



Dillingham Pathogens Water Quality Monitoring Project

# 2022 – 2023 Final Report

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## Abstract

Alaska Water Labs (AWL) and the Alaska Department of Environmental Conservation (DEC) established a two-year marine pathogen monitoring study at three recreational beaches in Dillingham, AK. The primary objective of this study is to protect human health and the environment by sampling three near-shore beaches in Dillingham for fecal indicator organisms (fecal coliform and enterococci bacteria) that signify the presence of fecal contamination. Fecal coliform and enterococci samples were collected from Snag Point Beach, Scandinavian Beach, and Kanakanak Beach between May and August, summer 2022 and 2023. No exceedances of the Alaska Water Quality Standards (WQS) for contact recreation occurred; however, results exceeded the most stringent criteria for the harvesting of raw aquatic life for consumption at all sites. Microbial Source Tracking (MST) analysis was conducted twice each year of the project, at each of the three beach sites. MST samples were analyzed for human, avian, gull, and dog DNA markers. Final results indicate varying bacteria levels during both years, with no persistent human-caused bacteria pollution. The primary suspected source is naturally occurring from gulls.

## Basic Waterbody Information

Table 1. Basic Waterbody Information.<sup>1</sup>

Assessment Unit Name	Snag Point Beach	Scandinavian Beach	Kanakanak Beach
Assessment Unit ID	AK_B_3030311_003	AK_B_3030311_002	AK_B_3030311_001
Location Description	Approximately 300 ft East of the Dillingham dock.	Approximately 500 FT East of the Dillingham Harbor entrance.	Near Kanakanak Hospital. Approximately 5 miles south of Dillingham.
Latitude, Longitude	59.037867, -158.462183	59.03733, -158.47673	59.00345, -158.5346
Hydrologic Unit Code	190303031108		
Water Type	Estuary		
Time of Year Sampled	May through August of 2022 and 2023		

## Water Quality Evaluation

### Background

Dillingham is located in the Bristol Bay region approximately 350 miles south west of Anchorage at the Wood River and Nushagak River confluence (Figure 1). To address concerns about potential water quality pollution from fishing vessel operation in Nushagak Bay, DEC partnered with Alaska Water Laboratories to collect near-shore water samples at three Dillingham area beaches during the summers of 2022 and 2023 before, during, and after the commercial fishing season. Besides wildlife, potential sources of pathogens include pet feces, discharges from fishing vessels, wastewater treatment discharge, on-site septic systems, and stormwater drain outfalls. Water samples were shipped to Alaska Water Laboratories in Wasilla, AK for fecal coliform and enterococci analysis. These bacteria occur naturally in the digestive tract of warm-blooded animals and can serve as indicators of possible sewage contamination. Though not harmful themselves,

<sup>1</sup> Appendix A—Monitoring Site Photos

fecal coliform and enterococci indicate the possible presence of disease-causing bacteria. Each monitoring location was sampled for MST and analyzed by LuminUltra Technologies for human, avian, gull, and dog DNA markers.

The Dillingham beaches selected (Kanakanak Beach, Scandinavian Beach, and Snag Point Beach) are all located around the City of Dillingham and serve as recreational waterways in the summer (Figures 1-4). Historic pathogen monitoring was conducted at these locations in 2006, 2008, 2009, and 2010. The most recent project is an effort to monitor those same sites as a continuation in protecting human health and the environment.

Sample collection occurred between May and August during the summers of 2022 and 2023 (Table 2). Sample event timing corresponded to open water conditions, the commercial fishing season (peak use in June and July), and the beach recreation period (May – September). MST sample collection occurred at each of the three beach sites twice each project year during the period of high use in June or July. A duplicate sample for fecal coliform and enterococci was collected during each sampling event and the location rotated between monitoring locations.

Table 2. 2022 and 2023 sample collection dates.

Sample Event Date	Snag Point Beach	Scandinavian Beach**	Kanakanak Beach
5/25/2022	•	•	•
6/21/2022	•	•	•
6/28/2022*	•	•	•
6/29/2022	•	•	•
7/6/2022	•	•	•
7/12/2022*	•	•	•
8/9/2022	•	•	•
5/24/2023	•		•
6/26/2023	•	•	•
7/5/2023*	•	•	•
7/13/2023	•	•	•
7/19/2023*	•	•	•
7/24/2023	•	•	•
8/7/2023	•	•	•

\* Indicates MST sample collection, all sites

\*\*Site conditions did not allow for sampling at Scandinavian Beach on 5/24/2023.



