Introducing Freshwater Beach Monitoring Program at PHSKC

Presented by:
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Public Health
Seattle & King County

My areas of responsibility include:

- Sewage Release Response
- Freshwater Beach Monitoring
- Marine Beach Monitoring
- Toxic Algae (HABs) Monitoring
- Recreational Shellfish Beach Monitoring
- Miscellaneous Water Rec work

Position funded through Foundational Public Health Services to deal with sewage

Topics Covered

- Freshwater Beaches in King County
- Health and Safety Hazards at Freshwater Beaches
- Laws, Rules, and Standards
- How PHSKC is Regulating Freshwater Beaches

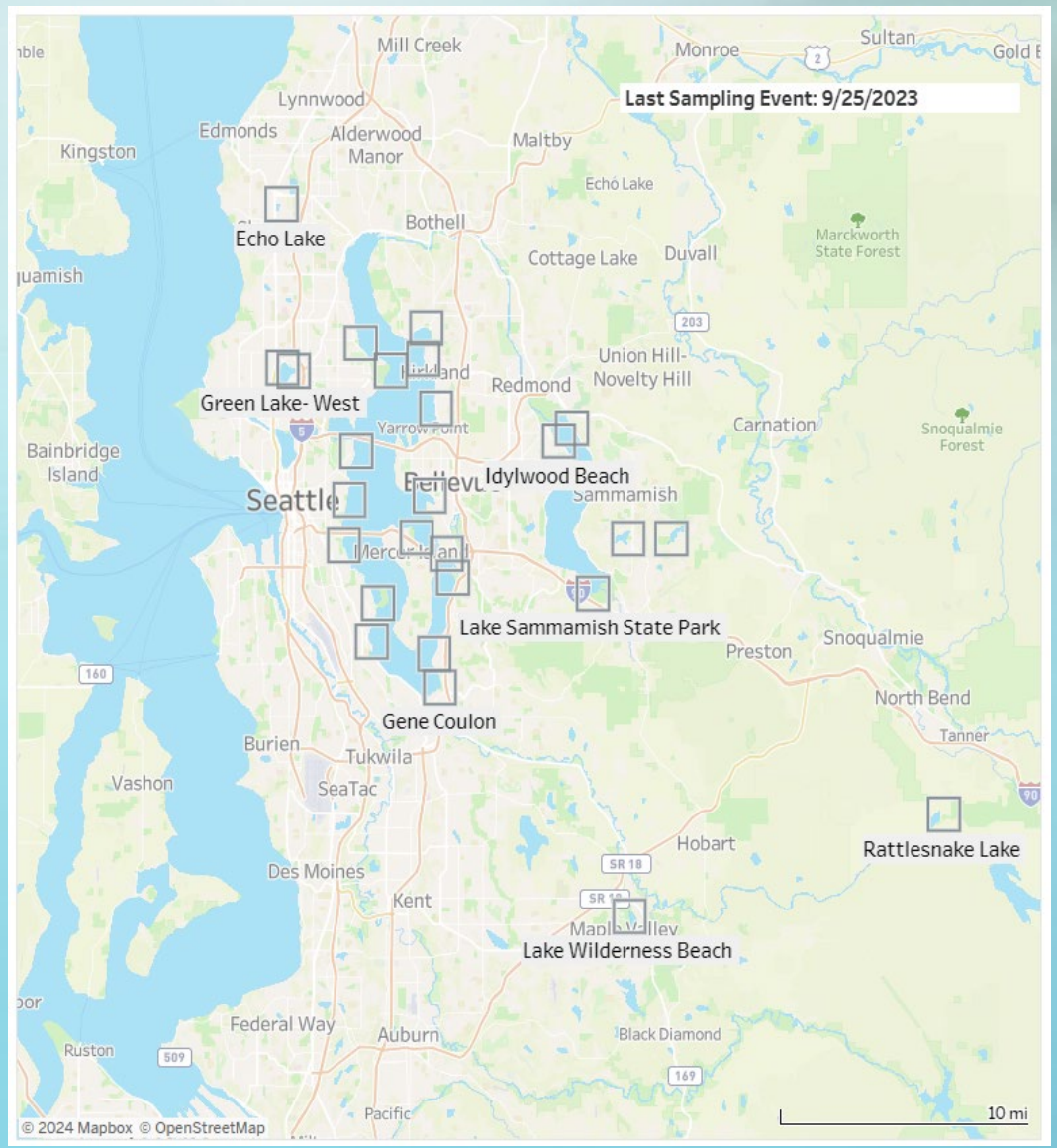
Freshwater Beaches in King County

Freshwater Beaches in King County

- We currently monitor 27 freshwater beaches in King County
- 8 Lakes involved

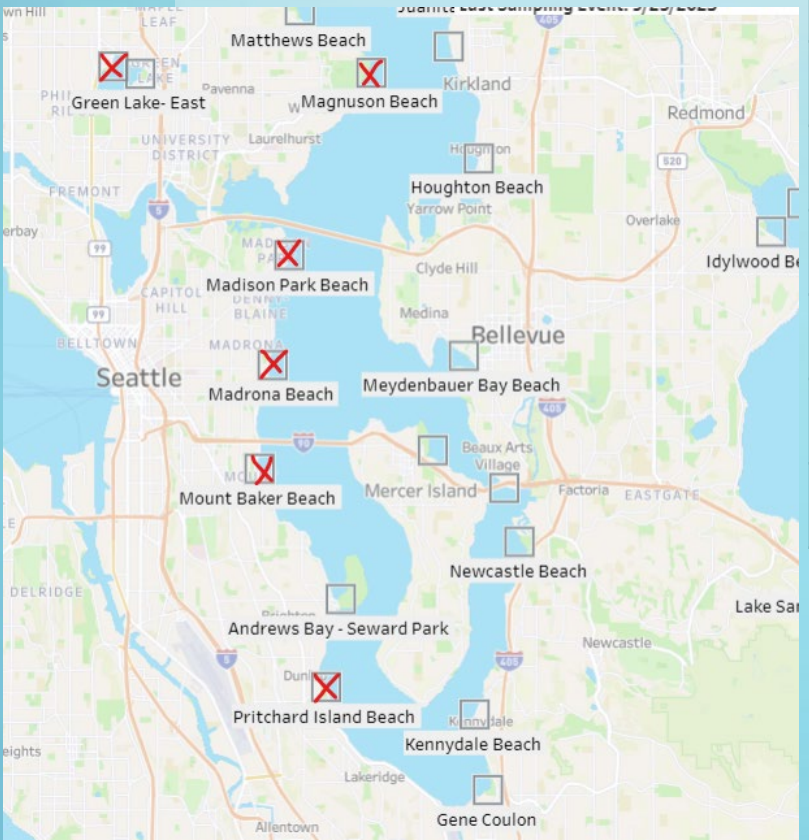
Lake	# of beaches
Lake Washington	17
Lake Sammamish	3
Green Lake	2
Beaver Lake	1
Echo Lake	1
Fivemile Lake	1
Lake Wilderness	1
Pine Lake	1

- 11 Municipalities involved



Beach Usage by Year

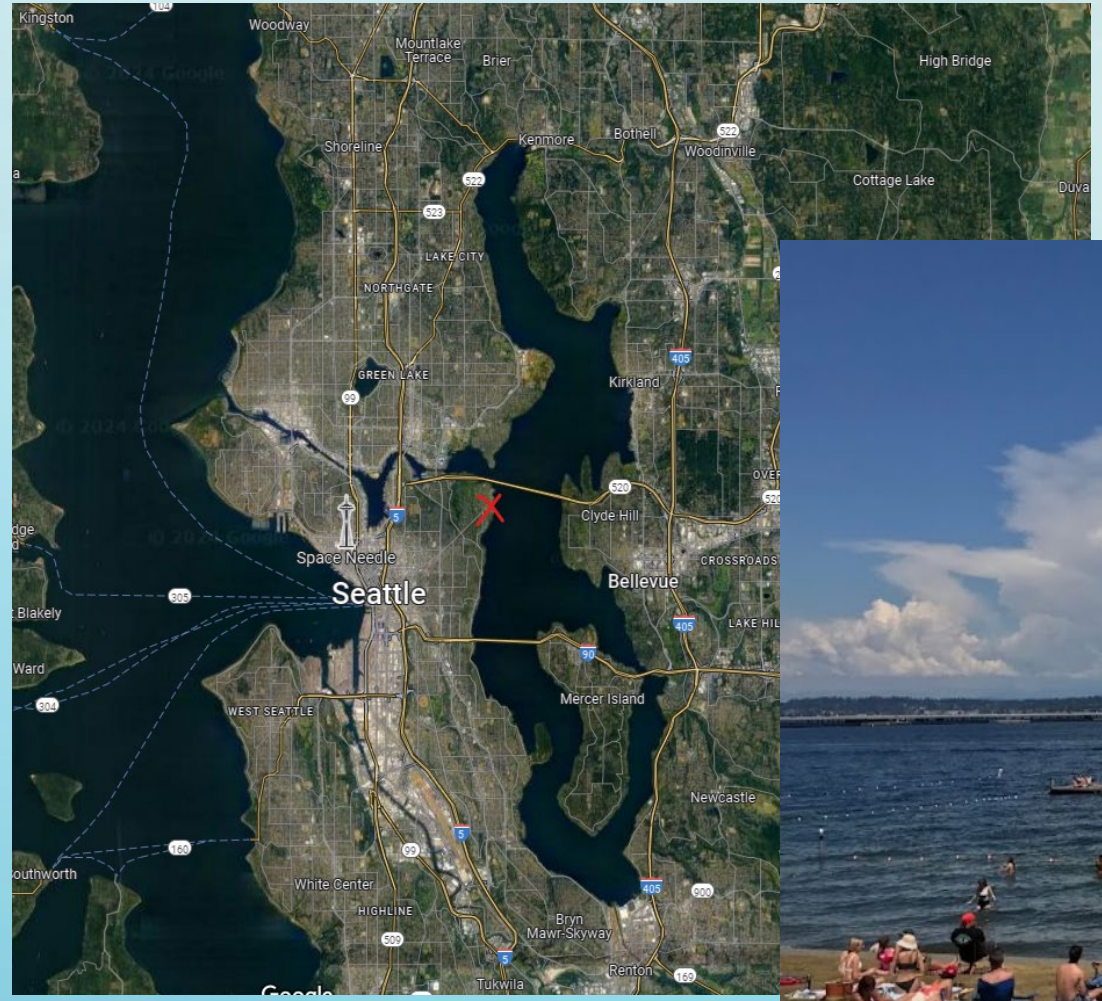
Seattle Parks Department counts bathers every 2 hours during open hours (4 times a day)



