The FTA Microbiology Project – Interim Results.
The Float Conference, Portland ME, 26-28 August 2022

Abstract
Samples of float tank solution from five float centers were analyzed for bacterial density using independent outside certified laboratories. No *E. coli*, coliforms, or *Staphylococcus aureus* were detected. One of three float centers reported low levels of HPC (avg 47.1 CFU/ml, range 33.9-73.8 CFU/ml) whereas the two other float centers that tested for HPC reported >90% of their samples were less than the detection limit. A few samples did detect *Pseudomonas aeruginosa* (7.7%; 10/130) with an average of 3.7 CFU/100 ml (range 1-9 CFU/100 ml). No single sample approached a recognized level of a health threat.

Introduction
Patron health is a core feature of the floating experience. While float tanks superficially may resemble hot tubs, the differences in design, operation and impact on the patron are immensely different. Numerous health departments have attempted to regulate float tanks in the same manner as swimming pools and hot tubs with the assumption that they operate in the same manner and pose the same health threats from infectious disease. Yet, there is extremely limited data on the microbial flora and health risks from exposure while floating. To date there have been only cursory examination of the flora of float solution and one informal assessments of microbial health risks to floating patrons. To better understand the microbial risks from floating the Float Tank Association initiated a collaborative effort to collect microbial data and publish it in a scientific journal. The intent was to involve a number of float centers using their own operating and treatment policies so as to achieve a broad-based sample of existing practices and microbial results. Data presented in this poster is the preliminary summary of shared data since this project was initiated at the Float Conference in 2021.

Material and Methods
Participating float centers

Float centers were contacted during the 2021 Float Conference as well as during FTA open Zoom calls and encouraged to share previous data or to initiate new microbial monitoring. Float centers were instructed how to identify a local certified laboratory and provided a list of testing options from Standard Methods for their microbial testing. In several cases the float centers were assisted in identifying the local testing facility as well as providing background to the laboratory regarding the nature of the testing. Float centers assumed all costs of the testing and were encouraged to provide test results over a several month period for at least two microbial parameters but not to assume testing costs that produced a financial burden on the float center.

Test methods

Float centers discussed testing options and costs with their local certified laboratory and developed their own testing pattern based on cost and testing capability. The test methods used by the participating float centers is shown in Table 1.

Table 1. List of testing options supplied to participating float centers

Test number	Test title	Focus of this test
SM 9213 E.	Membrane Filter Techniques for *Pseudomonas aeruginosa*	The bacteria that causes almost all rashes in swimming pools and hot tubs
SM 9215 D.	Heterotrophic Plate Count: Membrane Filter Method	A general count of viable bacteria of all types
SM 9222 B.	Standard Total Coliform Membrane Filter Procedure using Endo Media	One type of bacteria that may indicate feces are in the float solution
SM 9222 D.	Thermotolerant (Fecal) Coliform Membrane Filter Procedure	One type of bacteria that may indicate feces are in the float solution
AOAC 2003.07	Enumeration of Staphylococcus aureus in Selected Types of Processed and Prepared Foods - 3M Petri-film Staph Express Count Plate Method	Type of human skin bacteria but is not a cause of illness in swimming pools or hot tubs

In communicating the list of testing options float centers were also provided the order of importance that the authors theorized. This order was:

1. *Pseudomonas* (presumptive tests for *Pseudomonas aeruginosa* are adequate)
2. Heterotrophic Plate Count (HPC)
3. Total coliforms (optional rotation between total and fecal coliforms)
4. Fecal coliforms (presumptive results are adequate)
5. *Staph* or *Staph aureu*s (either one, presumptive results are adequate)

Submission and compilation of results

All results were accepted without regard to float tank design, disinfection system, age of the float solution, number of patrons per day/week, or concentration of the float solution at the time of sampling. Float centers submitted data as PDFs of the final report from the outside laboratory. Float centers were assigned an alphabetical letter designation on the order their data was tabulated. The letter assigned has no other significance.

