Gabriola Streamkeepers

Observations of Mallett and Winthuysen Creeks, Gabriola Island, BC, Canada, 2015/16

Nick Doe.

Background

Mallett Creek on Gabriola is the first creek on the island to be positively identified as hosting spawning salmon; yet, there is almost no information on the flow rate of the creek beyond that it is very low in summer, and there is currently no program in place to measure flow rates throughout the year. The following is a preliminary report on flow rates.

At the time of writing (August 2015), there is a weak El Niño (ENSO) in effect and the Pacific Decadal Oscillation (PDO) is entering a warm phase, both of which indicate that precipitation may be lower than normal, and temperatures warmer than normal, in this and the next few years. These trends are apart from potential changes due to global warming. The ability of the creek to continue to support salmon is therefore going to be severely tested.

Sources

There is anecdotal evidence that Mallett Creek is partially sourced from minor groundwater seepages that flow into Peacocks Lake year round. Part of the study will therefore involve electrical conductivity measurements and a measurement of the flow in Winthuysen Creek. Winthuysen Creek flows in a fault valley,[1] sub-parallel to Mallett Creek, and is entirely surface run-off.

Historical measurements

The only published flow rate measurement I have managed to locate was a record of a flow at the Taylor Bay Road culvert of:
Feb. 25, 1985: 14.00 L/s (litres per second) .

As part of a groundwater study, I measured the flow rates at the culverts (Taylor Bay Road and near the sea in Descanso Bay Regional Park) in 2005 as follows:

Nov.11, 2005: Mallett 0.13 L/s	Winthuysen: 0.08 L/s
Dec. 26, 2005: Mallett 18.00 L/s	Winthuysen: 7.41 L/s.

Historical estimates

The Gabriola, Valdes, Thetis, and Kuper Islands Provincial Water Allocation Plan, dated March 1994, included an estimate of the annual discharge from Mallett Creek based on its median elevation, watershed area, and streamflow records from six creeks on Vancouver Island. The estimate was 15 L/s. Based on discharge rates from Hoggan Lake, the monthly average discharge rates for Mallett Creek were further estimated to be:

Jan. 35 L/s; Feb. 31 L/s; Mar. 39 L/s; Apr. 06 L/s; May 02 L/s; Jun. 00 L/s;
Jul. 00 L/s; Aug. 00 L/s; Sep. 00 L/s; Oct. 00 L/s; Nov. 13 L/s; Dec. 52 L/s.

[1] Known locally as "Dan's Fault", it is one of two major faults on Gabriola and it runs across the island from Descanso Bay to LeBoeuf Bay.

These figures it must be stressed are not based on actual records of the flow in Mallett Creek and are therefore of limited value.

There are no published records for Winthuysen Creek.

Peacocks Lake

The open water area of Peacocks Lake is around 8260 m^2 (revised from 6139 m^2) perhaps around 425 m^2 less in an average summer. 1 mm of rain on this area alone would be sufficient to maintain a steady flow of 0.096 L/s for 24 hours, provided none sank into the ground or evaporated. The lake is about 570 m upstream of the culvert on Taylor Bay Road and is one of the GVFD's primary water sources, via the hydrant at the ferry lineup turn-around. The lake is also used for irrigating the lawns of the luxury properties in Sitka Cove.

September 18, 2015: Peacocks Lake water level is well below the outlet culvert intake (photo above). 1.27 m below the bottom of the one on the right. Those are 24-inch pipes.

The drainage/seepage? channels into the lake from Cox Park on the NE side of the lake are dry.

[The lake is on private land and not accessible for precise water-level measurements].

October 1, 2015: Just to be sure I checked that there is no inflow to the lake from River Place. There isn't. You can walk dry-footed and muddy-shoes-free across the creek bed next to the bridge. I also checked for evidence that the lake was a former beaver dam. There's a stump that looks like it was chewed by a beaver a long time ago, but it's on its own, so not very convincing. An auger sample of the soil below the meadow on the NE side might help resolve this.

October 24, 2015: Was assured by a resident that there has been no inflow from River Place this summer. Still dry. Also was assured that there are several old beaver stumps in the upper part of the lake. The only question now, is how old are the lake sediments.

November 13, 2015: Walked the property line on the south side of Cox Park to where there are channels flowing from the park into the NE upstream marsh (sedges) side of the lake. This is River Place Creek. Pools of water, but no perceptible flow in the channels. Specific conductivity was 67µS/cm (48µS/cm, 10.64ºC), indicating that this was just rain (no spring). Photograph of outlet pipes indicates water level at 0.93 m below the bottom of the one on the right. This is a rise of 340 mm in response to 176 mm of rain since September 18.

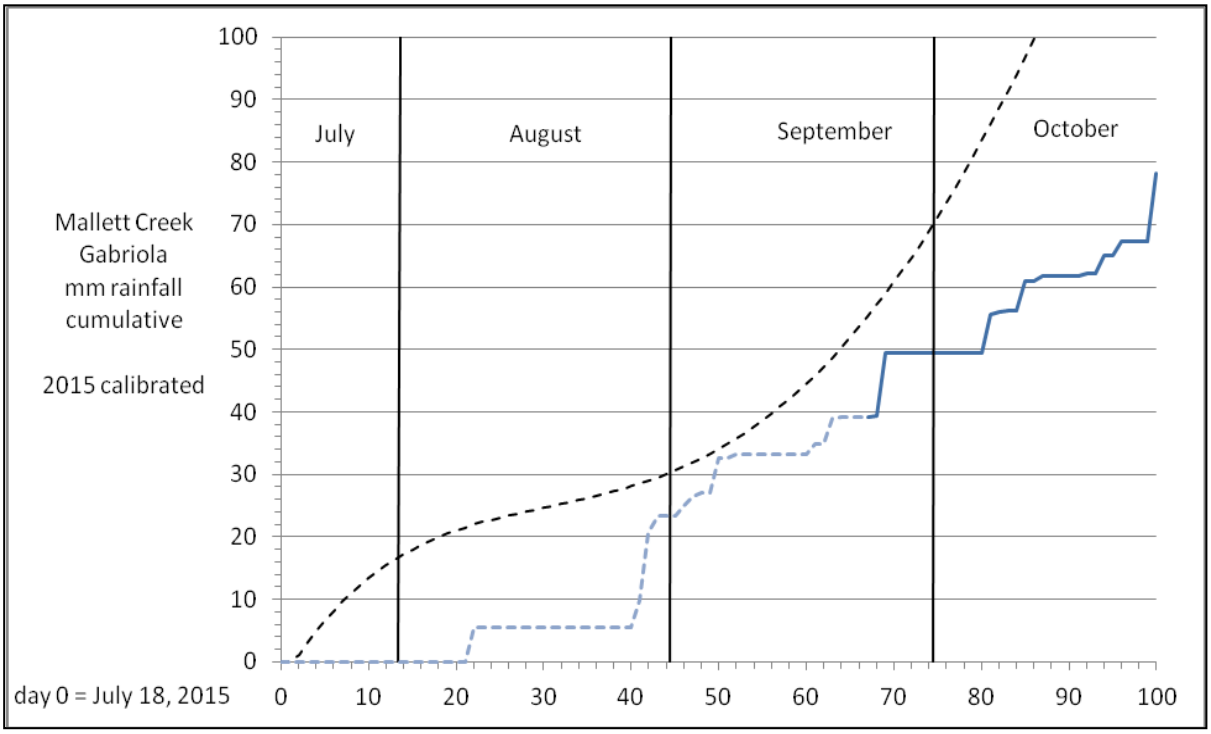
Continued to the NE corner post of the fenced property (sound of the creek clear) and then south 20m or so along the fence to the creek. Was flowing at a guesstimated 2½–3½ L/s enough to account for rise in lake level above rainfall rise in about 5 days. This is Mallett Creek.

