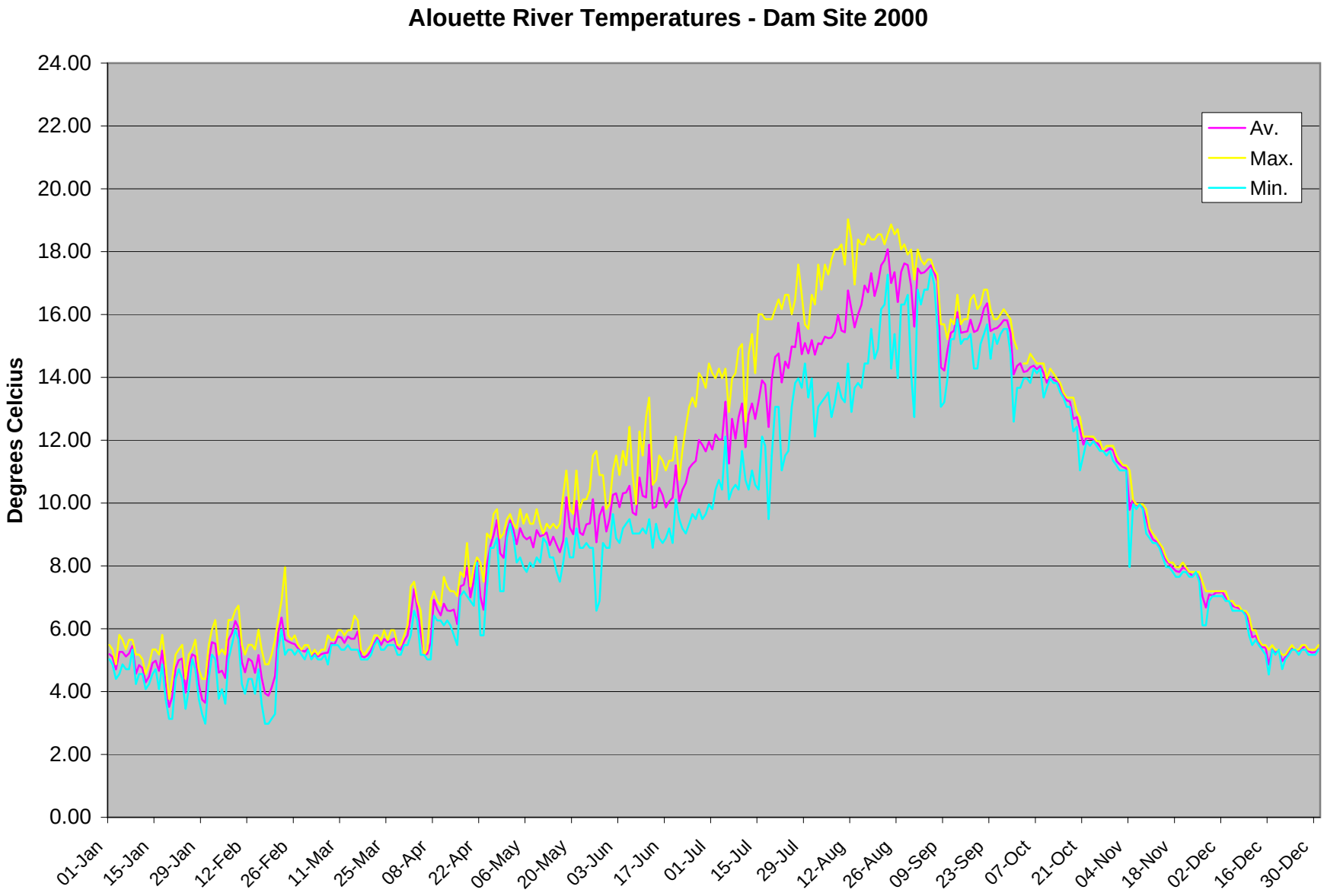
Appendix 1. Plot of daily mean, maximum and minimum temperatures for all years (1999-2011) from the Plunge Pool site.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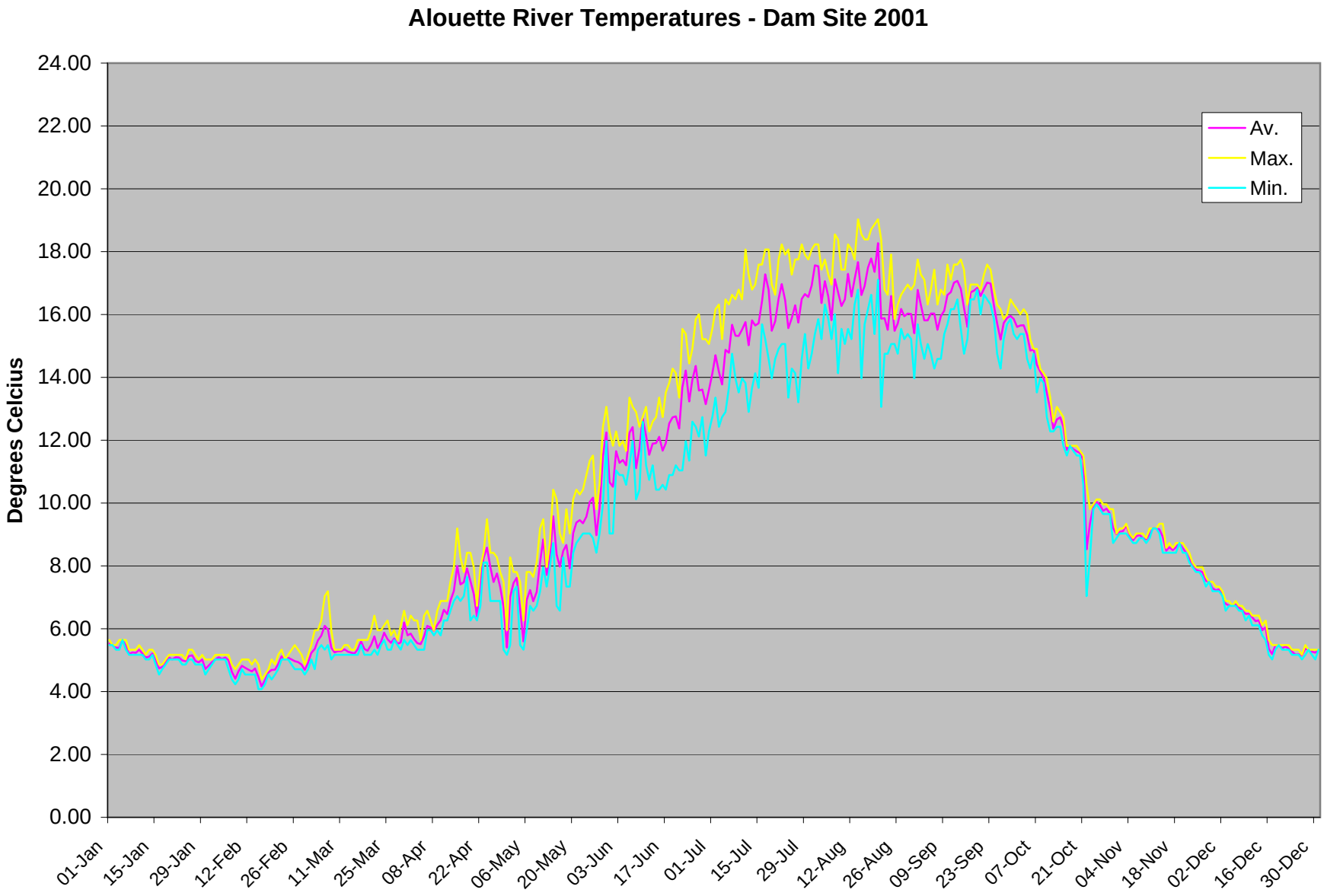
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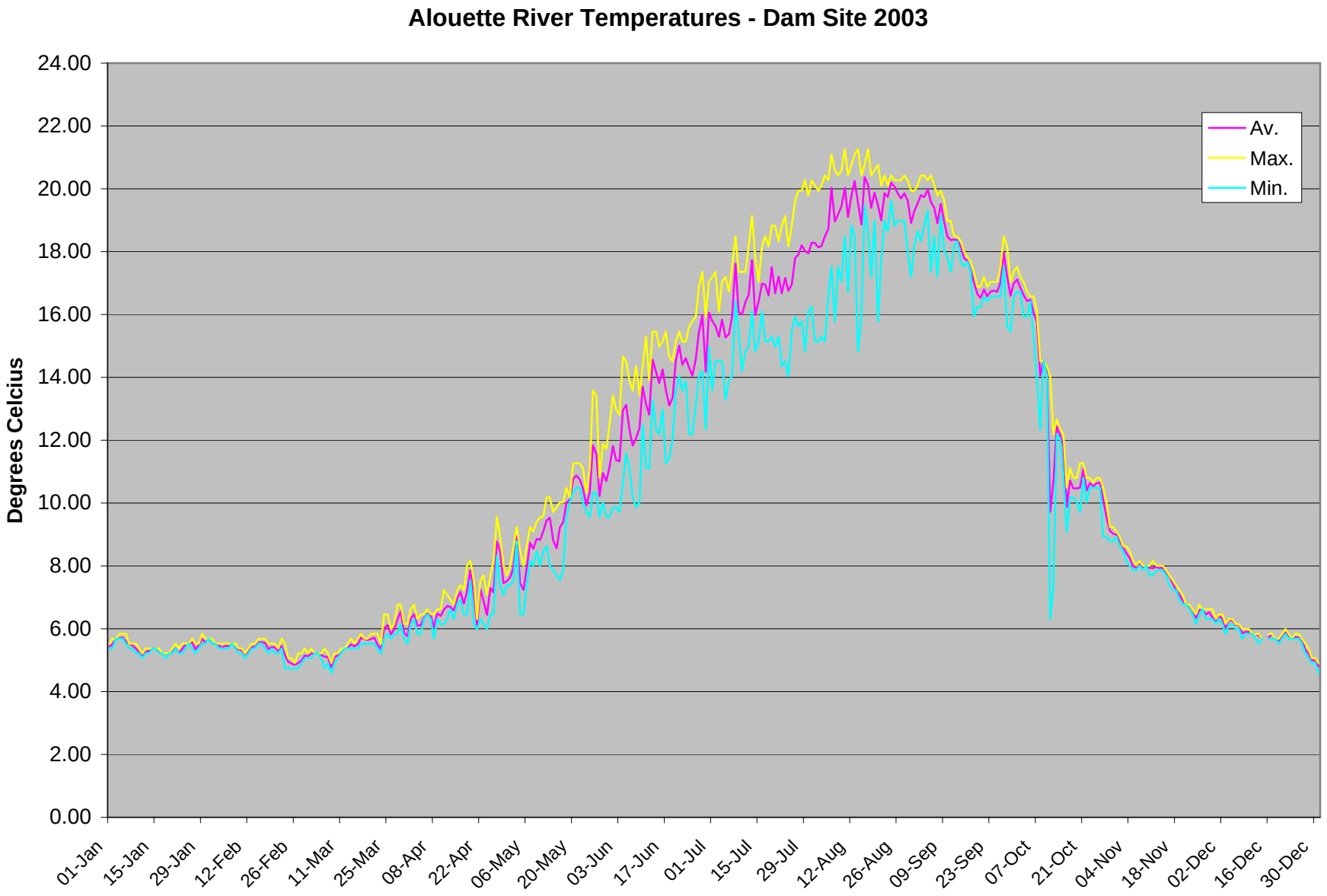
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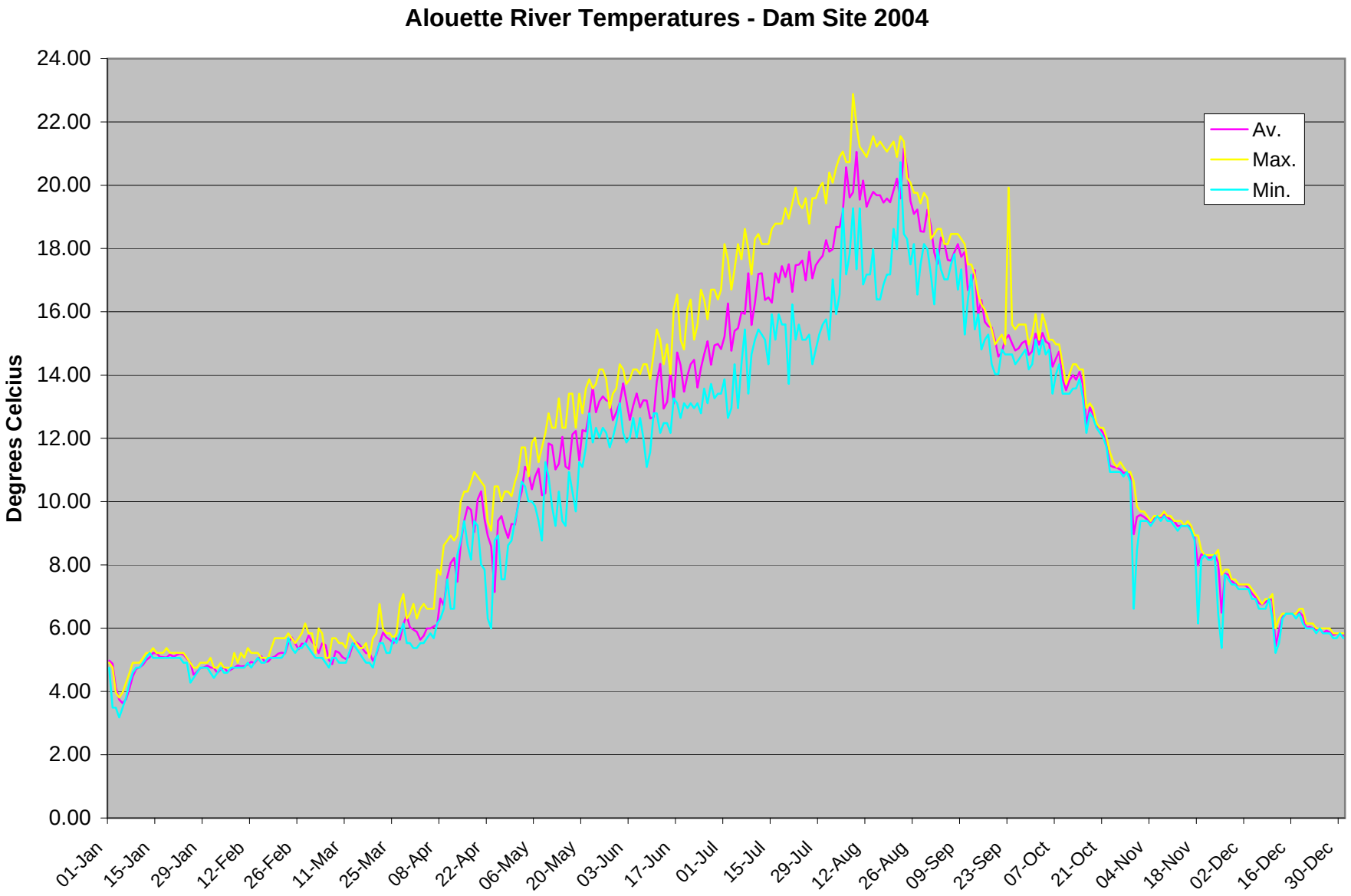
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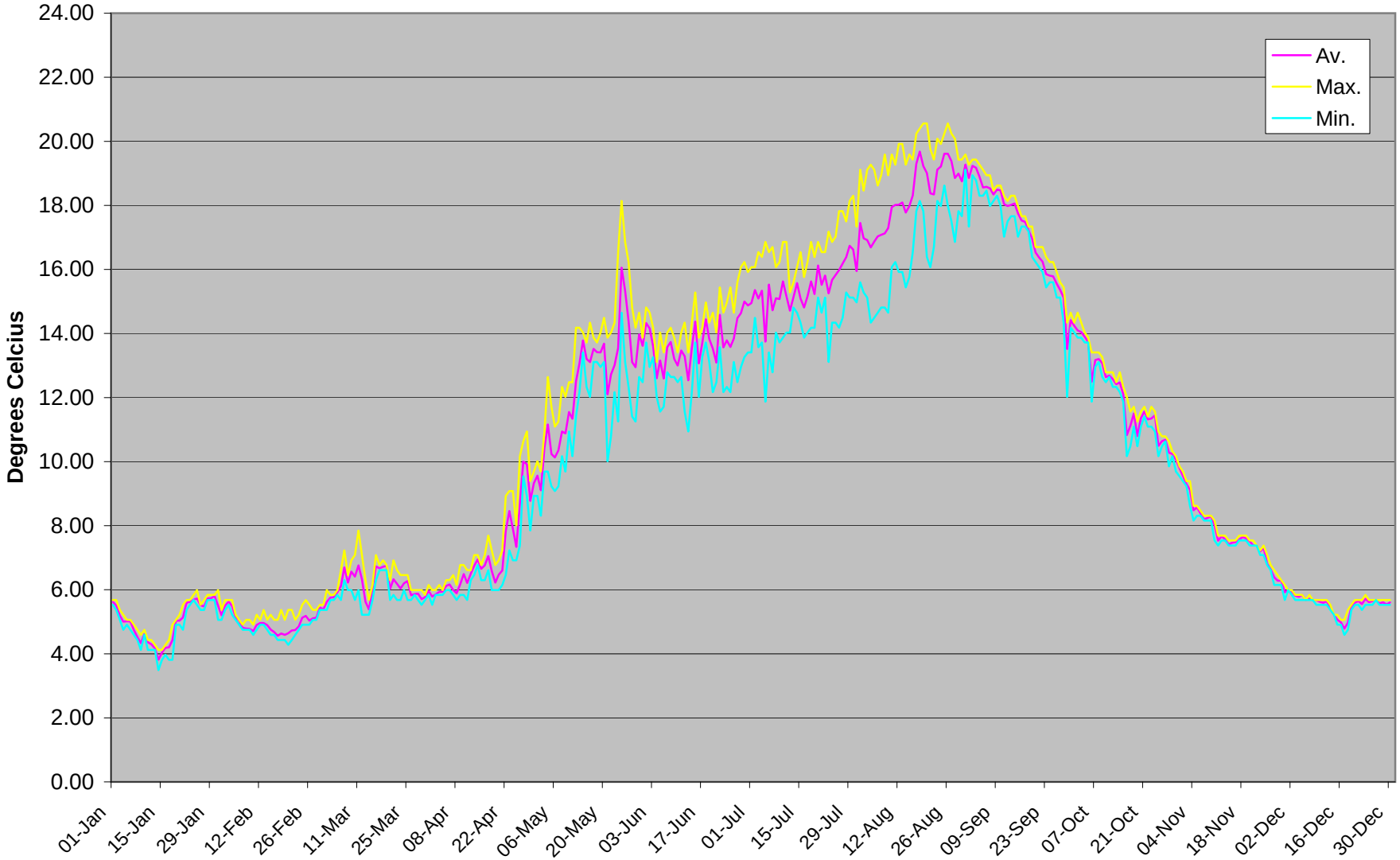
Alouette River Temperatures - Dam Site 2005