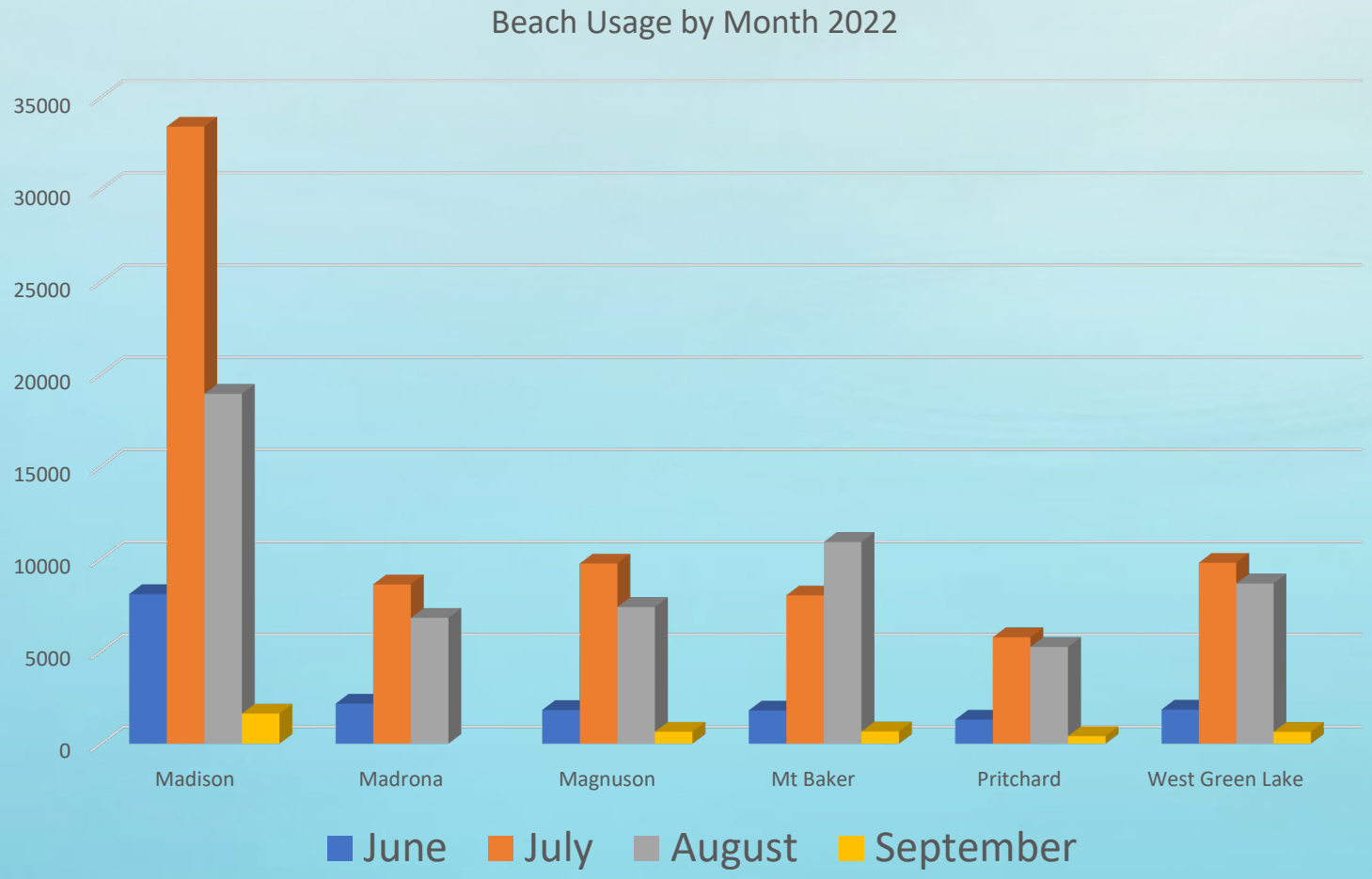
Year	2020 (1st COVID year)		2021		2022	
	# of bathers observed					
	Active	Passive	Active	Passive	Active	Passive
Madison	**4776**	**19126**	**11765**	**45728**	**12030**	**50025**
Madrona	N/A	N/A	4991	11720	4254	13325
Magnuson	1674	5514	3991	10614	5862	13731
Mt Baker	868	2259	3995	8488	5962	15446
Pritchard	N/A	N/A	2196	6105	3215	9470
Green Lake West Beach	2818	7081	N/A	N/A	8571	12339

City of Seattle Parks Department Data

Madison Park Beach



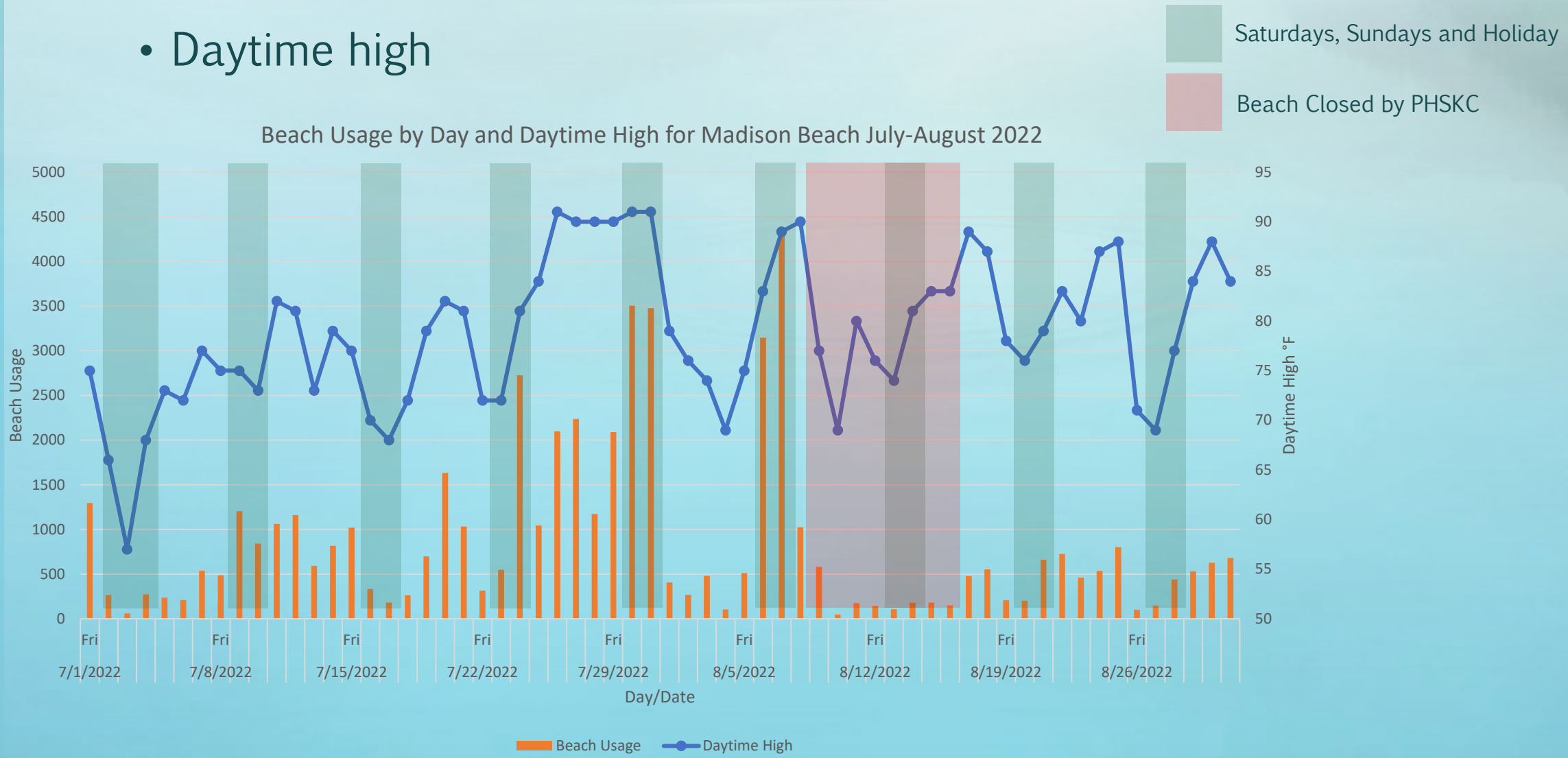
Beach Usage (Active + Passive) by Months in 2022



# of Days Included in Counting	
June	6
July	31
August	31
September	5

Beach Usage for Madison Beach in Jul-Aug 2022 by:

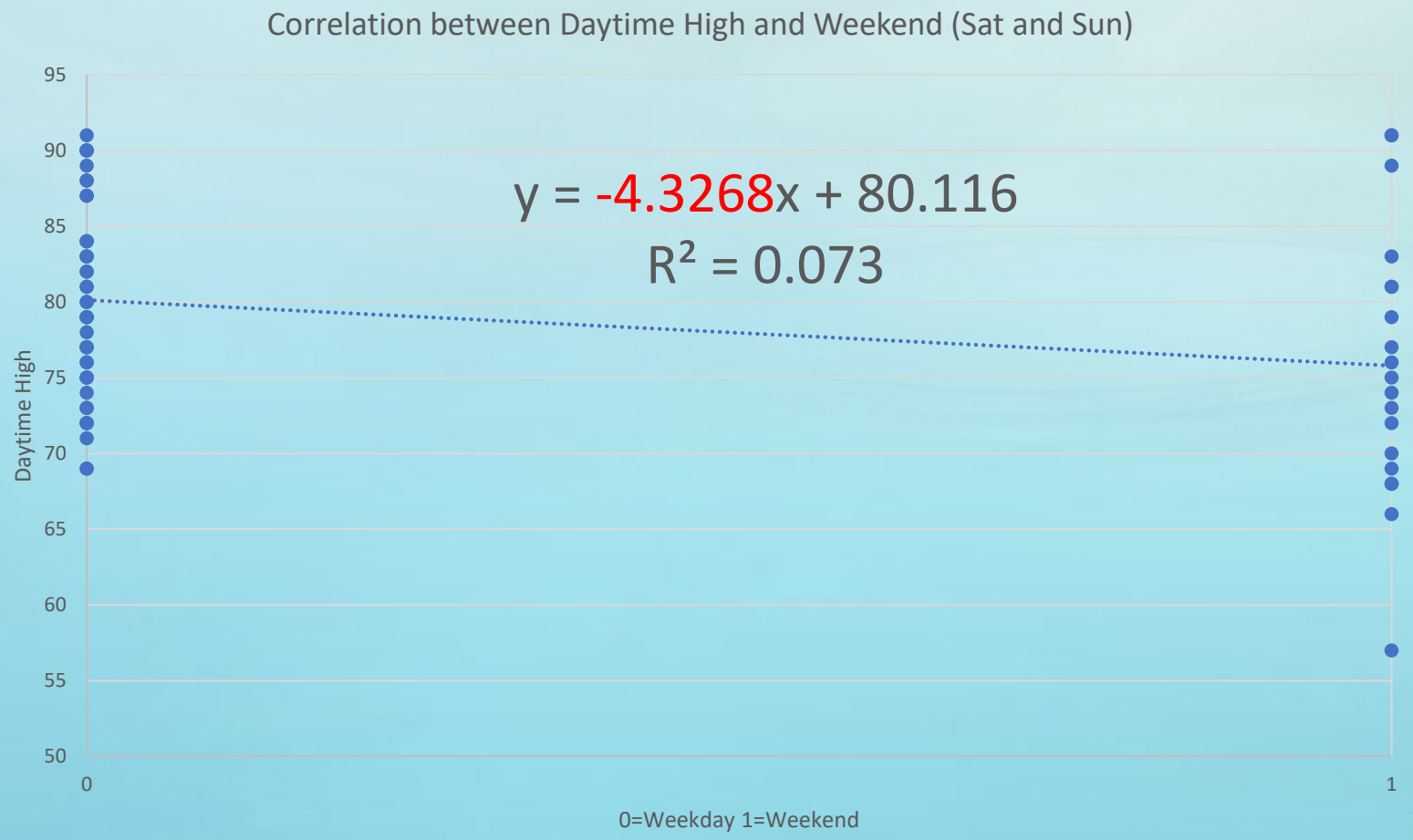
- Day of the week
- Daytime high



Correlation between Daytime Highs and Weekday Vs Weekend

Madison Beach Jul-Aug 2022

N=62



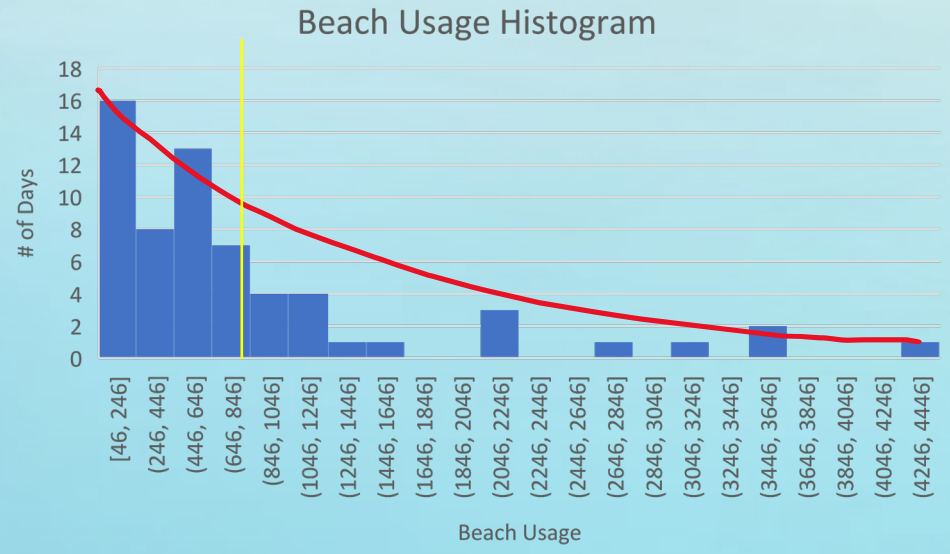
Weekends were 4.3 degrees cooler than weekdays on average but it's a weak correlation

