Draft Big Lake Water Quality Monitoring: 2013

Summary Report for Big Lake Community Council

The Alaska Department of Environmental Conservation

December 11, 2013

Summary

The Department of Environmental Conservation (DEC) conducted water quality monitoring on Big Lake in the summer of 2013 to determine whether the lake was meeting Water Quality Criterion for Total Aromatic Hydrocarbons (TAH), which are constituents in gasoline. Previous sampling on Big Lake (2004, 2005 and 2009) found that water quality did not meet the State of Alaska criterion. DEC has been working with the community to educate boaters on ways to reduce petroleum hydrocarbons entering the lake. Water quality sampling was also conducted to examine whether improvements in water quality could be measured since implementing the "Keep Big Lake Clean" campaign.

Sampling was conducted on 9 days at 11 sampling locations. Samples were collected June 7-10, June 29 and July 4-7, 2013. Sampling was conducted over 96 hours because the probability of negative effects to aquatic life are greater with longer exposure. Sampling locations were in the East Basin and mirrored previous studies. The number of watercraft operating during sampling were also determined.

The project report is currently in draft format. The results of sampling found the following:

- Average 4-day TAH concentrations exceeded Water Quality Standards criterion values of 10 µg/L at three sites during the June 7 – 10 sampling event, but not during the July 4 – 7 sampling event.
- Long term negative impacts to aquatic life are likely, because the 4-day TAH exposure averaged more than 10 µg/L, which toxicity testing indicates is detrimental to growth and reproductive success.
- TAH concentrations were highest at sites close to boat launches and marinas which is consistent with previous studies.
- Cumulative TAH concentrations over the 4-day sampling events were strongly correlated with cumulative watercraft hours and this relationship provides a metric to evaluate changes in water quality over time.
- Personal watercraft accounted for approximately 25% of all watercraft and known 2-cycle motors approximately 13% of all watercraft.
- Mixing depth, in addition to boat motor size and motor type, must be considered when evaluating the effects of TAH discharge from watercraft on Big Lake TAH concentrations.
- If boats are burning 4 gallons per hour, then average discharge was 0.33 gallons per boat hour. This represents an inefficiency rate of 8.2% for all boats/motor types. Carbureted 2-stroke engines are less efficient than 4-stroke or direct injected 2-strokes.
- During these two sampling events, ~34 to ~200 gallons of gasoline per day were discharged into Big Lake.
- TAH concentrations did not show a statistically significant increase or decrease from prior sampling events.