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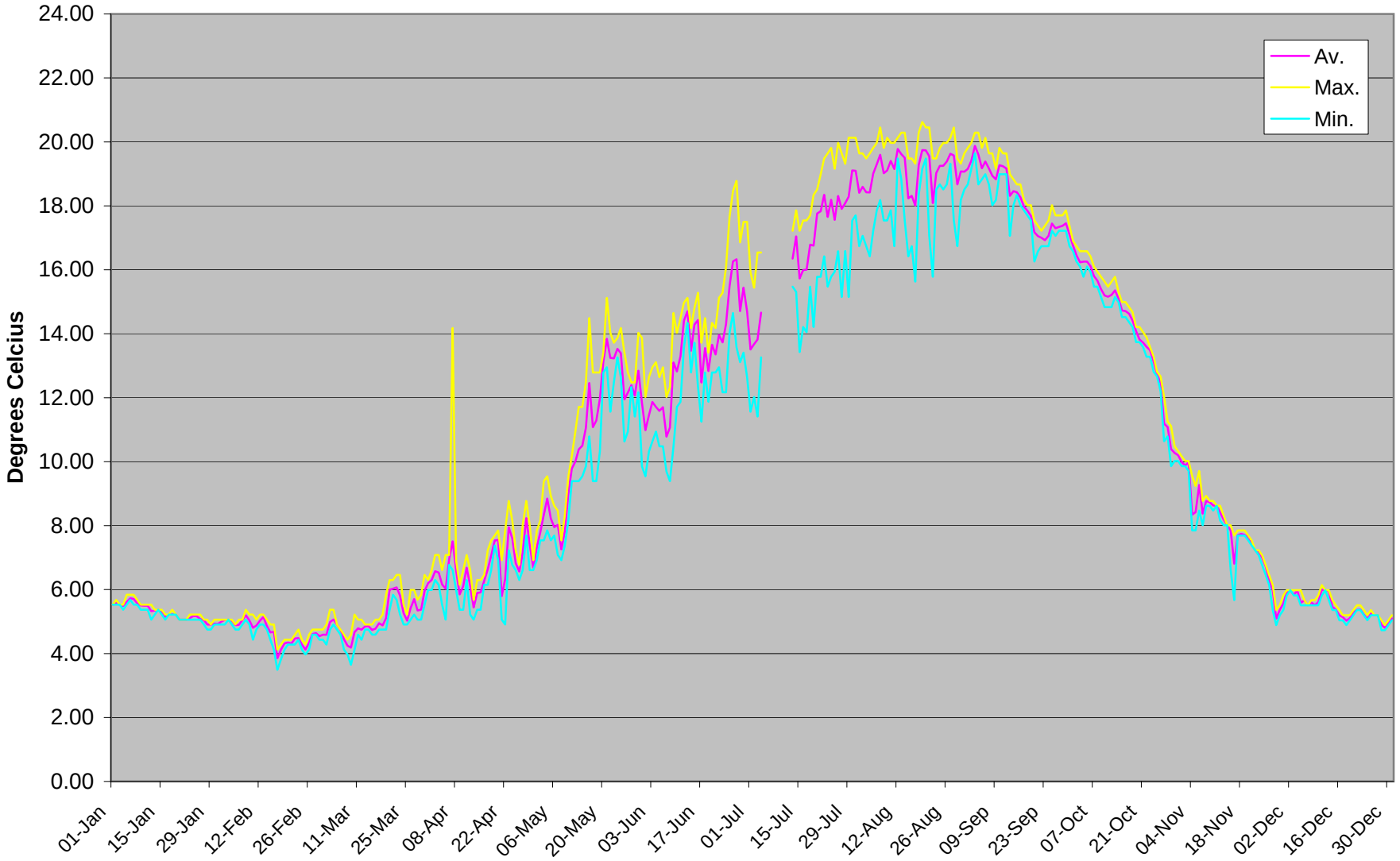

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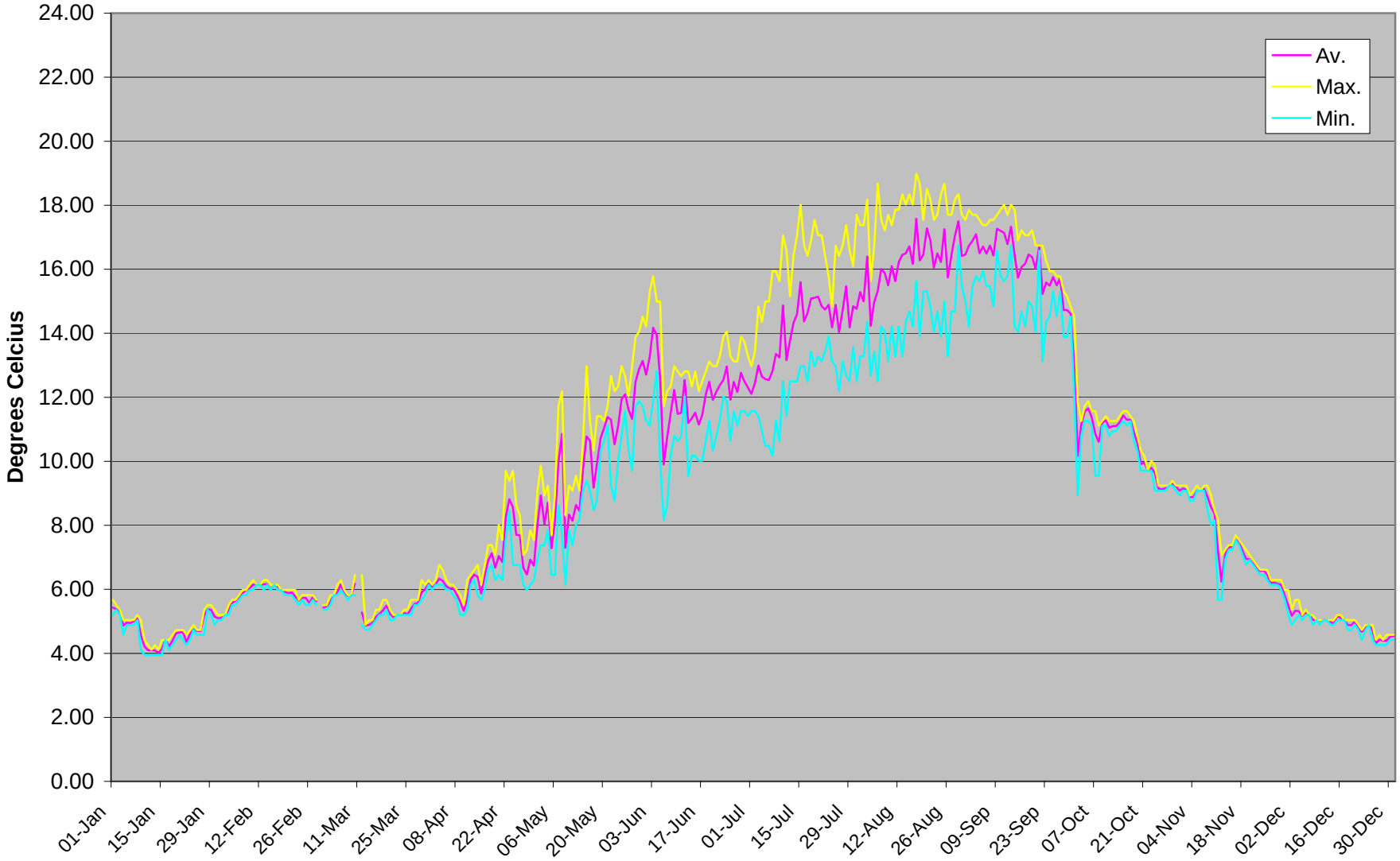

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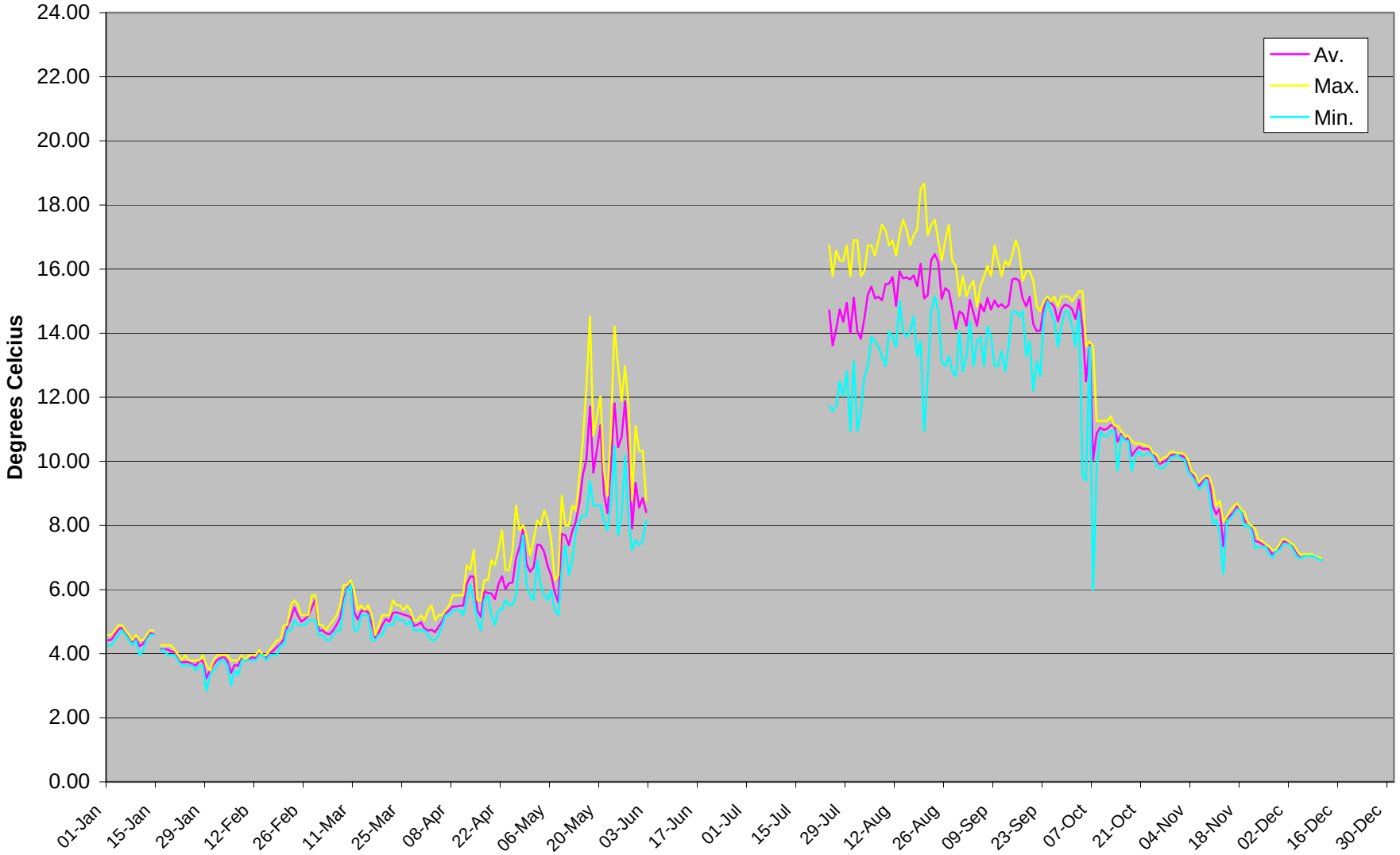