Distribution of Daily Beach Usage

Madison Beach Jul-Aug 2022

N=62

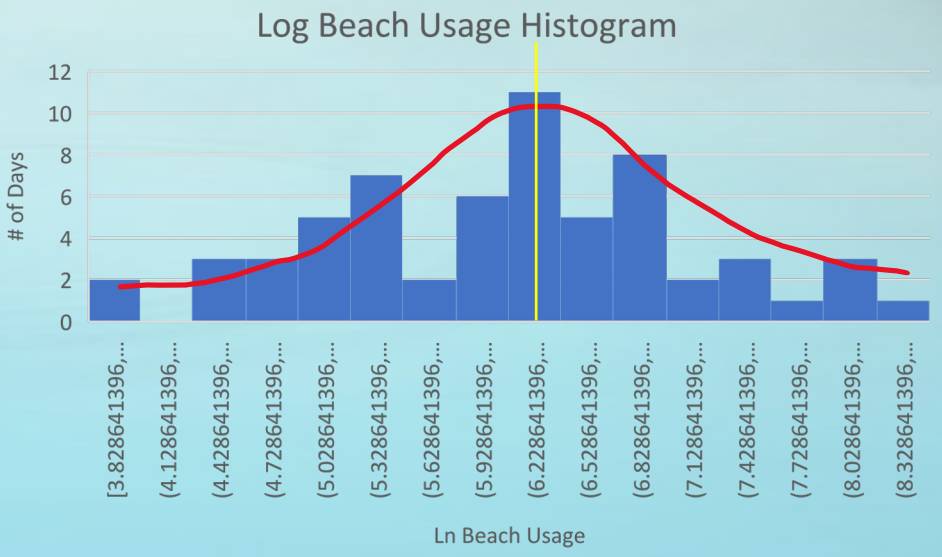
Raw Beach User Count



Arithmetic mean = 844

Natural Logarithm of Beach User Count

$Log_e(Beach\ User\ Count)$

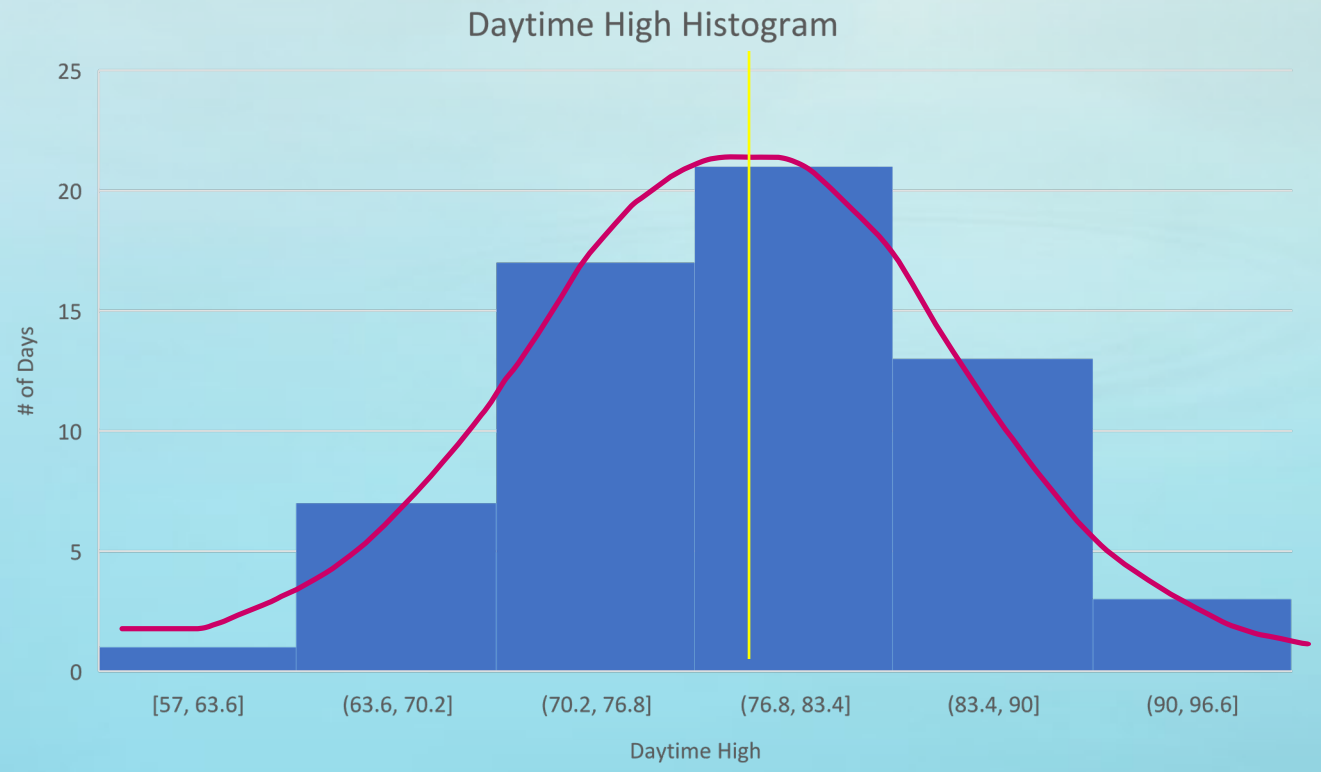


Arithmetic mean = 6.24
Antilog of arithmetic mean = 513

Daytime High Distribution

Madison Beach Jul-Aug 2022

N=62

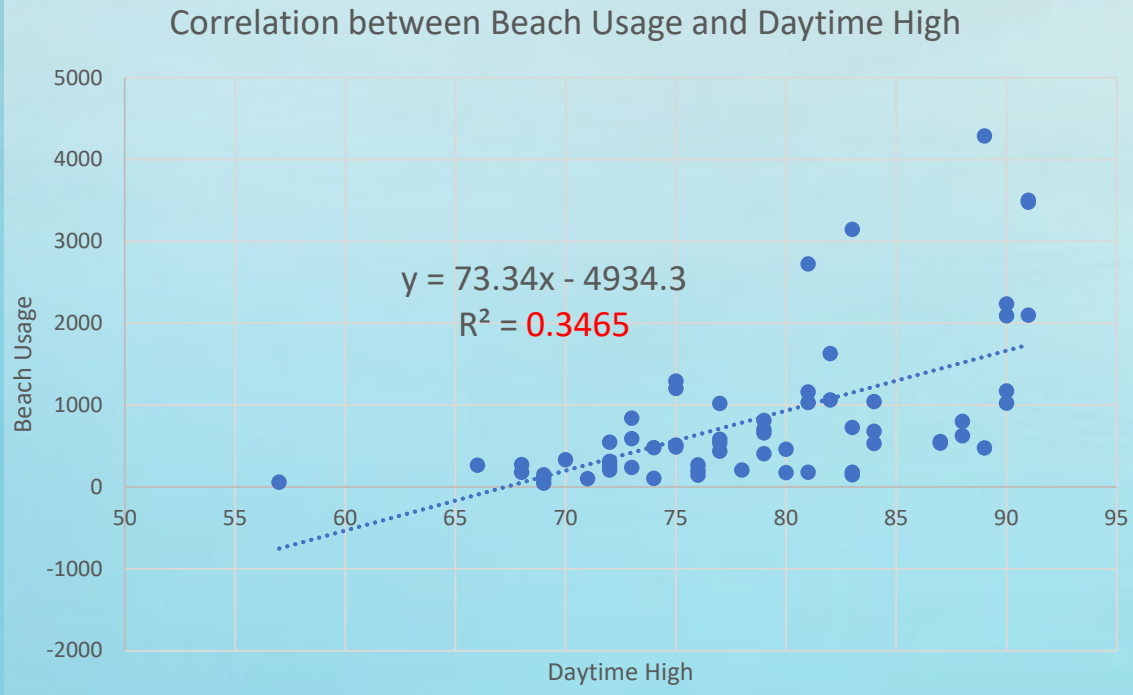


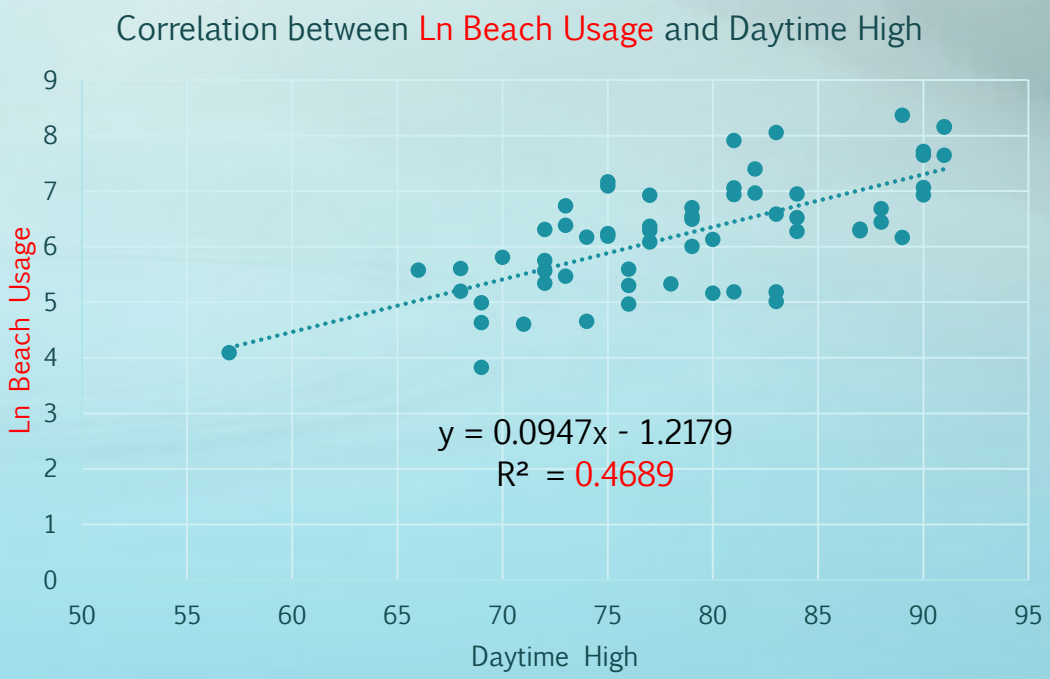
Arithmetic Mean = 78.8°F

Correlation between Daytime Highs and Beach Usage

Madison Beach Jul-Aug 2022

N=62





Stronger correlation when Log transformed

# Multivariate Regression Analysis with:
N=62

- Natural Log of Beach Usage as the Dependent Variable
- (Daytime High), (Weekday/Weekend), and (Beach Open/Closed) as the Independent Variables

Regression Statistics	
Multiple R	0.995168912
R Square	0.990361164
Adjusted R Square	0.973085271
Standard Error	0.636472546
Observations	62

	Coefficients	*P-value*
Intercept	0	#N/A
Weekend	0.404087895	0.022331
Closed	-1.19850515	1.56E-05
Temp	0.07951497	6.01E-56

At Madison Beach:

- $Beach\ Usage = e^{0.40409(Weekend) - 1.1985(Closed) + 0.079515(Daytime\ High)}$
- 97% of variability in Beach Usage explained by this model
- Weekend brings 50% more people than weekday does on average ($e^{0.40409} = 1.4979$)
- Beach closure brings 70% less people than otherwise ($e^{-1.19850515} = 0.30164$)
- Each 1 degree increase in daytime high brings 8% more people to the beach ($e^{0.07951497} = 1.08276$)

Disclaimer: This is a limited study with a very narrow scope!

Beach Usage

Beach Usage Pattern:

- Weekends bring more people to the beach
- Warmer temperatures bring more people to the beach
- Beach closure advisory is moderately effective at keeping people away from the beach (out of the water)

Things to keep in mind:

- High beach usage = A lot of exposure to beach water
- High fecal bacteria levels on a hot weekend is a big concern
- Beaches are sometimes used as cooling centers on hot days (Balancing between exposure to fecal bacteria and heat related risks is important)
- Who does and doesn't have access to alternatives (pools, air-conditioned places, etc.)?

Health and Safety Hazards at Freshwater Beaches

Health and Safety Hazards at Freshwater Beaches

- Physical hazards (Drowning and other injuries)
- Exposure to extreme temperatures and sunlight
- Pathogenic microorganisms (naturally occurring or through pollution) Focus of this presentation
- Toxic algae
- Hazardous chemical and physical agents
- Hazardous aquatic organisms (Swimmer's itch, Mosquitos, Alligators, Snakes, etc.)

Pathogenic microorganisms

- Fecal bacteria (mostly come from animals)
- Fecal viruses (mostly come from humans)
- Fecal parasites (can come from humans or animals)

Focus of this presentation

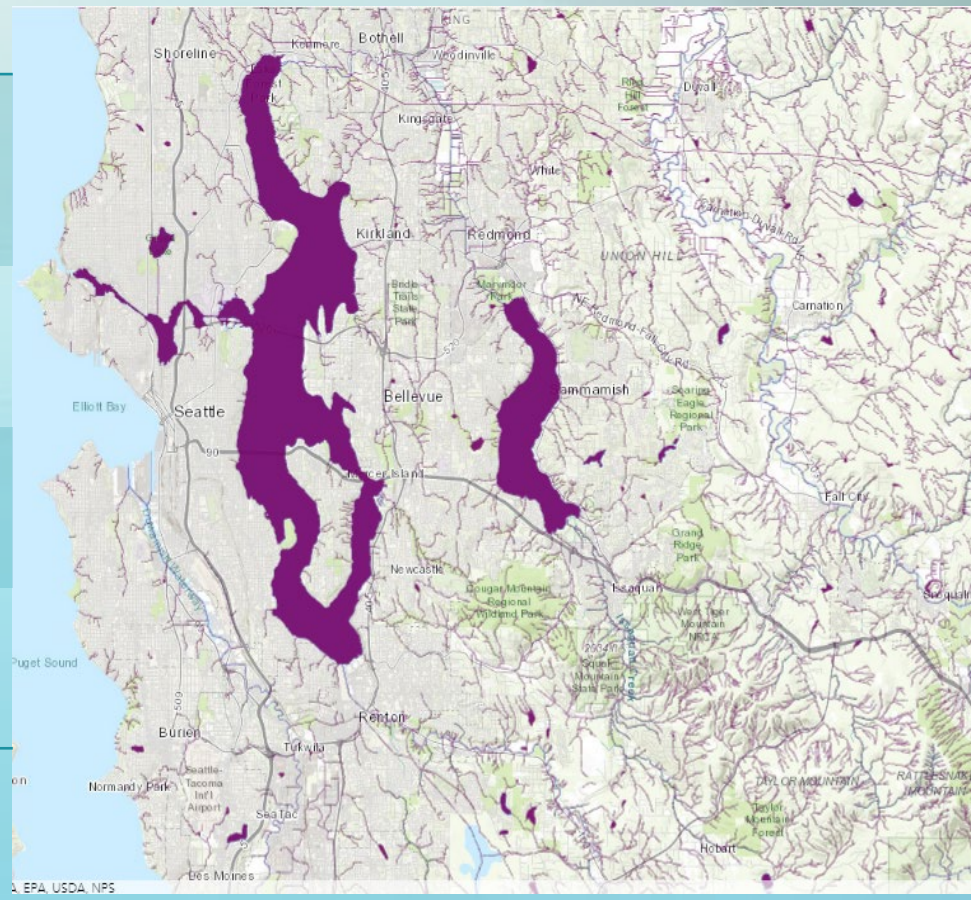
- Vibrio species (can be naturally occurring)
- Amoebae (can be naturally occurring)