Results

Tables 2 – 5 show results from individual float centers. As can be observed, the reporting limits and methods did vary between participating centers and their laboratories. Cells highlighted in yellow indicate positive growth, none of which indicate significant human health threats.

Table 2. Float Center A

date	Specific gravity	HPC	Total coliform*	fecal coliform	*E. coli*
		result/mL*	result/100 ml		
8-Feb-22		73.8		<1	
22-Feb-22	1.25	33.9	<1		<1
8-Mar-22	n/a	44		<1	
22-Mar-22	1.26	32.4	<1		<1
12-Apr-22	1.26	73.8		<1	
26-Apr-22	n/a	73.8	<1		<1
17-May-22	1.26	47		<1	
31-May-22	1.26	31.1	<1		<1
14-Jun-22	n/a	35.5		<1	
28-Jun-22	n/a	39.2	<1		<1
12-Jul-22	1.26	47		<1	
26-Jul-22	1.26	33.9	<1		<1
	Average	**47.12**	**<1**	**<1**	**<1**
	Samples	**12**	**6**	**6**	**6**

Table 3. Float Center C

date	Tank	*Pseudomonas*	HPC	Total coliform
		result/ ml	result/ ml	result/100 ml
16-Mar-18	1	<1	1	<1
16-Mar-18	2	<1	3	<1
16-Mar-18	3	<1	3	<1
23-Apr-19	OL suite	<1	<1	<1
23-Apr-19	FL suite	<1	<1	<1
23-Apr-19	OL suite	<1	<1	<1
28-Jan-20	FL cabin	<1	<1	<1
28-Jan-20	SL cabin	<1	1	<1
28-Jan-20	Orb cabin	<1	1	<1
	Average	<1	<1	<1
	Samples	9	9	9

Table 4. Float Center B			
date	**Tank**	*Pseudomonas*	fecal coliform
		result/100 ml	result/100 ml
2-Mar-22	1	<1	<1.1
	2	<1	<1.1
	3	<1	<1.1
	4	<1	<1.1
	5	<1	<1.1
	6	<1	<1.1
29-Apr-22	1	<1	<1.1
	2	<1	<1.1
	3	<1	<1.1
	4	<1	<1.1
	5	<1	<1.1
	6	<1	<1.1
27-May-22	1	<1	<1.1
	2	<1	<1.1
	3	<1	<1.1
	4	<1	<1.1
	5	<1	<1.1
	6	<1	<1.1
29-Jun-22	1	<1	<1.1
	2	<1	<1.1
	3	<1	<1.1
	4	<1	<1.1
	5	sample lost	
	6	<1	<1.1
	Average	**<1**	**<1.1**
	Samples	**23**	**23**

Table 5. Float Center D					
date	tank/pod	*Pseudomonas*	HPC	coliform	*E. coli*
		result/mL*	result/mL*	result	result
3-Feb-20	J	**<10**	**<0.2**		
3-Feb-20	J			**N/D**	**N/D**
3-Feb-20	O			**N/D**	**N/D**
3-Feb-20	B			**N/D**	**N/D**
3-Feb-20	O	**<10**	**<0.2**		
3-Feb-20	B	**<10**	**<0.2**		
11-Jan-21	B			**N/D**	**N/D**
11-Jan-21	J	**<1.0**	**<0.2**		
11-Jan-21	J			**N/D**	**N/D**
11-Jan-21	B	**<1.0**	**<0.2**		
11-Jan-21	O			**N/D**	**N/D**
11-Jan-21	O	**<1.0**	**<0.2**		
1-Sep-21	B	**<1.0**	**<0.2**		
1-Sep-21	J	**<1.0**	**<0.2**		
1-Sep-21	J			**N/D**	**N/D**
1-Sep-21	O	**<1.0**	**<0.2**		
1-Sep-21	O			**N/D**	**N/D**
1-Sep-21	B			**Positive**	**N/D**
14-Mar-22	D	**<1**	**<0.2**		
14-Mar-22	Blossom	**<1**	**<0.2**		
14-Mar-22	Oasis	**<1**	**<0.2**		
15-Mar-22	Blossom			**N/D**	**N/D**
15-Mar-22	D			**N/D**	**N/D**
15-Mar-22	Oasis			**N/D**	**N/D**
Notes:			*Reporting limit=0.2/ml	N/D=not detected	N/D=not detected