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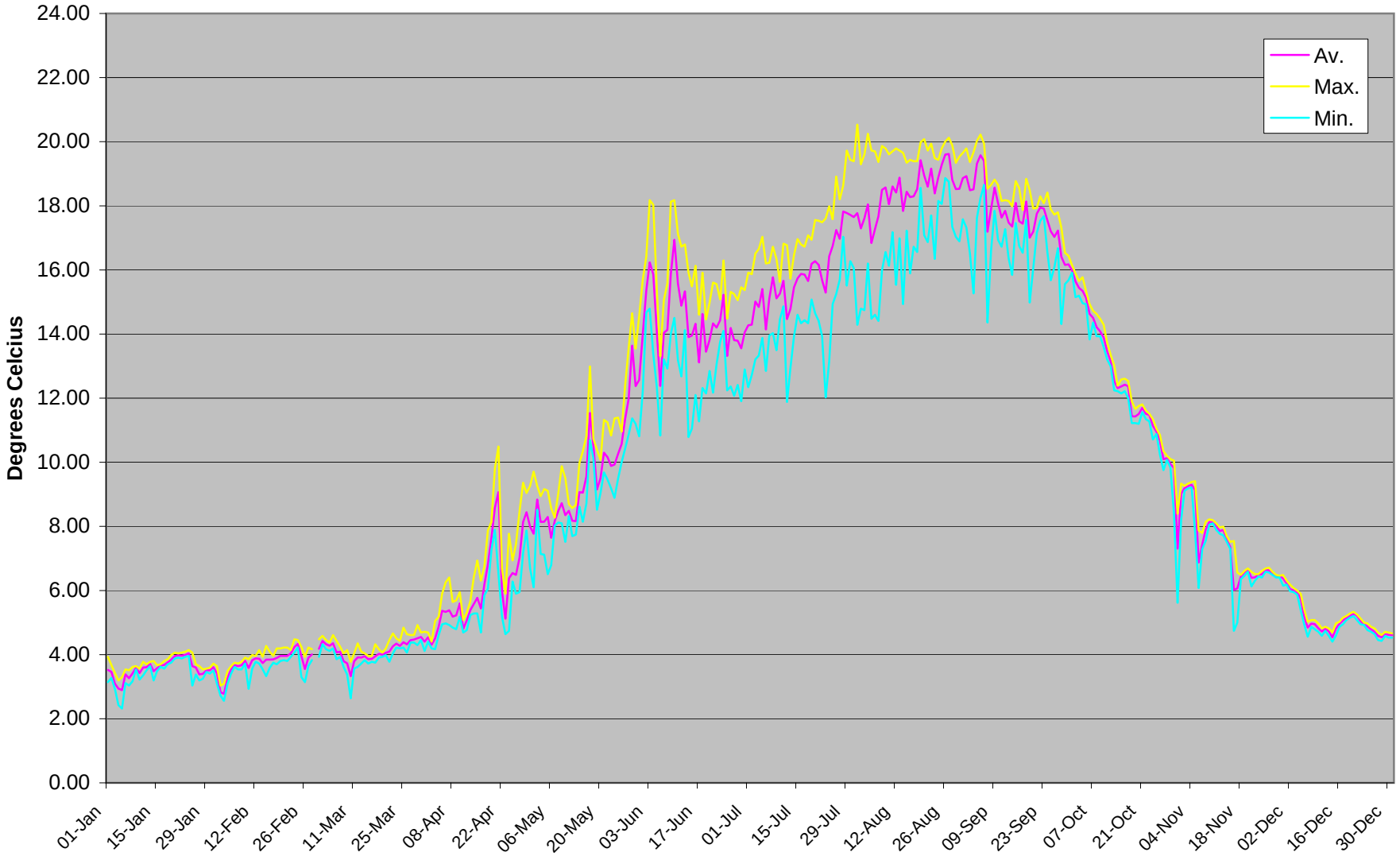

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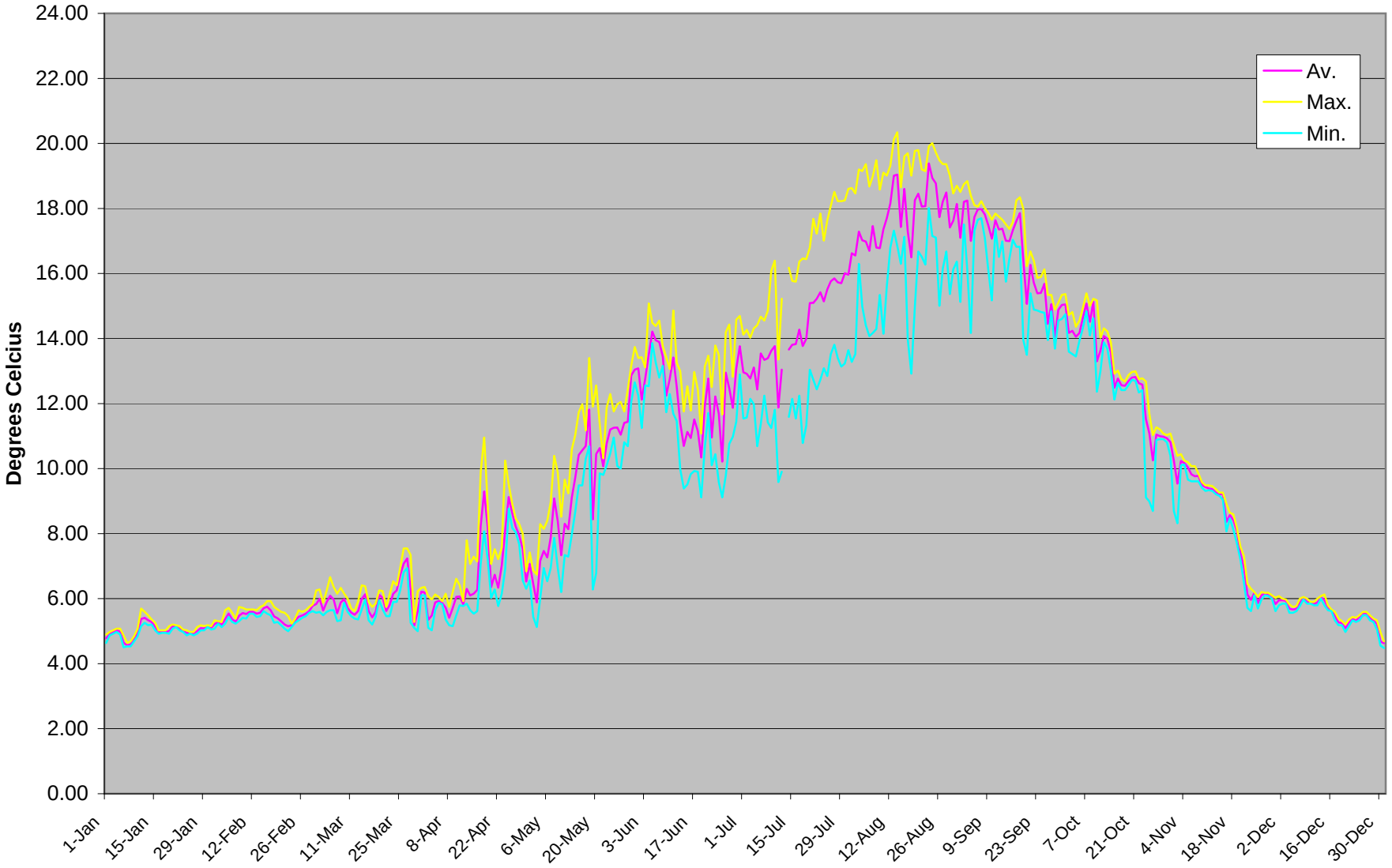