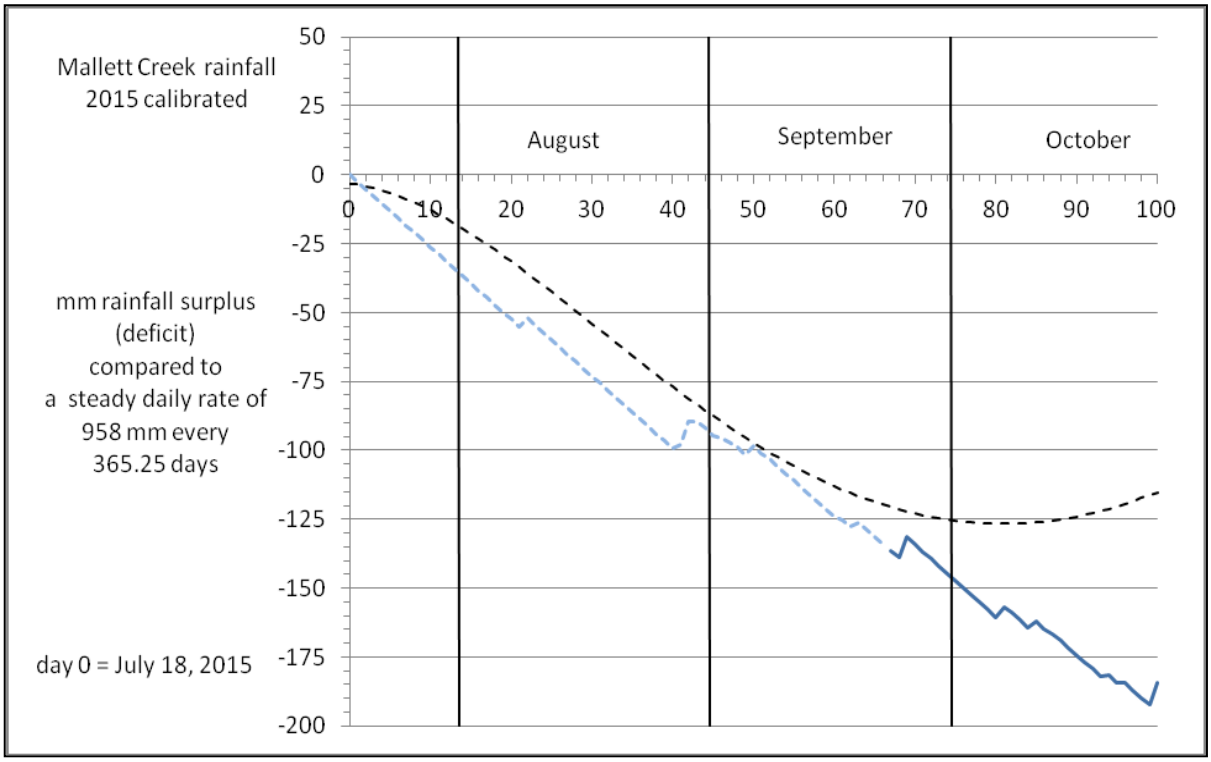
February 15, 2016: Checked that the pond-levellers (the two outlet culverts) were working. They were. Level of Peacocks Lake just above the bottoms of the inlets.

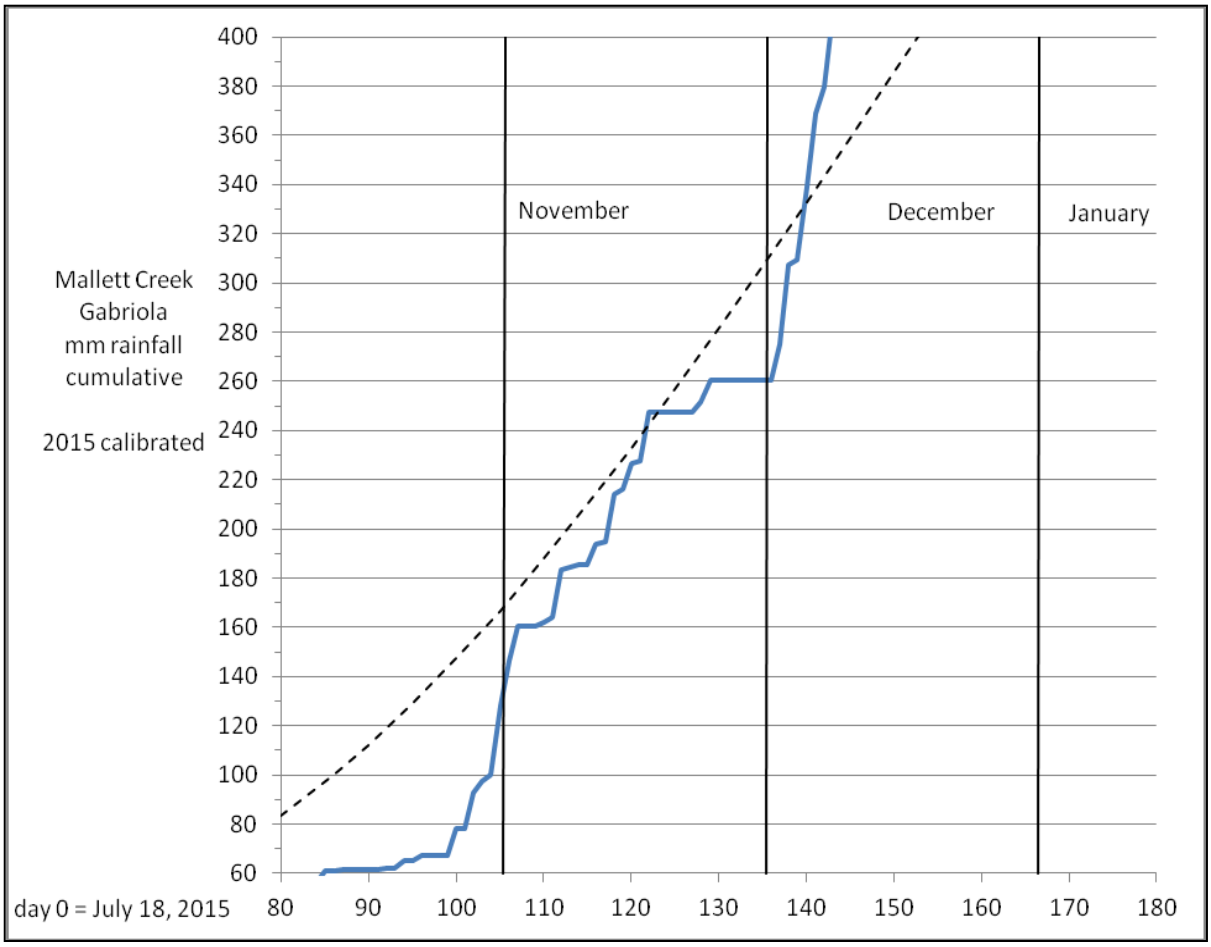
There is now a substantial flow (several litres/sec) from the park into the NE upstream marsh (sedges) side of the lake. This is an intermittent tributary of Mallett Creek that flows from the bridge at River Place. Along its course, it flows through wetland laced with ephemeral runoff rivulets and has a substantial branch about 60m long. The creek, River Place Creek, runs down a fair incline as it approaches the lake, so much so that I would be calling it a “babbling brook” if the tree roots were rock ledges, and the deadfalls, boulders. Because of this seasonal expansion of the watershed, the flow at River Place is significantly less than the total inflow to the lake. Mallett Creek proper, shown above, runs from the SE through a gulley to the nose of the lake.