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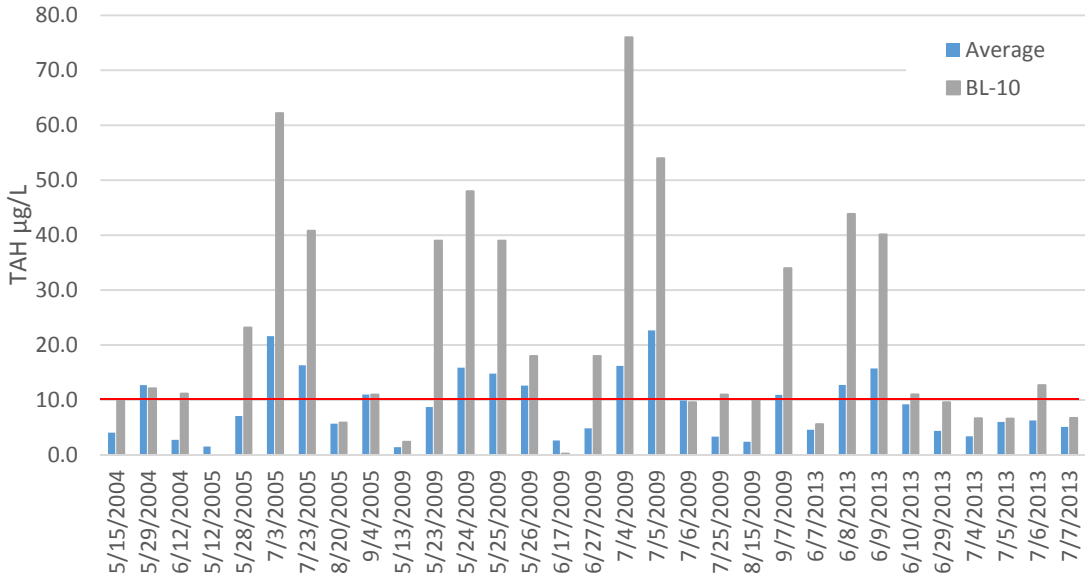
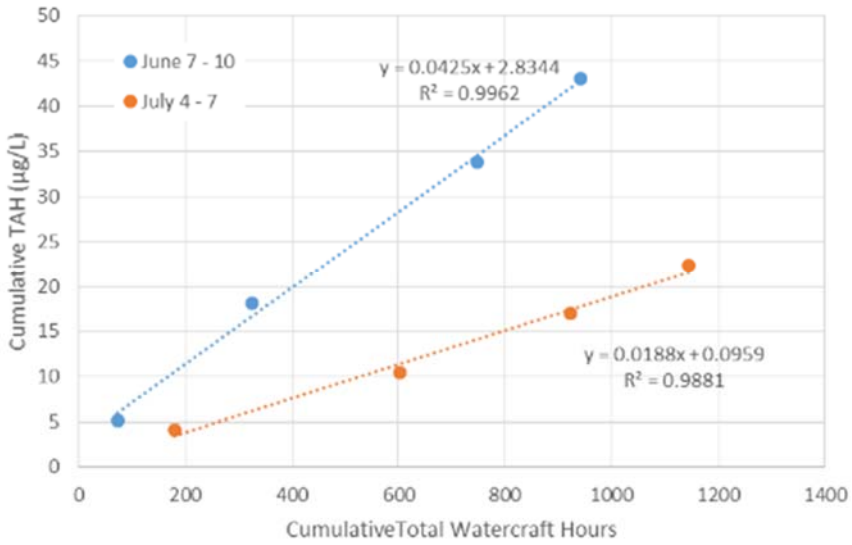


- There are no obvious declines or increases in TAH concentrations over the time period sampling has been occurring. Average Big Lake TAH concentrations did not exceed 20 µg/L in 2004 or 2013, and once in 2005 and 2009. Maximum average TAH or TAH for BL-10 does not decrease significantly over years sampled (N = 4).The percent of days with values over 10 µg/L is lower in 2013 than in 2005 or 2009 but not 2004; however, the number of days sampled has not been consistent, and there is not a long enough data set to determine if this trend will persist. Boat use was not reported for each sampling date. Therefore, differences in concentrations among years could be due to differences in the number of watercraft on each sampling date.

Cumulative TAH concentrations over the 4-day sampling events were strongly correlated with cumulative watercraft hours.



Personal watercraft accounted for approximately 25% of all watercraft, and 2-cycle motors approximately 13% of all watercraft.