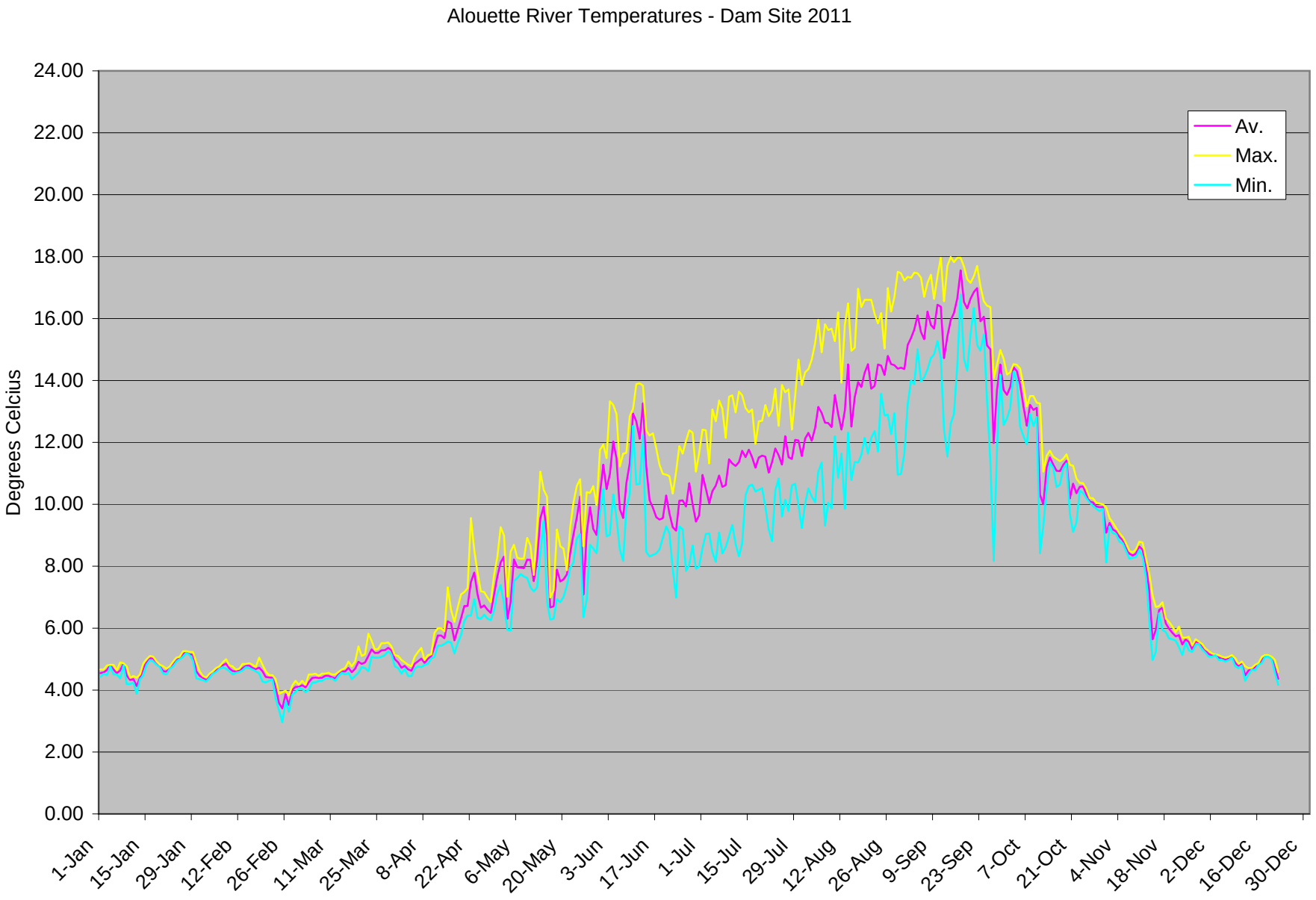
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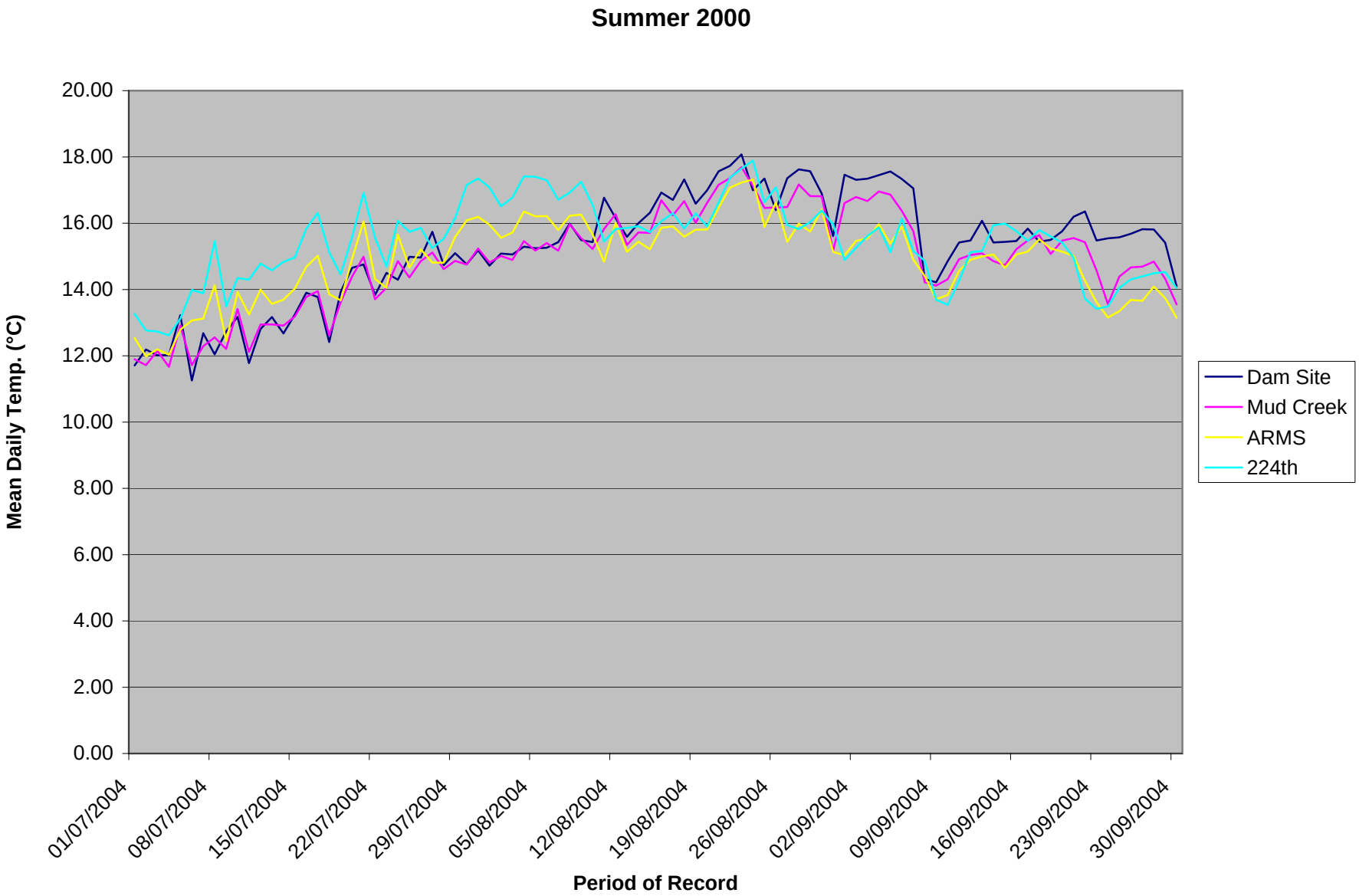
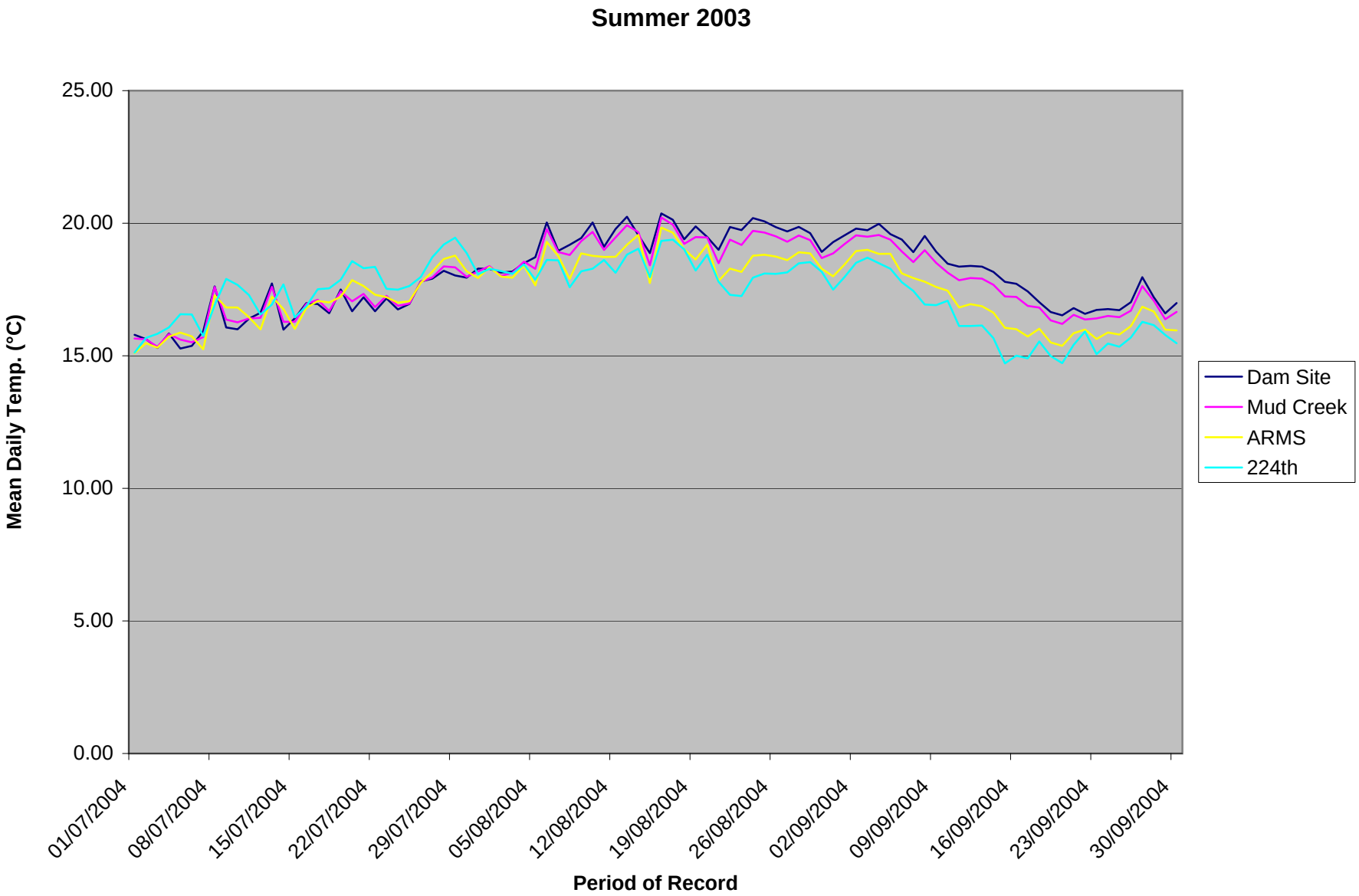
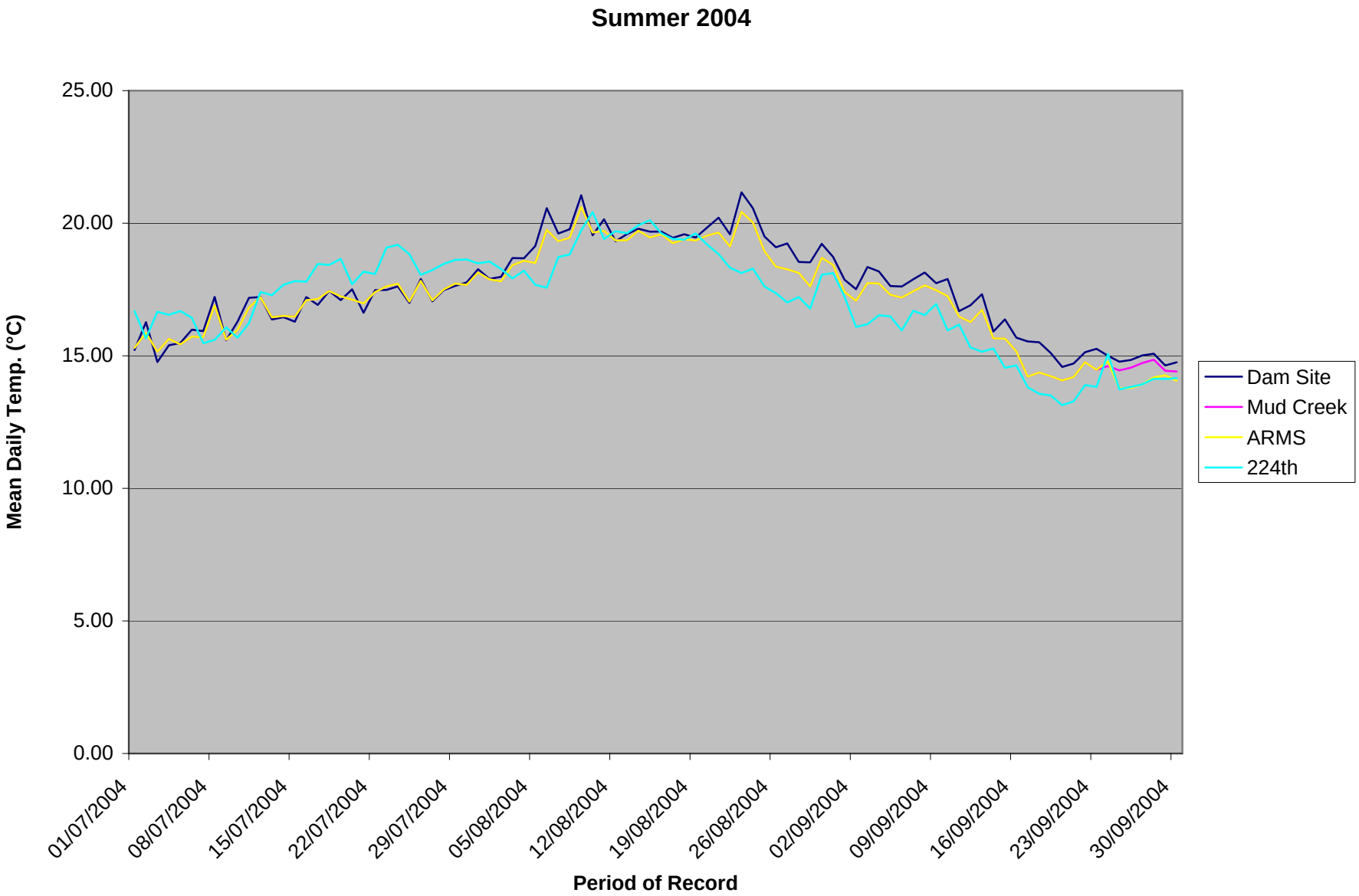
17-Jun
1-Jul
15-Jul
29-Jul
12-Aug
26-Aug
9-Sep
23-Sep
7-Oct
21-Oct
4-Nov
18-Nov
2-Dec
16-Dec
30-Dec
Av.
Max.
Min.

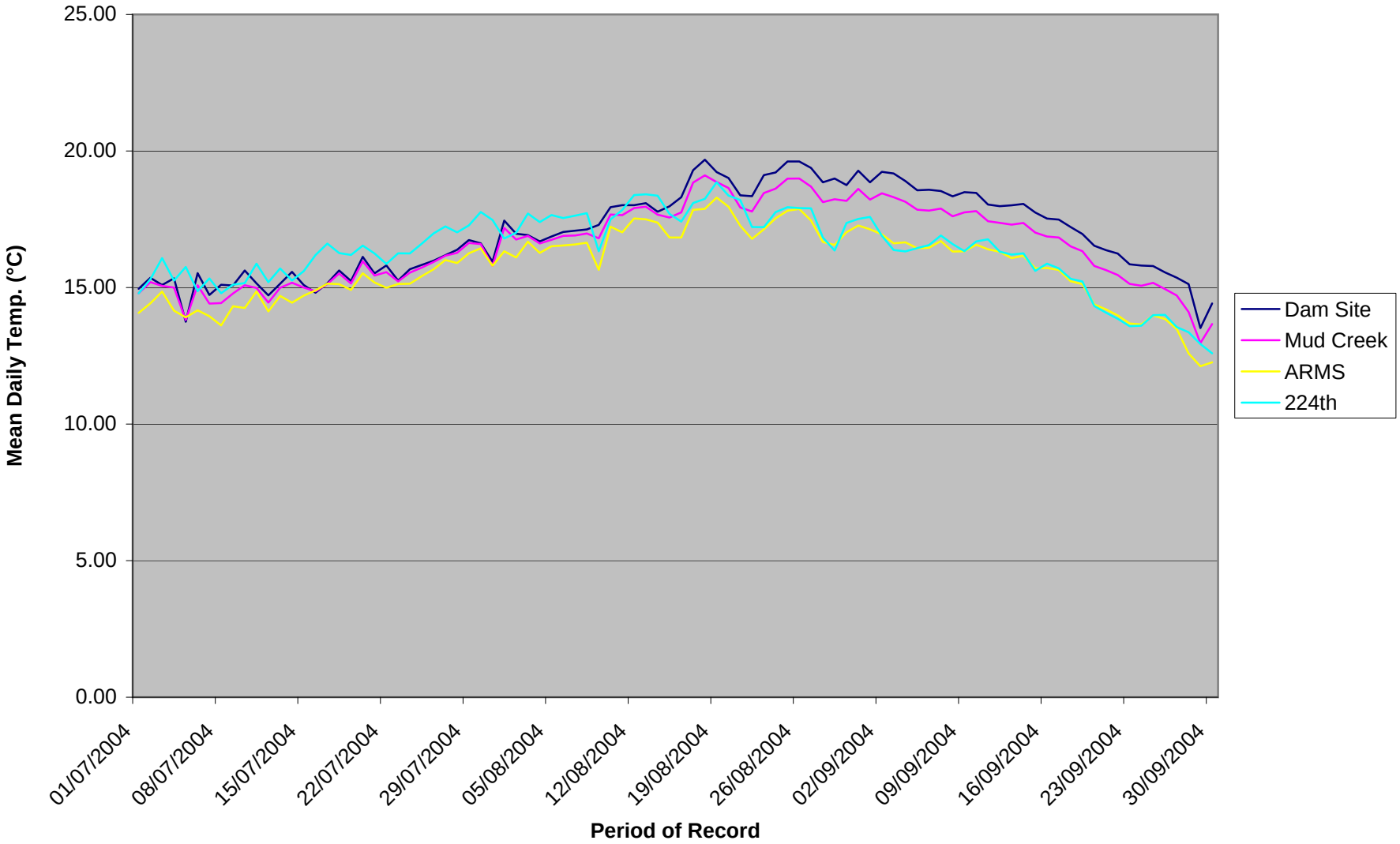
Appendix 2. Mean Daily summer water temperatures for all sites by year.