Laws, Rules, and Standards

Laws and Rules related to this Program

Authority	Laws/rules
EPA	Clean Water Act, CFR Title 40, Chapter I, Subchapter D, Part 131 (Water Quality Standards)
WA Dept. of Ecology	WAC 173-201A (Water Quality Standards for Surface Waters of the State of Washington)
SBOH/DOH LHJs	WAC 246-260-180 (Bathing Beaches)
LHJs	RCW 70.05.070 (Local Health Officer - Powers and duties)

https://apps.ecology.wa.gov/waterqualityatlas/wqa/map



Purple means the waterbody is for Primary Contact Recreation as per ECY

History of Beach Water Quality Standards

1968 US Department of Interior

- Fecal Coliform
- Geomean < 200 CFU/100mL
- No more than 10% of samples > 400 CFU/100mL

1976 US EPA

- Adopted US Department of Interior's criteria

1986 US EPA

- Enterococci or E. coli
- For 8 HCGI cases per 1,000 recreators
- Designated Beach Area
- E. Coli Geomean < 126 CFU/100mL
- No single sample > 235 CFU/100mL

2012 US EPA

- Enterococci or E. coli
- For estimated illness cases of 32 per 1,000 recreators
- E. Coli Geomean < 100 CFU/100mL
- No more than 10% of samples > 320 CFU/100mL

2019 WA Dept. of Ecology

- Adopted US EPA 2012 criteria (32 illness cases per 1,000 recreators)
- Primary Contact Recreation
- Enterococci for marine water
- E. Coli for freshwater

What is geomean?

Arithmetic Mean (Average)

$$= \frac{x_1 + x_2 + x_3 + \cdots + x_n}{n}$$

1	2	6	100

$x_1 + x_2 + x_3 + \cdots + x_n =$ 109

$n =$ 4

$Arithmetic\ Mean =$ 27.3

Vs

Geomean (Geometric mean)

$$= \sqrt[n]{x_1 \times x_2 \times x_3 \times \cdots x_n}$$

1	2	6	100

$x_1 \times x_2 \times x_3 \times \cdots \times x_n =$ 1200

$n =$ 4

$Geomean =$ 5.8857

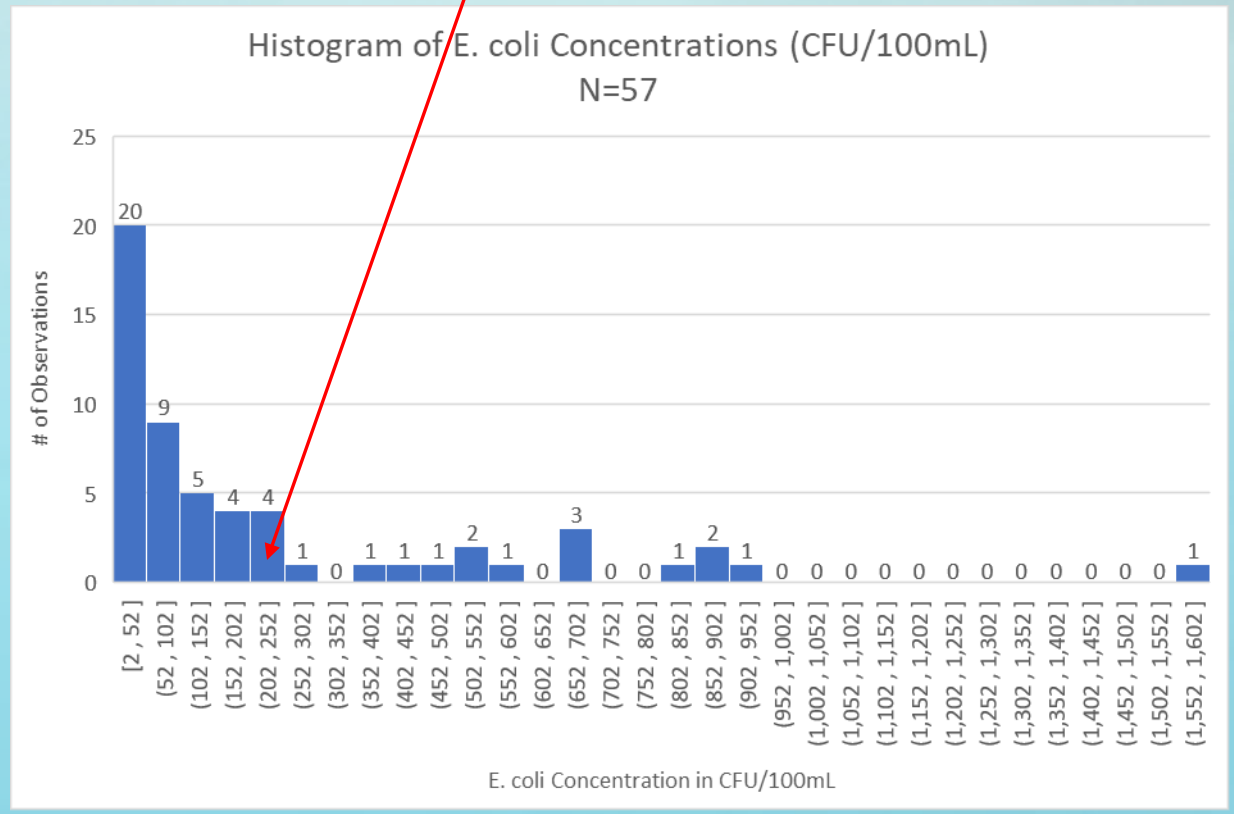
Why geomean?

Raw Data			
Sample Date (mm/dd/yy)	**Sample 1**	**Sample 2**	**Sample 3**
5/13/2019	21	32	28
5/20/2019	**450**	220	**690**
5/28/2019	72	130	56
6/3/2019	14	17	34
6/10/2019	250	**370**	**930**
6/17/2019	**520**	80	190
6/24/2019	52	7	21
7/1/2019	170	180	46
7/8/2019	**670**	**1600**	230
7/15/2019	120	120	53
7/22/2019	140	**550**	43
7/29/2019	**490**	31	24
8/5/2019	46	61	290
8/12/2019	86	86	65
8/19/2019	**870**	250	200
8/26/2019	10	6	2
9/3/2019	5	2	31
9/9/2019	**680**	60	**560**
9/16/2019	**810**	120	**860**

Raw data for Matthews Beach in 2019

Bacteria concentrations are not normally distributed (N=57)

Arithmetic mean = 241 CFU/100mL



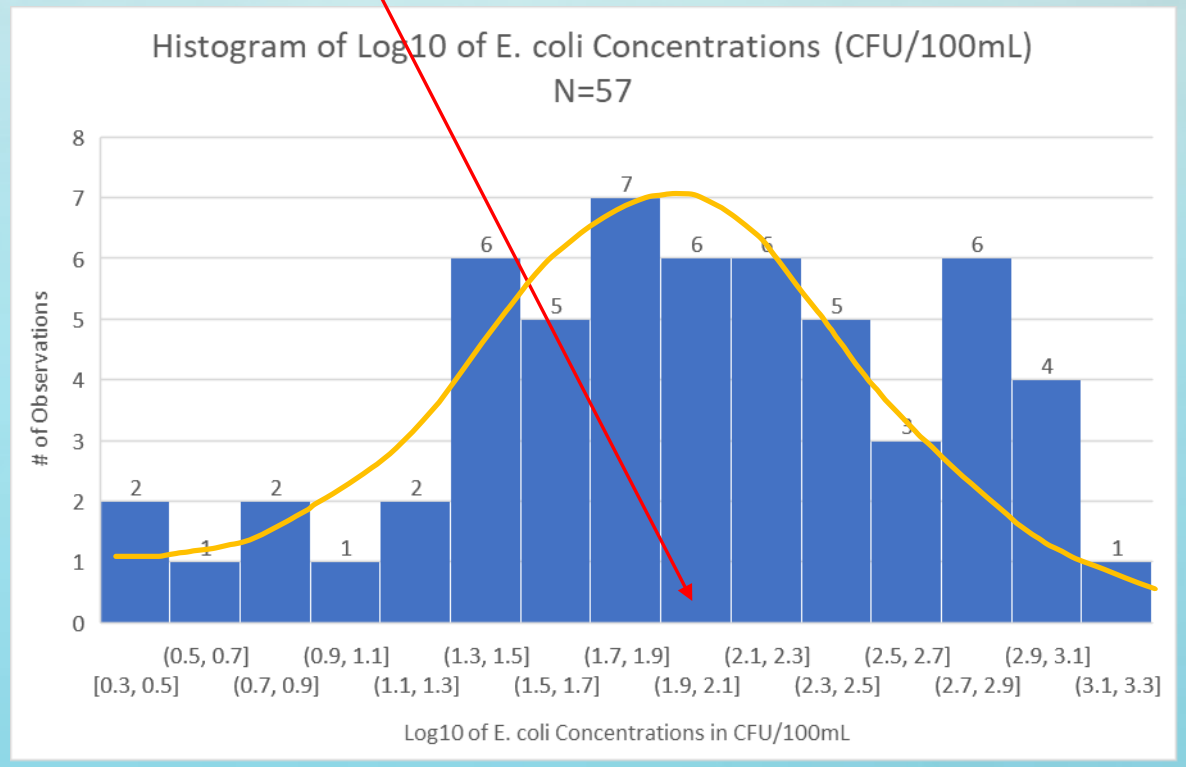
Why geomean? (continued)

Log Transformed Data			
Sample Date (mm/dd/yy)	Sample 1	Sample 2	Sample 3
5/13/2019	1.32	1.51	1.45
5/20/2019	2.65	2.34	2.84
5/28/2019	1.86	2.11	1.75
6/3/2019	1.15	1.23	1.53
6/10/2019	2.40	2.57	2.97
6/17/2019	2.72	1.90	2.28
6/24/2019	1.72	0.85	1.32
7/1/2019	2.23	2.26	1.66
7/8/2019	2.83	3.20	2.36
7/15/2019	2.08	2.08	1.72
7/22/2019	2.15	2.74	1.63
7/29/2019	2.69	1.49	1.38
8/5/2019	1.66	1.79	2.46
8/12/2019	1.93	1.93	1.81
8/19/2019	2.94	2.40	2.30
8/26/2019	1.00	0.78	0.30
9/3/2019	0.70	0.30	1.49
9/9/2019	2.83	1.78	2.75
9/16/2019	2.91	2.08	2.93

Log transformed data for Matthews Beach in 2019

Log-transformation makes it closer to normal curve (N=57)

Geomean = 92.4 CFU/100mL
(Log_{10} 92.4 = 1.966)



Do King County's Freshwater Beaches meet the EPA/ECY's Standard?