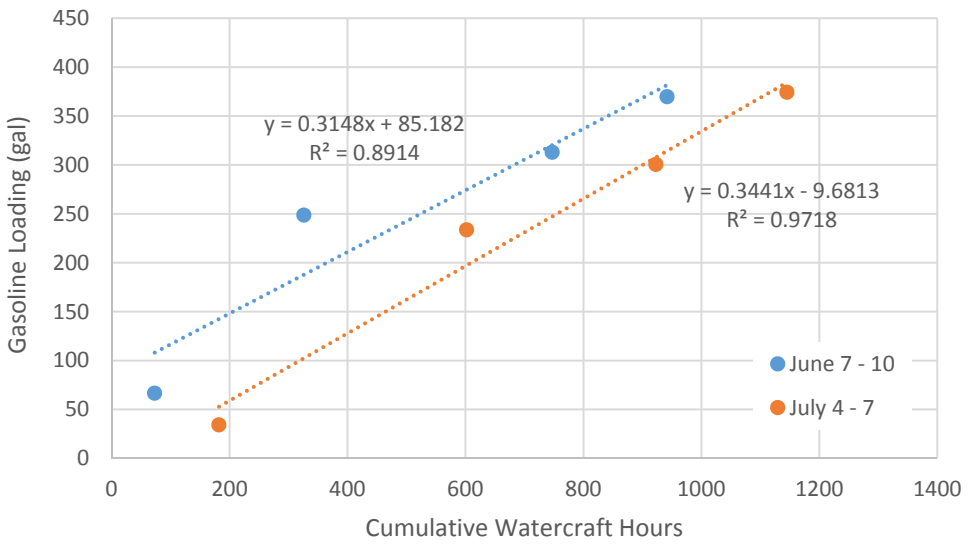
- Lake Transect Surveys: The ratio of PWC hours to total watercraft hours from surveys was 1:3.8 during the June sampling event and 1:3.2 during the July sampling event. There was no difference in the percent of boats that were PWC between the first and second sampling events. Approximately 24% of all watercraft were PWC including surveys from both sampling events.

- Boat Launch Surveys: The relative numbers of 2-stroke motors (Boats and PWC) to 4-stroke motors was 1:4 during the first sampling event and 1:3 during the second sampling event. These ratios are close, but slightly lower than ratios of PWC to total watercraft obtained from transect surveys. The percent of motors that were known 2-stroke was 16% during June and 10% during the July sampling event (13% average). This is similar to the percent 2-stroke of 12% obtained during 2009 surveys (Oasis 2010).

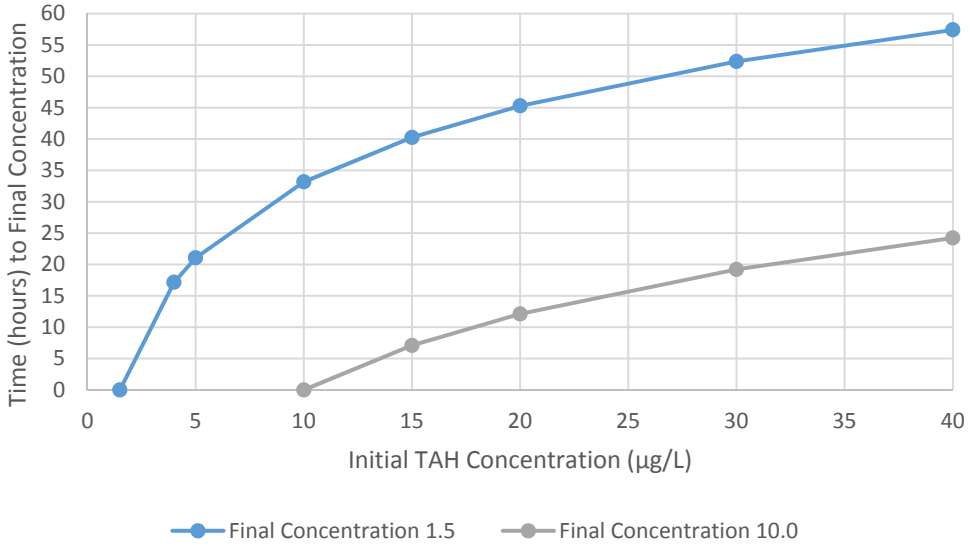
	June 7 - 10	July 4 - 7
All Watercraft Counted	36	41
All PWC + 2-Stroke Motors	9	18
2-Stroke Motors	6	4
PWC + 2-Stroke: Total Watercraft	1:4	1:3
2-Stroke:Total Watercraft	1:6	1:10
Average Motor Size (HP)	123	63
Median Motor Size (HP)	55	50

Gasoline discharge was 0.32 gallons per boat hour which is an inefficiency (gas discharged: gas burned) of 8.2% at a burn rate of 4 gallons per hour.