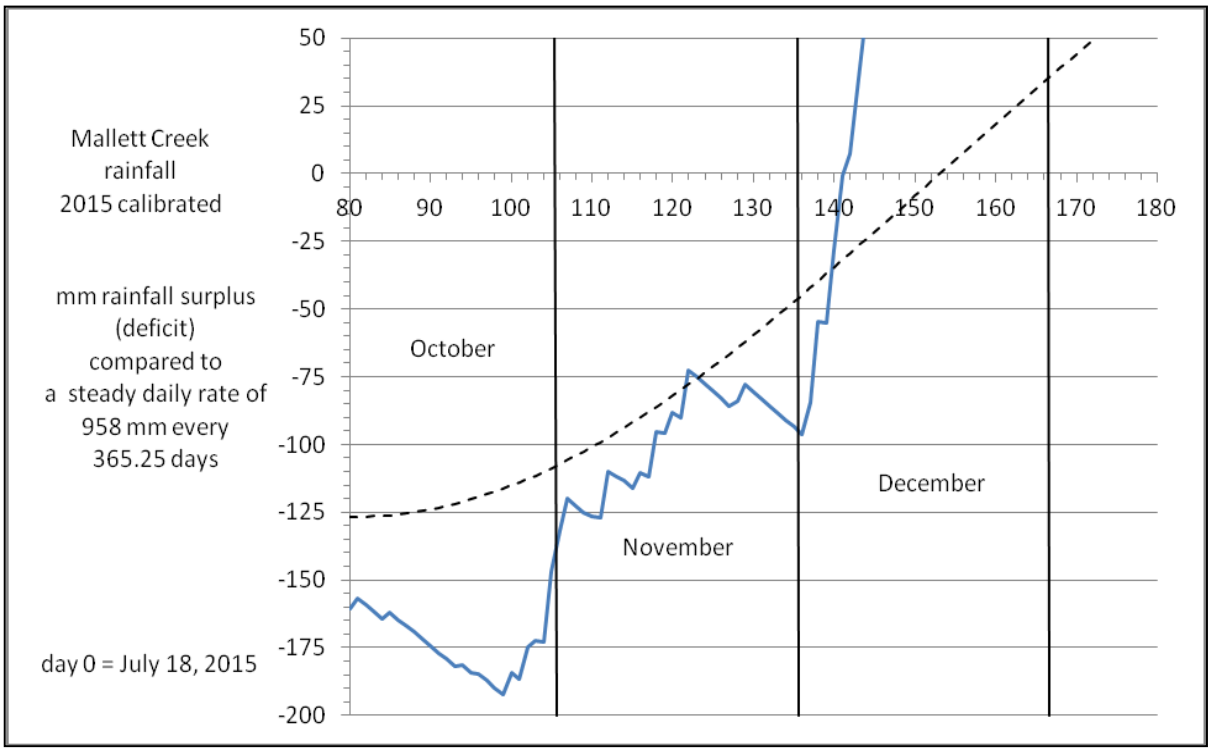
Observations

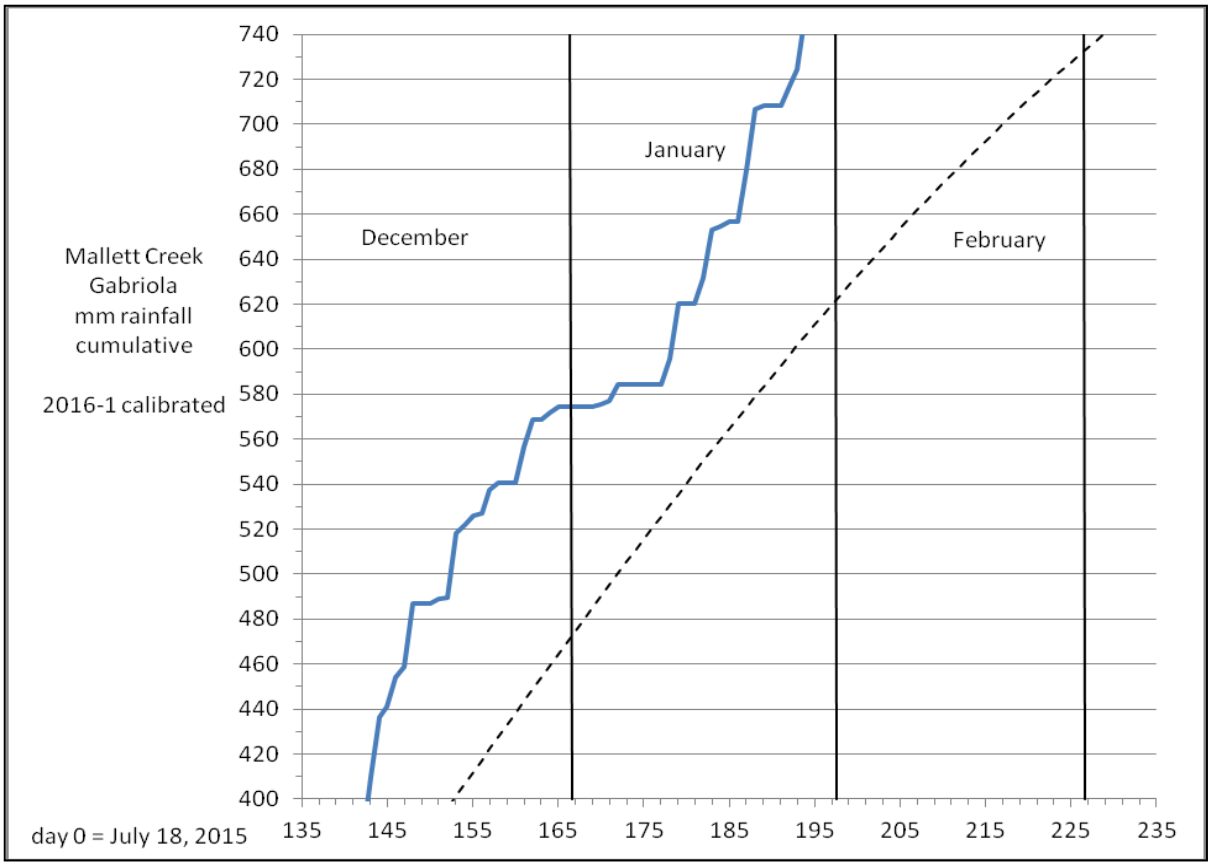
For the complications of measuring rainfall see the file:
http://www.nickdoe.ca/pdfs/Webp674.pdf .