Figure 1. Overview map of 2022-2023 sampling locations in Dillingham, AK.





Figure 2. Kanakanak Beach sampling location.



Figure 3. Scandinavian Beach sampling location.



Figure 4. Snag Point sampling location.

## Project Objectives

The primary objective of this study is to protect human health and the environment by sampling three near-shore beaches in Dillingham for fecal indicator organisms (fecal coliform and enterococci bacteria) that signify the presence of fecal contamination.

## Quality Assurance Review

All samples were collected under the protocols outlined in the approved project Quality Assurance Project Plan (QAPP) (DEC 2021.a<sup>2</sup>).

Seven sampling events were scheduled each season for a total of 14 sample events. All samples were successfully collected except for one. Due to unsafe environmental conditions, the sampler was unable to access the monitoring site; samples and field measurements were not collected at Scandinavian Beach on 5/24/2023. The Dillingham Pathogen Monitoring Project has a data completeness goal of 80% or greater. With one missed sampling event, the 2023 season achieved a completeness of 98.44% while the 2022 season achieved 100% completeness.

All holding times were met, except for the 7/05/2023 enterococcus sample from Scandinavian Beach which exceeded hold time by 5 minutes. Due to its minimal time exceedance, the DEC Quality Assurance Officer approved keeping the data point but adding a data flag on it. Additionally, the 2023 lab reports noted Heavy Sediment Masking (“HSM” or “SM”) in samples, indicating significant amounts of sediment on one or more of the analysis plates. DEC flagged these data points using a “J”, meaning that the analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample. Due to excessive sediment fouling, the fecal coliform and enterococci routine and duplicate samples collected at Kanakanak on 5/24/2023 were rejected.

To assess precision<sup>3</sup>, one set of duplicate samples was taken during each sampling event for fecal coliform and enterococcus. Duplicate sample collection sites rotated through each summer; each site had a representative duplicate for a minimum of two events per season. A Relative Percent Difference (RPD) calculation was completed comparing the actual sample result value to the duplicate sample value. In 2022, all but two RPD calculations met the goal of 60% or less per the QAPP. However, the RPD for the 2023 data exceeded the 60% limit in all but 3 calculations. The DEC Quality Assurance Officer approved keeping the samples in the dataset that exceeded the RPD due to the natural variability of pathogens in the environment.

## Methods

Three Dillingham beaches were monitored during the summer of 2022 and 2023. Field staff collected a single grab sample of marine water in roughly 3 feet of water, at approximately 12”-18” beneath the surface at each monitoring site in laboratory-provided sterile containers, plus one rotating duplicate sample. Samples were kept in coolers on gel ice and flown to Alaska Water Labs in Wasilla, AK for enterococci (ASTM D6503-99) and fecal coliform (SM 9222D) analyses within six

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<sup>2</sup> Available by contacting the DEC Nonpoint Source Water Quality section

<sup>3</sup> Appendix D—Relative Percent Difference Calculations

hours of collection. MST sample collection occurred at each of the three beach sites twice each project year during the period of high use in June or July. MST samples were submitted to LuminUltra Technologies Ltd. in Linthicum Heights, Maryland for analysis for human, bird, gull, and dog DNA markers. Each sampling event, samplers recorded environmental parameters including air and water temperature, pH, conductivity, and salinity (Table 7). Sanitary surveys were conducted at each site during the sampling events to note beach conditions, wildlife, recreators, and activities on or offshore that could identify potential pollution sources. Local tidal conditions were gathered from the National Oceanic and Atmospheric Administration (NOAA), and precipitation amounts were recorded according to the Dillingham Airport Station reports.

## Results

All of the enterococci results for 2022 and 2023 met criteria for contact recreation in which the geometric mean in a 30-day period may not exceed 35 MPN/ 100 mL, and not more than 10% of the samples may exceed 130 MPN/ 100 mL (Tables 3 and 4, Figures 5, 6, and 9). To meet the most stringent pathogen water quality criteria <sup>4</sup> for harvesting for consumption of raw mollusks or other raw aquatic life, the geometric mean for fecal coliform samples may not exceed 14 CFU/100 mL, and not more than 10% of the individual samples may exceed 31 CFU/100 mL. Each sample from all three monitoring locations in 2022 and 2023 exceed both criteria (Tables 3 and 4, Figures 7, 8, and 10).