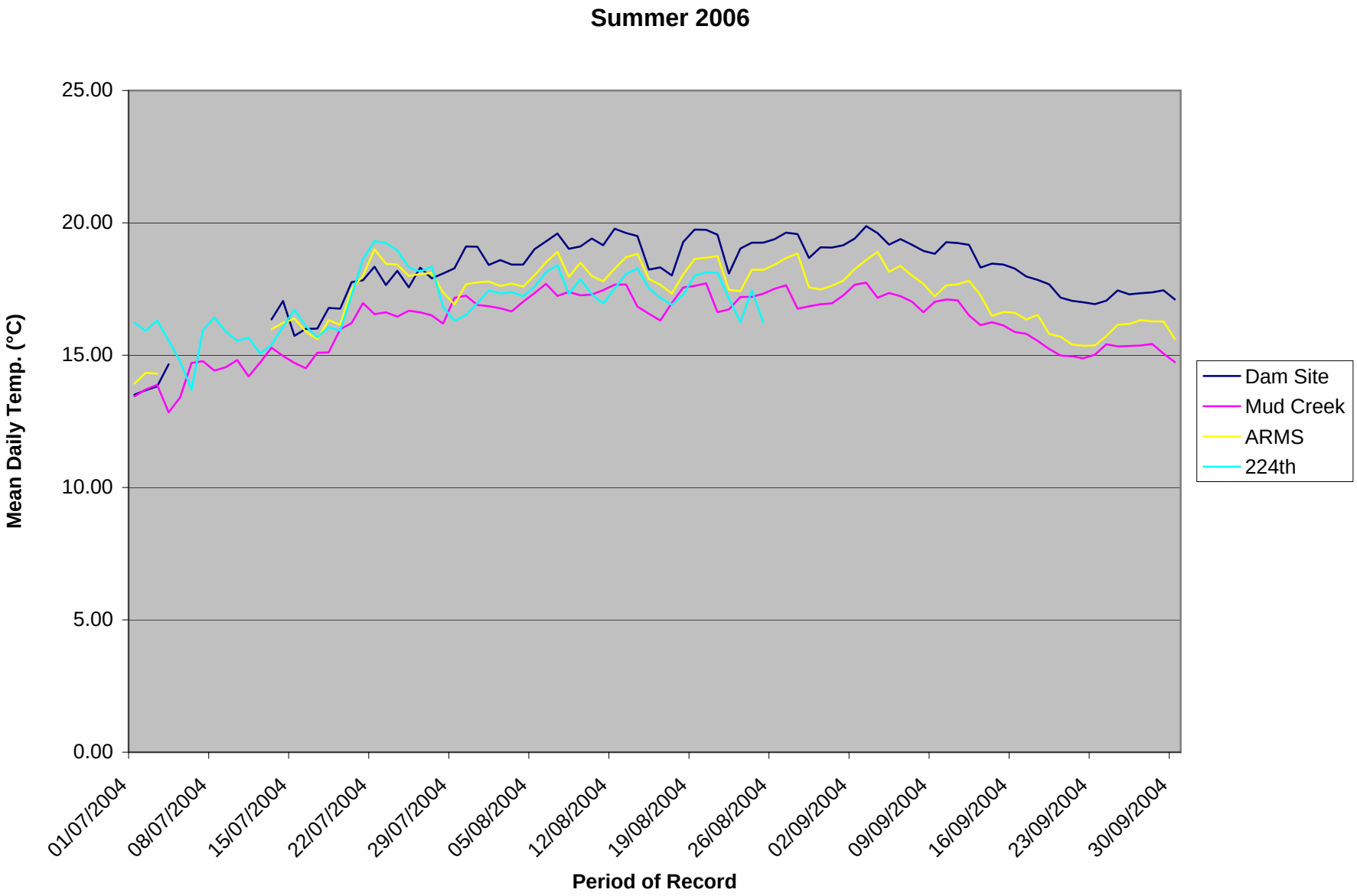

Summer 2000
Mean Daily Temp. (°C)
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
01/07/2004
08/07/2004
15/07/2004
22/07/2004
29/07/2004
05/08/2004
12/08/2004
19/08/2004
26/08/2004
02/09/2004
09/09/2004
16/09/2004
23/09/2004
30/09/2004
Period of Record
Dam Site
Mud Creek
ARMS
224th

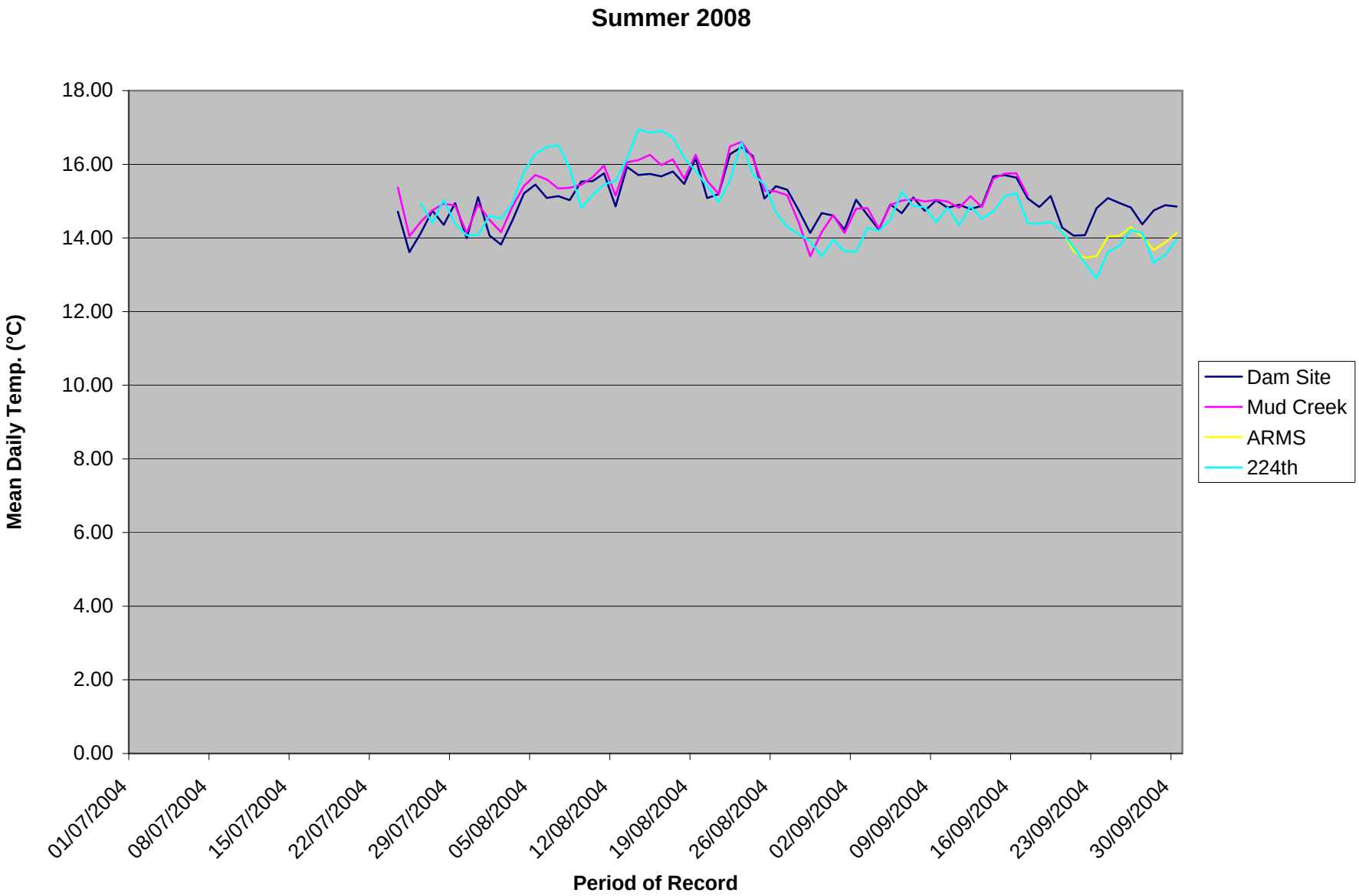

Summer 2003
25.00
20.00
15.00
10.00
5.00
0.00
Mean Daily Temp. (°C)
01/07/2004
08/07/2004
15/07/2004
22/07/2004
29/07/2004
05/08/2004
12/08/2004
19/08/2004
26/08/2004
02/09/2004
09/09/2004
16/09/2004
23/09/2004
30/09/2004
Period of Record
Dam Site
Mud Creek
ARMS
224th

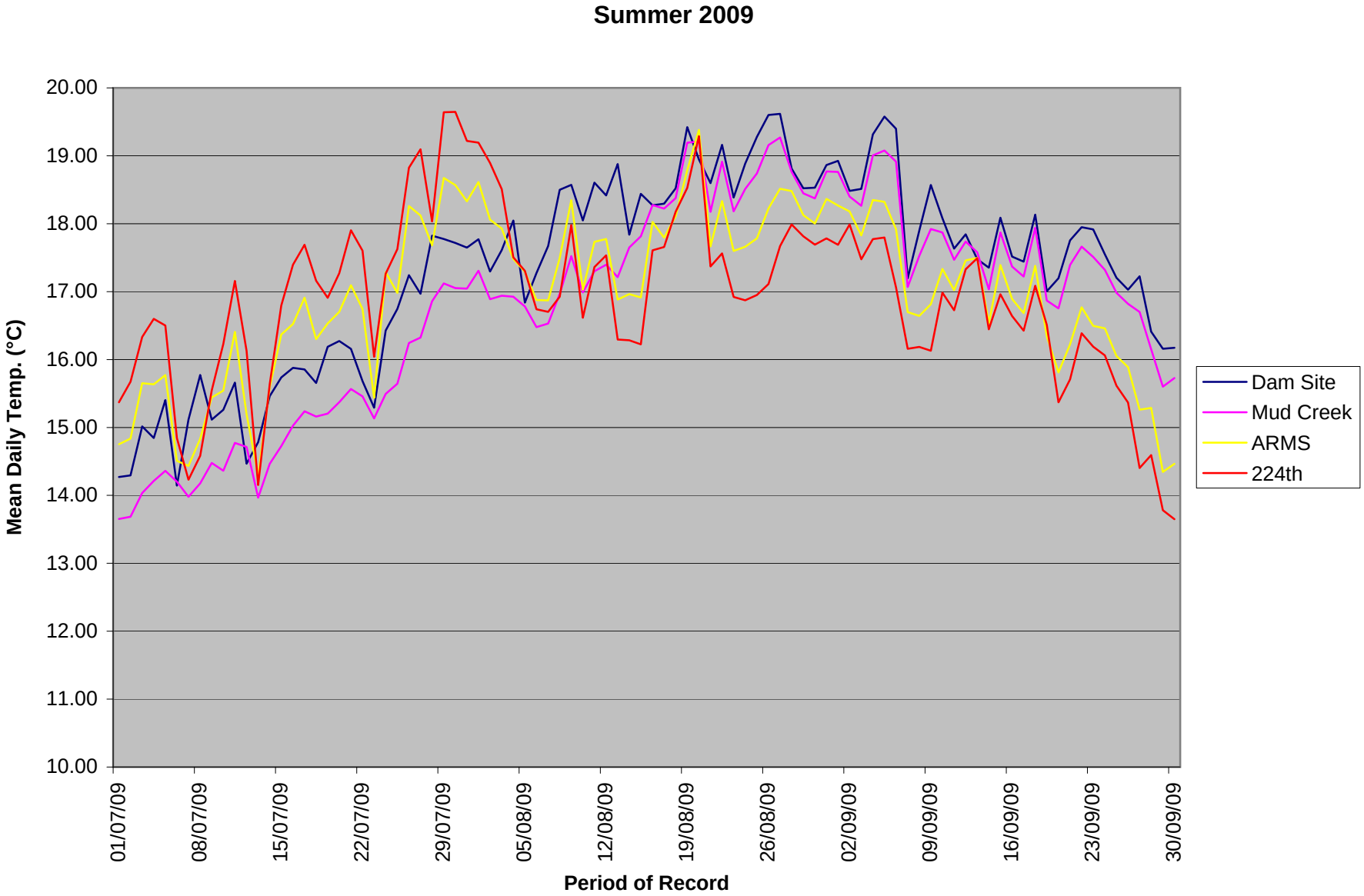

Summer 2004
25.00
20.00
15.00
10.00
5.00
0.00
Mean Daily Temp. (°C)
01/07/2004
08/07/2004
15/07/2004
22/07/2004
29/07/2004
05/08/2004
12/08/2004
19/08/2004
26/08/2004
02/09/2004
09/09/2004
16/09/2004
23/09/2004
30/09/2004
Period of Record
Dam Site
Mud Creek
ARMS
224th

