

Jacob Gellatly
Fern Lake Water Balance
Engr 115

#### Assumptions

- The Inputs from precipitation are negligible.
- The Evaporation rate for November is 1.04 inches/month.
- Interference from human and animal interaction is negligible.
- The Fishery is not pulling or returning water to the lake.

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Input Parameters	
Surface Area Lake (km <sup>2</sup> )	0.008
Surface Area Lake (m <sup>2</sup> )	8000
Evaporation Rate(in/month)	1.04
Evaporation rate(m <sup>3</sup> /hr)	3.66889E-05

Ping Pong Method										
Inflow Method 1	Depth(in)	Width(ft)	Length(ft)	Depth(m)	Width(m)	Length (m)	Volume(m <sup>3</sup> )	Time(s)	Time(hr)	Flowrate (m <sup>3</sup> /hr)
Trial 1		1	3	0.0254	0.9144	0.9144	0.021237635	13.31	0.003697222	5.744213809
Trial 2		1	3	0.0254	0.9144	0.9144	0.021237635	13.22	0.003672222	5.783319652
Trial 3		1	3	0.0254	0.9144	0.9144	0.021237635	13.4	0.003722222	5.705633269
									Avg Flowrate	5.74438891

Flow Probe Method								
Inflow Method 2	Depth(in)	Width(ft)	Depth(m)	Width(m)	Cross Area(m <sup>2</sup> )	Meter Value(ft/s)	Meter Value(m/hr)	Flowrate(m <sup>3</sup> /hr)
Trial 1	2	0.5	0.0508	0.1524	0.00774192	0.2	219.456	1.699010796
Trial 2	2	0.5	0.0508	0.1524	0.00774192	0.2	219.456	1.699010796
Trial 3	2	0.5	0.0508	0.1524	0.00774192	0.2	219.456	1.699010796
							Avg Flowrate	1.699010796

Bucket Method					
Outflow Method 1	Volume(Gal)	Volume(m <sup>3</sup> )	Time(s)	Time(hr)	Flowrate(m <sup>3</sup> /hr)
Trial 1	5	0.018927059	20.44	0.005677778	3.333532882
Trial 2	5	0.018927059	22.81	0.006336111	2.987172824
Trial 3	5	0.018927059	22.31	0.006197222	3.054119772
				Avg Flowrate	3.124941826

Results	
Total Inflow	Avg (m <sup>3</sup> /hr)
Method 1	5.74438891
Method 2	1.699010796
Avg Inflow Rate(m <sup>3</sup> /hr)	3.721699853

Outflow Rate(m <sup>3</sup> /hr)	3.124941826
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Rate of Volume Change					
Parameters	Inflow(m <sup>3</sup> /hr)	Outflow(m <sup>3</sup> /hr)	Percipitation(m <sup>3</sup> /hr)	Evaporation(m <sup>3</sup> /hr)	Total Rate of Change (m <sup>3</sup> /hr)
(Inflow-Outflow)+(Percipitation-Evaporation)	3.721699853	3.124941826	0	3.66889E-05	0.596721338

Fern lake is not at a steady state because the sum of the inputs are larger than the sum of the outputs.The lake's volume is rising at a rate of about 0.60 (m<sup>3</sup>/hr).

Rate of Depth Change	Rate of Volume Change (m <sup>3</sup> /hr)	Surface Area (m <sup>2</sup> )	Depth Change (m/hr)	Depth Change (cm/hr)	
	0.596721338	8000	7.45902E-05	0.007459017	Increasing

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These calculations are based off the assumptions that the inflow value given from the "Ping Pong Method" and the "Bucket Method" are +/- 10 % of their measured values from the field.

