

How Location affects Potential Tidal Energy

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Purpose

My purpose was to determine the tidal flow rate of different locations and their potential tidal energy output. I then determined if a tidal power generator in Juneau would be practical. My hypothesis was that there would be no difference in flow rate between each location.

Procedure

I tested the tidal flow rate of five locations:

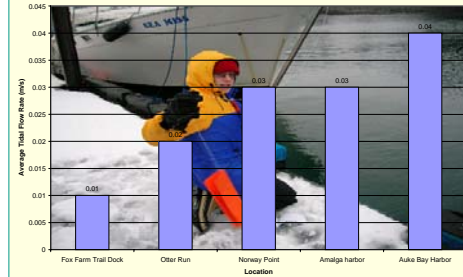
- Auke Bay
- Amalga harbor
- Norway Point
- Otter Run (near Smugglers Cove)
- Fox Farm Trail

I tested each site at mid tide. To take each measurement I used a drift card and a two meter long string. I timed the card while it floated away with the tide until the string was taut, meaning that the card was two meters away. I took ten measurements per site. I divided the average time for each site by two to get the average s/m. I then took the inverse of this to get the average surface flow rate of each location in m/s. Calculating the potential energy output took three steps:

1. Velocity = Surface Velocity (measured) x (Gradient Depth/Total Depth)^{1/10}
2. Power Density = ½ Water Density (1024 kg/m³) x Velocity³ (from first formula)
3. Power Density x Cross Sectional Area = Potential Tidal Energy (watts)

The cross sectional area was found by multiplying the average depth by the distance across each location.

Location vs. Average Tidal Flow Rate



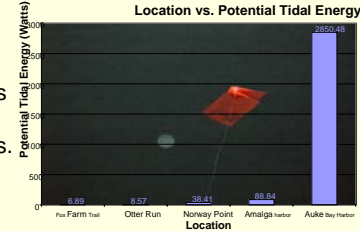
Results

My experiments showed that Auke Bay had the fastest tidal flow with the water in the bay flowing at 0.04m/s. Amalga Harbor and Norway Point had flow rates of 0.03m/s. Otter Run had a flow rate of 0.02m/s, and the Fox Farm Trail had a flow rate of 0.01m/s. Analysis of my data using an ANOVA test did not support the null hypothesis that all locations I tested would have the same flow rate (p<.05).

Conclusion

- Auke Bay had an energy potential of 2850.48 watts
- Amalga Harbor had an energy potential of 88.84 watts
- Norway Point had an energy potential of 38.41 watts
- Otter Run had an energy potential of 8.57 watts
- Fox Farm Trail had an energy potential of 6.89 watts.

A 60 watt light bulb could only be powered from Auke Bay or Amalga Harbor. However, only Auke Bay can produce enough energy to power at least two houses.



Applications

There have been a couple of articles in the Juneau Empire during the past year about tidal energy and companies looking into testing sites around Alaska and even in Juneau. If a tidal farm were set up in Juneau, it should go in Auke Bay. However, Auke Bay probably has the most boat traffic, therefore the placement of tidal turbines may be a problem there. There also is too small an amount of energy generated for it to be economically practical.

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Location	Fox Farm Trail	Otter Run	Norway Point	Amalga harbor	Auke Bay Harbor
Time (min. per 2m)	2:25	2:00	1:10	0:55	1:10
3:00	1:40	0:50	1:00	1:00	1:40
4:00	1:35	0:45	1:55	1:15	1:15
4:30	1:10	2:10	1:40	1:05	1:05
1:25	1:00	0:40	1:25	0:30	0:30
2:30	1:00	0:45	0:45	0:35	0:35
1:25	1:20	0:40	1:05	0:35	0:35
1:30	1:25	0:50	1:30	0:30	0:30
1:25	2:40	1:00	1:15	0:30	0:30
1:30	3:10	2:35	0:55	0:35	0:35
Data Average	2:22	1:42	1:08	1:14	0:50
Average min./m	1:11	0:51	0:34	0:37	0:25
Average m/s	0.01	0.02	0.03	0.03	0.04
Depth (m)	3.66	7.77	12.69	43.89	33.69
Rounded to nearest m	4	8	12	44	34
Distance across (m)	196.596	369.4176	551.896	170.9928	3372.492
Potential Power Energy (w)	6.89	8.57	38.41	88.84	2850.48