



FISH PASSAGE CENTER

847 NE 19th Avenue, #250, Portland, OR 97232

Phone: (503) 833-3900 Fax: (503) 232-1259

www.fpc.org/

e-mail us at fpcstaff@fpc.org

MEMORANDUM

TO: Tom Lorz, CRITFC

FROM: Brandon R. Chockley

DATE: March 13, 2015

SUBJECT: Summary of August Operations Data at the Bonneville Dam Second Powerhouse, 2006-2012.

In response to your request, we have reviewed the 5-minute operations data at the Bonneville Dam second powerhouse (PH2) in relation to the current Fish Passage Plan Change Form, 15BON006. This change form is seeking a modification to Chapter 2 (Section 5.2.1) of the 2015 Fish Passage Plan. Currently, operations of PH2 units are generally limited to the mid-range of the 1% efficiency curve from April 1st to October 31st. The proposed modification would remove this restriction after July 31st, allowing PH2 units to be operated within the full 1% range through October 31st. In addition, the change form is proposing to allow the Bonneville Dam first powerhouse (PH1) to be operated up to Best Operating Point (BOP) for the period of August 1st to October 31st. Per your request, the FPC reviewed actual operations data for August (2006–2012) to determine how often PH2 units have been operated outside the mid-range in past years. Below is a brief summary of our findings, followed by a more detailed explanation of how the data were reviewed, and the full set of results for each of the years we analyzed.

- Given the generally low flows in August, it appears PH2 is rarely operated at full capacity during this month. This means that, except under extreme circumstances, several units are often available at PH2 to pick up additional load at any given time.
- Over the years we reviewed (2006–2012), the operation of PH2 units above the mid-range in August was relatively uncommon, particularly when compared to operations below the mid-range.

- The operation of PH2 units above the mid-range in August was rare in low flow years (2009 and 2010) but increased in frequency among the intermediate (2006–2008) and higher (2011 and 2012) flow years.
- The operation of PH2 units below the mid-range in August was most common low flow years (2009 and 2010) and decreased in frequency among the intermediate (2006–2008) and higher (2011 and 2012) flow years.

Methods

For this request, FPC staff obtained Bonneville Dam unit operations data (i.e., 5-minute operations data) from the Corps of Engineers for the period of July to September, 2006–2012. However, for this request, we focused on only the August operations at Bonneville PH2. The 5-minute operations data we received from the Corps of Engineers did not include estimates of head. Therefore, we relied on hourly estimates of head, where the operation for a particular 5-minute period was matched up with the average head for that hour. For example, an operation for 19:55:00 would have been matched up with the average head estimate for the 1900 hour for that day.

Table 1. Estimated lower and upper limits of mid-range of 1% efficiency range of BON PH2 units, as a function of head. Estimates assume STS screens are in place.

Head (ft)	Mid-Range Lower Limit (Kcfs)	Mid-Range Upper Limit (Kcfs)	Head (ft)	Mid-Range Lower Limit (Kcfs)	Mid-Range Upper Limit (Kcfs)
35	13.013	15.012	53	13.011	15.011
36	13.011	14.988	54	12.980	14.965
37	13.005	15.000	55	13.000	14.996
38	12.997	15.008	56	13.005	14.985
39	12.982	15.001	57	12.985	14.998
40	13.006	15.004	58	13.011	15.007
41	12.999	15.012	59	13.012	14.993
42	12.991	15.018	60	13.013	15.001
43	13.014	14.989	61	13.024	15.027
44	13.002	14.991	62	13.031	15.024
45	12.991	14.992	63	13.042	15.050
46	13.006	14.992	64	13.052	15.054
47	13.020	15.023	65	13.061	15.053
48	12.998	14.982	66	13.060	15.064
49	13.011	15.010	67	13.056	15.049
50	13.022	15.008	68	13.056	15.062
51	12.990	14.989	69	13.052	15.066
52	12.985	14.995	70	13.052	15.058

We then assessed the operations for each 5-minute period in August, for each unit, in each year, to determine whether the operation was “outside” the mid-range. Operations “outside” the mid-range were broken into two scenarios: (1) below mid-range (i.e., below lower limit of mid-range) and (2) above mid-range (i.e., above upper limit of mid-range). The values we used to define the lower and upper limits of the mid-range are provided above (Table 1) and were estimated based on data provided in table BON-15 of the 2015 Fish Passage Plan. Specifically, for each foot of head, we relied on the ratio of Power (MW) to Flow (cfs) for the 1% Lower Limit with STS (left hand side of Table BON-15) to estimate the flow for the lower and upper limits of the mid-range. These lower and upper limits were then converted from cfs to Kcfs.

Finally, we estimated the daily proportion of hours that each unit was operated above the mid-range and the daily proportion of hours that each unit was operated below the mid-range. These estimates include only periods when a unit was actually in operation. For example, if a unit operated for only two total hours in a single day, of which 30 minutes were operated above the mid-range, the estimate for the proportion of hours operated above the mid-range would be 0.25 for that day. Furthermore, if, on that same day, this unit operated below the mid-range for 10 minutes, the proportion of hours operated below the mid-range would be 0.08 for that day.

Results

August Flow Conditions

When considering the results of the operations data, it is important to keep the August flow conditions in perspective. Among the years we analyzed, 2011 and 2012 had the highest August flows (Figure 1). Among the last 55 years (1960–2014), August flows in 2011 and 2012 were ranked 5th and 4th highest, respectively (Table 2). Water years 2009 and 2010 had the lowest August flows among the years we analyzed, with a ranking of 46th and 42nd, respectively (Figure 1, Table 2). August flows in 2006 and 2008 were slightly below average while August flows in 2007 were average (Figure 1, Table 2).

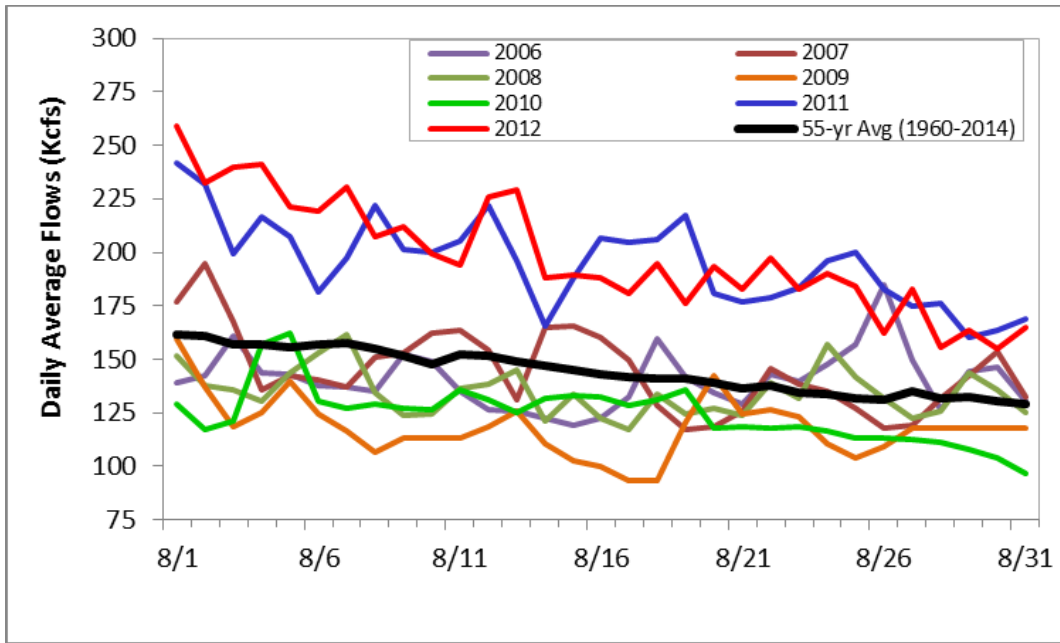


Figure 1. Daily average flows at Bonneville Dam in August 2006 through 2012 compared to the 55-year average (1960–2014).

Table 2. Average August outflow at Bonneville Dam (2006–2012) and respective rankings over to the last 55 years (1960–2014).

Water Year	Average August Outflow at Bonneville Dam (Kcfs)	55-Year Ranking (1960–2014)
2006	140.6	30
2007	144.6	27
2008	134.6	36
2009	118.1	46
2010	124.5	42
2011	195.3	5
2012	198.1	4

Operating Above Mid-Range

Over the years we reviewed (2006–2012), the operation of PH2 units above the mid-range was relatively uncommon (Tables 3–9 and Figures 2–8). However, there was a clear pattern in the frequency of operations above the mid-range among the different flow years. As August flows increased, the frequency of operations above the mid-range also increased. For example, in the low flow years (2009 and 2010), PH2 units rarely operated above the mid-range in August (Tables 6 and 7, Figures 5 and 6) whereas the high flow years (2011 and 2012) had many more instances of PH2 units operating above the mid-range (Tables 8 and 9, Figures 7 and 8).

Table 3. Proportion of hours each unit operated above the mid-range in 2006. Numbers in parentheses represent the number of hours that unit operated that day. Coloring is based on the proportion of hours operated above the mid-range as follows: Green = 0.0, Yellow = 0.5, and Red = 1.0. White cells represent days when a unit was not operated at all.

Date	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18
1-Aug	0.02 (24.0)	0.07 (24.0)	0.00 (5.9)	0.04 (8.7)	0.00 (0.3)	0.00 (0.3)	0.00 (0.3)	0.00 (0.3)
2-Aug	0.01 (24.0)	0.01 (16.4)	0.00 (17.2)	0.01 (16.7)				
3-Aug	0.12 (24.0)	0.23 (24.0)	0.03 (12.0)	0.07 (17.2)	0.00 (0.2)	0.00 (0.2)	0.00 (0.2)	0.00 (0.2)
4-Aug	0.53 (24.0)	0.50 (20.0)	0.00 (2.1)	0.00 (4.6)			0.04 (1.9)	0.15 (6.3)
5-Aug	0.54 (24.0)	0.69 (6.4)		0.00 (0.4)			0.69 (2.9)	0.33 (24.0)
6-Aug	0.12 (24.0)	0.00 (3.3)					0.00 (1.0)	0.17 (24.0)
7-Aug	0.03 (22.4)	0.07 (7.4)		0.00 (2.6)			0.00 (7.4)	0.04 (24.0)
8-Aug	0.08 (24.0)	0.00 (16.1)						0.05 (24.0)
9-Aug	0.01 (24.0)	0.02 (15.2)	0.04 (4.0)	0.02 (5.3)		0.00 (3.1)	0.02 (13.9)	0.02 (24.0)
10-Aug	0.18 (24.0)	0.26 (14.3)		0.58 (6.0)			0.41 (6.8)	0.18 (24.0)
11-Aug	0.01 (24.0)	0.00 (3.0)					0.00 (2.0)	0.01 (24.0)
12-Aug	0.00 (24.0)							0.00 (24.0)
13-Aug	0.00 (24.0)							0.00 (24.0)
14-Aug	0.00 (23.5)		0.00 (1.8)					0.01 (24.0)
15-Aug	0.00 (24.0)	0.00 (20.1)						0.00 (4.0)
16-Aug	0.00 (24.0)	0.00 (16.8)					0.00 (0.4)	0.00 (7.8)
17-Aug	0.03 (14.4)	0.01 (16.0)					0.00 (2.5)	0.01 (24.0)
18-Aug	0.00 (6.3)	0.09 (20.6)	0.00 (9.25)	0.00 (12.6)		0.00 (7.8)	0.13 (15.7)	0.06 (24.0)
19-Aug	0.35 (24.0)	0.05 (3.4)					0.00 (2.1)	0.56 (24.0)
20-Aug	0.06 (24.0)	0.29 (2.0)					0.50 (1.0)	0.23 (24.0)
21-Aug	0.17 (24.0)	0.00 (16.9)	0.01 (6.9)				0.00 (1.6)	0.00 (0.4)
22-Aug	0.03 (24.0)	0.05 (20.6)		0.00 (7.6)	0.00 (9.2)	0.00 (0.8)	0.00 (9.5)	
23-Aug	0.01 (24.0)			0.00 (6.2)	0.01 (20.8)	0.00 (5.3)	0.00 (9.6)	0.00 (3.4)
24-Aug	0.11 (24.0)	0.25 (13.0)		0.00 (2.0)	0.40 (12.6)		0.00 (1.8)	0.17 (24.0)
25-Aug	0.01 (24.0)	0.01 (12.0)		0.00 (6.3)	0.03 (12.1)	0.00 (6.2)	0.02 (8.6)	0.01 (24.0)
26-Aug	0.21 (24.0)	0.01 (19.1)		0.00 (17.6)	0.06 (19.3)	0.00 (14.6)	0.01 (18.8)	0.20 (24.0)
27-Aug	0.02 (24.0)	0.17 (16.4)			0.02 (20.7)		0.00 (1.3)	0.10 (24.0)
28-Aug	0.00 (24.0)	0.00 (3.7)			0.00 (4.7)			0.00 (24.0)
29-Aug	0.04 (24.0)	0.08 (7.5)		0.15 (5.9)	0.04 (9.5)		0.24 (6.8)	0.05 (24.0)
30-Aug	0.00 (24.0)	0.32 (12.7)			0.18 (12.6)			0.20 (24.0)
31-Aug	0.01 (24.0)	0.00 (0.1)		0.00 (0.1)	0.00 (8.9)	0.00 (0.1)		0.01 (17.8)

Table 4. Proportion of hours each unit operated above the mid-range in 2007. Numbers in parentheses represent the number of hours that unit operated that day. Coloring is based on the proportion of hours operated above the mid-range as follows: Green = 0.0, Yellow = 0.5, and Red = 1.0. White cells represent days when a unit was not operated at all.