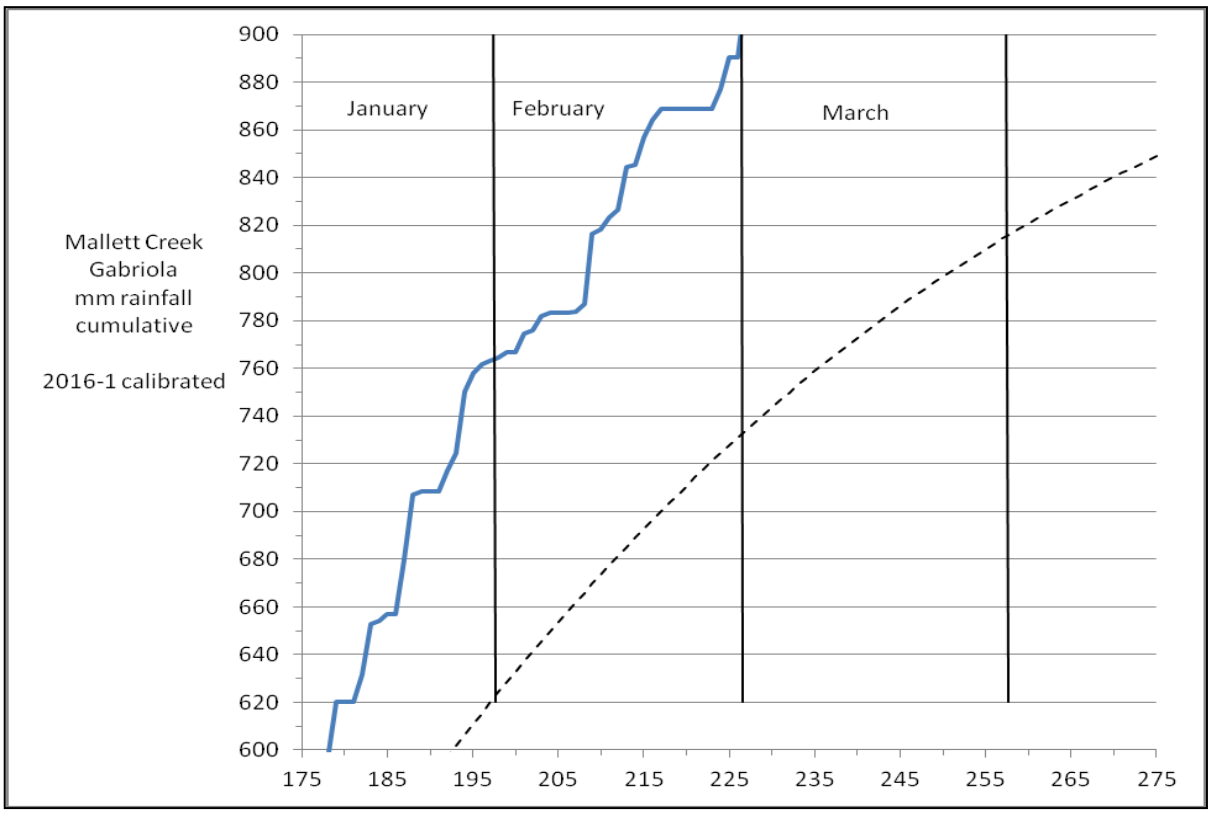


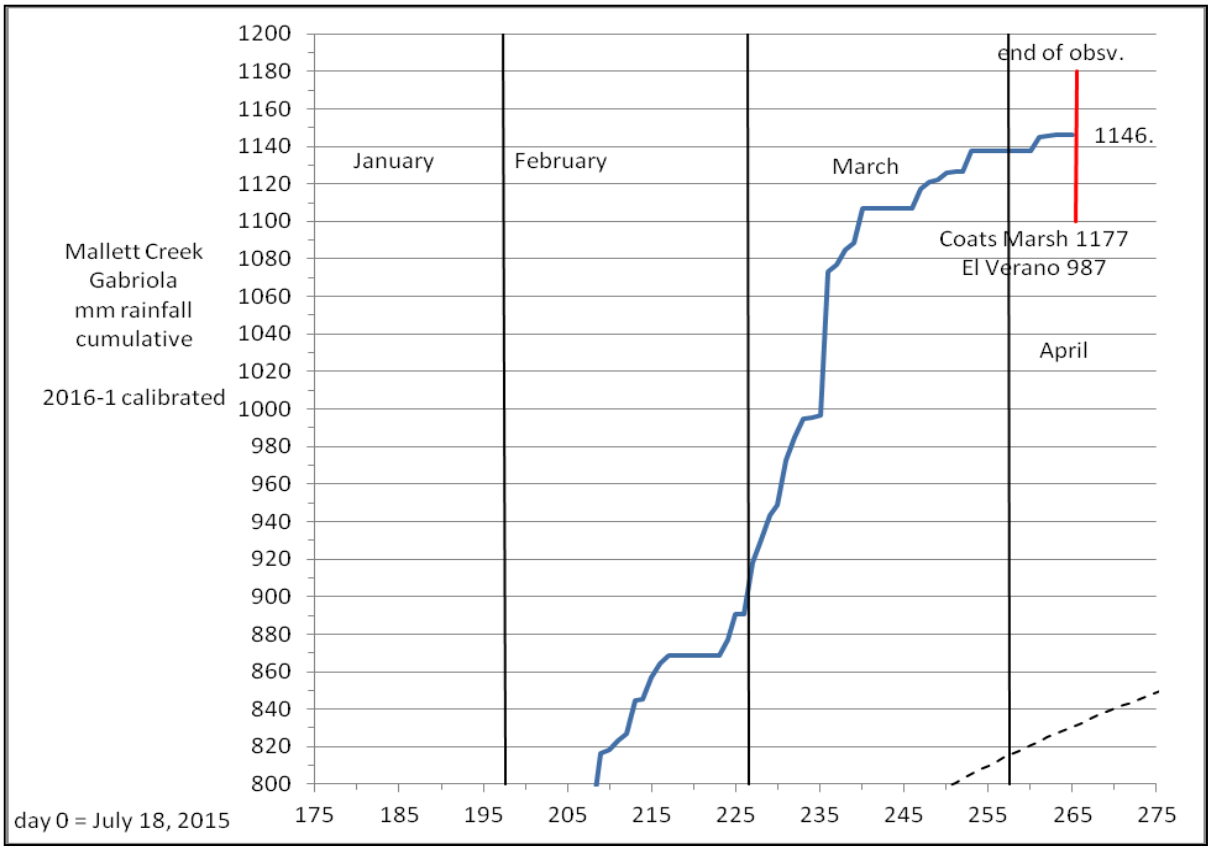


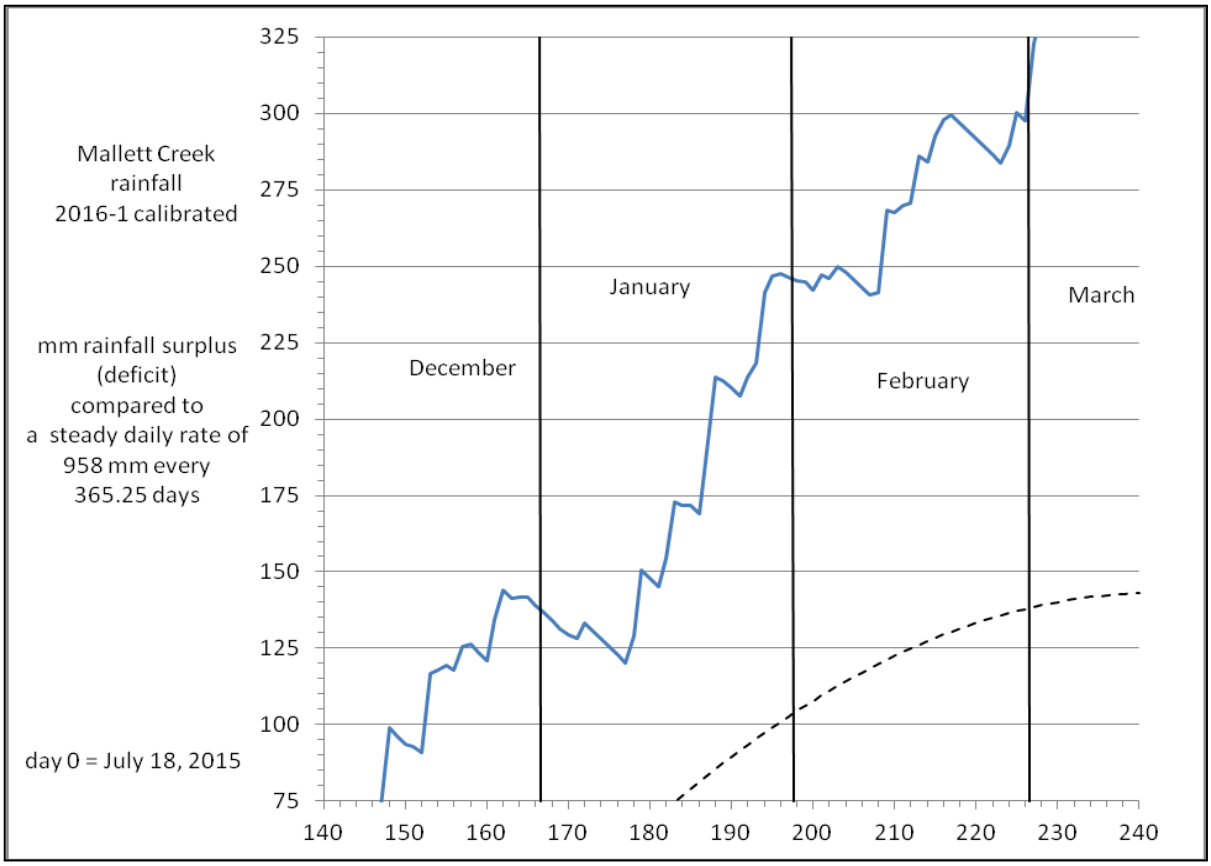

Mallett Creek
Gabriola
mm rainfall
cumulative
2015 calibrated
day 0 = July 18, 2015
November
December
January
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
80
90
100
110
120
130
140
150
160
170
180

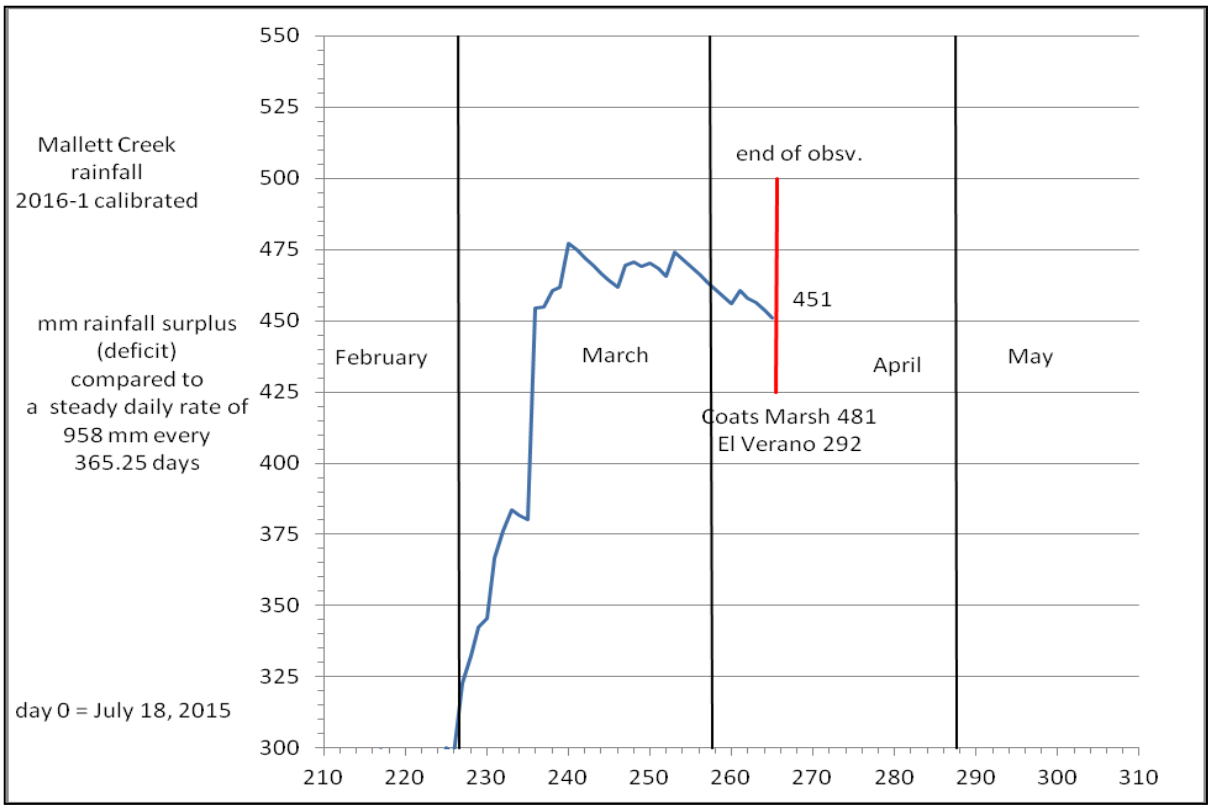

Mallett Creek
rainfall
2015 calibrated
mm rainfall surplus
(deficit)
compared to
a steady daily rate of
958 mm every
365.25 days
day 0 = July 18, 2015
October
November
December
50
25
0
-25
-50
-75
-100
-125
-150
-175
-200
80
90
100
110
120
130
140
150
160
170
180