- Depends on the length of sampling/monitoring period
  - EPA says to use a 30-day period for water quality analysis
  - ECY says 90 days or less

	2019	2020	2021	2022	2023
# of beaches that violated standard at least once in any 30 day period	19	13	11	12	8
# of beaches that violated standard at least once in any 90 day period	13	8	6	9	5
Total # of Beaches Monitored	27	26	26	26	26

2012 US EPA

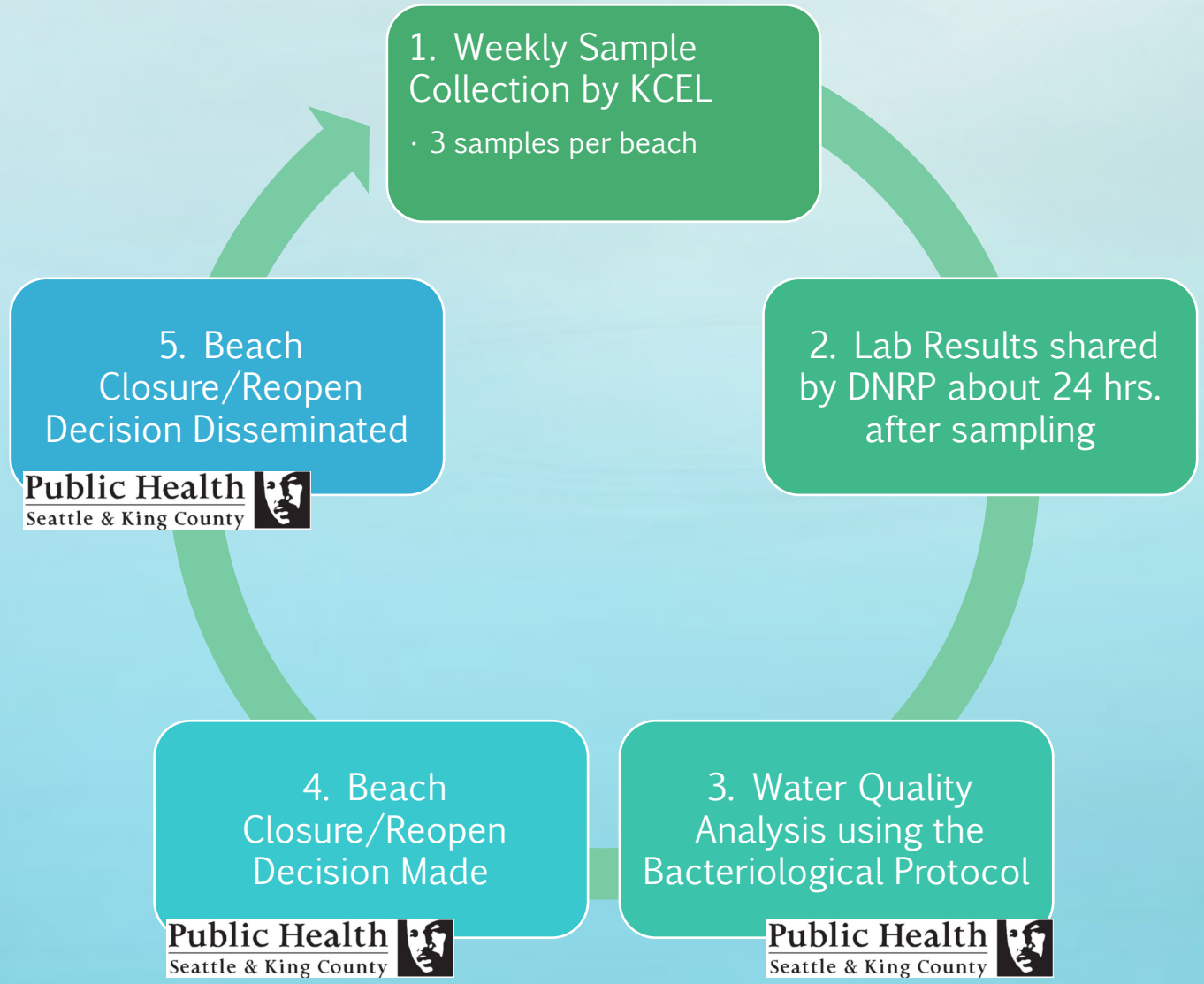
- Enterococci or E. coli
- For estimated illness cases of 32 per 1,000 recreators
- E. Coli Geomean < 100 CFU/100mL
- No more than 10% of samples > 320 CFU/100mL

2019 WA Dept. of Ecology

- Adopted US EPA 2012 criteria (32 illness cases per 1,000 recreators)
- Primary Contact Recreation
- Enterococci for marine water
- E. Coli for freshwater

How PHSKC is Regulating Freshwater Beaches

Weekly Beach Monitoring Process in King County
(Mid-May to Mid-September)



Development of New Beach Action Protocol in 2023

- Beach Action Protocol: Using Sample Results to Make Beach Open/Closure Decisions
- Old protocol (pre-2023): Modeled after an old outdated standard
- New protocol (post-2023): Purpose and objective of the New Protocol
  - Update and Modernize the Protocol Following EPA/ECY Standards
  - Minimize the change in the # of Beach Closures
  - Make it more sensitive to change in water quality so beach advisory decisions are more timely

King County's Freshwater Beach Action Protocol

1. If 2 or 3 samples this week are above 320 CFU/100mL, close the beach.

2. If only 1 sample this week is above 320 CFU/100mL, evaluate the last 30 days and:
    1. Close the beach if there is at least 1 other sample above 320 CFU/100mL in the last 30 days, or
    2. Close the beach if the geomean of all samples in the past 30 days is above 100 CFU/100mL.
    3. Otherwise, the beach remains open.

3. If no samples this week are above 320 CFU/100mL, the beach remains open, or it may reopen if it is currently closed.

This new protocol is more in line with the current EPA/ECY Water Quality Standards than the previous one

Simulation Results and Actual Results

Comparison between Previous and Current Protocols

	Previous Protocol	New Protocol
	# of Beach-week closures	# of Beach-weeks closures
2019	81	71
2020	39	44
2021	38	37
2022	34	41
2023	**15**	**18**

Successfully avoided changing the # of beach closures compared to the previous protocol!

Results (Continued)

Timeliness comparison between Previous and Current Protocols

Previous Protocol			New Protocol		
2019	Success rate=	81%		Success rate=	94%
2020	Success rate=	89%		Success rate=	96%
2021	Success rate=	88%		Success rate=	97%
2022	Success rate=	89%		Success rate=	97%
2023	Success rate=	93%		Success rate=	97%

Success is defined as:

- Closing the beach when at least one sample shows a number higher than 320 CFU/100mL
- Reopening the beach when there is no sample above 320 CFU/100mL

Increased the success rate!

Results (Continued)