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<sup>4</sup> Appendix B—18 AAC 70(14)(B)(i) Water Recreation, contact recreation, and 18 AAC 70(14)(D) Harvesting for Consumption of Raw Mollusks or Other Raw Aquatic Life



Table 3. 2022 Fecal coliform and enterococci results summary showing percentages of individual and seasonal geometric mean WQS exceedances in red.

Analyte	Site	Individual Criteria	% of Samples Exceeding Threshold	Seasonal Geometric Mean Criteria	30-day Geometric Mean Criteria
Enterococci (MPN/100 mL)	Snag Point	130 MPN/100 mL	0%	35 MPN/100 mL	9.17
	Scandinavian Beach		0%		5.05
	Kanakanak Beach		0%		9.21

Analyte	Site	Individual Criteria	% of Samples Exceeding Threshold	Seasonal Geometric Mean Criteria	30-day Geometric Mean Criteria
Fecal Coliform (CFU/100 mL)	Snag Point	31 CFU/100 mL	100%	14 CFU/ 100m mL	62.77
	Scandinavian Beach		85.7%		39.59
	Kanakanak Beach		85.7%		58.46

Table 4. 2023 Fecal coliform and enterococci results summary showing percentages of individual and seasonal geometric mean WQS exceedances in red.

Analyte	Site	Individual Criteria	% of Samples Exceeding Threshold	Seasonal Geometric Mean Criteria	30-day Geometric Mean Criteria
Enterococci (MPN/100 mL)	Snag Point	130 MPN/100 mL	0%	35 MPN/100 mL	3.12
	Scandinavian Beach		0%		3.84
	Kanakanak Beach		0%		8.09

Analyte	Site	Individual Criteria	% of Samples Exceeding Threshold	Seasonal Geometric Mean Criteria	30-day Geometric Mean Criteria
Fecal Coliform (CFU/100 mL)	Snag Point	31 CFU/100 mL	42.9%	14 CFU/ 100m mL	44.54
	Scandinavian Beach		50%		57.42
	Kanakanak Beach		85.7%		80.94

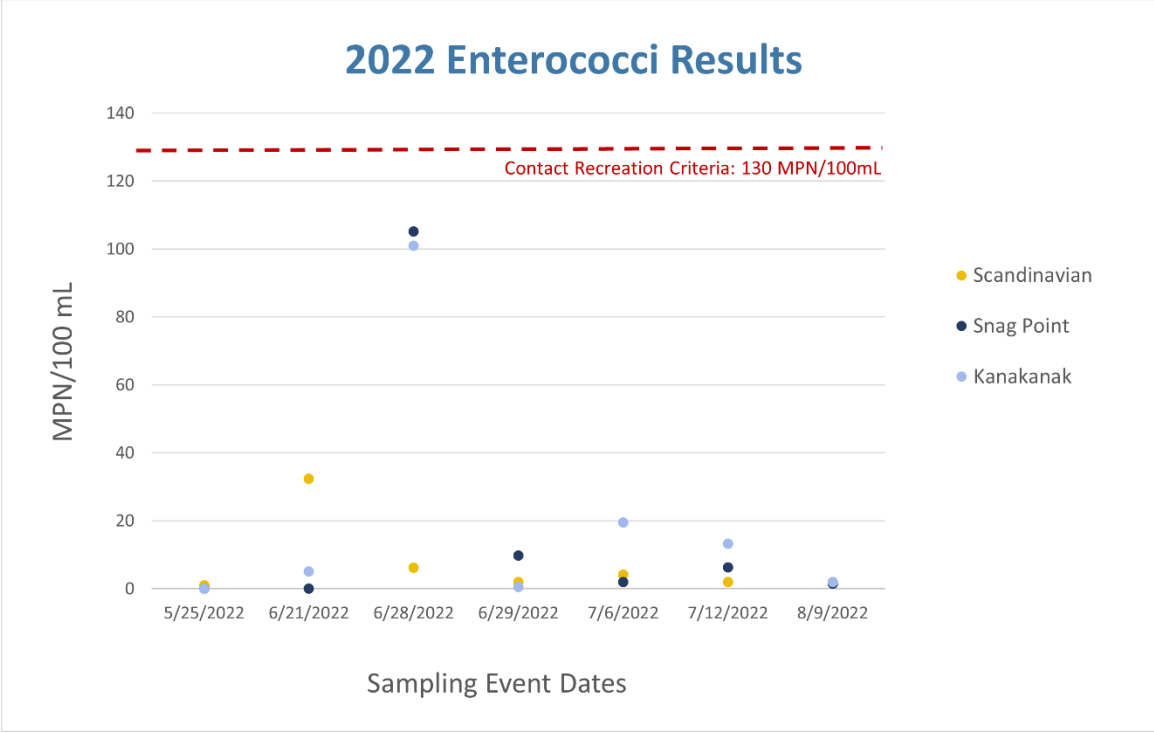


Figure 5. Results from 2022 enterococci analyses, all sites.