Date	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18
1-Aug	0.27 (22.5)	0.07 (17.8)	0.46 (8.3)	0.05 (16.8)			0.27 (17.2)	0.05 (24.0)
2-Aug	0.22 (24.0)	0.31 (19.1)	0.17 (16.8)	0.05 (15.8)		0.10 (11.1)	0.14 (17.0)	0.17 (14.5)
3-Aug	0.14 (24.0)	0.20 (22.1)	0.00 (3.8)	0.00 (16.8)		0.00 (3.2)	0.00 (16.9)	0.00 (15.3)
4-Aug	0.03 (24.0)	0.08 (5.1)					0.00 (2.6)	0.02 (24.0)
5-Aug	0.14 (24.0)	0.10 (7.3)					0.23 (2.9)	0.14 (24.0)
6-Aug	0.01 (24.0)	0.04 (6.9)	0.00 (0.9)	0.03 (2.9)			0.04 (17.0)	0.00 (4.7)
7-Aug	0.13 (24.0)	0.01 (7.2)		0.00 (1.8)			0.05 (4.9)	0.07 (15.9)
8-Aug	0.09 (23.4)	0.10 (17.2)	0.17 (0.5)	0.00 (0.8)		0.00 (0.3)	0.01 (7.7)	0.10 (24.0)
9-Aug	0.04 (24.0)		0.00 (4.3)	0.31 (4.1)		0.00 (1.3)	0.01 (10.8)	0.07 (24.0)
10-Aug	0.12 (24.0)	0.12 (5.6)	0.12 (6.3)	0.16 (13.4)			0.07 (15.0)	0.05 (24.0)
11-Aug	0.27 (24.0)	0.00 (17.1)	0.00 (2)	0.00 (4.9)		0.70 (3.6)	0.04 (12.3)	0.01 (23.8)
12-Aug	0.21 (24.0)	0.19 (12.6)	0.63 (3.2)	0.22 (4.2)		0.10 (1.7)	0.09 (8.7)	0.09 (22.6)
13-Aug	0.04 (11.9)	0.28 (10.4)		0.47 (2.5)	0.77 (2.5)		0.50 (1.0)	0.04 (23.25)
14-Aug	0.31 (23.6)	0.11 (12.3)	0.13 (9.9)			0.13 (9.4)	0.08 (14.7)	0.24 (24.0)
15-Aug	0.26 (24.0)	0.06 (15.8)	0.49 (7.4)		0.61 (3.7)	0.00 (0.8)	0.06 (14.1)	0.25 (24.0)
16-Aug	0.06 (24.0)	0.20 (5.5)	0.00 (3.8)		0.08 (9.2)		0.09 (8.3)	0.01 (24.0)
17-Aug	0.21 (24.0)	0.26 (3.6)			0.11 (11.5)		0.82 (0.9)	0.03 (24.0)
18-Aug	0.01 (24.0)	0.00 (1.2)					0.00 (0.9)	0.01 (24.0)
19-Aug	0.00 (24.0)							0.00 (24.0)
20-Aug	0.00 (24.0)							0.00 (24.0)
21-Aug	0.00 (24.0)	0.00 (1.3)	0.00 (0.2)	0.00 (0.2)	0.00 (1.6)	0.00 (0.2)	0.00 (0.2)	0.00 (24.0)
22-Aug	0.01 (24.0)	0.01 (6.3)	0.00 (0.2)	0.00 (0.2)	0.00 (9.5)	0.00 (0.2)	0.00 (1.4)	0.00 (24.0)
23-Aug	0.01 (24.0)	0.00 (0.1)			0.43 (3.7)			0.03 (24.0)
24-Aug	0.17 (24.0)	0.28 (3.6)			0.33 (3.3)		0.13 (0.7)	0.17 (24.0)
25-Aug	0.01 (24.0)				0.00 (1.0)			0.02 (24.0)
26-Aug	0.00 (24.0)							0.00 (24.0)
27-Aug	0.08 (24.0)						0.00 (1.2)	0.00 (21.2)
28-Aug	0.02 (24.0)	0.05 (5.1)			0.09 (7.7)		0.00 (2.5)	0.04 (24.0)
29-Aug	0.14 (24.0)	0.03 (6.7)			0.01 (15.5)		0.00 (2.1)	0.14 (24.0)
30-Aug	0.07 (24.0)	0.09 (11.4)	0.00 (6.7)	0.00 (2.0)	0.06 (18.2)	0.00 (2.0)	0.08 (10.1)	0.05 (24.0)
31-Aug	0.18 (24.0)		0.00 (0.4)		0.00 (15.8)			0.16 (24.0)

Table 5. Proportion of hours each unit operated above the mid-range in 2008. Numbers in parentheses represent the number of hours that unit operated that day. Coloring is based on the proportion of hours operated above the mid-range as follows: Green = 0.0, Yellow = 0.5, and Red = 1.0. White cells represent days when a unit was not operated at all.

Date	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18
1-Aug		0.22 (15.6)			0.02 (24.0)		0.00 (4.8)	0.06 (24.0)
2-Aug		0.48 (2.6)			0.05 (24.0)		0.00 (0.8)	0.01 (24.0)
3-Aug		0.07 (1.2)	0.00 (0.133)	0.00 (0.2)	0.01 (24.0)	0.00 (0.1)	0.00 (1.2)	0.02 (24.0)
4-Aug					0.18 (18.9)	0.00 (0.8)	0.00 (1.1)	0.30 (24.0)
5-Aug					0.03 (24.0)	0.00 (7.8)	0.06 (11.2)	0.03 (24.0)
6-Aug					0.08 (24.0)	0.01 (10.0)	0.04 (19.1)	0.04 (24.0)
7-Aug		0.00 (5.1)	0.00 (3.3)	0.00 (4.5)	0.05 (24.0)	0.02 (13.0)	0.01 (20.1)	0.05 (24.0)
8-Aug		0.00 (15.1)			0.18 (24.0)		0.00 (3.1)	0.20 (24.0)
9-Aug					0.00 (24.0)			0.00 (24.0)
10-Aug					0.00 (24.0)			0.00 (24.0)
11-Aug		0.02 (23.3)	0.04 (11.0)	0.02 (23.2)	0.00 (0.92)			0.00 (0.9)
12-Aug		0.03 (24.0)	0.07 (9.0)	0.04 (24.0)				
13-Aug		0.11 (24.0)	0.13 (19.3)	0.26 (24.0)				
14-Aug		0.18 (19.8)		0.21 (17.3)	0.00 (7.2)			0.00 (5.1)
15-Aug		0.06 (8.0)	0.00 (5.1)	0.02 (7.5)	0.02 (24.0)		0.00 (0.2)	0.03 (24.0)
16-Aug		0.00 (2.1)		0.00 (1.0)	0.08 (24.0)			0.00 (24.0)
17-Aug					0.00 (24.0)			0.00 (24.0)
18-Aug		0.05 (19.7)	0.00 (1.8)	0.02 (10.7)	0.06 (23.6)	0.00 (1.2)	0.00 (7.7)	0.01 (23.7)
19-Aug		0.00 (7.8)			0.11 (24.0)		0.00 (7.1)	0.01 (24.0)
20-Aug		0.01 (11.1)			0.00 (20.7)		0.00 (5.4)	0.00 (24.0)
21-Aug		0.00 (6.0)			0.00 (18.1)			0.00 (24.0)
22-Aug		0.09 (6.8)	0.00 (1.9)	0.04 (5.8)	0.02 (24.0)		0.04 (5.8)	0.02 (24.0)
23-Aug		0.20 (4.5)			0.05 (24.0)		0.29 (3.5)	0.05 (24.0)
24-Aug		0.00 (19.1)		0.00 (6.6)	0.02 (24.0)		0.00 (15.6)	0.13 (24.0)
25-Aug		0.50 (9.3)			0.57 (10.2)		0.00 (1.1)	0.52 (11.0)
26-Aug		0.00 (1.2)			0.12 (24.0)			0.12 (24.0)
27-Aug					0.06 (24.0)		0.00 (0.2)	0.06 (24.0)
28-Aug		0.00 (0.8)			0.09 (24.0)		0.00 (0.1)	0.18 (24.0)
29-Aug		0.00 (8.8)			0.15 (24.0)		0.00 (1.8)	0.12 (24.0)
30-Aug		0.00 (2.6)			0.24 (24.0)		0.00 (1.0)	0.23 (24.0)
31-Aug		0.00 (0.1)			0.17 (24.0)		0.00 (0.1)	0.17 (24.0)

Table 6. Proportion of hours each unit operated above the mid-range in 2009. Numbers in parentheses represent the number of hours that unit operated that day. Coloring is based on the proportion of hours operated above the mid-range as follows: Green = 0.0, Yellow = 0.5, and Red = 1.0. White cells represent days when a unit was not operated at all.

Date	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18
1-Aug		0.09 (24.0)	0.17 (15.1)	0.19 (15.9)	0.13 (24.0)		0.00 (16.7)	0.00 (24.0)
2-Aug		0.00 (24.0)		0.00 (0.2)	0.00 (24.0)		0.00 (14.4)	0.00 (24.0)
3-Aug		0.00 (24.0)			0.00 (0.2)			0.00 (24.0)
4-Aug		0.00 (24.0)			0.00 (13.4)			0.00 (24.0)
5-Aug		0.01 (24.0)		0.00 (7.0)	0.00 (10.0)		0.01 (10.2)	0.00 (24.0)
6-Aug		0.07 (24.0)						0.09 (24.0)
7-Aug		0.00 (24.0)						0.00 (24.0)
8-Aug		0.00 (24.0)						0.00 (24.0)
9-Aug		0.00 (24.0)						0.00 (24.0)
10-Aug		0.00 (1.0)			0.00 (23.2)			0.00 (24.0)
11-Aug		0.00 (6.7)			0.00 (17.5)			0.00 (24.0)
12-Aug		0.00 (24.0)	0.00 (0.2)					0.00 (24.0)
13-Aug		0.00 (24.0)						0.00 (24.0)
14-Aug		0.00 (24.0)						0.00 (24.0)
15-Aug		0.00 (24.0)						0.00 (24.0)
16-Aug		0.00 (24.0)						0.00 (24.0)
17-Aug		0.00 (24.0)						0.00 (24.0)
18-Aug		0.00 (24.0)						0.00 (24.0)
19-Aug		0.00 (24.0)		0.00 (5.5)			0.00 (5.4)	0.00 (24.0)
20-Aug		0.00 (24.0)		0.00 (12.6)	0.00 (6.8)		0.00 (19.1)	0.00 (24.0)
21-Aug		0.00 (24.0)			0.00 (2.1)		0.00 (0.2)	0.00 (24.0)
22-Aug		0.00 (24.0)						0.00 (24.0)
23-Aug		0.00 (24.0)						0.00 (24.0)
24-Aug		0.00 (24.0)			0.00 (22.9)			0.00 (1.3)
25-Aug		0.00 (24.0)			0.00 (16.5)			0.00 (7.8)
26-Aug		0.00 (24.0)						0.00 (24.0)
27-Aug		0.00 (24.0)						0.00 (24.0)
28-Aug		0.00 (24.0)						0.00 (24.0)
29-Aug		0.00 (24.0)						0.00 (24.0)
30-Aug		0.00 (24.0)						0.00 (24.0)
31-Aug		0.00 (24.0)		0.00 (0.1)	0.00 (0.2)		0.00 (0.1)	0.00 (24.0)

Table 7. Proportion of hours each unit operated above the mid-range in 2010. Numbers in parentheses represent the number of hours that unit operated that day. Coloring is based on the proportion of hours operated above the mid-range as follows: Green = 0.0, Yellow = 0.5, and Red = 1.0. White cells represent days when a unit was not operated at all.

Date	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18
1-Aug		0.00 (24.0)			0.00 (1.3)		0.00 (0.8)	0.00 (24.0)
2-Aug		0.00 (24.0)						0.00 (24.0)
3-Aug		0.00 (23.5)			0.00 (4.7)			0.00 (24.0)
4-Aug		0.00 (24.0)		0.00 (13.1)	0.00 (19.1)	0.00 (12.8)	0.00 (18.9)	0.00 (24.0)
5-Aug		0.00 (24.0)		0.00 (18.8)	0.00 (24.0)	0.00 (3.3)	0.00 (23.1)	0.00 (24.0)
6-Aug		0.00 (24.0)			0.00 (10.9)			0.00 (24.0)
7-Aug		0.00 (24.0)			0.00 (5.1)			0.00 (24.0)
8-Aug		0.00 (24.0)			0.00 (8.7)			0.00 (24.0)
9-Aug		0.00 (24.0)			0.00 (7.0)			0.00 (24.0)
10-Aug		0.01 (24.0)			0.00 (5.0)			0.00 (24.0)
11-Aug		0.01 (24.0)			0.00 (8.9)	0.00 (2.1)	0.00 (7.9)	0.00 (24.0)
12-Aug		0.00 (24.0)			0.00 (2.2)		0.00 (1.0)	0.00 (24.0)
13-Aug		0.00 (24.0)						0.00 (24.0)
14-Aug		0.00 (24.0)			0.00 (2.3)		0.00 (1.8)	0.00 (24.0)
15-Aug		0.00 (24.0)			0.00 (2.1)		0.00 (1.8)	0.00 (24.0)
16-Aug		0.00 (24.0)			0.00 (1.1)		0.00 (1.2)	0.00 (24.0)
17-Aug		0.00 (24.0)			0.00 (3.1)	0.00 (0.3)		0.00 (24.0)
18-Aug		0.02 (24.0)		0.00 (3.3)	0.03 (5.2)	0.00 (2.0)		0.02 (24.0)
19-Aug		0.17 (24.0)		0.00 (10.1)	0.04 (14.2)		0.00 (0.1)	0.05 (24.0)
20-Aug		0.00 (24.0)						0.00 (24.0)
21-Aug		0.00 (24.0)						0.00 (24.0)
22-Aug		0.00 (24.0)						0.00 (24.0)
23-Aug	0.00 (0.17)	0.00 (24.0)	0.00 (0.2)		0.00 (0.2)	0.00 (0.2)	0.00 (0.2)	0.00 (24.0)
24-Aug		0.00 (24.0)	0.00 (0.3)				0.00 (23.2)	0.00 (0.9)
25-Aug		0.00 (24.0)					0.00 (20.3)	0.00 (3.8)
26-Aug		0.00 (24.0)						0.00 (24.0)
27-Aug		0.00 (24.0)						0.00 (24.0)
28-Aug		0.00 (24.0)						0.00 (24.0)
29-Aug		0.00 (24.0)						0.00 (24.0)
30-Aug		0.00 (24.0)			0.00 (13.1)			0.00 (11.0)
31-Aug		0.00 (24.0)	0.00 (0.3)		0.00 (24.0)		0.00 (0.1)	

Table 8. Proportion of hours each unit operated above the mid-range in 2011. Numbers in parentheses represent the number of hours that unit operated that day. Coloring is based on the proportion of hours operated above the mid-range as follows: Green = 0.0, Yellow = 0.5, and Red = 1.0. White cells represent days when a unit was not operated at all.