The single positive coliform noted in float center D was a qualitative presence/absence test. Conventional monitoring methods are quantitative and employed to detect levels of coliforms >2 CFU/100 ml. In conventional monitoring programs any, result showing that bacterial levels that exceed maximum permissible levels are immediately followed up with a repeat test. In this case, a repeat test was not conducted.

Table 5. Float Center E							
date	tank/pod	*Pseudomonas*	HPC	*E. coli*	Fecal coliforms	Total coliforms	*Staph aureus*
		CFU/mL	CFU/mL*	MPN/100 ml	MPN/100 ml	MPN/100 ml	CFU/ml
20-Aug-12	1	<10		<2		<2	
20-Aug-12	2	<10		<2		<2	
20-Aug-12	3	<10		<2		<2	

20-Aug-12	4	<10		<2		<2	
11-Sep-12	2	<10		<2		<2	
24-Sep-12	1	<10		<2		<2	
24-Sep-12	2	<10		<2		<2	
24-Sep-12	3	<10		<2		<2	
24-Sep-12	4	<10		<2		<2	
8-Oct-12	1	<10		<2		<2	
8-Oct-12	2	<10		<2		<2	
8-Oct-12	3	<10		<2		<2	
8-Oct-12	4	<10		<2		<2	
22-Oct-12	1	<10		<2		<2	
22-Oct-12	2	<10		<2		<2	
22-Oct-12	3	<10		<2		<2	
22-Oct-12	4	<10		<2		<2	
		CFU/mL	CFU/mL*	MPN/100 ml	MPN/100 ml	MPN/100 ml	CFU/ml
20-Jun-13	3			absent		absent	
		CFU/100 mL	CFU/mL*	MPN/100 ml	MPN/100 ml	MPN/100 ml	CFU/ml
13-Feb-17	1	<1	<1	<1		<1	<1
13-Feb-17	2	<1	<1	<1		<1	<1
13-Feb-17	3	<1	<1	<1		<1	<1
13-Feb-17	4	<1	<1	<1		<1	<1
13-Feb-17	5	<1	<1	<1		<1	<1
13-Feb-17	6	<1	<1	<1		<1	<1
		CFU/100 mL	CFU/mL*	MPN/100 ml	MPN/100 ml	MPN/100 ml	CFU/ml
1-Feb-18	1	<10	<1		<2	<2	<1
12-Mar-18	2	<1	<1	<1.8		<1.8	<1
12-Mar-18	3	<1	6	<1.8		<1.8	<1
2-Apr-18	3	<1	<1	<1.8		<1.8	<1
2-Apr-18	4	2	<1	<1.8		<1.8	<1
30-Apr-18	5	5	<1	<1.8		<1.8	<1
12-May-18	5	<1	<1	<1.8		<1.8	<1
14-May-18	5	<1	<1	<1.8		<1.8	<1
4-Jun-18	6	1	<1	<1.8		<1.8	<1
8-Jun-18	6	<1					
9-Jun-18	6	<1					
11-Jun-18	6	<1					
11-Jul-18	1	<1	<1	<1.8		<1.8	<1
12-Jul-18	1	<1					
13-Jul-18	1	<1					
8-Aug-18	2	2	<1	<1.8		<1.8	<1
14-Aug-18	2	5					
18-Aug-18	2	<1					