Mallett Creek
Gabriola
mm rainfall
cumulative
2016-1 calibrated
day 0 = July 18, 2015
December
January
February
740
720
700
680
660
640
620
600
580
560
540
520
500
480
460
440
420
400
135
145
155
165
175
185
195
205
215
225
235


Mallett Creek
Gabriola
mm rainfall
cumulative
2016-1 calibrated
January
February
March
900
880
860
840
820
800
780
760
740
720
700
680
660
640
620
600
175
185
195
205
215
225
235
245
255
265
275


Mallett Creek
Gabriola
mm rainfall
cumulative
2016-1 calibrated
day 0 = July 18, 2015
1200
1180
1160
1140
1120
1100
1080
1060
1040
1020
1000
980
960
940
920
900
880
860
840
820
800
175
185
195
205
215
225
235
245
255
265
275
January
February
March
April
end of obsv.
1146.
Coats Marsh 1177
El Verano 987


Mallett Creek
rainfall
2016-1 calibrated
mm rainfall surplus
(deficit)
compared to
a steady daily rate of
958 mm every
365.25 days
day 0 = July 18, 2015
December
January
February
March
325
300
275
250
225
200
175
150
125
100
75
140
150
160
170
180
190
200
210
220
230
240


Mallett Creek
rainfall
2016-1 calibrated
mm rainfall surplus
(deficit)
compared to
a steady daily rate of
958 mm every
365.25 days
day 0 = July 18, 2015
end of obsv.
451
Coats Marsh 481
El Verano 292
February
March
April
May
550
525
500
475
450
425
400
375
350
325
300
210
220
230
240
250
260
270
280
290
300
310

Specific Conductivity (mostly in the pool just upstream of Taylor Bay Road culvert)

Aug.04, 2015: Mallett: 169 µS/cm (RDN)
Aug.11, 2015: Mallett: 189 µS/cm (RDN)
Oct.13, 2015: Mallett: 151 µS/cm (RDN) 156 µS/cm (117µS/cm, 12.4ºC)(GSK in flask)
Oct.20, 2015: Mallett: 150 µS/cm (RDN) 133 µS/cm (96µS/cm, 11.0ºC) (GSK in flask)
105 µS/cm (75µS/cm, 10.9ºC) (GSK in stream)
117 µS/cm (86µS/cm, 11.9ºC) (GSK in Pk. Lake)

These numbers are low for groundwater, but higher than rainwater. The recent light rain may have depressed the conductivity slightly, as one would expect. Note the similarity of the reading at Peacocks Lake and down by the culvert.

Oct.27, 2015: Mallett: 150 µS/cm (RDN) 96 µS/cm (68µS/cm, 10.3ºC) (GSK in stream)
Calibration of the GSK sensor was OK (1290µS/cm, 20.1ºC against standard 1281µS/cm), but it is easy to get a bubble trapped in the sensor housing which lowers the reading. Will watch this in future.
Nov.3, 2015: Mallett: 120 µS/cm (RDN) 80 µS/cm (55µS/cm, 9.3ºC), pH 7.8 (GSK in stream)

Nov.5, 2015: 107 µS/cm (73µS/cm, 9.3ºC) (GSK in flask downstream of the culvert).

Nov. 10, 2015: *Calibration: GSK sensor with 1413µS/cm solution measured 1435µS/cm@18.56ºC should be 1240µS/cm +16%. After cleaning in de-ionized water 1343µS/cm@18.7ºC should be 1243µS/cm +8%. After cleaning with dishwasher liquid 1410µS/cm@18.7ºC should be 1243µS/cm +14%. Use de-ionized water only. 1031µS/cm@18.95ºC should be 1250µS/cm –18%. Making sure no contact with bottom of flask. 1350µS/cm@18.38ºC should be 1235µS/cm +9%. After good soaking in de-ionized water.*

These are maximum errors for >1000µS/cm water. At 100µS/cm they will be 1/10th as the zero point seems OK.

New calibration procedure developed by testing at different temperatures to give a multi-point curve. GSK results are closer to the RDN values after doing this.

Apr.14, 2016: 133 µS/cm calibrated (75µS/cm, 9.7ºC) (GSK downstream culvert).

Dissolved oxygen (pool just upstream of Taylor Bay Road culvert)

Oct.13, 2015: Mallett: 7.9 mg/L (RDN) 9.4 mg/L (GSK in flask)

Oct.20, 2015: Mallett: 8.0 mg/L 72% 10.7ºC (RDN)
9.7 mg/L 88% 11.0ºC 102.5 kPa 96 µS/cm (GSK in flask)
9.7 mg/L 87% 10.9ºC 102.5 kPa 75µS/cm (GSK in stream)
11.1 mg/L 105% 13.0ºC 102.2 kPa 86µS/cm (GSK in Pk. Lake)

Lack of agreement RDN:GSK is puzzling. Oversaturation (>100%) in lakes is not uncommon. It can be a result of photosynthesis or of non-equilibrium, for example, water temperature rising too fast for excess oxygen to escape.

Oct.27, 2015: Mallett: 9.3 mg/L 85% 11.0ºC (RDN)
9.7 mg/L 87% 10.7ºC 101.7 kPa 68µS/cm (GSK in stream)

9.7 mg/L Winkler titration—perfect agreement with GSK sensor. Calibration: GSK sensor with half-full bottle of water shaken for several minutes, saturation measured 96–99%.

Nov.3, 2015: Mallett: 10.9 mg/L 94% 9.2ºC (RDN)
10.3–10.7 mg/L 90–93% 9.4–9.3ºC 101.8 kPa 55µS/cm (GSK in stream)
It was noted that there was some variation of DO over a very short stretch of the creek. Measurements were taken in the mid-section of a pool where saturation was 94%, but at the exit of the pool, the running water saturation was down to 90% and the temperature a fraction higher

Nov.6, 2015: *Calibration: GSK sensor with sodium sulfite solution, saturation measured 1%.*

Apr.14, 2016: Mallett: 10.1 mg/L, 92%, 10.9ºC, 100.9 kPa (GSK culvert downstream side).

[October 8, Mallett Creek, young vertebrates becoming acquainted with young invertebrates]

Flow measurements at the culverts

Until flow rates increase, the measurement technique is pail and stopwatch at the downstream side of the culvert on Taylor Bay Road for Mallett.

Day 0 is Julian Day 2457222.0 at 4 am PST (July 18, 2015). Rain is as recorded at the El Verano field gauge. This is suspected as being low and needs calibrating.

Jul.22 (4):	Mallett:	0.118 L/s	
Aug.4 (17):	Mallett:	0.094 L/s	no rain
Aug.10 (23):	Mallett:	0.085 L/s	rain not measured ≈5 mm
Aug.16 (29):	Mallett:	0.079 L/s	no rain
Aug.25 (38):	Mallett:	0.041 L/s	no rain
Aug.27 (40):	Mallett:	0.030 L/s	no rain
Aug.30 (43):	Mallett:	0.111 L/s	rain 17 mm at El Verano
Sep.5 (49):	Mallett:	0.084 L/s	rain 5 mm at El Verano
Sep.10 (54):	Mallett:	0.068 L/s	rain 6 mm at El Verano
Sep.14 (58):	Mallett:	0.033 L/s	no rain
Sep.18 (62):	Mallett:	0.081 L/s	rain 2.3 mm at El Verano
Sep.20 (64):	Mallett:	0.095 L/s	rain 4.2 mm at El Verano
Sep.23 (67):	Mallett:	0.047 L/s	no rain
Sep.25 (69):	Mallett:	0.227 L/s	rain 11.9 mm at El Verano, 9.6 mm at the creek.
Sep.28 (72):	Mallett:	0.079 L/s	no rain
Oct. 1 (75):	Mallett:	0.074 L/s	no rain
Oct. 5 (79):	Mallett:	0.047 L/s	rain 1 mm at El Verano, 0.1 mm at the creek.
Oct. 8 (82):	Mallett:	0.107 L/s	rain 8.1 mm at El Verano, 6.1 mm at the creek.

[a measurement, not very reliable, a short distance downstream from the dam was 0.033 L/s]

Oct. 13 (87):	Mallett:	0.107 L/s	rain 13.9 mm at El Verano, 5.0 mm at the creek.