Date	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18
1-Aug		0.93 (24.0)	0.90 (24.0)	0.91 (24.0)		0.88 (24.0)	0.91 (24.0)	0.91 (24.0)
2-Aug		0.56 (24.0)	0.52 (24.0)	0.52 (24.0)		0.13 (24.0)	0.59 (22.2)	0.50 (24.0)
3-Aug		0.01 (24.0)	0.00 (0.5)	0.00 (24.0)		0.00 (24.0)	0.00 (24.0)	0.00 (24.0)
4-Aug		0.00 (24.0)	0.00 (12.8)	0.00 (24.0)		0.00 (24.0)	0.00 (24.0)	0.00 (24.0)
5-Aug		0.03 (24.0)	0.07 (23.6)	0.01 (21.8)		0.03 (21.8)	0.03 (24.0)	0.05 (24.0)
6-Aug		0.06 (24.0)	0.07 (19.1)	0.01 (17.2)		0.00 (15.5)	0.03 (20.2)	0.05 (24.0)
7-Aug		0.02 (24.0)	0.03 (22.1)	0.00 (19.1)		0.00 (19.1)	0.01 (24.0)	0.03 (21.3)
8-Aug		0.01 (24.0)	0.01 (24.0)	0.14 (24.0)		0.05 (24.0)	0.01 (24.0)	0.00 (24.0)
9-Aug		0.01 (24.0)	0.00 (21.9)	0.00 (21.9)		0.00 (21.8)	0.01 (10.7)	0.00 (24.0)
10-Aug		0.05 (21.8)	0.10 (10.3)	0.08 (10.1)		0.10 (9.5)		0.28 (21.7)
11-Aug		0.03 (15.8)	0.17 (7.2)					0.00 (2.7)
12-Aug		0.41 (21.9)	0.59 (16.8)					
13-Aug		0.02 (4.0)	0.28 (5.0)	0.09 (1.8)				
14-Aug								
15-Aug		0.00 (9.5)						
16-Aug		0.73 (15.6)	0.67 (12.3)	0.00 (2.4)				
17-Aug		0.08 (15.6)	0.05 (10.3)	0.00 (0.7)		0.00 (0.2)		0.29 (1.2)
18-Aug		0.00 (12.2)	0.00 (11.9)	0.00 (9.8)		0.00 (9.4)		0.00 (9.5)
19-Aug		0.02 (24.0)	0.01 (24.0)	0.03 (24.0)		0.03 (21.2)		0.02 (24.0)
20-Aug		0.00 (24.0)	0.00 (24.0)	0.00 (20.8)		0.00 (15.8)		0.00 (24.0)
21-Aug		0.01 (24.0)	0.02 (20.8)	0.01 (15.6)		0.01 (15.6)		0.02 (24.0)
22-Aug		0.02 (24.0)	0.01 (15.8)	0.00 (15.8)		0.00 (15.7)		0.02 (24.0)
23-Aug		0.29 (24.0)	0.35 (19.1)	0.35 (17.3)	0.00 (4.7)	0.43 (15.7)		0.20 (24.0)
24-Aug		0.24 (24.0)	0.19 (19.3)	0.14 (19.1)	0.14 (18.3)	0.20 (15.9)		0.13 (24.0)
25-Aug		0.00 (24.0)	0.00 (24.0)	0.00 (24.0)	0.00 (24.0)	0.00 (15.8)		0.00 (24.0)
26-Aug		0.01 (24.0)	0.00 (24.0)	0.00 (15.9)	0.00 (15.8)	0.00 (15.8)		0.00 (24.0)
27-Aug		0.01 (24.0)	0.00 (24.0)	0.00 (19.0)	0.00 (19.0)	0.00 (7.8)		0.03 (24.0)
28-Aug		0.01 (24.0)	0.01 (20.7)	0.01 (20.7)	0.00 (20.3)	0.00 (15.8)		0.01 (24.0)
29-Aug		0.01 (24.0)	0.01 (15.7)	0.01 (15.6)	0.02 (5.4)	0.00 (4.5)		0.02 (24.0)
30-Aug		0.01 (24.0)	0.01 (15.8)	0.00 (15.8)	0.00 (9.4)	0.00 (6.4)		0.00 (24.0)
31-Aug	0.00 (0.2)	0.08 (24.0)	0.01 (14.6)	0.01 (16.1)	0.00 (15.8)	0.00 (10.8)	0.00 (0.7)	0.09 (24.0)

Table 9. Proportion of hours each unit operated above the mid-range in 2012. Numbers in parentheses represent the number of hours that unit operated that day. Coloring is based on the proportion of hours operated above the mid-range as follows: Green = 0.0, Yellow = 0.5, and Red = 1.0. White cells represent days when a unit was not operated at all.

Date	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18
1-Aug		0.00 (20.4)	0.86 (20.3)		0.86 (20.3)	0.84 (20.4)	0.34 (4.2)	0.00 (20.5)
2-Aug		0.00 (24.0)	0.11 (24.0)		0.10 (24.0)	0.09 (24.0)		0.00 (24.0)
3-Aug		0.00 (24.0)	0.08 (24.0)		0.08 (24.0)	0.08 (24.0)		0.00 (24.0)
4-Aug		0.00 (24.0)	0.35 (24.0)		0.35 (24.0)	0.36 (24.0)		0.00 (24.0)
5-Aug		0.00 (21.9)	0.00 (21.9)		0.00 (24.0)	0.01 (24.0)		0.00 (24.0)
6-Aug					0.42 (24.0)	0.45 (24.0)		0.00 (24.0)
7-Aug					0.70 (24.0)	0.71 (24.0)		0.00 (24.0)
8-Aug					0.32 (24.0)	0.33 (24.0)		0.00 (24.0)
9-Aug					0.23 (24.0)	0.24 (24.0)		0.00 (24.0)
10-Aug					0.00 (24.0)	0.00 (24.0)		0.00 (24.0)
11-Aug					0.40 (24.0)	0.40 (24.0)		0.00 (24.0)
12-Aug					0.51 (24.0)	0.61 (24.0)		0.00 (24.0)
13-Aug					0.62 (20.25)	0.67 (24.0)		0.00 (24.0)
14-Aug					0.00 (24.0)	0.00 (24.0)		0.00 (24.0)
15-Aug					0.00 (24.0)	0.00 (24.0)		0.00 (24.0)
16-Aug		0.00 (11.3)	0.00 (11.4)		0.00 (17.25)	0.00 (20.6)		0.00 (24.0)
17-Aug		0.01 (24.0)	0.02 (24.0)		0.03 (19.0)	0.03 (14.9)		0.00 (24.0)
18-Aug		0.01 (24.0)	0.01 (24.0)		0.01 (24.0)	0.01 (20.6)		0.00 (24.0)
19-Aug		0.00 (24.0)	0.18 (24.0)		0.11 (20.8)	0.02 (17.0)		0.00 (24.0)
20-Aug	0.00 (0.1)	0.00 (24.0)	0.01 (24.0)	0.00 (0.1)	0.01 (24.0)	0.00 (18.9)	0.00 (0.1)	0.00 (24.0)
21-Aug		0.00 (24.0)	0.05 (24.0)		0.06 (24.0)	0.01 (20.2)		0.00 (24.0)
22-Aug	0.00 (0.2)	0.00 (24.0)	0.14 (24.0)	0.00 (0.2)	0.18 (19.0)	0.14 (19.0)	0.00 (0.2)	0.00 (24.0)
23-Aug		0.00 (24.0)	0.05 (24.0)		0.02 (17.4)	0.03 (15.8)		0.00 (24.0)
24-Aug		0.00 (24.0)	0.06 (24.0)		0.02 (19.2)	0.08 (18.2)		0.00 (24.0)
25-Aug		0.00 (24.0)	0.18 (24.0)		0.15 (24.0)	0.00 (19.1)		0.00 (24.0)
26-Aug		0.01 (24.0)	0.13 (20.8)		0.14 (15.9)	0.17 (13.0)		0.01 (24.0)
27-Aug		0.04 (24.0)	0.37 (24.0)					0.50 (0.2)
28-Aug	0.00 (10.1)	0.00 (24.0)	0.03 (23.2)					
29-Aug	0.00 (6.7)	0.00 (24.0)	0.00 (24.0)					
30-Aug	0.00 (24.0)	0.01 (24.0)	0.05 (24.0)					
31-Aug	0.00 (24.0)	0.00 (24.0)	0.00 (24.0)					

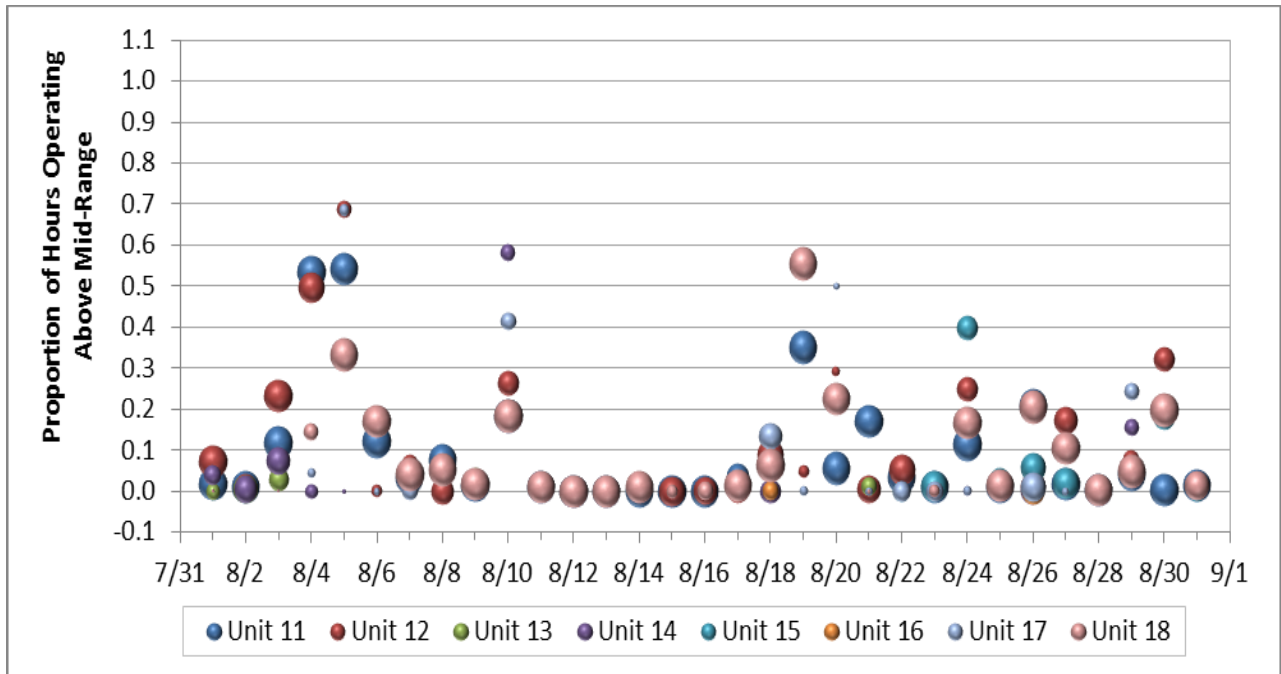


Figure 2. Proportion of hours each unit operated above the mid-range in 2006. Size of each symbol is proportional to the total number of hours that the unit operated each day. See Figure 16 for a depiction of the scale for these symbols.