Input Parameters	
Surface Area Lake (km <sup>2</sup> )	0.008
Surface Area Lake (m <sup>2</sup> )	8000
Evaporation Rate(in/month)	1.04
Evaporation rate(m <sup>3</sup> /hr)	3.66889E-05

Ping Pong Method												
Inflow Method 1	Depth(in)	Width(ft)	Length(ft)	Depth(m)	Width(m)	Length (m)	Volume(m <sup>3</sup> )	Time(s)	Time(hr)	Measured Flowrate (m <sup>3</sup> /hr)	+10% Flowrate (m <sup>3</sup> /hr)	-10% Flowrate (m <sup>3</sup> /hr)
Trial 1	1	3	3	0.0254	0.9144	0.9144	0.021237635	13.31	0.003697222	5.744213809	6.31863519	5.169792428
Trial 2	1	3	3	0.0254	0.9144	0.9144	0.021237635	13.22	0.003672222	5.783319652	6.361651617	5.204987687
Trial 3	1	3	3	0.0254	0.9144	0.9144	0.021237635	13.4	0.003722222	5.705633269	6.276196595	5.135069942
Avg Flowrate										5.74438891	6.318827801	5.169950019

Flow Probe Method									
Inflow Method 2	Depth(in)	Width(ft)	Depth(m)	Width(m)	Cross Area(m <sup>2</sup> )	Meter Value(ft/s)	Meter Value(m/hr)	Flowrate(m <sup>3</sup> /hr)	
Trial 1	2	0.5	0.0508	0.1524	0.00774192	0.2	219.456	1.699010796	
Trial 2	2	0.5	0.0508	0.1524	0.00774192	0.2	219.456	1.699010796	
Trial 3	2	0.5	0.0508	0.1524	0.00774192	0.2	219.456	1.699010796	
Avg Flowrate								1.699010796	

Bucket Method							
Outflow Method 1	Volume(Gal)	Volume(m <sup>3</sup> )	Time(s)	Time(hr)	Measured Flowrate(m <sup>3</sup> /hr)	+10% Flowrate (m <sup>3</sup> /hr)	-10% Flowrate (m <sup>3</sup> /hr)
Trial 1	5	0.018927059	20.44	0.005677778	3.33532882	3.66888617	3.000179594
Trial 2	5	0.018927059	22.81	0.006336111	2.987172824	3.285890106	2.688455541
Trial 3	5	0.018927059	22.31	0.006197222	3.054119772	3.359531749	2.748707795
Avg Flowrate					3.124941826	3.437436009	2.812447643

Results	
Total Inflow	Avg (m <sup>3</sup> /hr)
Method 1	5.74438891
Method 2	1.699010796
Avg Inflow Rate(m <sup>3</sup> /hr)	3.721699853

Outflow Rate(m <sup>3</sup> /hr)	3.124941826
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Rate of Volume Change					
Parameters	Inflow(m <sup>3</sup> /hr)	Outflow(m <sup>3</sup> /hr)	Percipitation(m <sup>3</sup> /hr)	Evaporation(m <sup>3</sup> /hr)	Total Rate of Change (m <sup>3</sup> /hr)
(Inflow-Outflow)+(Percipitation-Evaporation)	3.721699853	3.124941826	0	3.66889E-05	0.596721338
+10% Flowrate (m <sup>3</sup> /hr)	4.008919298	3.437436009	0	3.66889E-05	0.571446601
-10% Flowrate (m <sup>3</sup> /hr)	3.434480407	2.812447643	0	3.66889E-05	0.621996075

Increasing

Increasing

Increasing

Fern lake is not at a steady state because the sum of the inputs are larger than the sum of the outputs. The lake's volume is rising at a rate of about 0.60 (m<sup>3</sup>/hr).

Rate of Depth Change	Rate of Volume Change (m <sup>3</sup> /hr)	Surface Area (m <sup>2</sup> )	Depth Change (m/hr)	Depth Change (cm/hr)	
	0.596721338	8000	7.45902E-05	0.007459017	Increasing

Extra Credit

By raising the value of the measured flowrates for one of the inflow values, and the outflow values by 10 percent, the total rate of change went down my about 0.025 (m<sup>3</sup>/hr). Alternatively when we lowered these values by 10 percent the total rate of change went up by about 0.025 (m<sup>3</sup>/hr).