Actual beach advisory decisions in 2023

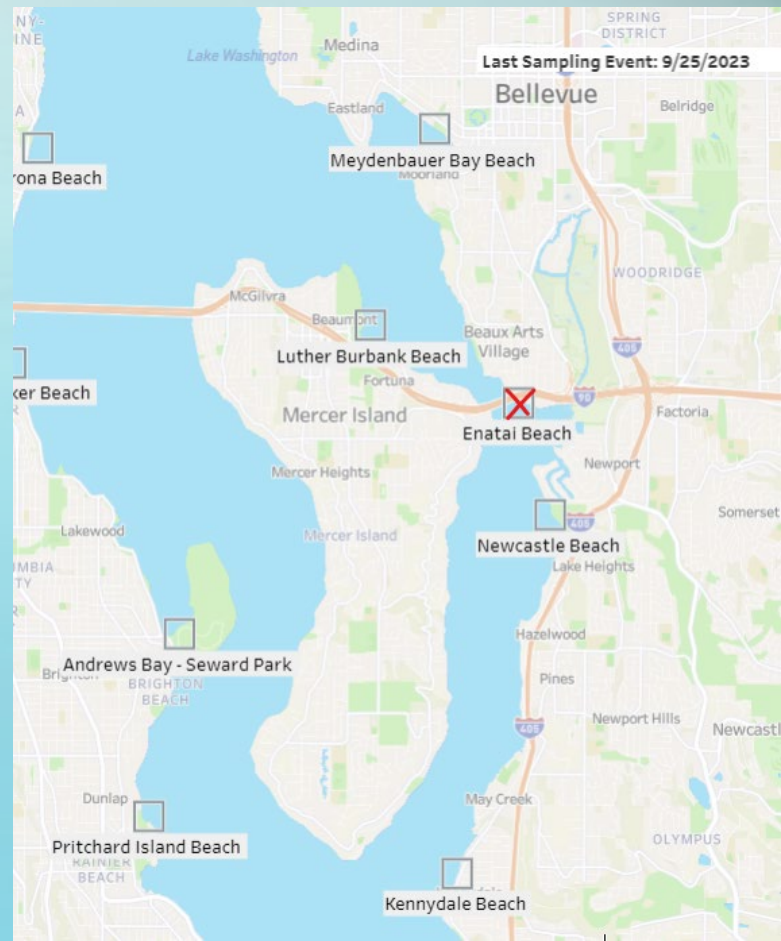
		Beaver Lake	Echo Lake	Enatai	Gene Coulon	Green Lake E	Green Lake W	Groveland	Houghton	Idylwood	Juanita	Kennydale	Lake Wilderness	Luther Burbank	Madison Park	Madrona	Magnuson	Matthews	Meydenbauer	Mt Baker	Newcastle	Pine Lake	Pritchard	Sammamish Landing	Sammamish State Park	Seward Park	Waverly Park
Week 1	May		Open	Open	Open	Open	Open		Open	Open	Open	Open	Open	Open	Open	Closure	Open	Open	Open	Open	Open		Open		Open	Open	Open
Week 2	May		Open	Open	Open	Open	Open		Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Closure	Open		Open		Open	Open	Open
Week 3	May	Open	Open	Open	Open	Open	Open		Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Closure	Open	Open	Open	Open	Open	Open	Open
Week 4	June	Skipped	Open	Open	Open	Open	Open		Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Closure	Open	Skipped	Open	Skipped	Open	Open	Open
Week 5	June	Open	Open	Open	Open	Open	Open		Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Closure	Open	Open	Open	Open	Open	Open	Open
Week 6	June	Skipped	Open	Open	Open	Open	Open	Open	Open	Open	Closure	Open	Open	Open	Open	Open	Open	Open	Open	Closure	Open	Skipped	Open	Skipped	Open	Open	Open
Week 7	June	Open	Open	Closure	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open
Week 8	July	Skipped	Open	Open	Open	Open	Open	Open	Closure	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Skipped	Open	Skipped	Open	Open	Open
Week 9	July	Open	Open	Open	Closure	Open	Open	Open	Open	Open	Open	Open	Open	Open	Closure	Open	Open	Closure	Open	Open	Open	Open	Open	Open	Open	Open	Open
Week 10	July	Skipped	Open	Open	Closure	Open	Open	Open	Closure	Open	Open	Open	Open	Open	Open	Open	Open	Closure	Open	Open	Open	Skipped	Open	Skipped	Open	Open	Open
Week 11	July	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open
Week 12	July	Open	Open	Open	Open	Open	Open	Open	Closure	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open
Week 13	August	Open	Open	Closure	Open	Open	Open	Open	Closure	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open
Week 14	August	Open	Open	Closure	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open
Week 15	August	Open	Open	Open	Open	Open	Open	Open	Closure	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open
Week 16	August	Open	Open	Open	Open	Open	Open		Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Closure	Open	Open	Open	Open	Open	Open
Week 17	August	Open	Open	Open	Open	Open	Open		Closure	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open
Week 18	September		Open	Open	Open	Open	Open		Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open		Open		Open	Open	Open
Week 19	September		Open	Open	Open	Open	Open		Closure	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open		Open		Open	Open	Open
Week 20	September								Closure																		
# of Beach-week Closures		0	0	3	2	0	0	0	8	0	1	0	0	0	1	1	0	2	0	5	1	0	0	0	0	0	0

Results (Continued)

Enatai Beach 2023

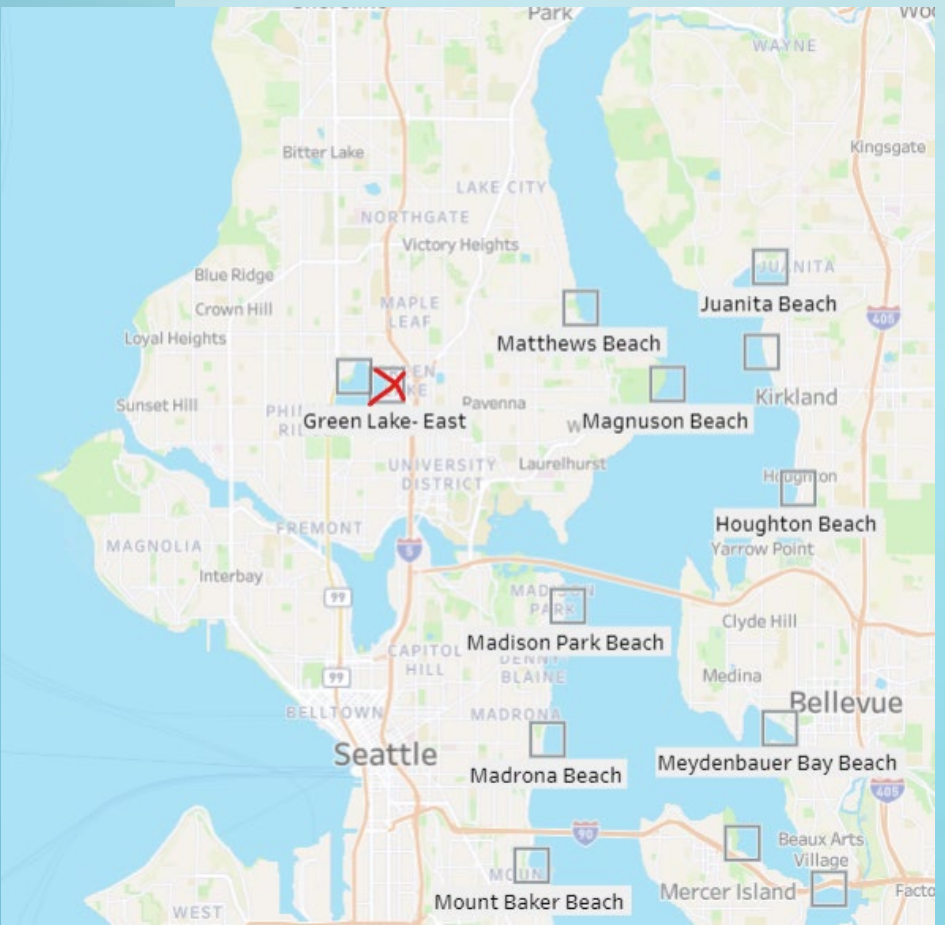
Sample Date (mm/dd/yy)	Sample 1	Sample 2	Sample 3	30 day geomean	30 day % above 320	Any sample > 320	30-day Water Quality Standard	Actual Advisory Decision	Daily geomean
5/16/2023	1	1	11	2.2	0.0%	No	Meet	Open	2.22
5/23/2023	6	2	2	2.5	0.0%	No	Meet	Open	2.88
5/31/2023	3	5	5	3.0	0.0%	No	Meet	Open	4.22
6/6/2023	12	40	260	6.1	0.0%	No	Meet	Open	49.97
6/13/2023	12	22	15	7.3	0.0%	No	Meet	Open	15.82
6/20/2023	4	10	6	9.0	0.0%	No	Meet	Open	6.21
6/27/2023	35	**690**	**1000**	22.7	13.3%	Yes	Does not	Closure	289.05
7/5/2023	16	30	87	34.6	13.3%	No	Does not	Open	34.69
7/11/2023	26	23	21	29.7	13.3%	No	Does not	Open	23.24
7/18/2023	230	200	41	44.7	13.3%	No	Does not	Open	123.55
7/25/2023	41	99	300	79.0	13.3%	No	Does not	Open	106.79
8/1/2023	59	23	58	53.9	0.0%	No	Meet	Open	42.86
8/8/2023	**840**	**670**	110	87.7	13.3%	Yes	Does not	Closure	395.59
8/15/2023	**440**	300	170	144.5	20.0%	Yes	Does not	Closure	282.06
8/22/2023	15	41	14	100.9	20.0%	No	Does not	Open	20.50
8/29/2023	9	240	6	74.5	20.0%	No	Does not	Open	23.49
9/6/2023	10	17	83	66.5	20.0%	No	Does not	Open	24.16
9/12/2023	3	4	27	29.6	6.7%	No	Meet	Open	6.87
9/19/2023	290	210	79	26.7	0.0%	No	Meet	Open	168.82

Overall geomean	**31.32**
Overall % above 320	**8.8%**



Results (Continued)

Green Lake E Beach 2023



Sample Date (mm/dd/yy)	Sample 1	Sample 2	Sample 3	30 day geomean	30 day % above 320	Any sample > 320	30-day Water Quality Standard	Actual Advisory Decision	Daily geomean
5/15/2023	1	4	5	2.7	0.0%	No	Meet	Open	2.71
5/22/2023	11	15	23	6.5	0.0%	No	Meet	Open	15.60
5/30/2023	13	14	23	8.8	0.0%	No	Meet	Open	16.12
6/5/2023	62	77	77	14.9	0.0%	No	Meet	Open	71.63
6/12/2023	65	39	18	17.7	0.0%	No	Meet	Open	35.73
6/20/2023	320	74	260	41.1	0.0%	No	Meet	Open	183.28
6/26/2023	23	9	16	40.8	0.0%	No	Meet	Open	14.91
7/5/2023	3	7	1	28.6	0.0%	No	Meet	Open	2.76
7/10/2023	6	9	5	17.7	0.0%	No	Meet	Open	6.46
7/17/2023	18	32	36	16.8	0.0%	No	Meet	Open	27.47
7/24/2023	23	25	20	11.1	0.0%	No	Meet	Open	22.57
7/31/2023	62	83	39	14.5	0.0%	No	Meet	Open	58.55
8/7/2023	38	14	51	23.4	0.0%	No	Meet	Open	30.05
8/14/2023	14	19	24	28.9	0.0%	No	Meet	Open	18.55
8/21/2023	16	46	22	28.4	0.0%	No	Meet	Open	25.30
8/28/2023	18	14	9	25.5	0.0%	No	Meet	Open	13.14
9/5/2023	190	57	32	26.5	0.0%	No	Meet	Open	70.24
9/11/2023	6	53	41	25.2	0.0%	No	Meet	Open	23.54
9/18/2023	24	18	17	25.5	0.0%	No	Meet	Open	19.44