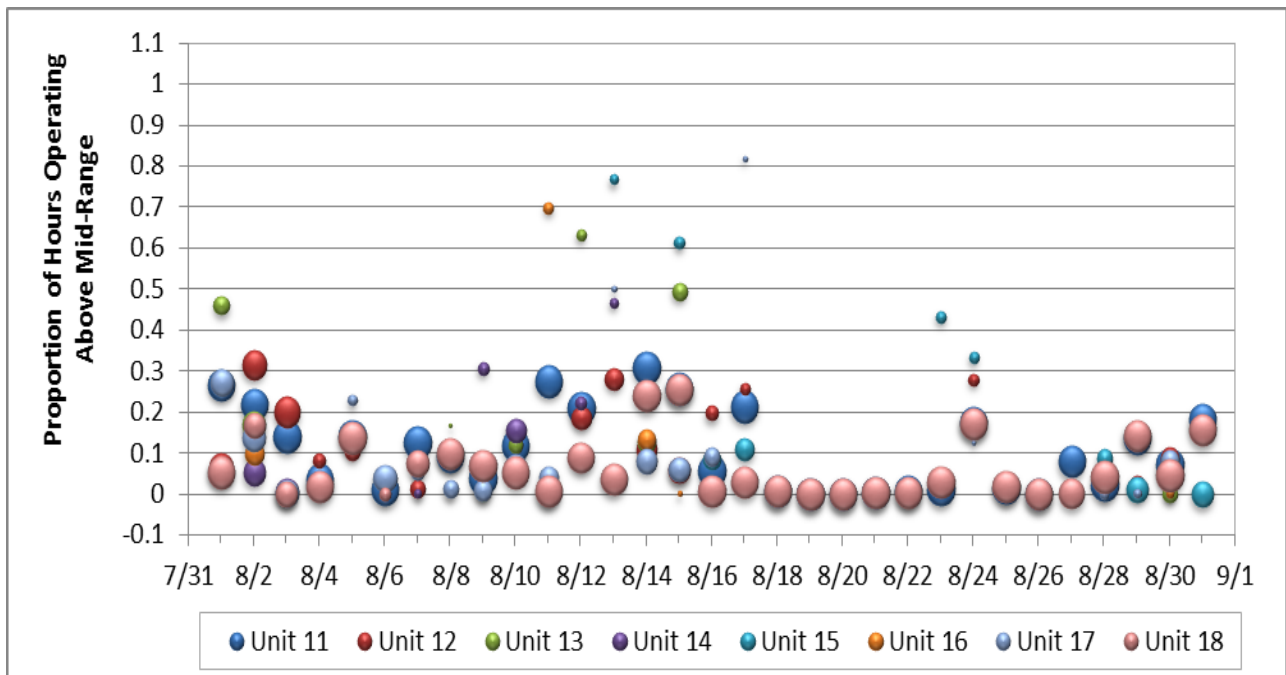


Figure 3. Proportion of hours each unit operated above the Mid-Range in 2007. Size of each symbol is proportional to the total number of hours that the unit operated each day. See Figure 16 for a depiction of the scale for these symbols.

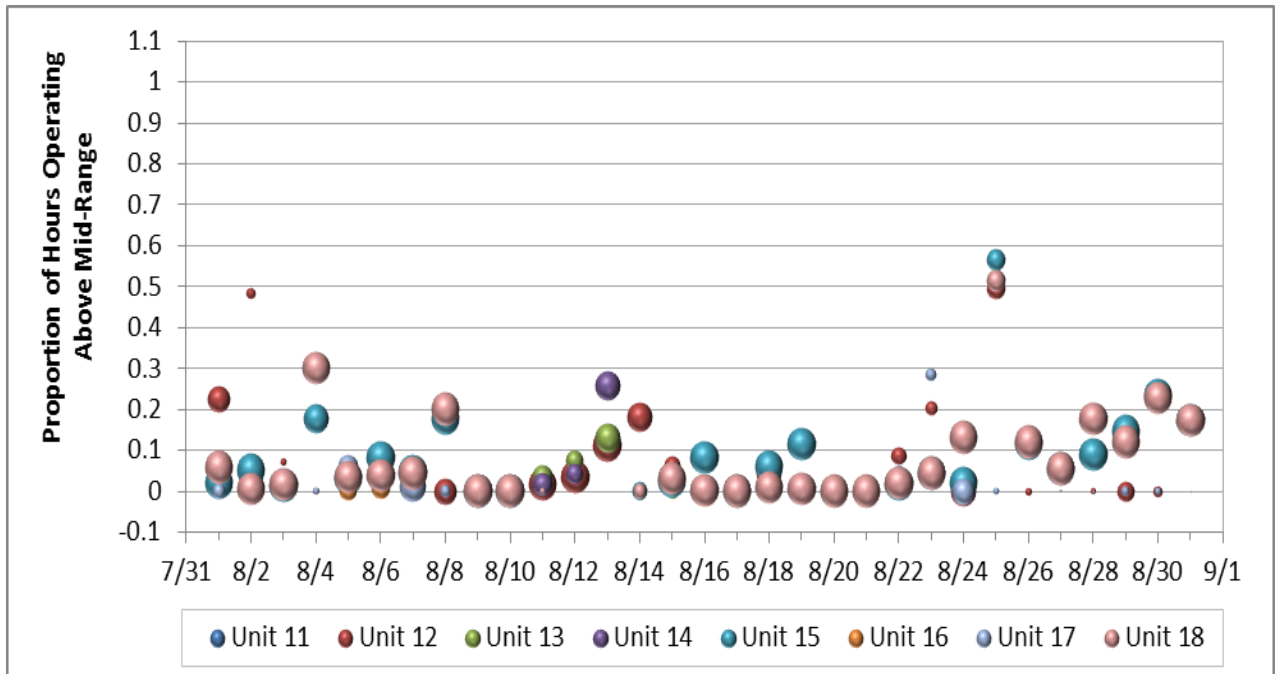


Figure 4. Proportion of hours each unit operated above the mid-range in 2008. Size of each symbol is proportional to the total number of hours that the unit operated each day. See Figure 16 for a depiction of the scale for these symbols.

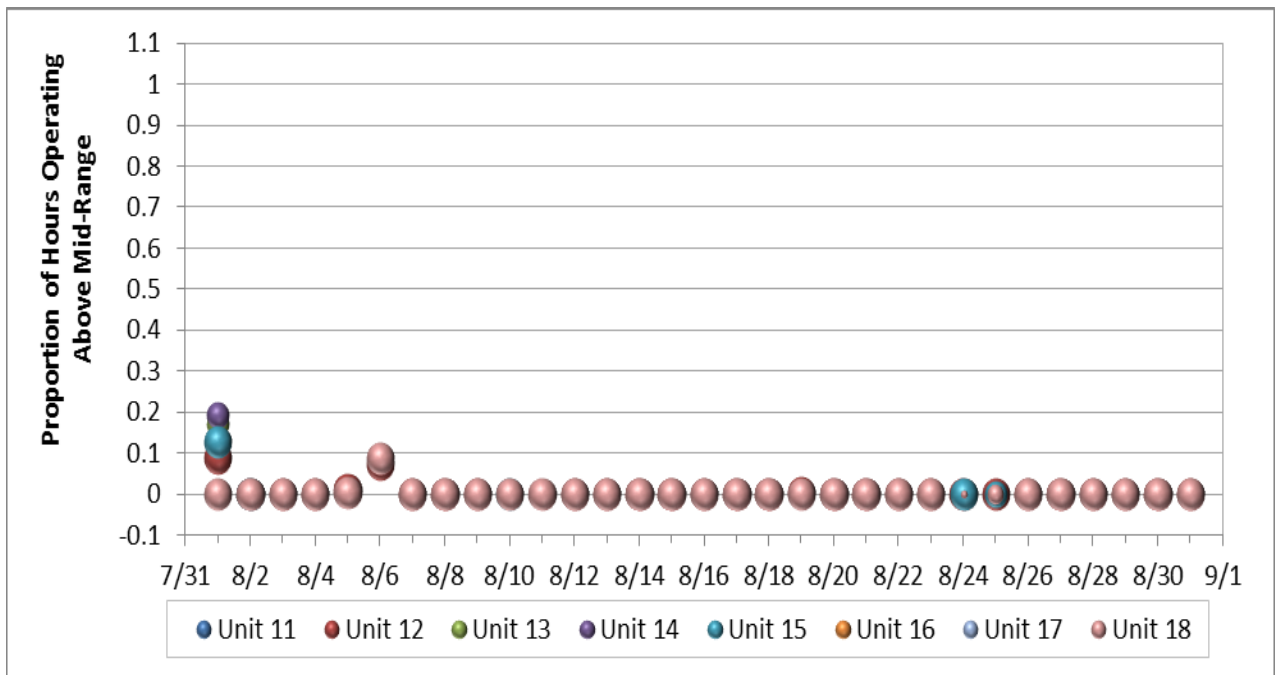


Figure 5. Proportion of hours each unit operated above the mid-range in 2009. Size of each symbol is proportional to the total number of hours that the unit operated each day. See Figure 16 for a depiction of the scale for these symbols.

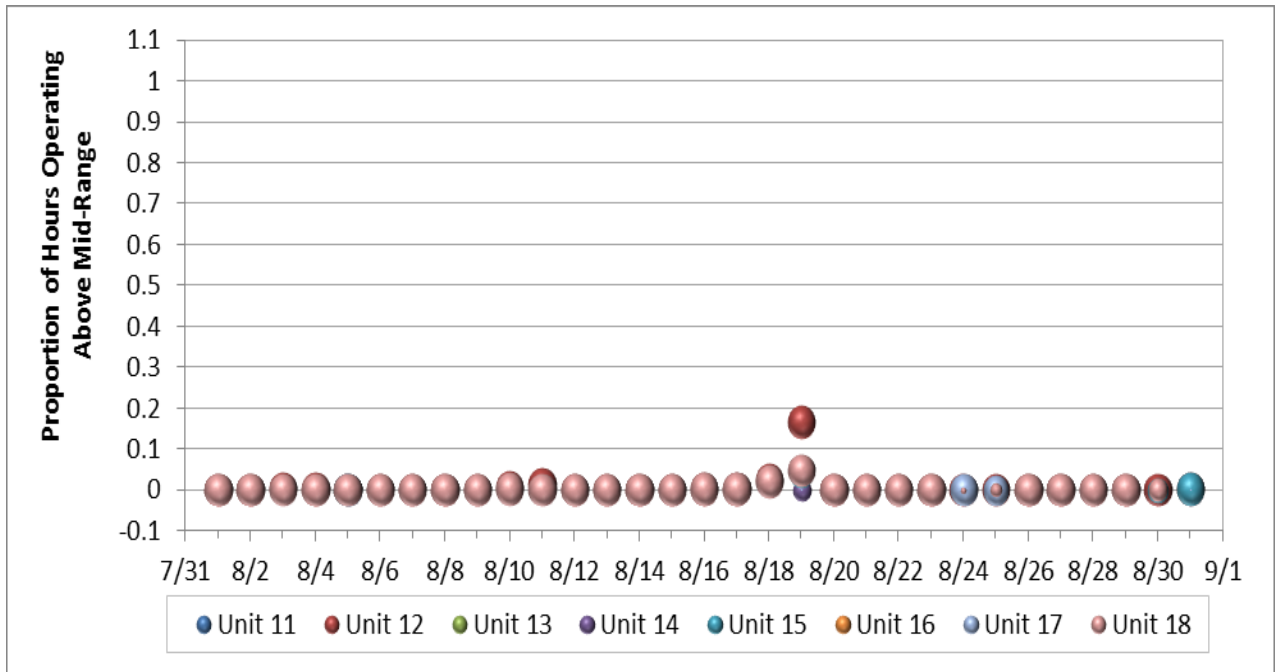


Figure 6. Proportion of hours each unit operated above the mid-range in 2010. Size of each symbol is proportional to the total number of hours that the unit operated each day. See Figure 16 for a depiction of the scale for these symbols.

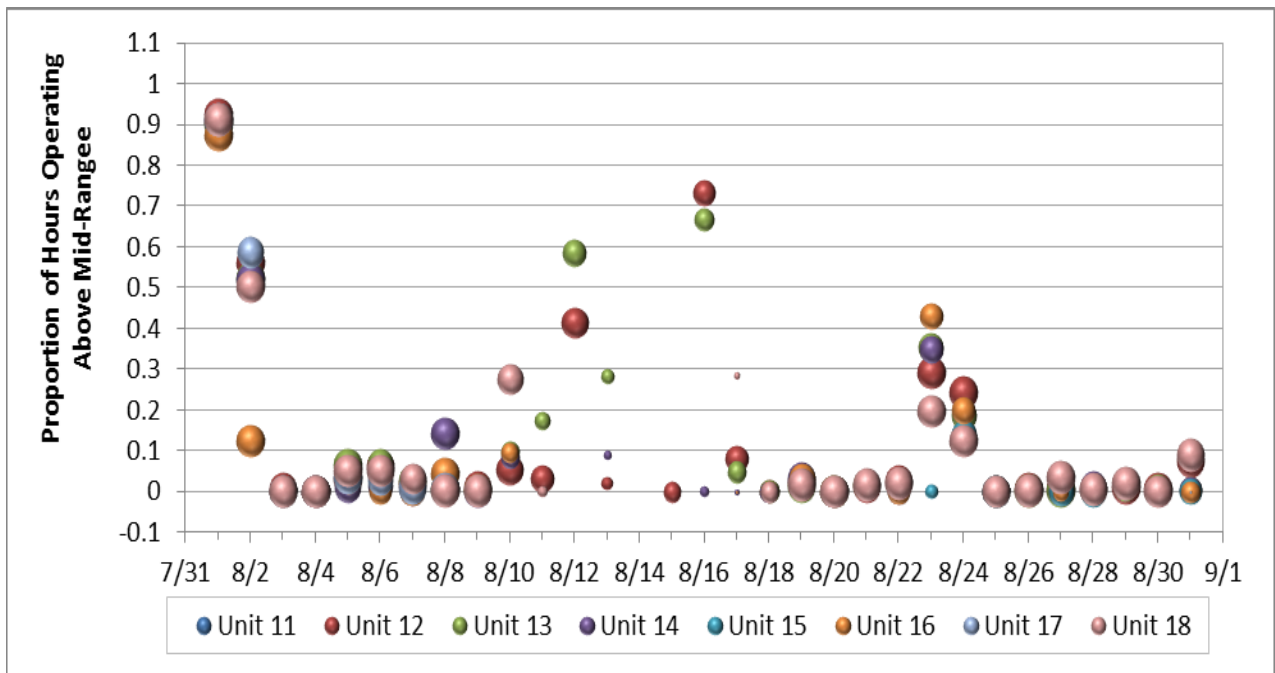


Figure 7. Proportion of hours each unit operated above the mid-range in 2011. Size of each symbol is proportional to the total number of hours that the unit operated each day. See Figure 16 for a depiction of the scale for these symbols.