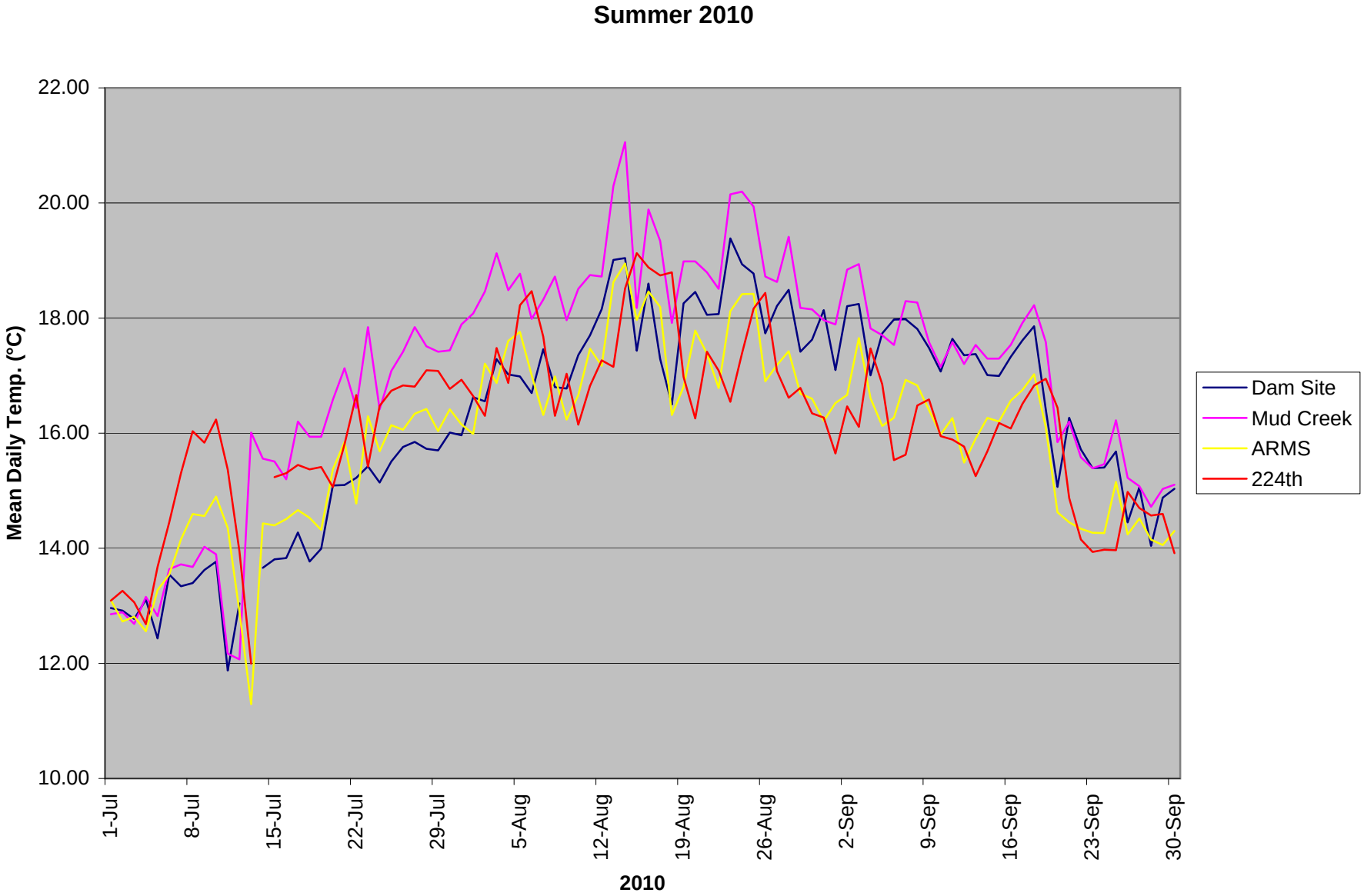
Summer 2005


25.00
20.00
15.00
10.00
5.00
0.00
Mean Daily Temp. (°C)
01/07/2004
08/07/2004
15/07/2004
22/07/2004
29/07/2004
05/08/2004
12/08/2004
19/08/2004
26/08/2004
02/09/2004
09/09/2004
16/09/2004
23/09/2004
30/09/2004
Period of Record
Dam Site
Mud Creek
ARMS
224th

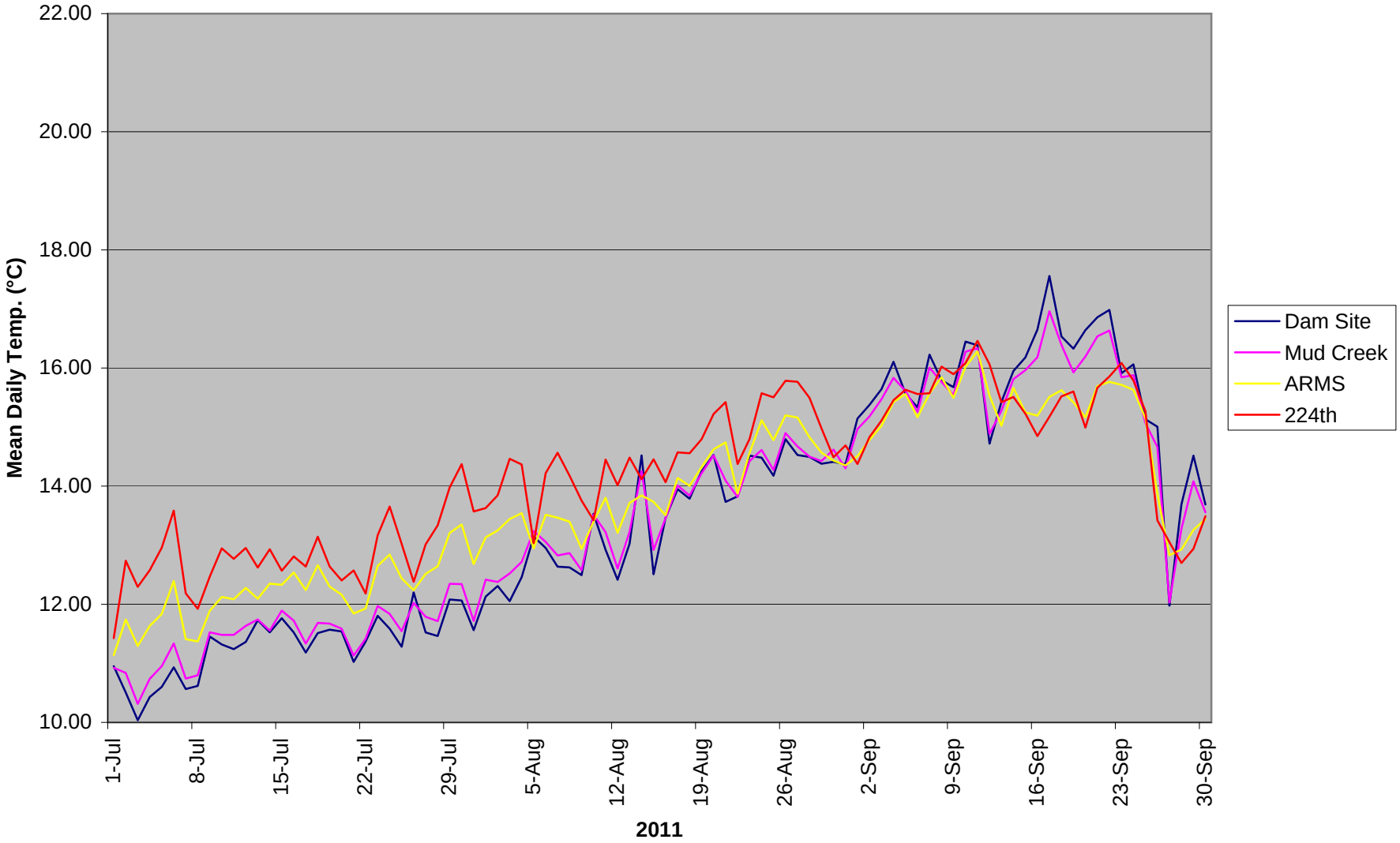

Summer 2006
25.00
20.00
15.00
10.00
5.00
0.00
Mean Daily Temp. (°C)
01/07/2004
08/07/2004
15/07/2004
22/07/2004
29/07/2004
05/08/2004
12/08/2004
19/08/2004
26/08/2004
02/09/2004
09/09/2004
16/09/2004
23/09/2004
30/09/2004
Period of Record
Dam Site
Mud Creek
ARMS
224th


Summer 2008
Mean Daily Temp. (°C)
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
01/07/2004
08/07/2004
15/07/2004
22/07/2004
29/07/2004
05/08/2004
12/08/2004
19/08/2004
26/08/2004
02/09/2004
09/09/2004
16/09/2004
23/09/2004
30/09/2004
Period of Record
Dam Site
Mud Creek
ARMS
224th

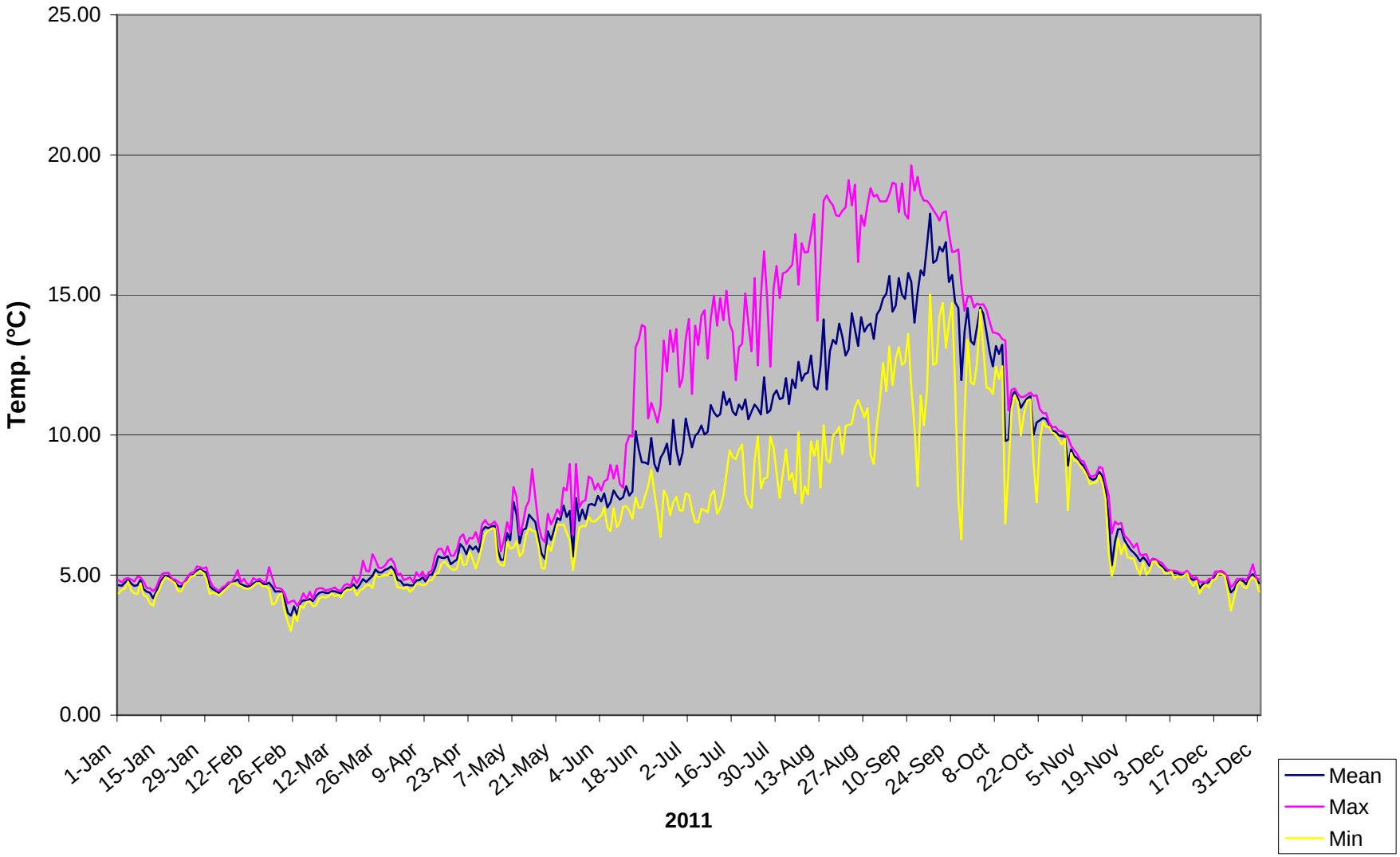

Summer 2009
Mean Daily Temp. (°C)
20.00
19.00
18.00
17.00
16.00
15.00
14.00
13.00
12.00
11.00
10.00
01/07/09
08/07/09
15/07/09
22/07/09
29/07/09
05/08/09
12/08/09
19/08/09
26/08/09
02/09/09
09/09/09
16/09/09
23/09/09
30/09/09
Period of Record
Dam Site
Mud Creek
ARMS
224th

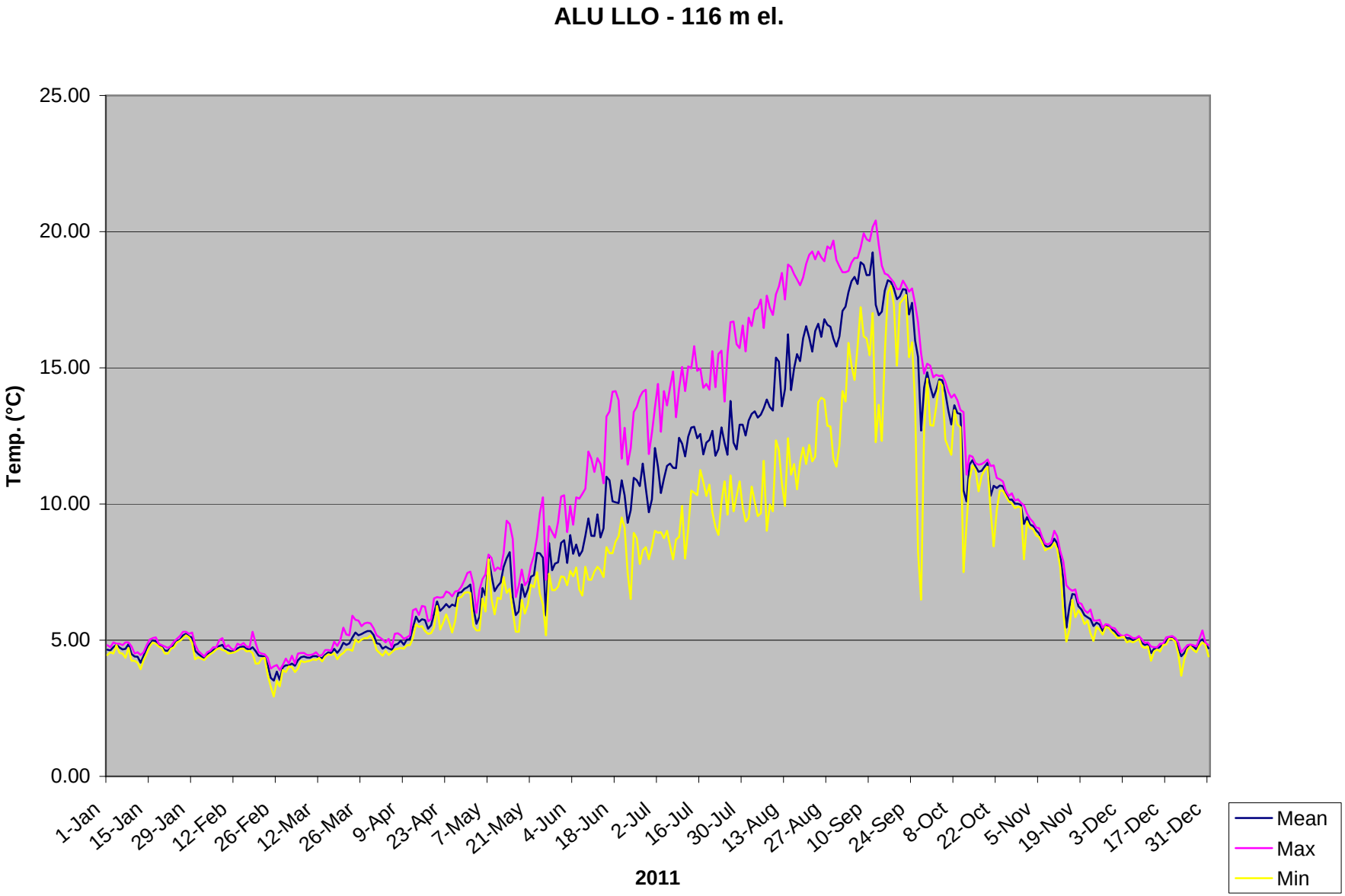

Summer 2010
Mean Daily Temp. (°C)
22.00
20.00
18.00
16.00
14.00
12.00
10.00
1-Jul
8-Jul
15-Jul
22-Jul
29-Jul
5-Aug
12-Aug
19-Aug
26-Aug
2-Sep
9-Sep
16-Sep
23-Sep
30-Sep
2010
Dam Site
Mud Creek
ARMS
224th