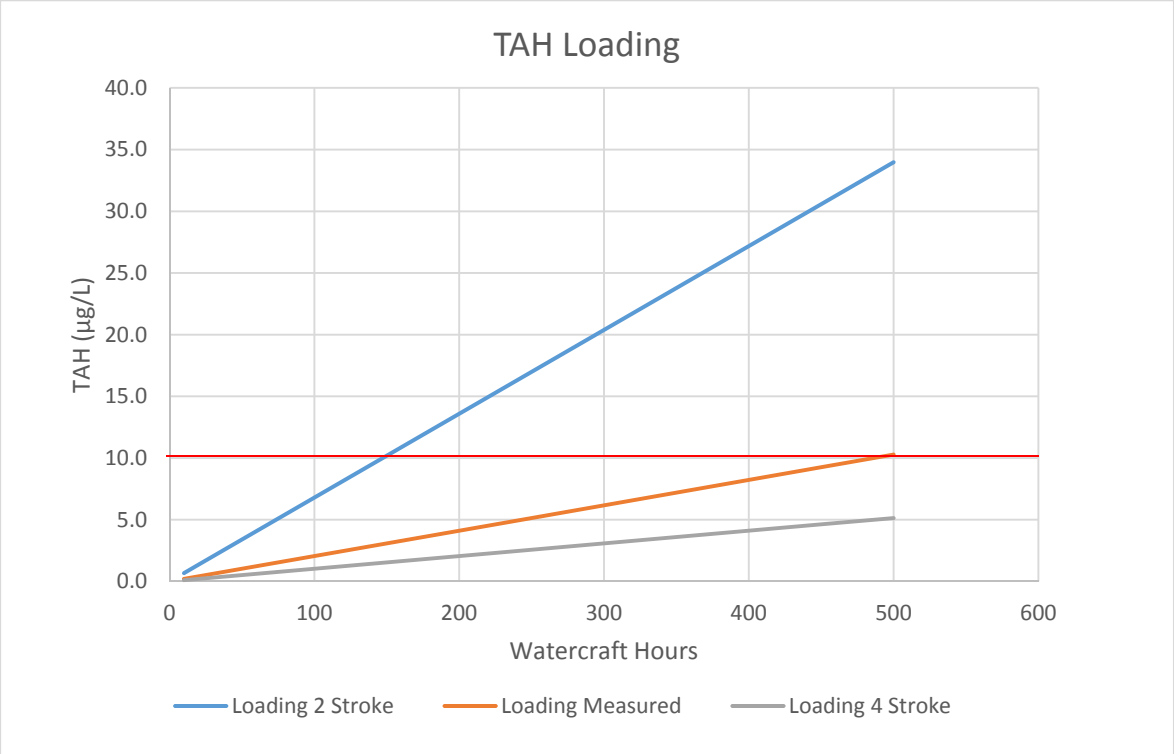
During these two sampling events, ~34 (July 4) to ~200 (June 8 and July 5) gallons of gasoline per day were discharged into Big Lake.



Based on overnight loss, it will take 20 hours for TAH concentration to drop from 30 µg/L to less than 10 µg/L.