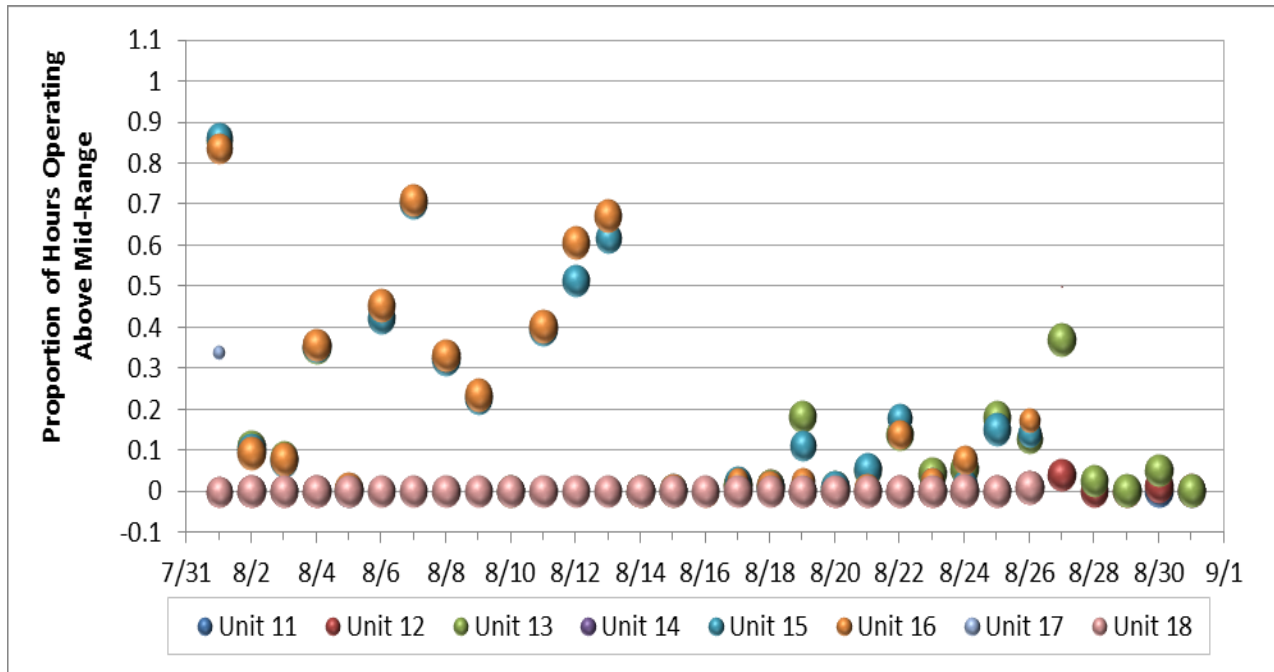


Figure 8. Proportion of hours each unit operated above the mid-range in 2012. Size of each symbol is proportional to the total number of hours that the unit operated each day. See Figure 16 for a depiction of the scale for these symbols.

Operating Below Mid-Range

Compared to operations above the mid-range, the operation of PH2 units below the mid-range in August was much more common over the years we reviewed (Tables 10–16, Figures 9–15). There was also a clear opposite pattern in the frequency of operations below the mid-range among the different flow years. As August flows increased, the frequency of operations below the mid-range decreased. The highest frequency of units operating below the mid-range occurred in 2009 and 2010, the two low flow years that we analyzed (Tables 13 and 14 and Figures 12 and 13). Operations below the mid-range in intermediate (2006–2008) and high (2011 and 2012) years were less prevalent than the low flow years (2009 and 2010).

Table 10. Proportion of hours each unit operated below the mid-range in 2006. Numbers in parentheses represent the number of hours that unit operated that day. Coloring is based on the proportion of hours operated below the mid-range as follows: Green = 0.0, Yellow = 0.5, and Red = 1.0. White cells represent days when a unit was not operated at all.

Date	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18
1-Aug	0.47 (24.0)	0.56 (24.0)	0.04 (5.9)	0.14 (8.7)	0.00 (0.3)	0.00 (0.3)	0.00 (0.3)	0.00 (0.3)
2-Aug	0.57 (24.0)	0.51 (16.4)	0.47 (17.2)	0.47 (16.7)				
3-Aug	0.44 (24.0)	0.38 (24.0)	0.46 (12.0)	0.47 (17.2)	0.00 (0.2)	0.00 (0.2)	0.00 (0.2)	0.00 (0.2)
4-Aug	0.13 (24.0)	0.14 (20.0)	0.92 (2.1)	0.69 (4.6)			0.48 (1.9)	0.03 (6.25)
5-Aug	0.03 (24.0)	0.12 (6.4)		1.00 (0.4)			0.20 (2.9)	0.02 (24.0)
6-Aug	0.02 (24.0)	0.18 (3.3)					0.17 (1.0)	0.02 (24.0)
7-Aug	0.35 (22.4)	0.85 (7.4)		0.97 (2.6)			0.98 (7.4)	0.43 (24.0)
8-Aug	0.30 (24.0)	0.54 (16.1)						0.27 (24.0)
9-Aug	0.48 (24.0)	0.74 (15.2)	0.54 (4.0)	0.63 (5.3)		0.46 (3.1)	0.81 (13.9)	0.45 (24.0)
10-Aug	0.18 (24.0)	0.29 (14.3)		0.06 (6.0)			0.16 (6.8)	0.13 (24.0)
11-Aug	0.09 (24.0)	0.75 (3.0)					0.21 (2.0)	0.08 (24.0)
12-Aug	0.04 (24.0)							0.02 (24.0)
13-Aug	0.00 (24.0)							0.00 (24.0)
14-Aug	0.01 (23.5)		0.90 (1.75)					0.02 (24.0)
15-Aug	0.01 (24.0)	0.00 (20.1)						0.02 (4.0)
16-Aug	0.11 (24.0)	0.06 (16.8)					1.00 (0.4)	0.10 (7.8)
17-Aug	0.40 (14.4)	0.41 (16.0)					1.00 (2.5)	0.28 (24.0)
18-Aug	0.26 (6.3)	0.17 (20.6)	0.52 (9.25)	0.44 (12.6)		0.15 (7.8)	0.18 (15.7)	0.21 (24.0)
19-Aug	0.05 (24.0)	0.34 (3.4)					0.52 (2.1)	0.05 (24.0)
20-Aug	0.40 (24.0)	0.33 (2.0)					0.17 (1.0)	0.24 (24.0)
21-Aug	0.09 (24.0)	0.11 (16.9)	0.02 (6.9)				1.00 (1.6)	0.20 (0.4)
22-Aug	0.21 (24.0)	0.18 (20.6)		0.37 (7.6)	0.15 (9.2)	1.00 (0.8)	0.44 (9.5)	
23-Aug	0.42 (24.0)			0.88 (6.2)	0.42 (20.8)	0.75 (5.3)	0.93 (9.6)	0.02 (3.4)
24-Aug	0.24 (24.0)	0.26 (13.0)		0.92 (2.0)	0.21 (12.6)		0.86 (1.8)	0.11 (24.0)
25-Aug	0.42 (24.0)	0.62 (12.0)		0.72 (6.3)	0.26 (12.1)	0.07 (6.2)	0.15 (8.6)	0.33 (24.0)
26-Aug	0.44 (24.0)	0.55 (19.1)		0.73 (17.6)	0.71 (19.3)	0.29 (14.6)	0.61 (18.8)	0.27 (24.0)
27-Aug	0.50 (24.0)	0.39 (16.4)			0.40 (20.7)		1.00 (1.3)	0.52 (24.0)
28-Aug	0.64 (24.0)	1.00 (3.7)			0.98 (4.7)			0.38 (24.0)
29-Aug	0.10 (24.0)	0.17 (7.5)		0.03 (5.9)	0.31 (9.5)		0.07 (6.8)	0.12 (24.0)
30-Aug	0.09 (24.0)	0.17 (12.7)			0.09 (12.6)			0.07 (24.0)
31-Aug	0.07 (24.0)	1.00 (0.13)		1.00 (0.1)	0.43 (8.9)	1.00 (0.1)		0.07 (17.8)

Table 11. Proportion of hours each unit operated below the mid-range in 2007. Numbers in parentheses represent the number of hours that unit operated that day. Coloring is based on the proportion of hours operated below the mid-range as follows: Green = 0.0, Yellow = 0.5, and Red = 1.0. White cells represent days when a unit was not operated at all.

Date	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18
1-Aug	0.10 (22.5)	0.51 (17.8)	0.04 (8.3)	0.55 (16.8)			0.43 (17.2)	0.44 (24.0)
2-Aug	0.02 (24.0)	0.04 (19.1)	0.14 (16.8)	0.20 (15.8)		0.21 (11.1)	0.26 (17.0)	0.37 (14.5)
3-Aug	0.52 (24.0)	0.45 (22.1)	0.16 (3.8)	0.79 (16.8)		1.00 (3.2)	0.91 (16.9)	0.61 (15.3)
4-Aug	0.75 (24.0)	0.30 (5.1)					0.77 (2.6)	0.70 (24.0)
5-Aug	0.36 (24.0)	0.25 (7.3)					0.46 (2.9)	0.41 (24.0)
6-Aug	0.30 (24.0)	0.37 (6.9)	0.36 (0.92)	0.49 (2.9)			0.05 (17.0)	0.02 (4.7)
7-Aug	0.34 (24.0)	0.17 (7.2)		0.55 (1.8)			0.31 (4.9)	0.07 (15.9)
8-Aug	0.60 (23.4)	0.5 (17.2)	0.83 (0.5)	0.30 (0.8)		1.00 (0.3)	0.66 (7.7)	0.39 (24.0)
9-Aug	0.40 (24.0)		0.48 (4.3)	0.61 (4.1)		0.40 (1.3)	0.51 (10.8)	0.25 (24.0)
10-Aug	0.69 (24.0)	0.48 (5.6)	0.56 (6.3)	0.61 (13.4)			0.75 (15.0)	0.41 (24.0)
11-Aug	0.45 (24.0)	0.71 (17.1)	0.25 (2.0)	0.36 (4.9)		0.28 (3.6)	0.34 (12.3)	0.43 (23.75)
12-Aug	0.53 (24.0)	0.53 (12.6)	0.29 (3.2)	0.28 (4.2)		0.35 (1.7)	0.61 (8.7)	0.40 (22.6)
13-Aug	0.38 (11.9)	0.31 (10.4)		0.07 (2.5)	0.23 (2.5)		0.42 (1.0)	0.38 (23.3)
14-Aug	0.34 (23.6)	0.26 (12.3)	0.36 (9.9)			0.19 (9.4)	0.48 (14.7)	0.24 (24.0)
15-Aug	0.19 (24.0)	0.23 (15.8)	0.24 (7.4)		0.27 (3.7)	1.00 (0.8)	0.37 (14.1)	0.24 (24.0)
16-Aug	0.33 (24.0)	0.27 (5.5)	0.43 (3.8)		0.54 (9.2)		0.36 (8.3)	0.48 (24.0)
17-Aug	0.57 (24.0)	0.23 (3.6)			0.28 (11.5)		0.18 (0.9)	0.12 (24.0)
18-Aug	0.19 (24.0)	0.79 (1.2)					1.00 (0.9)	0.00 (24.0)
19-Aug	0.40 (24.0)							0.78 (24.0)
20-Aug	0.81 (24.0)							0.16 (24.0)
21-Aug	0.99 (24.0)	0.88 (1.3)	0.00 (0.2)	0.00 (0.2)	0.89 (1.6)	0.00 (0.2)	0.00 (0.2)	0.97 (24.0)
22-Aug	0.73 (24.0)	0.91 (6.3)	0.00 (0.2)	0.00 (0.2)	0.84 (9.5)	0.00 (0.2)	0.53 (1.4)	0.68 (24.0)
23-Aug	0.45 (24.0)	1.00 (0.1)			0.34 (3.7)			0.27 (24.0)
24-Aug	0.77 (24.0)	0.37 (3.6)			0.23 (3.3)		0.38 (0.7)	0.77 (24.0)
25-Aug	0.78 (24.0)				0.92 (1.0)			0.78 (24.0)
26-Aug	0.93 (24.0)							0.88 (24.0)
27-Aug	0.56 (24.0)						0.71 (1.2)	0.56 (21.2)
28-Aug	0.50 (24.0)	0.15 (5.1)			0.20 (7.7)		0.10 (2.5)	0.33 (24.0)
29-Aug	0.13 (24.0)	0.25 (6.7)			0.11 (15.5)		0.12 (2.1)	0.21 (24.0)
30-Aug	0.43 (24.0)	0.34 (11.4)	0.34 (6.7)	0.00 (2.0)	0.45 (18.2)	0.00 (2.0)	0.29 (10.1)	0.47 (24.0)
31-Aug	0.74 (24.0)		1.00 (0.4)		0.96 (15.8)			0.76 (24.0)

Table 12. Proportion of hours each unit operated below the mid-range in 2008. Numbers in parentheses represent the number of hours that unit operated that day. Coloring is based on the proportion of hours operated below the mid-range as follows: Green = 0.0, Yellow = 0.5, and Red = 1.0. White cells represent days when a unit was not operated at all.