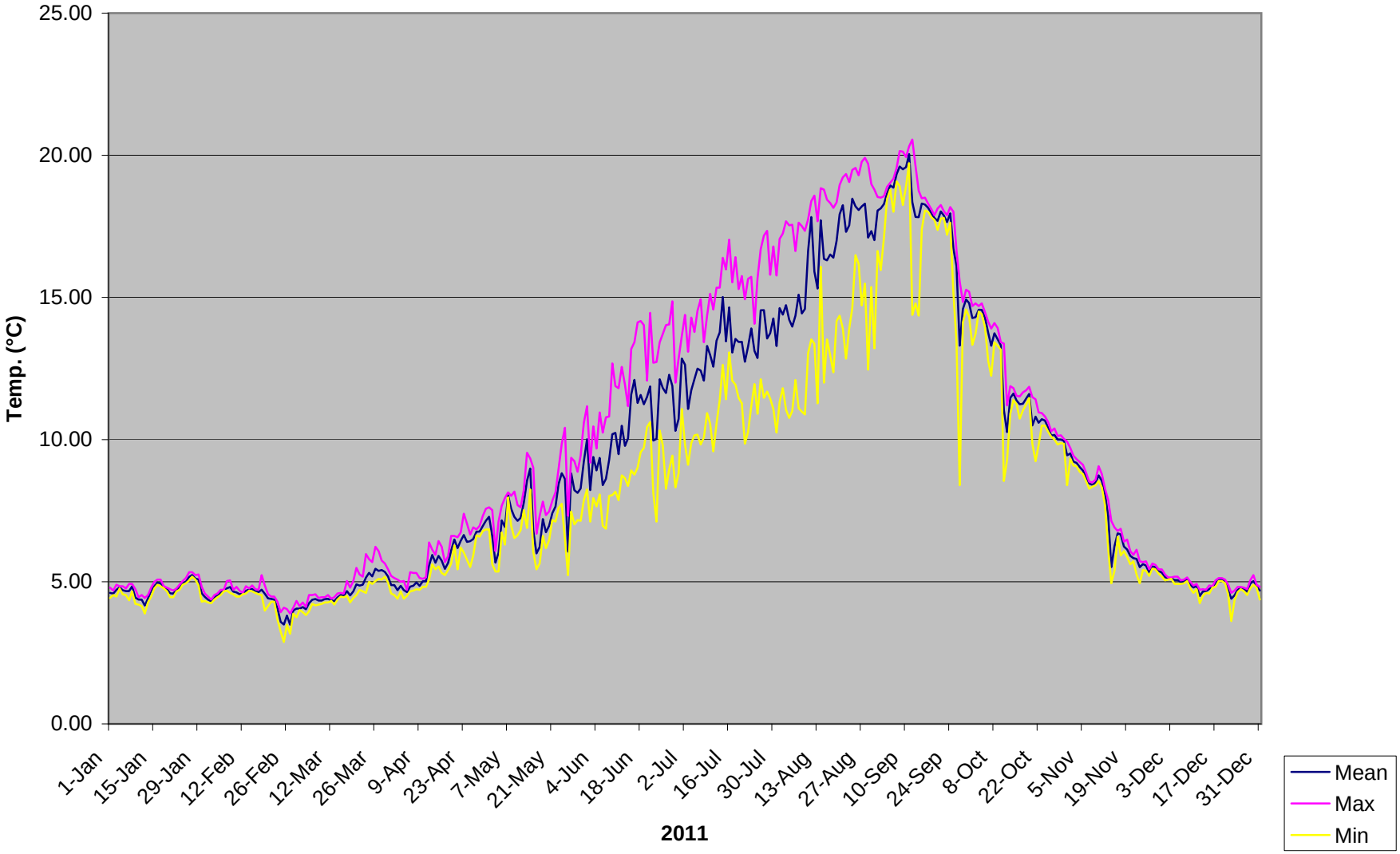
Summer 2011

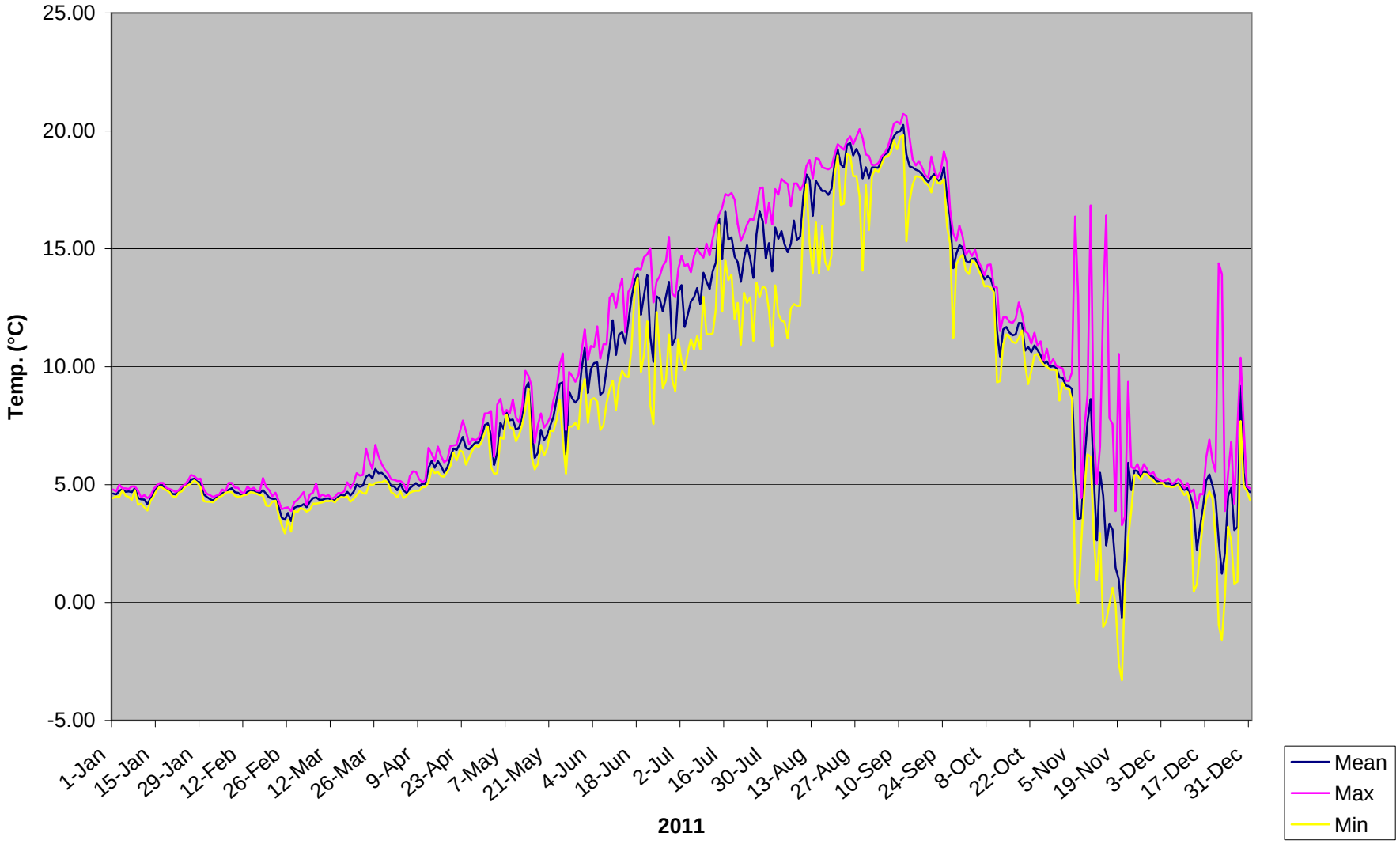

22.00
20.00
18.00
16.00
14.00
12.00
10.00
Mean Daily Temp. (°C)
1-Jul
8-Jul
15-Jul
22-Jul
29-Jul
5-Aug
12-Aug
19-Aug
26-Aug
2-Sep
9-Sep
16-Sep
23-Sep
30-Sep
2011
Dam Site
Mud Creek
ARMS
224th

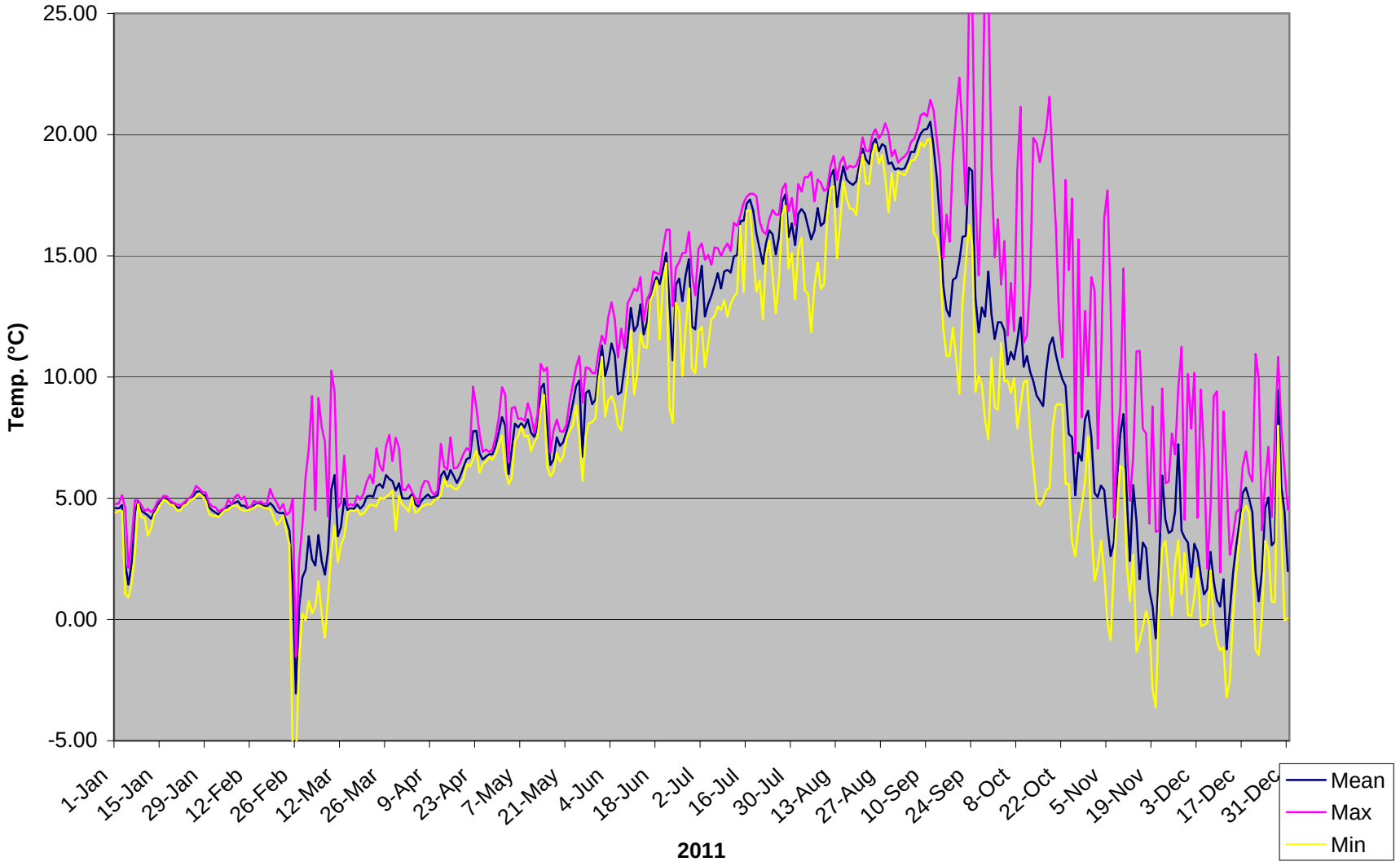
Appendix 3. Reservoir temperatures by elevation.