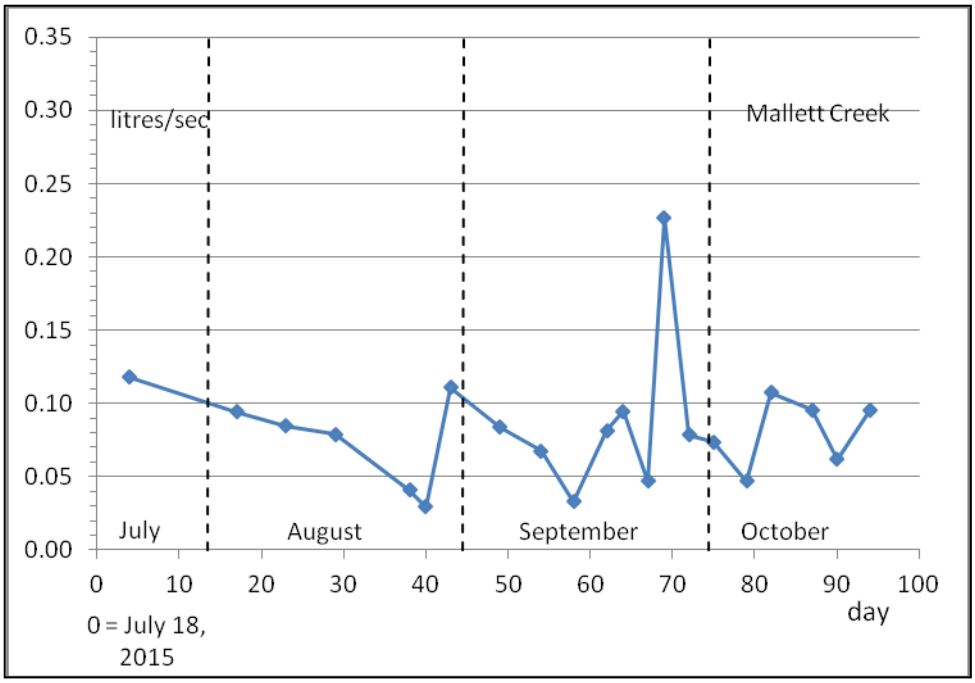
[a measurement at the half-way culvert in the upper watershed was 0.102 L/s]
[a measurement, not very reliable, a short distance upstream of this culvert was an-only-just-perceptible 0.058 L/s]

Oct. 16 (90):	Mallett:	0.062 L/s	no rain
Oct. 20 (94):	Mallett:	0.095 L/s	rain 2.4 mm at El Verano, 3.5 mm at the creek.

[half-way culvert in the upper watershed about the same]

Oct. 27 (101):	Mallett:	0.169 L/s	rain 8.7 mm at El Verano, 12 mm at the creek.
Oct. 29 (103):	Mallett:	0.324 L/s	rain 20 mm at El Verano, 18 mm at the creek.
Nov. 2 (107):	Mallett:	1.797 L/s	rain 64 mm at El Verano, 63 mm at the creek.
Nov. 3 (108):	Mallett:	1.292 L/s	rain (trace) at El Verano, trace at the creek.

[half-way culvert in the upper watershed 1.020 L/s]
[a measurement, not very reliable, a short distance upstream of this culvert was 0.942 L/s]
[upstream of this point, the flow decreased becoming zero near the dam. No flow in dam outlet pipes]



Precipitation appears to affect the flow rate almost instantaneously, but there is a steady, but in summer always declining, small flow not related directly to precipitation. There is at the same time, absolutely no flowing water in Winthuysen Creek.

Possibly the "groundwater seepage" is actually leakage through the dam wall? The source is without doubt somewhere upstream of the half-way culvert.

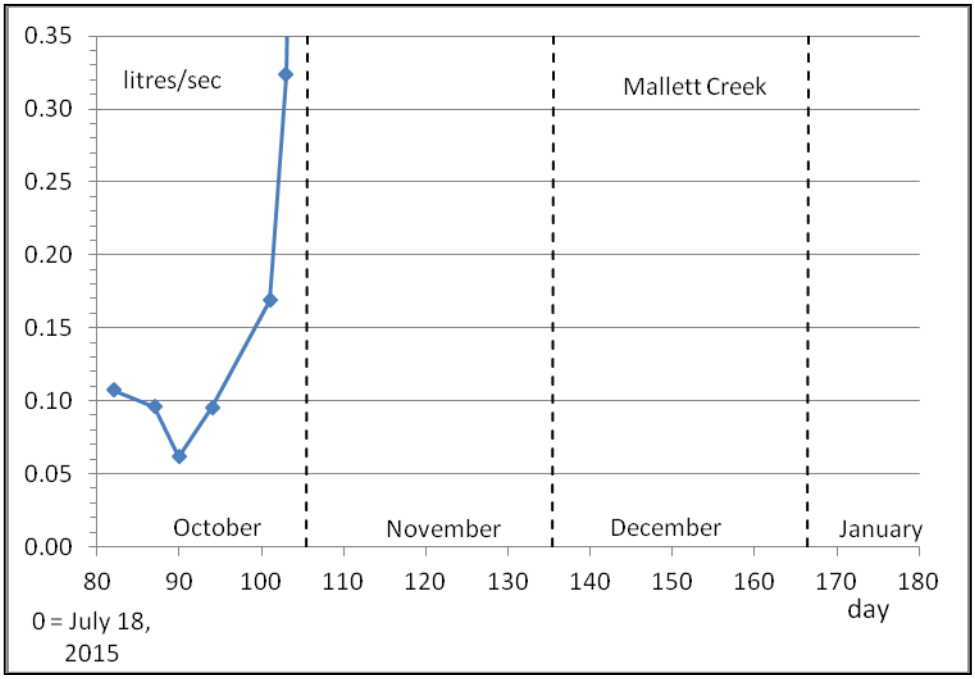
<u>Reality check</u>:
Integrated volume through the culvert Sep.20 to Oct. 1 = 157.3 m^3
Loss in height of lake as a consequence (8260 m^2) = –19.0 mm
Rainfall in that period = +16.1 mm
Evaporation loss @ 2.9 mm/day = –37.7 mm
Hence drop in lake level if the culvert water is from the lake = –37.7–19.0+16.1 = –40.6 mm.

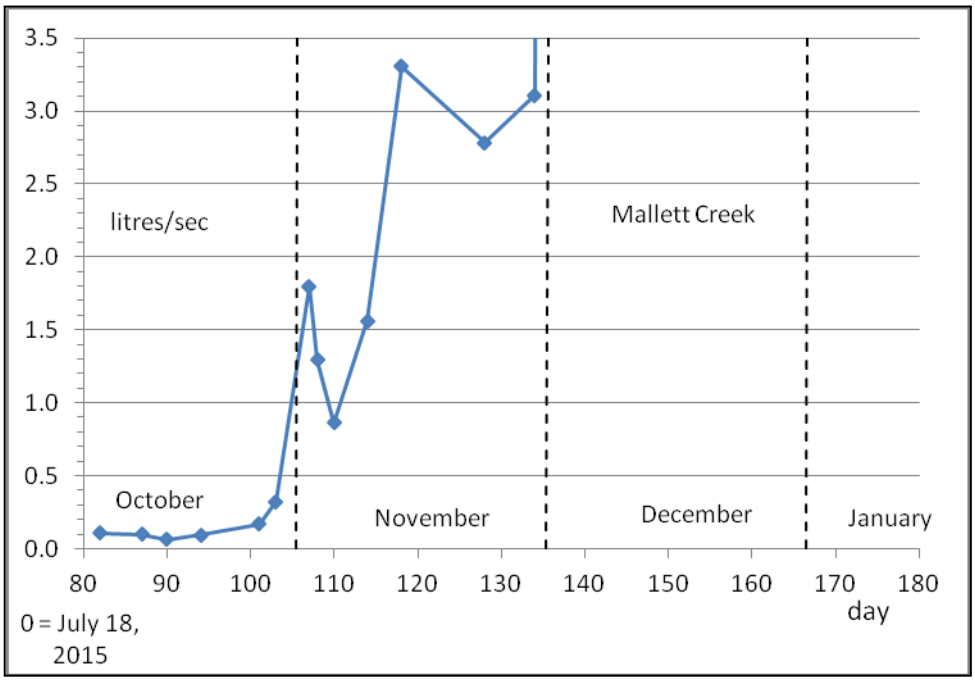
This assumes no significant draw-down in this period by the GVFD, which is likely the case since one 2000-Imperial-gallon load would only reduce the lake level by just over one millimetre. The draw-down as a result of watering lawns in times of drought is also hopefully small.

Judging from photographs taken with a telephoto lens including the 610-mm culverts, forty millimetres is very close to the drop in level. It is thus plausible, but not proven, that the lake keeps the creek from drying out completely in summer and thus plays a vital role in providing fish habitat.

Conductivities in the pool near the Taylor Bay Road culvert and in Peacocks Lake are fairly low indicating that groundwater is an unlikely source of the water. The similarity of the conductivities also strongly supports the idea that the lake is the source of the flow in the creek in drought conditions.

Dissolved oxygen is very high in the lake and also high in the pool by Taylor Bay Road.





Note change in vertical scale

Flow peaks in direct response to rain, declines almost immediately after it stops. Evidence is that at this time of year, with no flow from the dam outlets, most of this water is collected rainfall from the valley below the dam.

<u>Reality check</u>

Suppose the initial flow is V_0 L/s (litres/sec) and this decays exponentially with a time constant of T_0 days = 86400 T_0 sec. Then after T_0 days, the flow would have been reduced to 0.368 V_0 L/s, and the volume of water will have been $0.632 \times 86.4\ V_0 T_0$ m^3 (1 litre ≈ .001 m^3).