Date	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18
1-Aug		0.16 (15.6)			0.24 (24.0)		0.18 (4.8)	0.22 (24.0)
2-Aug		0.35 (2.6)			0.38 (24.0)		0.30 (0.8)	0.32 (24.0)
3-Aug		0.29 (1.2)	1.00 (0.1)	1.00 (0.2)	0.42 (24.0)	1.00 (0.1)	0.29 (1.2)	0.44 (24.0)
4-Aug					0.70 (18.9)	1.00 (0.8)	0.92 (1.1)	0.46 (24.0)
5-Aug					0.69 (24.0)	0.98 (7.8)	0.91 (11.2)	0.80 (24.0)
6-Aug					0.40 (24.0)	0.24 (10.0)	0.57 (19.1)	0.43 (24.0)
7-Aug		0.75 (5.1)	0.64 (3.3)	0.74 (4.5)	0.42 (24.0)	0.31 (13.0)	0.35 (20.1)	0.36 (24.0)
8-Aug		0.38 (15.1)			0.35 (24.0)		1.00 (3.1)	0.32 (24.0)
9-Aug					0.56 (24.0)			0.66 (24.0)
10-Aug					0.00 (24.0)			0.00 (24.0)
11-Aug		0.15 (23.3)	0.32 (11.0)	0.14 (23.2)	0.09 (0.9)			0.09 (0.9)
12-Aug		0.53 (24.0)	0.17 (9.0)	0.51 (24.0)				
13-Aug		0.20 (24.0)	0.13 (19.3)	0.21 (24.0)				
14-Aug		0.43 (19.8)		0.48 (17.3)	0.65 (7.2)			0.20 (5.1)
15-Aug		0.21 (8.0)	0.05 (5.1)	0.21 (7.5)	0.07 (24.0)		1.00 (0.2)	0.06 (24.0)
16-Aug		0.88 (2.1)		0.83 (1.0)	0.59 (24.0)			0.44 (24.0)
17-Aug					0.41 (24.0)			0.49 (24.0)
18-Aug		0.30 (19.7)	0.57 (1.8)	0.23 (10.7)	0.23 (23.6)	0.21 (1.2)	0.52 (7.7)	0.23 (23.7)
19-Aug		0.10 (7.8)			0.57 (24.0)		0.06 (7.1)	0.22 (24.0)
20-Aug		0.95 (11.1)			0.58 (20.7)		1.00 (5.4)	0.35 (24.0)
21-Aug		0.25 (6.0)			0.94 (18.1)			0.74 (24.0)
22-Aug		0.05 (6.75)	0.09 (1.9)	0.03 (5.8)	0.67 (24.0)		0.04 (5.8)	0.73 (24.0)
23-Aug		0.57 (4.5)			0.89 (24.0)		0.69 (3.5)	0.85 (24.0)
24-Aug		0.47 (19.1)		0.05 (6.6)	0.58 (24.0)		0.58 (15.6)	0.40 (24.0)
25-Aug		0.11 (9.3)			0.11 (10.2)		0.23 (1.1)	0.13 (11.0)
26-Aug		0.43 (1.2)			0.13 (24.0)			0.13 (24.0)
27-Aug					0.39 (24.0)		1.00 (0.2)	0.15 (24.0)
28-Aug		0.30 (0.8)			0.47 (24.0)		1.00 (0.1)	0.50 (24.0)
29-Aug		0.72 (8.8)			0.53 (24.0)		0.24 (1.8)	0.53 (24.0)
30-Aug		0.35 (2.6)			0.20 (24.0)		0.67 (1.0)	0.53 (24.0)
31-Aug		1.00 (0.1)			0.60 (24.0)		1.00 (0.1)	0.28 (24.0)

Table 13. Proportion of hours each unit operated below the mid-range in 2009. Numbers in parentheses represent the number of hours that unit operated that day. Coloring is based on the proportion of hours operated below the mid-range as follows: Green = 0.0, Yellow = 0.5, and Red = 1.0. White cells represent days when a unit was not operated at all.

Date	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18
1-Aug		0.28 (24.0)	0.38 (15.1)	0.40 (15.9)	0.50 (24.0)		0.23 (16.7)	0.48 (24.0)
2-Aug		0.46 (24.0)		0.50 (0.2)	0.70 (24.0)		0.33 (14.4)	0.72 (24.0)
3-Aug		0.81 (24.0)			1.00 (0.2)			0.68 (24.0)
4-Aug		0.68 (24.0)			1.00 (13.4)			0.73 (24.0)
5-Aug		0.26 (24.0)		0.17 (7.0)	0.27 (10.0)		0.29 (10.2)	0.32 (24.0)
6-Aug		0.76 (24.0)						0.69 (24.0)
7-Aug		0.77 (24.0)						0.80 (24.0)
8-Aug		1.00 (24.0)						0.98 (24.0)
9-Aug		0.97 (24.0)						0.94 (24.0)
10-Aug		0.17 (1.0)			0.83 (23.2)			0.66 (24.0)
11-Aug		0.59 (6.7)			0.97 (17.5)			0.61 (24.0)
12-Aug		0.61 (24.0)	1.00 (0.2)					0.59 (24.0)
13-Aug		0.91 (24.0)						0.93 (24.0)
14-Aug		0.74 (24.0)						0.78 (24.0)
15-Aug		0.88 (24.0)						0.88 (24.0)
16-Aug		0.61 (24.0)						0.73 (24.0)
17-Aug		0.81 (24.0)						0.67 (24.0)
18-Aug		0.56 (24.0)						0.62 (24.0)
19-Aug		0.70 (24.0)		1.00 (5.5)			1.00 (5.4)	0.63 (24.0)
20-Aug		0.87 (24.0)		1.00 (12.6)	0.66 (6.8)		0.90 (19.1)	0.87 (24.0)
21-Aug		0.89 (24.0)			0.60 (2.1)		1.00 (0.2)	0.58 (24.0)
22-Aug		1.00 (24.0)						0.99 (24.0)
23-Aug		0.80 (24.0)						0.72 (24.0)
24-Aug		0.63 (24.0)			0.76 (22.9)			0.07 (1.25)
25-Aug		0.62 (24.0)			0.23 (16.5)			0.76 (7.8)
26-Aug		0.41 (24.0)						0.78 (24.0)
27-Aug		0.73 (24.0)						0.72 (24.0)
28-Aug		0.65 (24.0)						0.61 (24.0)
29-Aug		0.80 (24.0)						0.76 (24.0)
30-Aug		0.91 (24.0)						0.92 (24.0)
31-Aug		0.60 (24.0)		1.00 (0.1)	0.50 (0.2)		1.00 (0.1)	0.83 (24.0)

Table 14. Proportion of hours each unit operated below the mid-range in 2010. Numbers in parentheses represent the number of hours that unit operated that day. Coloring is based on the proportion of hours operated below the mid-range as follows: Green = 0.0, Yellow = 0.5, and Red = 1.0. White cells represent days when a unit was not operated at all.

Date	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18
1-Aug		0.37 (24.0)			0.87 (1.25)		1.00 (0.8)	0.60 (24.0)
2-Aug		0.83 (24.0)						0.84 (24.0)
3-Aug		0.83 (23.5)			1.00 (4.7)			0.8 (24.0)
4-Aug		0.66 (24.0)		0.92 (13.1)	0.82 (19.1)	0.92 (12.8)	0.81 (18.9)	0.69 (24.0)
5-Aug		0.70 (24.0)		0.87 (18.8)	0.74 (24.0)	0.21 (3.3)	0.79 (23.1)	0.61 (24.0)
6-Aug		0.97 (24.0)			0.80 (10.9)			0.85 (24.0)
7-Aug		0.90 (24.0)			1.00 (5.1)			0.89 (24.0)
8-Aug		0.78 (24.0)			1.00 (8.7)			0.78 (24.0)
9-Aug		0.95 (24.0)			1.00 (7.0)			0.98 (24.0)
10-Aug		0.82 (24.0)			1.00 (5.0)			0.82 (24.0)
11-Aug		0.67 (24.0)			1.00 (8.9)	1.00 (2.1)	1.00 (7.9)	0.67 (24.0)
12-Aug		0.67 (24.0)			0.96 (2.2)		1.00 (1.0)	0.64 (24.0)
13-Aug		0.69 (24.0)						0.69 (24.0)
14-Aug		0.67 (24.0)			0.93 (2.3)		1.00 (1.8)	0.62 (24.0)
15-Aug		0.49 (24.0)			0.96 (2.1)		0.95 (1.8)	0.53 (24.0)
16-Aug		0.59 (24.0)			1.00 (1.1)		0.71 (1.2)	0.49 (24.0)
17-Aug		0.55 (24.0)			0.08 (3.1)	1.00 (0.3)		0.60 (24.0)
18-Aug		0.66 (24.0)		0.85 (3.3)	0.79 (5.2)	1.00 (2.0)		0.74 (24.0)
19-Aug		0.58 (24.0)		0.78 (10.1)	0.57 (14.2)		1.00 (0.1)	0.55 (24.0)
20-Aug		0.57 (24.0)						0.64 (24.0)
21-Aug		0.19 (24.0)						0.56 (24.0)
22-Aug		0.55 (24.0)						0.17 (24.0)
23-Aug	0.00 (0.2)	0.11 (24.0)	0.00 (0.2)		0.00 (0.2)	0.00 (0.2)	0.00 (0.2)	0.11 (24.0)
24-Aug		0.13 (24.0)	1.00 (0.3)				0.40 (23.2)	0.09 (0.9)
25-Aug		0.20 (24.0)					0.45 (20.3)	0.20 (3.8)
26-Aug		0.63 (24.0)						0.44 (24.0)
27-Aug		0.64 (24.0)						0.63 (24.0)
28-Aug		0.64 (24.0)						0.59 (24.0)
29-Aug		0.66 (24.0)						0.58 (24.0)
30-Aug		0.57 (24.0)			0.52 (13.1)			0.55 (11.0)
31-Aug		0.61 (24.0)	1.00 (0.3)		0.61 (24.0)		1.00 (0.1)	

Table 15. Proportion of hours each unit operated below the mid-range in 2011. Numbers in parentheses represent the number of hours that unit operated that day. Coloring is based on the proportion of hours operated below the mid-range as follows: Green = 0.0, Yellow = 0.5, and Red = 1.0. White cells represent days when a unit was not operated at all.

Date	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18
1-Aug		0.00 (24.0)	0.00 (24.0)	0.02 (24.0)		0.00 (24.0)	0.00 (24.0)	0.00 (24.0)
2-Aug		0.19 (24.0)	0.20 (24.0)	0.17 (24.0)		0.20 (24.0)	0.15 (22.2)	0.10 (24.0)
3-Aug		0.54 (24.0)	1.00 (0.5)	0.54 (24.0)		0.47 (24.0)	0.63 (24.0)	0.57 (24.0)
4-Aug		0.83 (24.0)	0.97 (12.8)	0.85 (24.0)		0.75 (24.0)	0.83 (24.0)	0.83 (24.0)
5-Aug		0.35 (24.0)	0.36 (23.6)	0.31 (21.8)		0.32 (21.8)	0.31 (24.0)	0.36 (24.0)
6-Aug		0.39 (24.0)	0.17 (19.1)	0.02 (17.2)		0.01 (15.5)	0.14 (20.2)	0.22 (24.0)
7-Aug		0.67 (24.0)	0.66 (22.1)	0.68 (19.1)		0.65 (19.1)	0.68 (24.0)	0.59 (21.3)
8-Aug		0.21 (24.0)	0.03 (24.0)	0.28 (24.0)		0.01 (24.0)	0.04 (24.0)	0.06 (24.0)
9-Aug		0.31 (24.0)	0.29 (21.9)	0.49 (21.9)		0.30 (21.8)	0.32 (10.2)	0.36 (24.0)
10-Aug		0.06 (21.8)	0.09 (10.3)	0.08 (10.1)		0.04 (9.5)		0.05 (21.7)
11-Aug		0.52 (15.8)	0.05 (7.2)					0.88 (2.7)
12-Aug		0.06 (21.9)	0.19 (16.8)					
13-Aug		0.96 (4.0)	0.22 (5.0)	0.09 (1.8)				
14-Aug								
15-Aug		0.98 (9.5)						
16-Aug		0.11 (15.6)	0.17 (12.3)	0.21 (2.4)				
17-Aug		0.53 (15.6)	0.62 (10.3)	1.00 (0.7)		1.00 (0.2)		0.29 (1.2)
18-Aug		0.75 (12.2)	0.56 (11.9)	0.62 (9.75)		0.50 (9.4)		0.83 (9.5)
19-Aug		0.14 (24.0)	0.08 (24.0)	0.14 (24.0)		0.09 (21.2)		0.15 (24.0)
20-Aug		0.32 (24.0)	0.35 (24.0)	0.37 (20.8)		0.21 (15.8)		0.38 (24.0)
21-Aug		0.61 (24.0)	0.68 (20.8)	0.93 (15.6)		0.91 (15.6)		0.58 (24.0)
22-Aug		0.44 (24.0)	0.69 (15.8)	0.69 (15.8)		0.66 (15.7)		0.42 (24.0)
23-Aug		0.29 (24.0)	0.28 (19.1)	0.33 (17.3)	0.70 (4.7)	0.39 (15.7)		0.34 (24.0)
24-Aug		0.06 (24.0)	0.13 (19.3)	0.24 (19.1)	0.14 (18.3)	0.14 (15.9)		0.08 (24.0)
25-Aug		0.39 (24.0)	0.39 (24.0)	0.39 (24.0)	0.38 (24.0)	0.31 (15.8)		0.39 (24.0)
26-Aug		0.76 (24.0)	0.74 (24.0)	0.65 (15.9)	0.65 (15.8)	0.65 (15.8)		0.75 (24.0)
27-Aug		0.36 (24.0)	0.47 (24.0)	0.79 (19.0)	0.55 (19.0)	0.47 (7.8)		0.51 (24.0)
28-Aug		0.76 (24.0)	0.90 (20.7)	0.90 (20.7)	0.90 (20.3)	0.93 (15.8)		0.77 (24.0)
29-Aug		0.36 (24.0)	0.71 (15.7)	0.67 (15.6)	0.95 (5.4)	0.98 (4.5)		0.46 (24.0)
30-Aug		0.28 (24.0)	0.47 (15.8)	0.77 (15.8)	0.59 (9.4)	0.84 (6.4)		0.50 (24.0)
31-Aug	0.00 (0.2)	0.63 (24.0)	0.94 (14.6)	0.94 (16.1)	0.95 (15.8)	0.95 (10.8)	0.00 (0.2)	0.63 (24.0)

Table 16. Proportion of hours each unit operated below the mid-range in 2012. Numbers in parentheses represent the number of hours that unit operated that day. Coloring is based on the proportion of hours operated below the mid-range as follows: Green = 0.0, Yellow = 0.5, and Red = 1.0. White cells represent days when a unit was not operated at all.