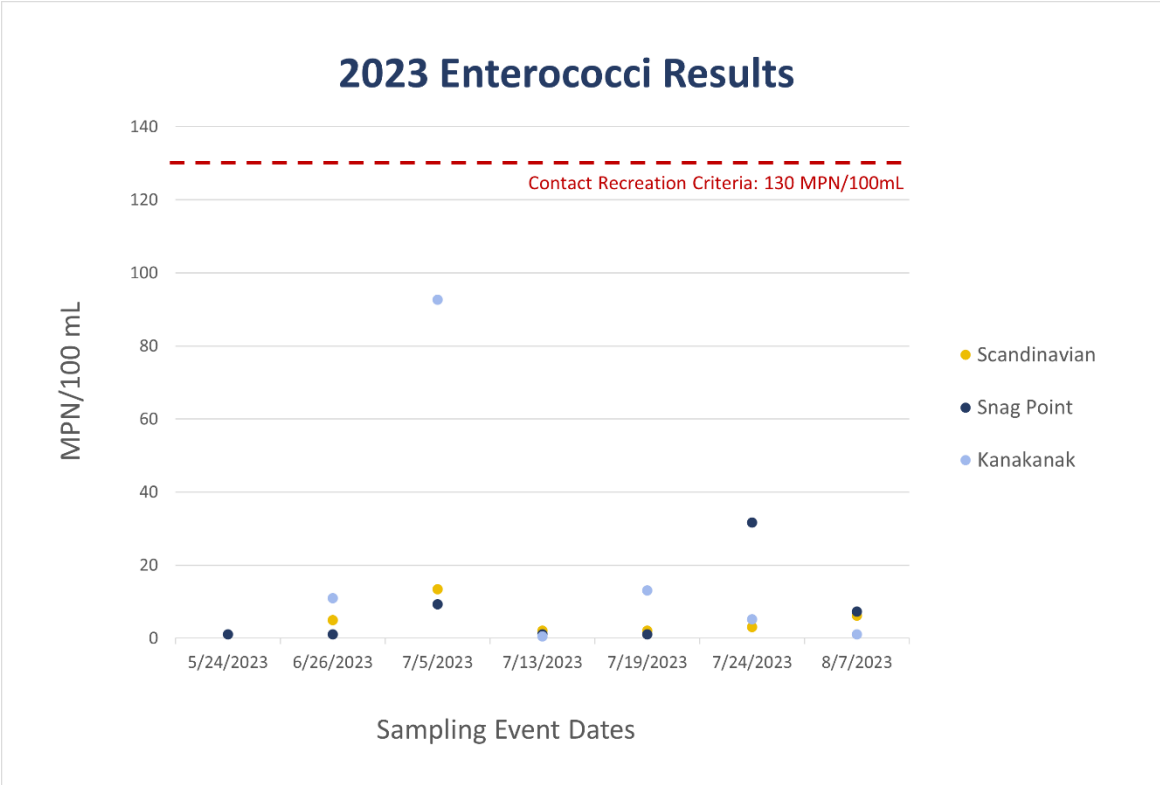


Figure 6. Results from 2023 enterococci analyses, all sites.