Given the length of the valley L as 570 m, the drainage width of the valley W times the rainfall R = $0.1V_0T_0$ m^2. For R = 60 mm of rain, T_0 = 4 days, and V_0 = 2 L/s (V_4 = 0.74 L/s), the drainage width W = 13 metres. Quite plausible.

Conductivity is similar to Coats Marsh which is probably all collected rainfall with no spring water inflow.

Nov. 5 (110): Mallett: 0.860 L/s rain 1.8 mm at El Verano, 2 mm at the creek.
Nov. 9 (114): Mallett: 1.562 L/s rain 18.5 mm at El Verano, 22 mm at the creek.
Nov. 13 (118): Mallett: 3.306 L/s rain 21.8 mm at El Verano, 27.1 mm at the creek
[at the limit of the pail/stopwatch method]
Nov. 23 (128): Mallett: 2.781 L/s rain 26.5 mm at El Verano, 36.1 mm at the creek.
[at a guess, the lake is not yet overflowing]

Photo Nov. 23.

Tried measuring flow using velocity × area method:
Pipe diameter = 0.900 m (36-inch), water depth = 23 mm, water vel = 1.8 ft/s (Brunton); hence, R = 0.450 m, d = 0.011, V_0 = 0.55 m/s (actually more like an average as the Brunton propeller diameter is 10 mm), η = 0.0216, ó = 29.20, B =1.49, T = 18.4, λ_0 = 0.096, Q = 0.23 L/s.
As with the Chapple Creek measurement, November 20, this order of magnitude underestimate is clearly the result of a nonsensical value for λ_0 in such shallow water. Substituting $\lambda_0 = 1$ instead of the formula value gives Q = 2.4 L/s, which is low, but not too bad. Surface velocity measured using a float gave V_0 = 0.60 m/s (2.0 ft/s), which would give the Brunton average velocity with a factor λ_0 of 0.55/0.60 = 0.92, which is plausible and the same as the Chapple Creek determination. Bottom line: as a temporary fudge, for $\lambda_0 V_0$ use $1.2V_{Brunton}$ m/s.

Nov. 29 (134): Mallett: 3.108 L/s rain 9.0 mm at El Verano, 8.0 mm at the creek.
Dec. 04 (139): Mallett: 56.5 L/s rain 31.5 mm at El Verano, 49.0 mm at the creek.
water depth = 100 mm, water vel = 4.0 ft/s (Brunton).

Dec. 09 (144): Mallett: 109.3 L/s rain 91.5 mm at El Verano, 127 mm at the creek.
water depth = 180 mm, water vel = 3.3 ft/s (Brunton).
Peacocks Lake is now full up to the two 610-mm outlet pipes. Depth, judged from Cox Park is 260 mm, so flow in each pipe is in the 70–125 L/s range each (no velocity measurement), which is more than the culvert flow, so something is not quite right with these estimates and measurements.

Dec. 15 (150): Mallett: 70.7 L/s rain 27 mm at El Verano, 50.5 mm at the creek.
water depth = 100 mm, water vel = 1.8 m/s (float).

Now that Peacocks Lake is full, the flow at the culvert is more than an order of magnitude greater than in November.

Dec. 29 (164): Mallett: 30.3 L/s (Brunton), 35.2 L/s (float), rain 31.8 (Dec.20) + 22.2 = 54 mm at El Verano, rain 38 (Dec.20) + 46 = 84 mm at the creek.
water depth = 90 mm, water vel = 0.76 m/s (Brunton), 1.25 m/s (float). Flow turbulent.

Dec. 31 (166): Mallett: 33.4 L/s, rain = 3 mm at the creek.
water depth = 85 mm, water vel = 0.914 m/s (Brunton).

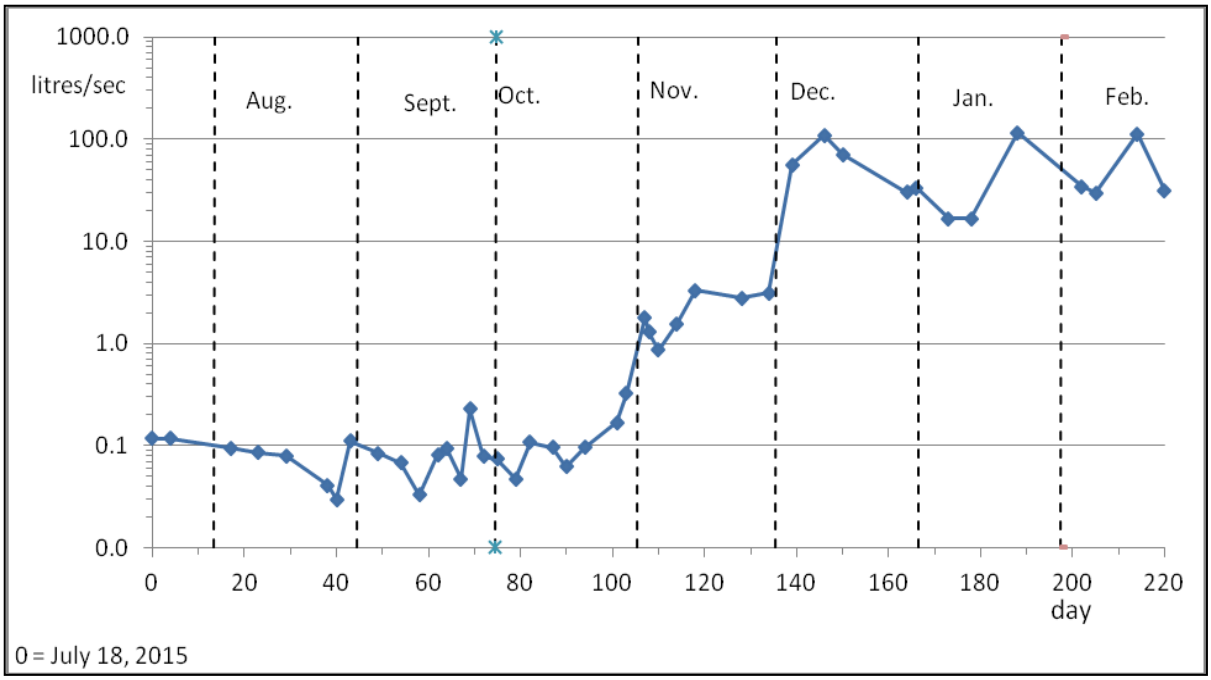
Jan. 7, 2016 (173): Mallett: 16.6 L/s, rain calib. = 10.5 mm at the creek.
water depth = 60 mm, water vel = 1.070 m/s (float).

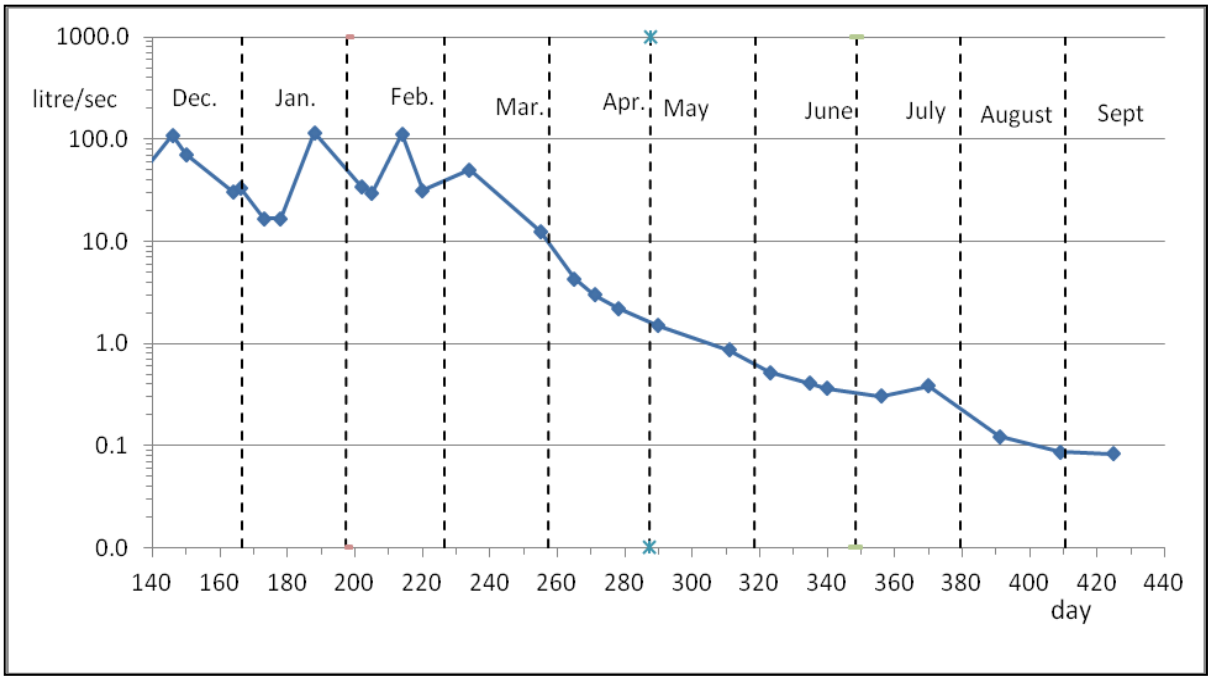
Jan. 12 (178): Mallett: 16.6 L/s, rain calib. = 12.1 mm at the creek.
water depth = 60 mm, water vel = 1.075 m/s (float).