Date	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18
1-Aug		0.11 (20.4)	0.03 (20.3)		0.02 (20.3)	0.03 (20.4)	0.18 (4.2)	0.12 (20.5)
2-Aug		0.69 (24.0)	0.54 (24.0)		0.48 (24.0)	0.57 (24.0)		0.72 (24.0)
3-Aug		0.68 (24.0)	0.43 (24.0)		0.44 (24.0)	0.43 (24.0)		0.69 (24.0)
4-Aug		0.68 (24.0)	0.57 (24.0)		0.56 (24.0)	0.57 (24.0)		0.68 (24.0)
5-Aug		1.00 (21.9)	0.41 (21.9)		0.42 (24.0)	0.44 (24.0)		1.00 (24.0)
6-Aug					0.44 (24.0)	0.45 (24.0)		0.69 (24.0)
7-Aug					0.21 (24.0)	0.21 (24.0)		0.30 (24.0)
8-Aug					0.28 (24.0)	0.28 (24.0)		0.90 (24.0)
9-Aug					0.29 (24.0)	0.32 (24.0)		1.00 (24.0)
10-Aug					0.57 (24.0)	0.56 (24.0)		0.91 (24.0)
11-Aug					0.36 (24.0)	0.32 (24.0)		0.48 (24.0)
12-Aug					0.32 (24.0)	0.31 (24.0)		0.30 (24.0)
13-Aug					0.26 (20.25)	0.21 (24.0)		0.22 (24.0)
14-Aug					0.82 (24.0)	0.85 (24.0)		1.00 (24.0)
15-Aug					0.63 (24.0)	0.60 (24.0)		1.00 (24.0)
16-Aug		0.72 (11.0)	0.66 (11.4)		0.79 (17.3)	0.62 (20.6)		0.79 (24.0)
17-Aug		0.63 (24.0)	0.35 (24.0)		0.15 (19.0)	0.16 (14.9)		0.95 (24.0)
18-Aug		0.78 (24.0)	0.69 (24.0)		0.75 (24.0)	0.75 (20.6)		1.00 (24.0)
19-Aug		0.90 (24.0)	0.51 (24.0)		0.64 (20.8)	0.55 (17.0)		0.96 (24.0)
20-Aug	0.00 (0.1)	0.43 (24.0)	0.43 (24.0)	0.00 (0.1)	0.41 (24.0)	0.25 (18.9)	0.00 (0.1)	0.63 (24.0)
21-Aug		0.78 (24.0)	0.78 (24.0)		0.82 (24.0)	0.90 (20.2)		0.94 (24.0)
22-Aug	0.00 (0.2)	0.60 (24.0)	0.18 (24.0)	0.00 (0.2)	0.12 (19.0)	0.13 (19.0)	0.00 (0.2)	0.71 (24.0)
23-Aug		0.98 (24.0)	0.77 (24.0)		0.78 (17.4)	0.73 (15.75)		0.99 (24.0)
24-Aug		0.99 (24.0)	0.57 (24.0)		0.50 (19.2)	0.67 (18.2)		0.99 (24.0)
25-Aug		0.96 (24.0)	0.55 (24.0)		0.48 (24.0)	0.75 (19.1)		0.97 (24.0)
26-Aug		0.64 (24.0)	0.40 (20.8)		0.59 (15.9)	0.54 (13.0)		0.65 (24.0)
27-Aug		0.00 (24.0)	0.33 (24.0)					0.50 (0.2)
28-Aug	0.31 (10.1)	0.60 (24.0)	0.58 (23.2)					
29-Aug	0.81 (6.7)	0.73 (24.0)	0.56 (24.0)					
30-Aug	0.73 (24.0)	0.72 (24.0)	0.76 (24.0)					
31-Aug	1.00 (24.0)	0.83 (24.0)	0.75 (24.0)					

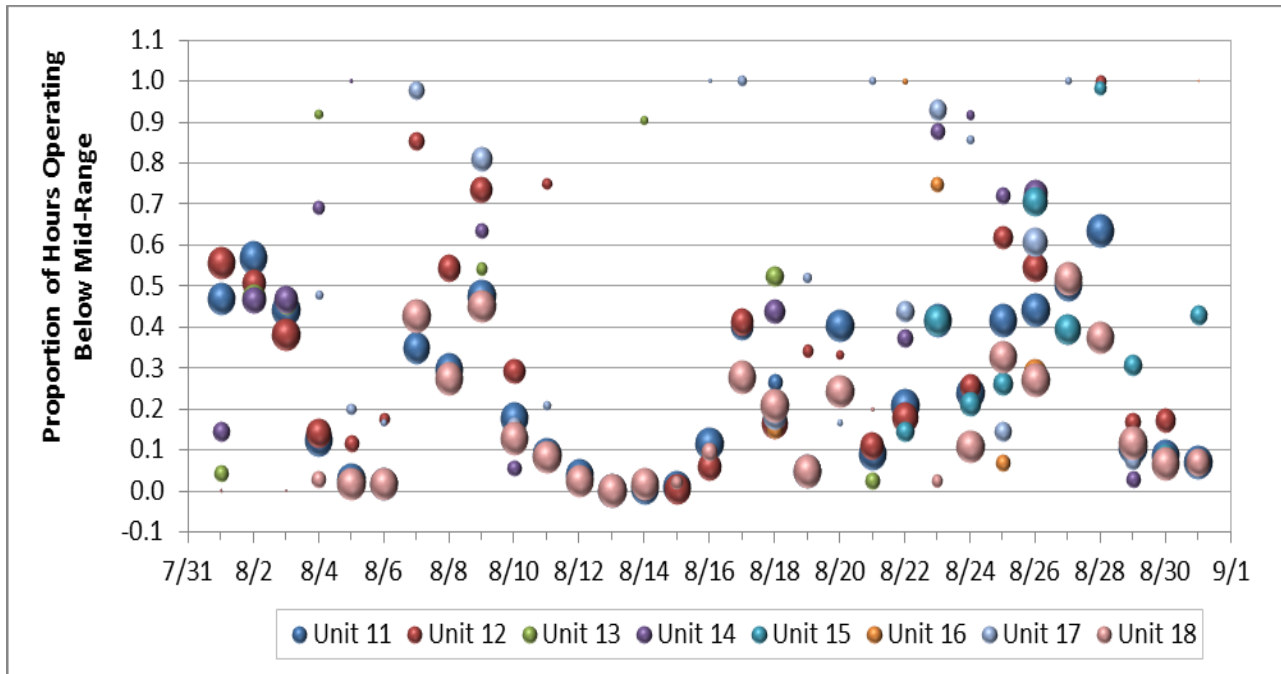


Figure 9. Proportion of hours each unit operated below the mid-range in 2006. Size of each symbol is proportional to the total number of hours that the unit operated each day. See Figure 16 for a depiction of the scale for these symbols.

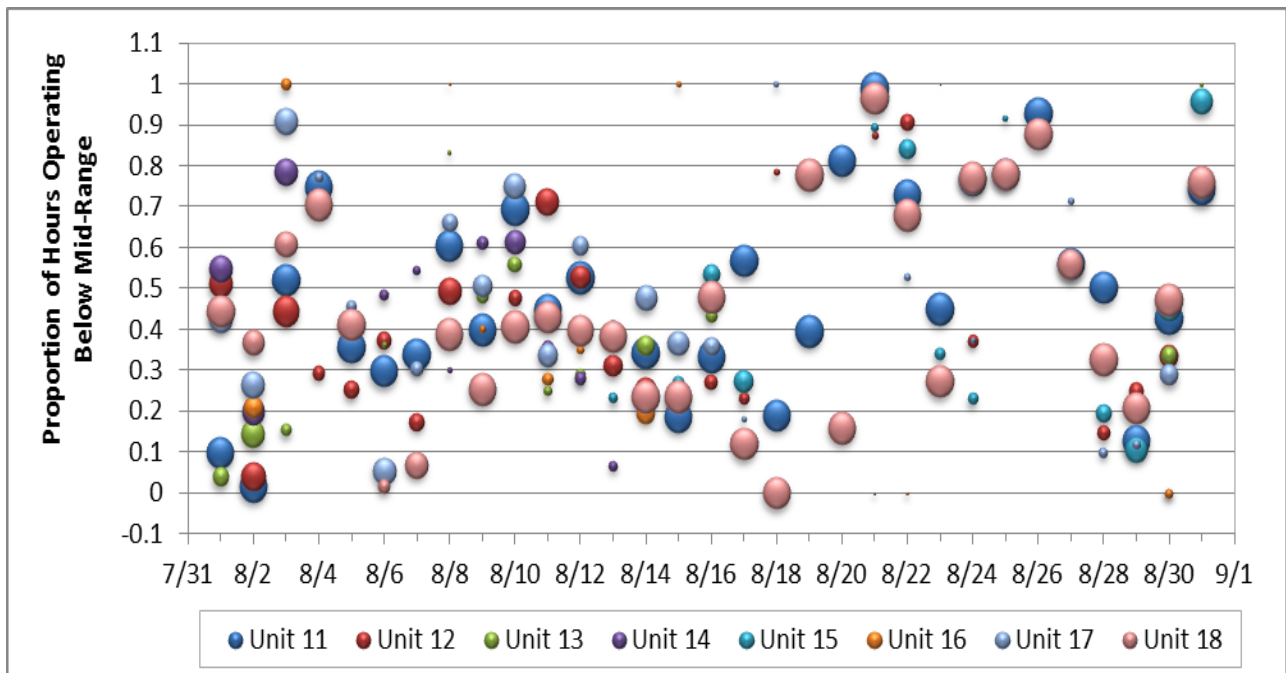


Figure 10. Proportion of hours each unit operated below the mid-range in 2007. Size of each symbol is proportional to the total number of hours that the unit operated each day. See Figure 16 for a depiction of the scale for these symbols.

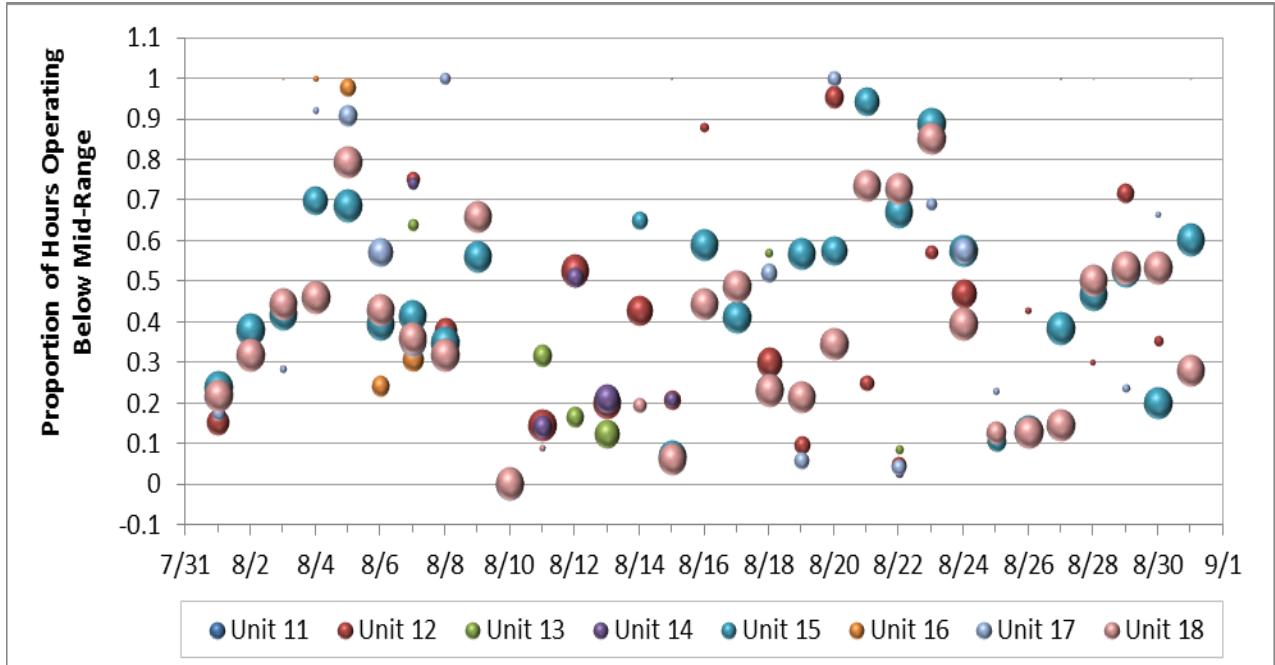


Figure 11. Proportion of hours each unit operated below the mid-range in 2008. Size of each symbol is proportional to the total number of hours that the unit operated each day. See Figure 16 for a depiction of the scale for these symbols.