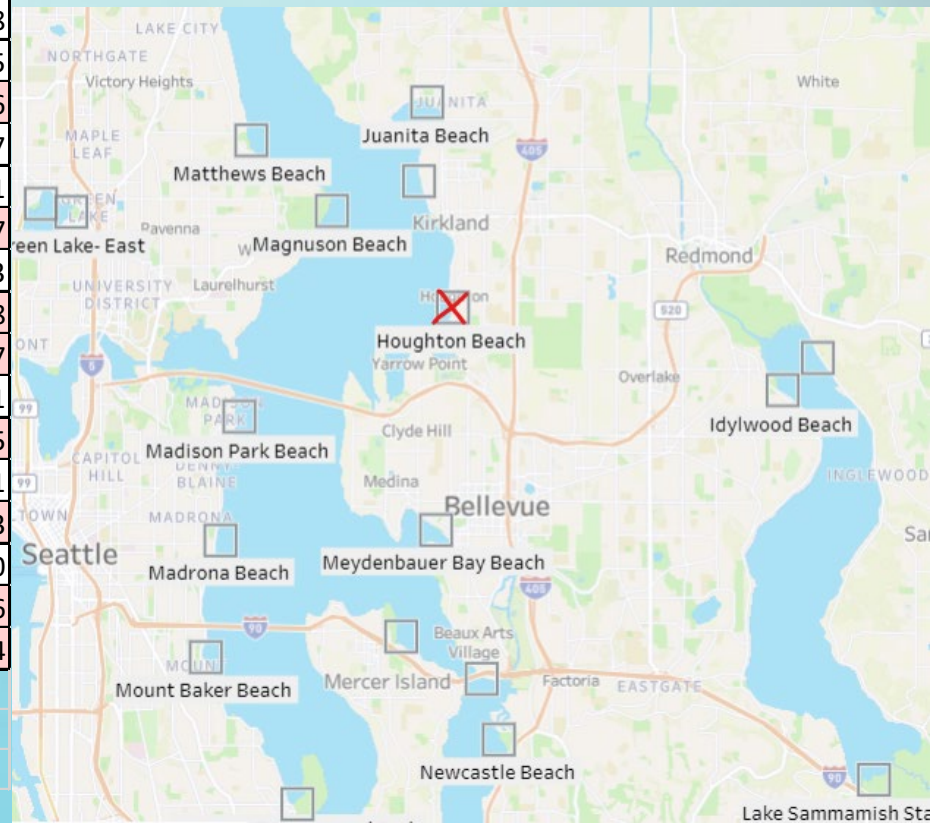
Overall geomean	**21.37**
Overall % above 320	**0.0%**

Results (Continued)

Houghton Beach 2023

Sample Date (mm/dd/yy)	Sample 1	Sample 2	Sample 3	30 day geomean	30 day % above 320	Any sample > 320	30-day Water Quality Standard	Actual Advisory Decision	Daily geomean
5/15/2023	5	5	5	5.0	0.0%	No	Meet	Open	5.00
5/22/2023	26	10	25	9.7	0.0%	No	Meet	Open	18.66
5/30/2023	5	11	4	8.3	0.0%	No	Meet	Open	6.04
6/5/2023	34	17	16	10.4	0.0%	No	Meet	Open	20.99
6/12/2023	14	1	160	10.9	0.0%	No	Meet	Open	13.08
6/20/2023	33	43	47	16.6	0.0%	No	Meet	Open	40.55
6/26/2023	270	240	**1000**	30.6	6.7%	Yes	Meet	Open	401.66
7/5/2023	44	63	**330**	53.4	13.3%	Yes	Does not	Closure	97.07
7/10/2023	20	17	25	53.1	13.3%	No	Does not	Open	20.41
7/17/2023	**630**	**940**	**4800**	135.5	33.3%	Yes	Does not	Closure	1416.57
7/25/2023	50	39	42	137.4	33.3%	No	Does not	Open	43.43
7/31/2023	240	68	**330**	116.4	33.3%	Yes	Does not	Closure	175.28
8/7/2023	**460**	72	38	118.9	33.3%	Yes	Does not	Closure	107.97
8/14/2023	38	16	41	127.7	33.3%	No	Does not	Open	29.21
8/21/2023	**720**	**810**	32	91.4	26.7%	Yes	Does not	Closure	265.25
8/28/2023	41	16	50	86.0	26.7%	No	Does not	Open	32.01
9/5/2023	**730**	**610**	**630**	111.9	40.0%	Yes	Does not	Closure	654.63
9/11/2023	24	28	41	86.7	33.3%	No	Does not	Open	30.20
9/18/2023	**880**	56	250	131.1	40.0%	Yes	Does not	Closure	230.96
9/25/2023	**550**	67	84	116.3	33.3%	Yes	Does not	Closure	145.74

Overall geomean	**71.95**
Overall % above 320	**24.6%**



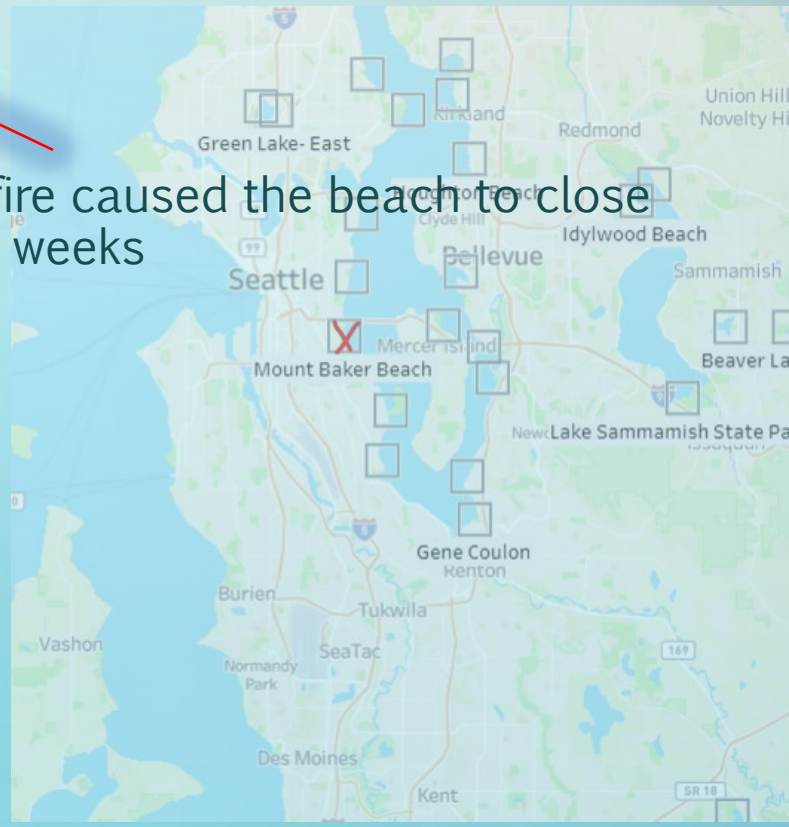
Results (Continued)

Mt Baker Beach 2023

Sample Date (mm/dd/yy)	Sample 1	Sample 2	Sample 3	30 day geomean	30 day % above 320	Any sample > 320	30-day Water Quality Standard	Actual Advisory Decision	Daily geomean
5/15/2023	22	20	13	17.9	0.0%	No	Meet	Open	17.88
5/22/2023	**No Samp**	**No Samp**	**No Samp**	17.9	0.0%	No	Meet	Closure	#NUM!
5/30/2023	**No Samp**	**No Samp**	**No Samp**	17.9	0.0%	No	Meet	Closure	#NUM!
6/5/2023	5	4	5	9.1	0.0%	No	Meet	Closure	4.64
6/12/2023	69	**350**	95	22.2	11.1%	Yes	Does not	Closure	131.89
6/20/2023	16	29	14	22.5	11.1%	No	Does not	Closure	18.66
6/26/2023	50	7	5	19.3	8.3%	No	Meet	Open	12.05
7/5/2023	5	10	6	15.6	6.7%	No	Meet	Open	6.69
7/10/2023	5	6	11	16.9	6.7%	No	Meet	Open	6.91
7/17/2023	12	12	11	10.4	0.0%	No	Meet	Open	11.66
7/24/2023	23	37	33	11.5	0.0%	No	Meet	Open	30.40
7/31/2023	2	6	4	9.0	0.0%	No	Meet	Open	3.63
8/7/2023	4	9	8	9.0	0.0%	No	Meet	Open	6.60
8/14/2023	8	8	14	9.6	0.0%	No	Meet	Open	9.64
8/21/2023	5	2	1	6.9	0.0%	No	Meet	Open	2.15
8/28/2023	2	2	2	4.0	0.0%	No	Meet	Open	2.00
9/5/2023	1	1	1	3.1	0.0%	No	Meet	Open	1.00
9/11/2023	1	1	1	2.1	0.0%	No	Meet	Open	1.00
9/18/2023	4	1	1	1.5	0.0%	No	Meet	Open	1.59

Overall geomean	**6.49**
Overall % above 320	**2.0%**

Car fire caused the beach to close for 5 weeks



Still much to learn

- Are beachgoers getting sick?
- What kind of illnesses are common?
- Are E. coli good indicator organisms?
- Where are E. coli bacteria coming from?
- How much do E. coli concentrations vary?
  - from day to day or hour to hour
  - From one sampling location to another
- How many samples should be collected?

Studies being Considered

- Effect of Daytime High and Usage on E. coli concentrations
- Sanitary survey of beaches to identify sources of E. coli
- qPCR testing for Bacteroides to identify sources
- Hourly and real-time monitoring of E. coli concentrations
- Epidemiological investigation
- QMRA for specific pathogens
- Development of Beach Advisory Protocol using the results of the above studies

Acknowledgement

This Program would not be possible if it weren't for:

- FPHS funding
- King County Department of Natural Resources and Parks
  - Water and Land Resources Division
  - King County Environmental Lab
  - King County Wastewater Treatment Division
- City Parks Departments

References

- WHO Guidelines for Safe Recreational Water Environments Volume 1: Coastal and Fresh Waters
- EPA Ambient Water Quality Criteria for Bacteria 1986
- EPA Recreational Water Quality Criteria 2012
- WAC 173-201A
- EPA 40 CFR §131
- WAC 246-260
- RCW 70.05
- CDC MMWR Outbreaks Associated with Untreated Recreational Water — California, Maine, and Minnesota, 2018–2019
- CDC MMWR Outbreaks Associated with Untreated Recreational Water — United States, 2000–2014

Thank you!