Jan. 17 (183): Mallett: – L/s, rain calib. = 57.0 mm at the creek.

Jan. 22 (188): Mallett: 115.5 L/s, rain calib. = 54.0 mm at the creek.
water depth = 180 mm, water vel = 1.50 m/s (float).

Feb. 5 (202): Mallett: 34.5 L/s, rain calib. = 69.0 mm at the creek.
water depth = 85 mm, water vel = 1.33 m/s (float). Photo.





The flow in Mallett Creek varies by over three orders of magnitude from:
—the summer dry season (<1 L/s);
—to the fall, when rainfall in the ravine below the dam increases the flow (<10 L/s) but there is no flow from Peacocks Lake;
—to the time in the winter when Peacocks Lake has been recharged and water is flowing through the two outlet pipes (<100 L/s) from the upper reaches of the creek.

Feb. 15 (212): Mallett: no flow rate observation. Rain calib. = 43.8 mm at the creek.

Feb. 17 (214): Mallett: 111.8 L/s, rain calib. = 19.4 mm at the creek.
water depth = 135 mm, water vel = 2.20 m/s (float).

Feb. 23 (220): Mallett: 31.4 L/s, rain calib. = 23.5 mm at the creek.
water depth = 70 mm, water vel = 1.61 m/s (float).

Mar. 2 (228): Mallett: —, rain calib. = 62.0 mm at the creek.

Mar. 8 (234): Mallett: 50.3 L/s, rain calib. = 65.0 mm at the creek.
water depth = 110 mm, water vel = 1.33 m/s (float).

Mar. 11 (237): Mallett: —, rain calib. = 81.0 mm at the creek.

Mar. 23 (249): Mallett: —, rain calib. = 45.5 mm at the creek.

Mar. 29 (255): Mallett: 12.6 L/s, rain calib. = 16.3 mm at the creek.
water depth = 50 mm, water vel = 1.06 m/s (float).

Apr. 8 (265): Mallett: 4.3 L/s, rain calib. = 8.9 mm at the creek.
water depth = 30 mm, water vel = 0.77 m/s (float)

Total rain at Mallett Creek to date is 1150.3 mm. Rainfall observations discontinued.
Total rain at Coast Marsh to date is 1187.4 mm.
Total rain at El Verano to date is 1003.8 mm. (old calibration, graph figures are better)

Apr. 10 (267): Observed level in Peacocks Lake, the bottom of the input to the twin pond levellers. River Place Creek is just a barely perceptible trickle at the bridge with ponding along most of its length.

Apr. 14 (271): Mallett: 3.0 L/s
water depth = 30 mm, water vel = 0.54 m/s (float).

Apr. 21 (278): Mallett: 2.2 L/s
water depth = 25 mm, water vel = 0.52 m/s (float).

May 03 (290): Mallett: 1.5 L/s (pail and stopwatch).

May 24 (311): Mallett: 0.86 L/s (pail and stopwatch).

June 05 (323): Mallett: 0.52 L/s (pail and stopwatch).

June 12 (330): River Place Creek: dry at the lake.

June 17 (335): Mallett: 0.41 L/s (pail and stopwatch).

June 22 (340): Mallett: 0.36 L/s (pail and stopwatch).

July 08 (356): Mallett: 0.30 L/s (pail and stopwatch).

July 22 (370, 366+4): Mallett: 0.39 L/s (pail and stopwatch).

August 12 (391, 366+25): Mallett: 0.12 L/s (pail and stopwatch).

August 30 (409, 366+43): Mallett: 0.09 L/s (pail and stopwatch).

September 15 (425, 366+59): Mallett: 0.08 L/s (pail and stopwatch).

Winthuysen Creek

There is a grove of western redcedar, sword ferns, and in the drier areas, salal, between Taylor Bay Road and the upper meadows of the Descanso Bay Regional Park campground. It is dry in summer, but in the wet season it becomes swampy and the course of Winthuysen Creek through it is mainly of braided rivulets, many with no well-defined channel. Measuring the flow of the creek through this area is practically impossible. It can only be readily measured once the creek is clear of the forest and into the meadow where the old fruit trees are. Here the creek is culverted shortly before it enters the sea.

A complication that has to be considered in measuring the flow at the culvert is that there is a dug-out a short way upstream of the meadow. This used to be used by the Gabriola Volunteer Fire Department (GVFD) for water storage, but no longer is. The dug-out is fenced, but a rough survey from outside the fence at the beginning of October 2015 gave the following results.

Inlet: from a channel in Winthuysen carrying a significant portion of the total flow, but not all of it. Wooden baffle. Pipe culvert 203-mm (8-inch) PVC into the dug-out, its bottom is 0.7 metre below top of the bank, perched unil the dug-out is full. The channel continues below the baffle on the righthand side (looking downstream) of the bank and fence around the dug-out.

Overflow: no obvious outlet that I can see. Relies on seepage through the bank? There is a substantial flow in winter into the inlet channel from the bottom of the bank on the seaward side of the dug-out, shortly before the combined flows enter the meadow.

Estimated surface area: varies between 172 m^2 when virtually empty to 360 m^2 when the water level is up to the level of the inlet culvert.

Estimated volume: varies between being virtually empty (there is an inaccessible puddle, obviously shallow) to around 440 m^3 when the water level is up to the level of the inlet culvert.

As best I can estimate from outside the fence, the bottom of the perched inlet PVC culvert is 1.68 m above the flat floor of the dug-out.

Proposed method of measuring area and volume is to take these as being functions of D, the estimated depth of the water. This amounts to:

$D = d_f - d \sin(\theta) - d_0$ where:
d_f = height of the bottom of the inlet culvert above the floor = 1.68 m;
d = distance measured with a rangefinder between observer's eye at the fence and a selected point on the surface of the water;

θ = angle measured with an inclinometer between observer's eye at the fence and the selected point on the surface of the water;

d_0 =height of observer's eye (1.4 m) plus depth below the top of the bank of the bottom of the PVC inlet culvert (0.7 m).

The volume is then given by: volume (m^3) = $56 D^2 + 166.68 D$
The surface area is then given by: area (m^2) = $9 D^2 + 96 D + 172$ for $D > 0.1$ m

By measuring the changes in volume in the dug-out, and allowing for evaporation, it might be possible to judge how the dug-out's presence in the watershed affects the flow in the lower part of the creek, and also to gain some insight into the storage capacity of the forested seasonal swamp.

Observations

Oct. 29 (103): Winthuysen: 0.00 L/s no flow
Nov. 3 (108): Winthuysen: 0.00 L/s rain 64.0 mm
[pooling in creek bed, but no flow. Inlet to GVFD dug-out is dry]
Nov. 10 (115): Winthuysen: ≈0.10 L/s rain 20.4 mm
[first flow of the season through the culvert, but inlet to GVFD dug-out is still dry]

Dec. 9 (144): Winthuysen: 53.2 L/s rain 180.2 mm
culvert diameter 600 mm, depth 140 mm, Brunton 2.9 ft./sec, lambda 1.2

The GVFD dug-out is full (perched inlet pipe almost submerged in the dug-out). There is a minor flow into the dug-out, but it seems about the same as the leakage on the downstream side of the dug-out, so I guess the measured flow at the culvert is now the full flow. Seems to be around half of the Mallett flow, which makes sense as the Winthuysen watershed area is definitely smaller. Unfortunately, the rapid onset and volume of rain and activity at Coats Marsh did not leave time to observe the dry-wet season transition closely.

March 23 (249), 2016: WATER QUALITY
pH ~~8.3~~ 7.4
Water faint yellow, JTU=5.

April 21 (278), 2016: WATER QUALITY
HANNA pH ~~7.9~~ 7.0; PASCO ~~6.3~~ 6.5
8.9 mg/L, 87%, 13.8ºC, 756 mm Hg (campground).
Water faint yellow, JTU=5.
Winthuysen: 0.7 L/s.

May 03 (290): Winthuysen: a drindle, <<1 L/s.

June 05 (323): Winthuysen: ponding, 0.00 L/s no flow. Treefrog in one pool.

June 17 (335): Winthuysen: mostly dry, isolated stagnant puddles.

There is now an analysis of these observations here. ◊