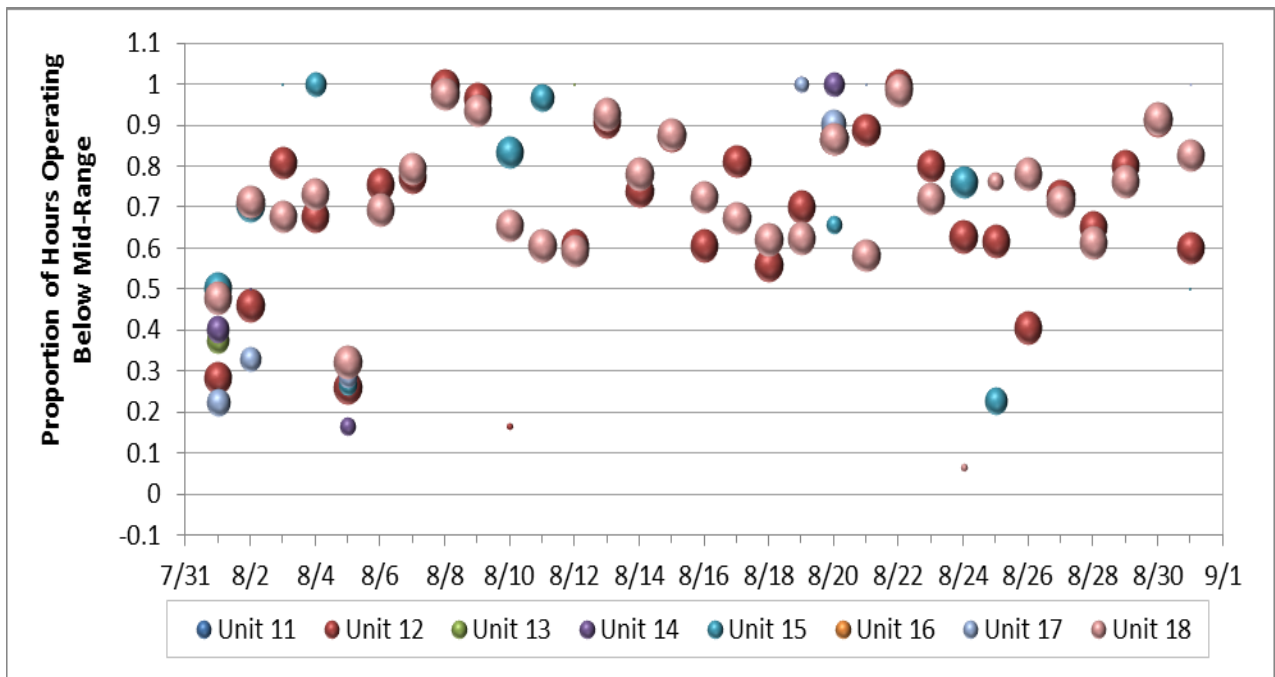


Figure 12. Proportion of hours each unit operated below the mid-range in 2009. Size of each symbol is proportional to the total number of hours that the unit operated each day. See Figure 16 for a depiction of the scale for these symbols.

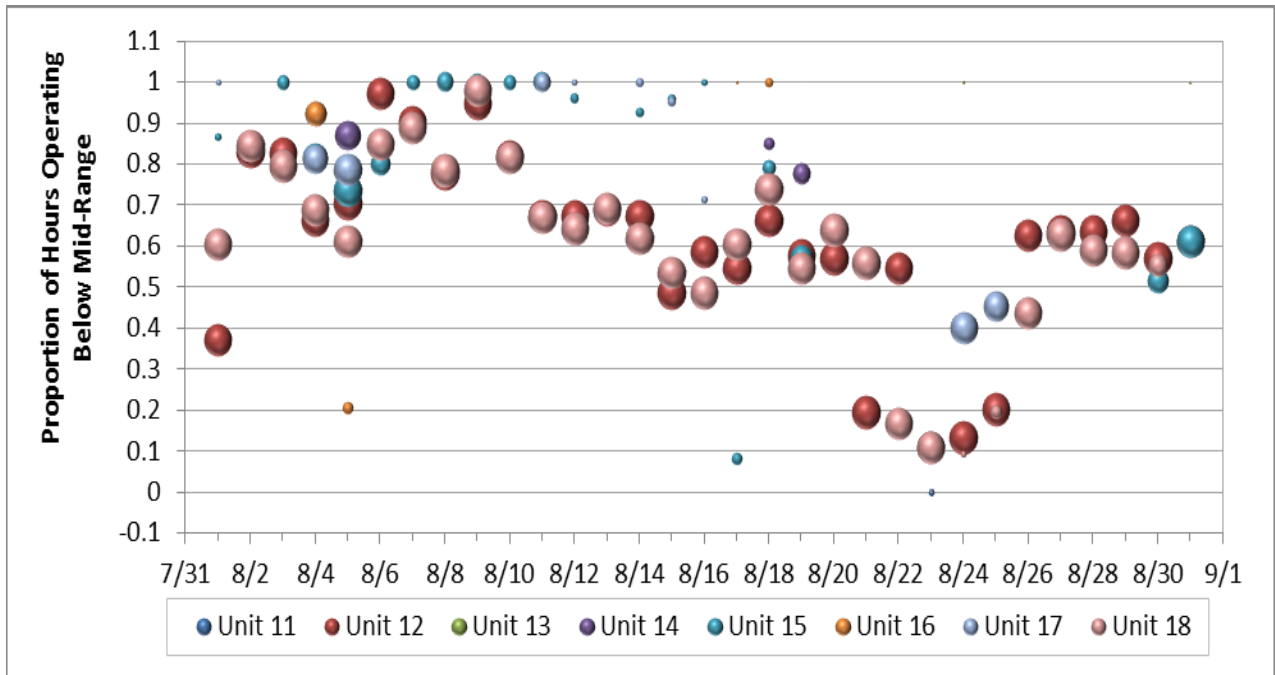


Figure 13. Proportion of hours each unit operated below the mid-range in 2010. Size of each symbol is proportional to the total number of hours that the unit operated each day. See Figure 16 for a depiction of the scale for these symbols.

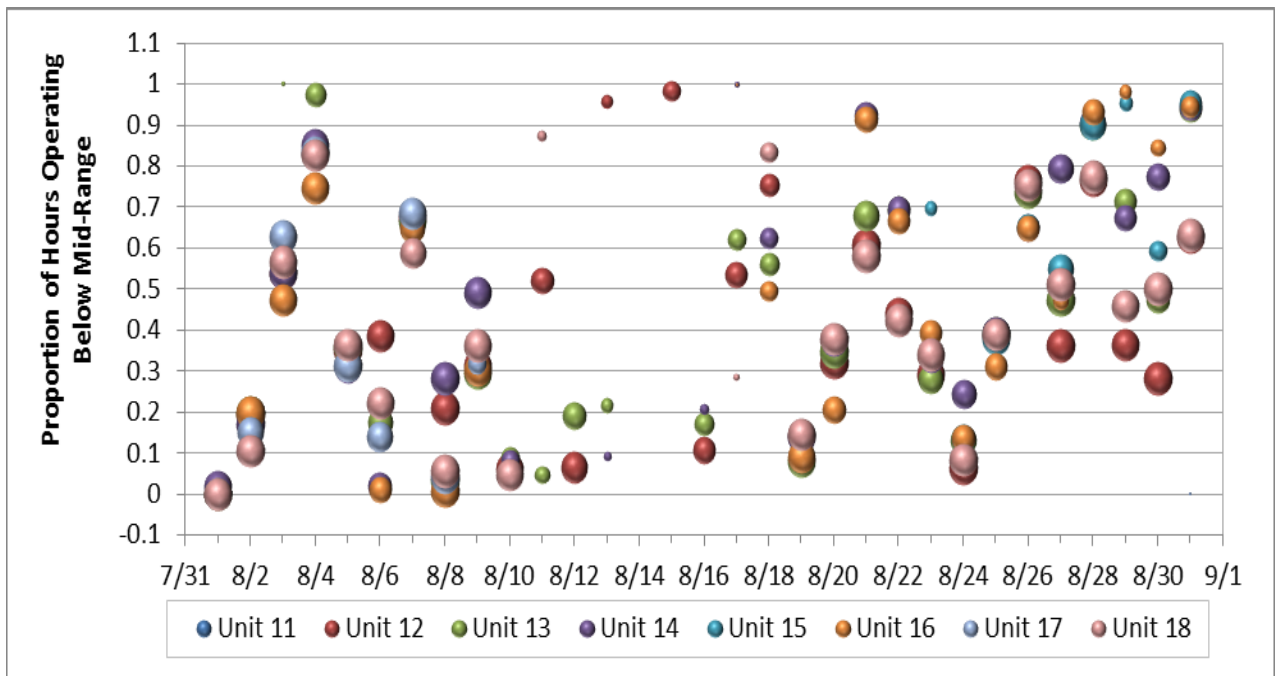


Figure 14. Proportion of hours each unit operated below the mid-range in 2011. Size of each symbol is proportional to the total number of hours that the unit operated each day. See Figure 16 for a depiction of the scale for these symbols.

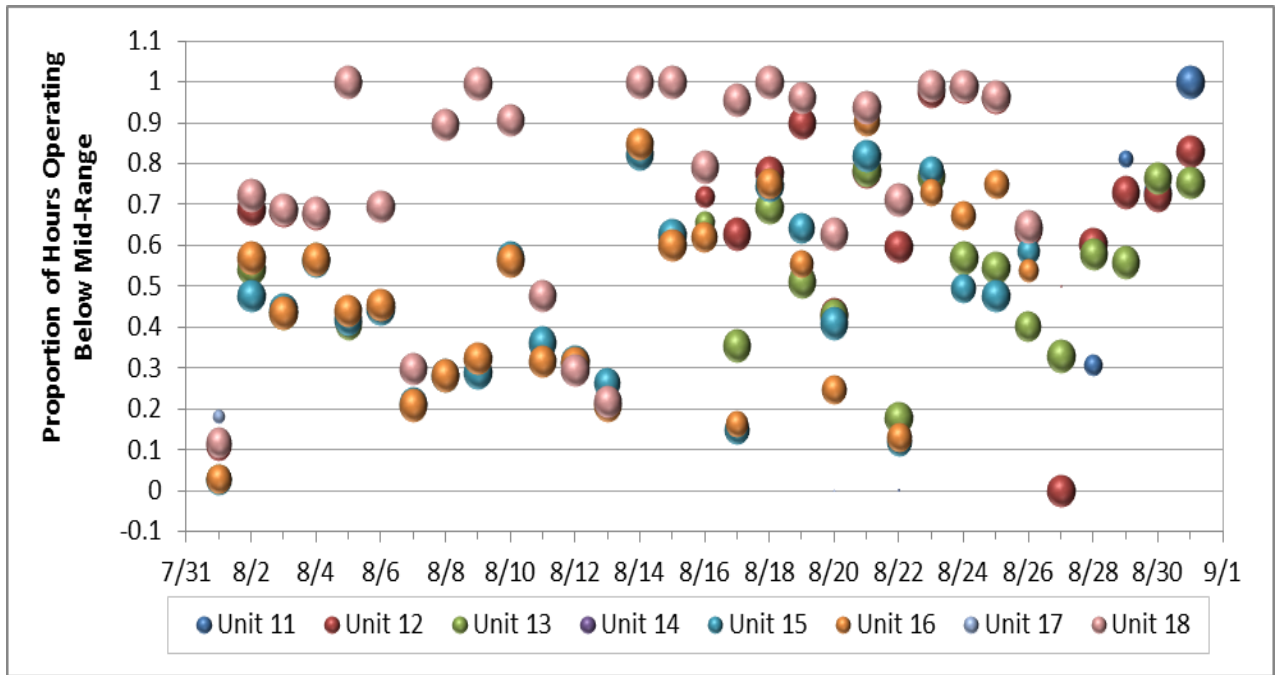


Figure 15. Proportion of hours each unit operated below the mid-range in 2012. Size of each symbol is proportional to the total number of hours that the unit operated each day. See Figure 16 for a depiction of the scale for these symbols.

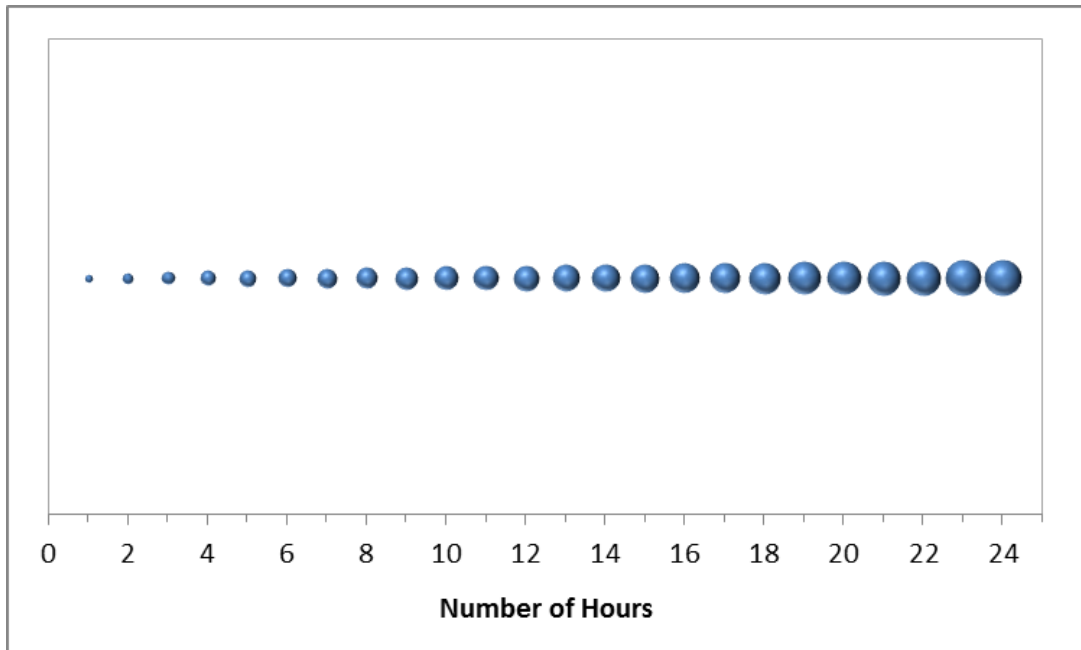


Figure 16. Sample figure to assess scale of points in Figures 2–15. Scale of these symbols corresponds to the values on the x-axis and is the same as in Figures 2–15.