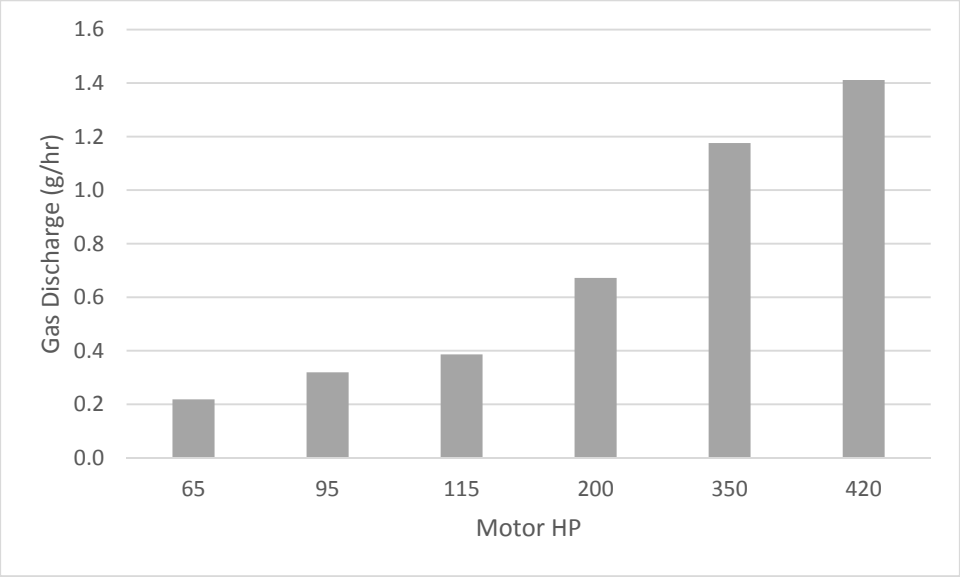


Increasing motor efficiency will result in lower TAH discharge per boat.

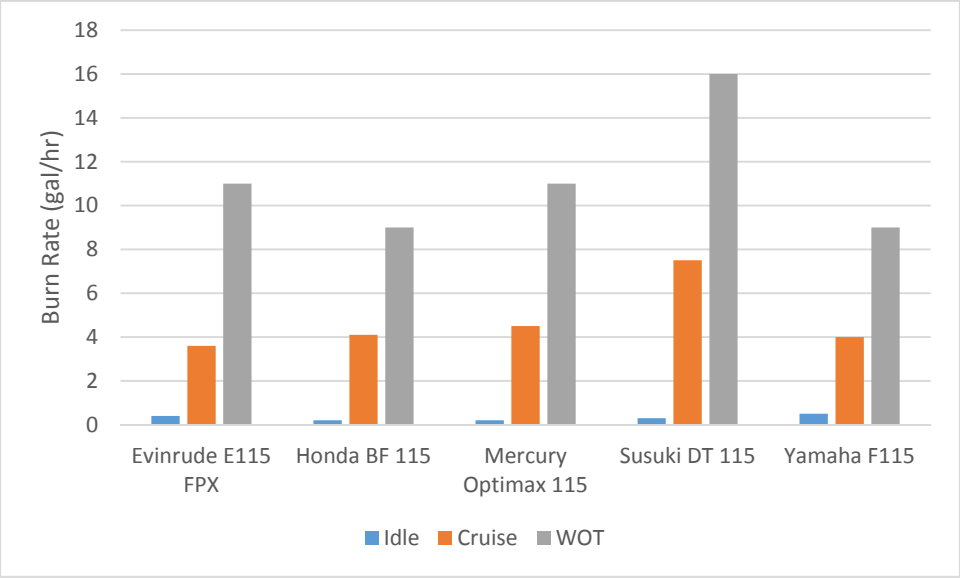


- Approximately 150 watercraft hours of 2- stroke motors at an inefficiency of 27% will result in TAH concentration over 10 µg/L. In 2013 at inefficiencies of 8%, approximately 500 cumulative watercraft hours will result in TAH concentrations over 10 µg/L. Over 900 cumulative watercraft hours would be necessary to reach these levels at an inefficiency of 4%.

Fuel burn rate and discharge can increase with motor HP and operation.



- Estimated gasoline discharge by motor type at an inefficiency of 4% for 4-stroke motors. Fuel burn rate (gal/hr) by HP based on equations in Boating Magazine (Specific Fuel Consumption of 0.5/HP).



- Difference in fuel burn rate for different 115 HP motors at idle, cruise and wide open throttle (source Popular Mechanics).
- At an inefficiency of 4% (average value used to represent a 4-stroke motor), at idle the Yamaha would discharge 1/50th of a gallon, at cruising speed 1/6th of a gallon, and wide open 1/3rd of a gallon of gasoline in an hour. At an inefficiency of 27% (value used to represent a carbureted 2-stroke motor) discharge at idle would be 1/7th of a gallon, at cruising speed 1 gallon, and wide open 2 and ½ gallons of gasoline.