ALU LLO - 114 m el.
Temp. (°C)
25.00
20.00
15.00
10.00
5.00
0.00
1-Jan
15-Jan
29-Jan
12-Feb
26-Feb
12-Mar
26-Mar
9-Apr
23-Apr
7-May
21-May
4-Jun
18-Jun
2-Jul
16-Jul
30-Jul
13-Aug
27-Aug
10-Sep
24-Sep
8-Oct
22-Oct
5-Nov
19-Nov
3-Dec
17-Dec
31-Dec
2011
Mean
Max
Min

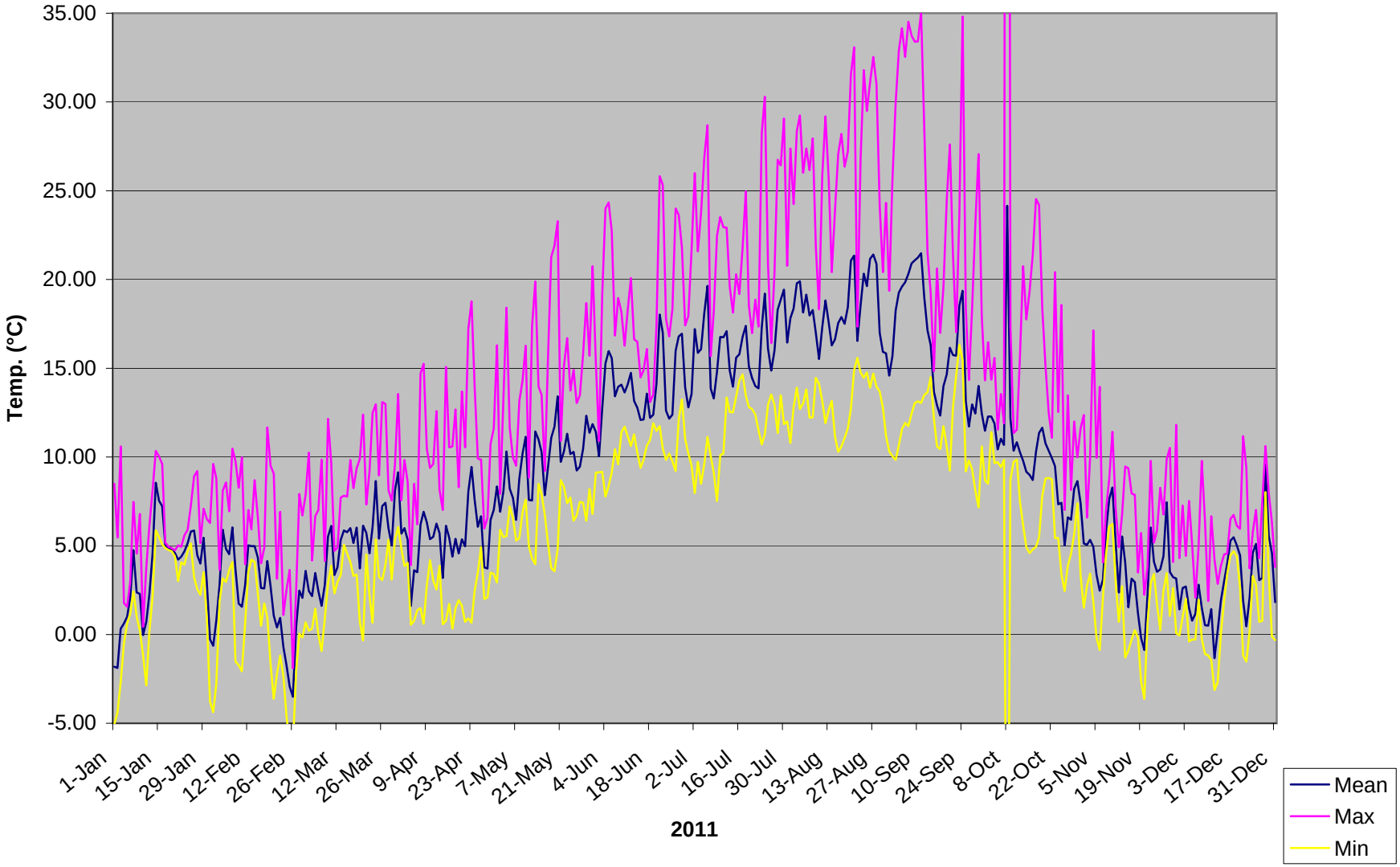

ALU LLO - 116 m el.
25.00
20.00
15.00
10.00
5.00
0.00
Temp. (°C)
1-Jan
15-Jan
29-Jan
12-Feb
26-Feb
12-Mar
26-Mar
9-Apr
23-Apr
7-May
21-May
4-Jun
18-Jun
2-Jul
16-Jul
30-Jul
13-Aug
27-Aug
10-Sep
24-Sep
8-Oct
22-Oct
5-Nov
19-Nov
3-Dec
17-Dec
31-Dec
2011
Mean
Max
Min


ALU LLO - 118 m el.
25.00
20.00
15.00
10.00
5.00
0.00
Temp. (°C)
1-Jan
15-Jan
29-Jan
12-Feb
26-Feb
12-Mar
26-Mar
9-Apr
23-Apr
7-May
21-May
4-Jun
18-Jun
2-Jul
16-Jul
30-Jul
13-Aug
27-Aug
10-Sep
24-Sep
8-Oct
22-Oct
5-Nov
19-Nov
3-Dec
17-Dec
31-Dec
2011
Mean
Max
Min

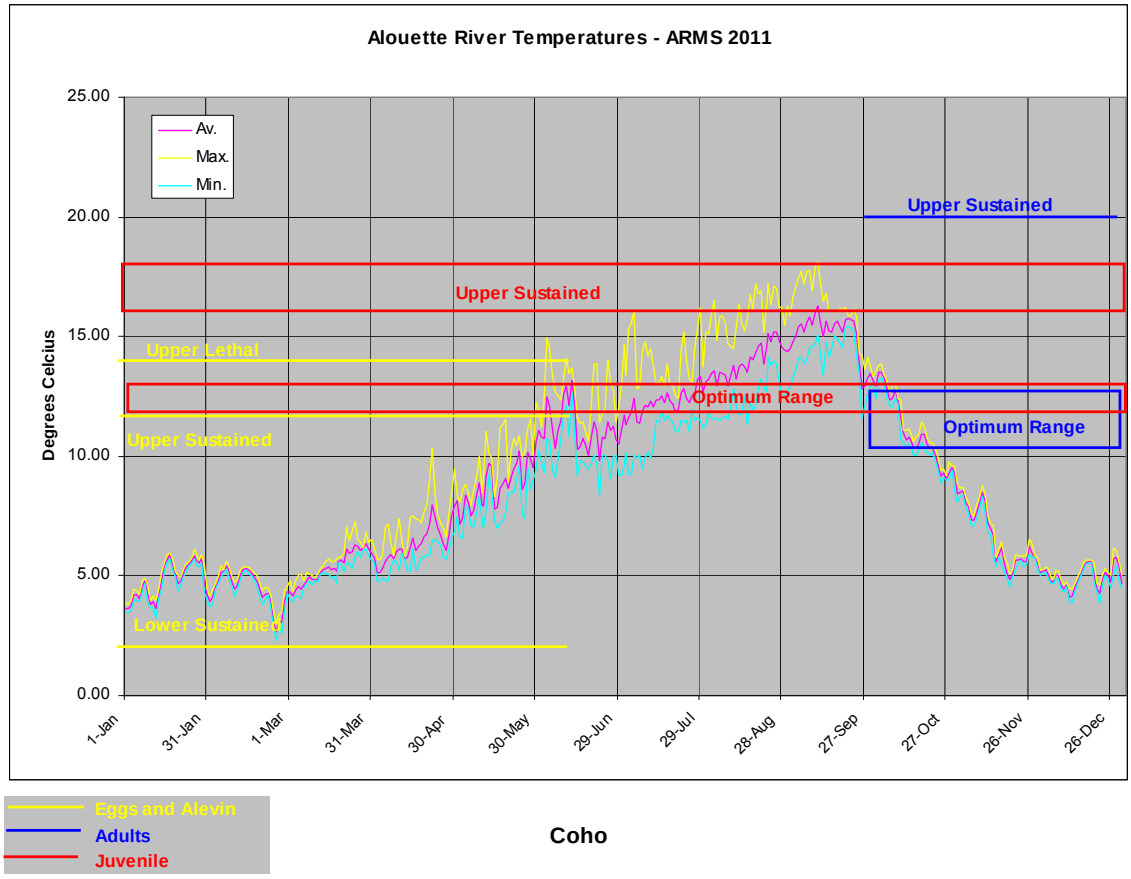

ALU LLO - 120 m el.
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
Temp. (°C)
1-Jan
15-Jan
29-Jan
12-Feb
26-Feb
12-Mar
26-Mar
9-Apr
23-Apr
7-May
21-May
4-Jun
18-Jun
2-Jul
16-Jul
30-Jul
13-Aug
27-Aug
10-Sep
24-Sep
8-Oct
22-Oct
5-Nov
19-Nov
3-Dec
17-Dec
31-Dec
2011
Mean
Max
Min


ALU LLO - 122 m el.
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
Temp. (°C)
1-Jan
15-Jan
29-Jan
12-Feb
26-Feb
12-Mar
26-Mar
9-Apr
23-Apr
7-May
21-May
4-Jun
18-Jun
2-Jul
16-Jul
30-Jul
13-Aug
27-Aug
10-Sep
24-Sep
8-Oct
22-Oct
5-Nov
19-Nov
3-Dec
17-Dec
31-Dec
2011
Mean
Max
Min

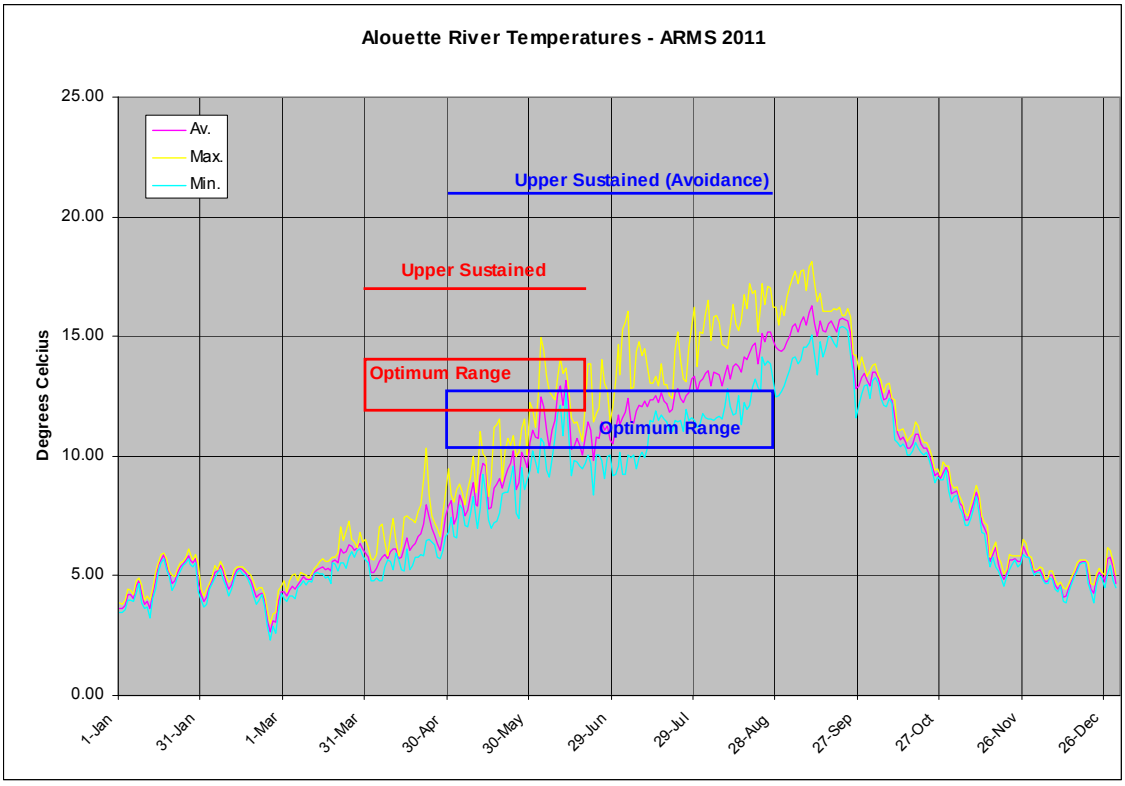
ALU LLO - 124 m el.



Appendix 4. An illustration of fish periodicity and water temperature tolerances by life history stage along with water temperature from the ARMS Site, 2011.

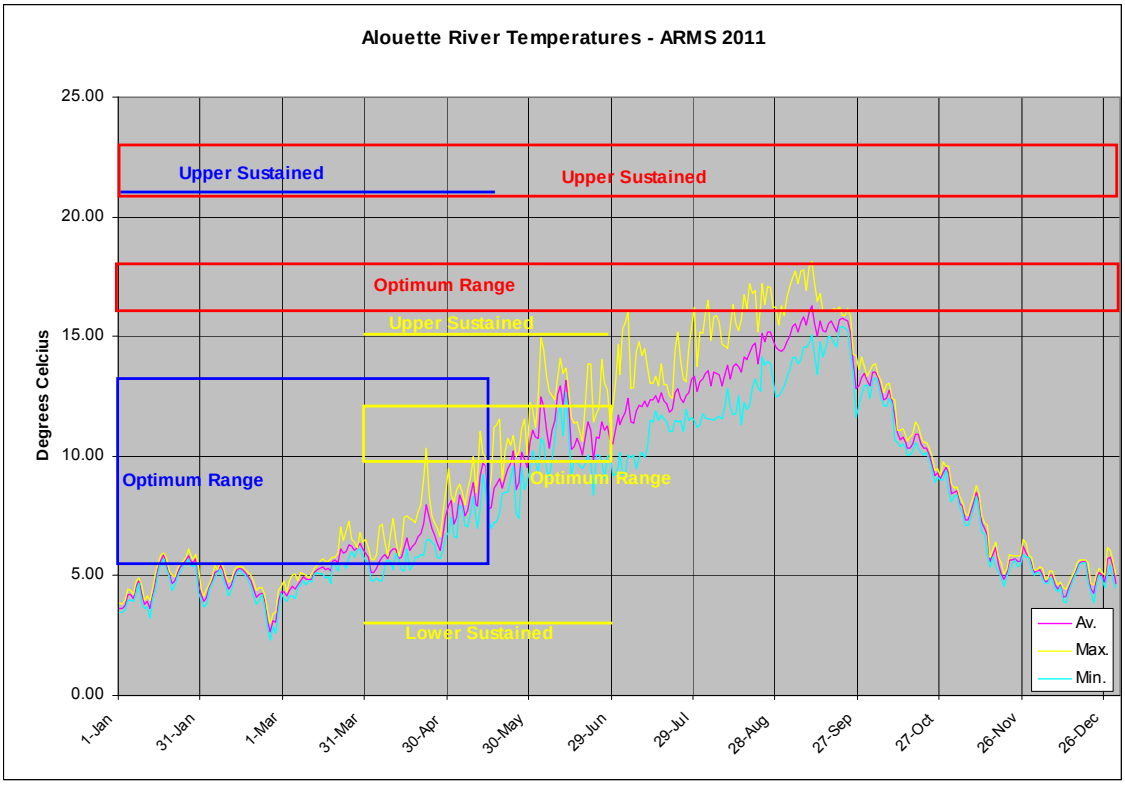


Coho



Adults
Juvenile

Sockeye



Eggs and Alevin
Adults
Juvenile

Steelhead