19-Aug-18	2	<1					
29-Aug-18	3	<1	<1	<1.8		<1.8	<1
27-Sep-18	3	<1					
4-Oct-18	3	<1	<1	<2		<2	<1
26-Oct-18	4	<1	<1	<1.8		<1.8	<1
28-Nov-18	5	3	<1	<1.8		<1.8	<1
30-Nov-18	5	<1					
20-Dec-18	6	<1	<1	<1.8		<1.8	<1
20-Dec-18	shower	<1					
1-Feb-19	1	5	1	<1.8		<1.8	<1
22-Feb-19	2	<1	<1	<1.8		<1.8	<1
13-Mar-19	1	<1	<1	<1.8		<1.8	<1
10-Apr-19	4	<1	<1	<1.8		<1.8	<1
8-May-19	5	1	<1	<1.8			<1
20-Jun-19	6	<1	<1	<1.8			<1
11-Jul-22	1	<1	<1	<1.8			<1
1-Aug-19	2	<1	<1	<1.8			<1
28-Aug-19	3	<1	<1	<1.8			<1
4-Oct-19	4	<1	<1				<1
5-Nov-19	5	<1	<1	<1.8			<1
3-Dec-19	6	<1	<1	<1.8		<1.8	<1
16-Jan-20	1	<1	<1	<1.8			<1
28-Feb-20	1		<1				
28-Feb-20	2	<1	<1	<1.8			<1
12-Mar-20	3	<1	<1	<1.8			<1
17-Jul-20	1	<1	<1	<1.8			<1
7-Aug-20	2	<1	<1	<1.8			<1
7-Oct-20	3	<1	<1	<1.8			<1
22-Oct-20	4	9	<1	<1.8			<1
26-Oct-20	4	4					
11-Nov-20	4	<1					
11-Nov-20	5	<1	<1	<1.8			
18-Dec-20	6	<1	<1	<1.8			<1
8-Jan-21	1	<1	<1	<1.8			<1
11-Feb-21	2	<1	<1	<1.8			<1
5-Mar-21	3	<1	<1	<1.8			<1
6-Apr-21	4	<1	<1	<1.8			<1
7-May-21	5	<1	<1	<1.8			<1
15-Jul-21	6	<1	<1	<1.8			<1
20-Aug-21	1	<1	2	<1.8			<1
8-Sep-21	1	<1	<1	<1.8			<1

8-Sep-21	2	<1	<1	<1.8			<1
7-Oct-21	n/a	<1	<1	<1.8			<1
9-Mar-22	3	<1	<1	<1.8			<1
9-Mar-22	4	<1	<1	<1.8			<1
4-May-22	5	<1	<1	<1.8			<1
8-Jun-22	6	<1	<1	<1.8			<1

Cells highlighted in yellow indicate recovery of viable bacterial. The levels detected were well below those that indicate a human health threat.

Table 6. summarizes the results from all float centers.

Table 6.A. Summary of individual samples collected at each float center.

Center	total samples	*Pseudomonas aeruginosa**	HPC**	*E. coli****	Fecal coliforms / 100 ml***	Total coliforms ***	*Staphylococcus aureus**
A	24		12	6	6		
B	46	23			23		
C	27	9	9			9	
D	48	12	12	12		12	
E	318	86	58	72		46	56
total	**463**	**130**	**91**	**90**	**29**	**67**	**56**

Table 6.B. Average results from samples analyzed

Center	total samples	*Pseudomonas aeruginosa**	HPC**	*E. coli****	Fecal coliforms / 100 ml***	Total coliforms ***	*Staphylococcus aureus**
A	24		47.12/ ml	<1/100 ml	<1/100 ml	<1/100 ml	
B	46	<1/100 ml			<1.1/100	N/D	
C	27	<1 /ml	1/ml	<1/100 ml		<1/100 ml	
D	48	<1/ml	<0.2/m l	<1/100 ml		<1/100 ml	
E	318	<1/100 ml	<1/ml	<2/100	only 1 sample	<2/100	<1/ml
	463						

Table 6.C. Percentage of samples showing bacterial level of concern.

Center	total samples	*Pseudomonas aeruginosa**	HPC**	*E. coli****	Fecal coliforms / 100 ml***	Total coliforms ***	*Staphylococcus aureus**
A	24		0%		0%		
B	46	0%			0%		
C	27	0%	0%			0%	
D	48	0%	0%	0%		0%	
E	318	0%	0%	0%		0%	0%

total	**463**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**

* The US EPA has not established a limit for this organism in swimming pools or hot tubs

** The US EPA established limit is ≤200/ml

*** The US EPA established limit is ≤2/100 ml

Discussion

All coliform, fecal coliform and *E. coli* specific tests were negative (0/67 coliform, 0/29 fecal coliform, and 0/90 *E. coli*, respectively). *E. coli* and similar Gram negative bacteria are known to display die off patterns in saline environments. Future studies should consider using enterococci as a means of monitoring for fecal bacteria.

The heterotrophic plate count (HPC) showed considerable variability between the three float centers reporting HPC results. The two float centers with nearly all results at less than the detection limit did not report hold times for their samples. Float Center A had well documented sampling and transmittal times and reported an average HPC of 47.1 CFU/ml (range 33.9 to 73.8 CFU/ml). All values reported by float center A were well below the maximum permissible limit of 200 CFU/ml.

No viable *Staphylococcus aureus* were recovered (0/56). *S. aureus* are most resistant to high osmotic pressure of the bacteria monitored in this survey. As such, this species is likely to survive for an extended period in the hypersaline environment of a float solution. The method used in this study was designed for monitoring food and specifically for disease causing strains of *S. aureus*. It would have been more appropriate to monitor for total staphylococci using non-specific methods such as SM 9213 B.6.

A few samples did detect *Pseudomonas aeruginosa* (7.7%; 10/130) with an average of 3.7 CFU/100 ml (range 1-9 CFU/100 ml). The US EPA has not established a maximum permissible concentration of *Pseudomonas* in swimming pools or spas. Nor has the minimum infective concentration been determined. One study in the mid-1980s recovered *Pseudomonas* from chlorinate and brominate hot tubs and suggested that cells densities of $>10^3$ CFU/ml were needed for infection of health individuals (Price and Ahearn, 1988). The levels detected here are 10,000 time lower than those suggested by Price and Ahearn. *Pseudomonas* is not able to replicate at high osmotic pressures. This is particularly the case with float solution. NSF International demonstrated a >99 reduction in *Pseudomonas* concentration in 24 hours in uncirculated float solution (NSF International J-00114729). It is highly likely that the population detected was either transitory or due contamination of during sampling by untrained personnel.

This survey was limited in several aspects:

1. The outside laboratories employed standardized methods which were not optimized for enumerating bacteria in a hypersaline medium such as float solution. High levels of magnesium sulfate may have reduced the recovery and enumeration of sub-lethally injured cells. However, the methods used are those that will be readily

available to public health officials if they choose to monitor the hygiene of float centers. Therefore, these results are predictive of future monitoring programs.

2. The samples were not collected, documented and transported by trained personnel. This resulted in numerous samples with poor documentation, improper hold times and improper temperature holds. The net impact of this in not known. At least one center, Float Center A, did have proper hold and processing times. Float Center A results do show some HPC counts but a total lack of coliforms of all types. This tends to support the overall results on coliforms but suggests that the HPC counts from other centers may be under-reported.

Conclusions

The microbial health risk from bacteria in float solution is comparable to that in well maintained swimming pools and hot tubs. A total of 155 samples were collected and produced a grand total of 463 separate assays for bacteria. No single sample exceeded the maximum permissible level of coliforms, fecal coliforms or *E.coli.* Nine samples did contain *Pseudomonas aeruginosa* with a range 3.7 CFU/100 ml which is 1,000 times lower than likely minimum infective dose of a health adult.

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