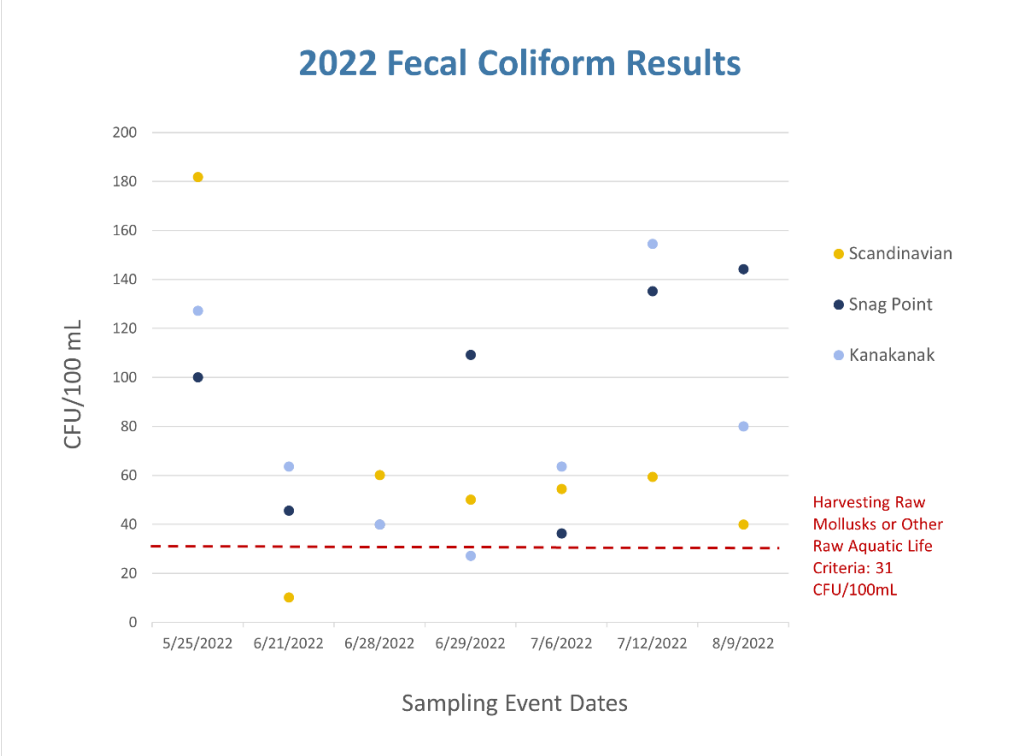


Figure 7. Results from 2022 fecal coliform analyses, all sites.

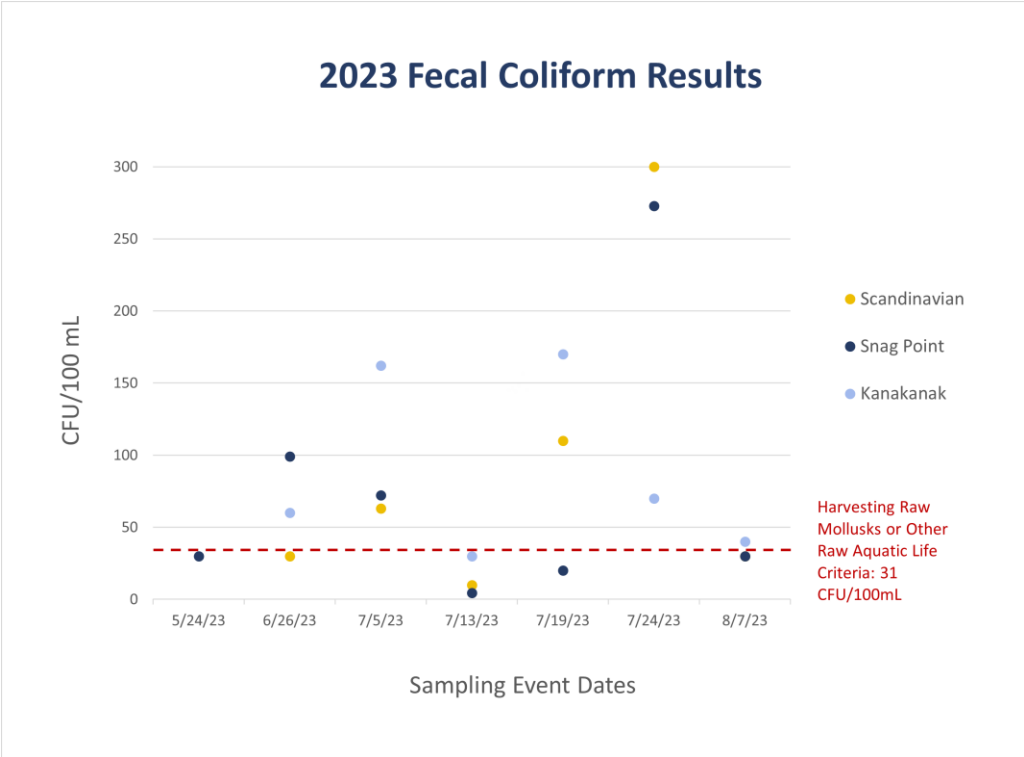


Figure 8. Results from 2023 fecal coliform analyses, all sites.

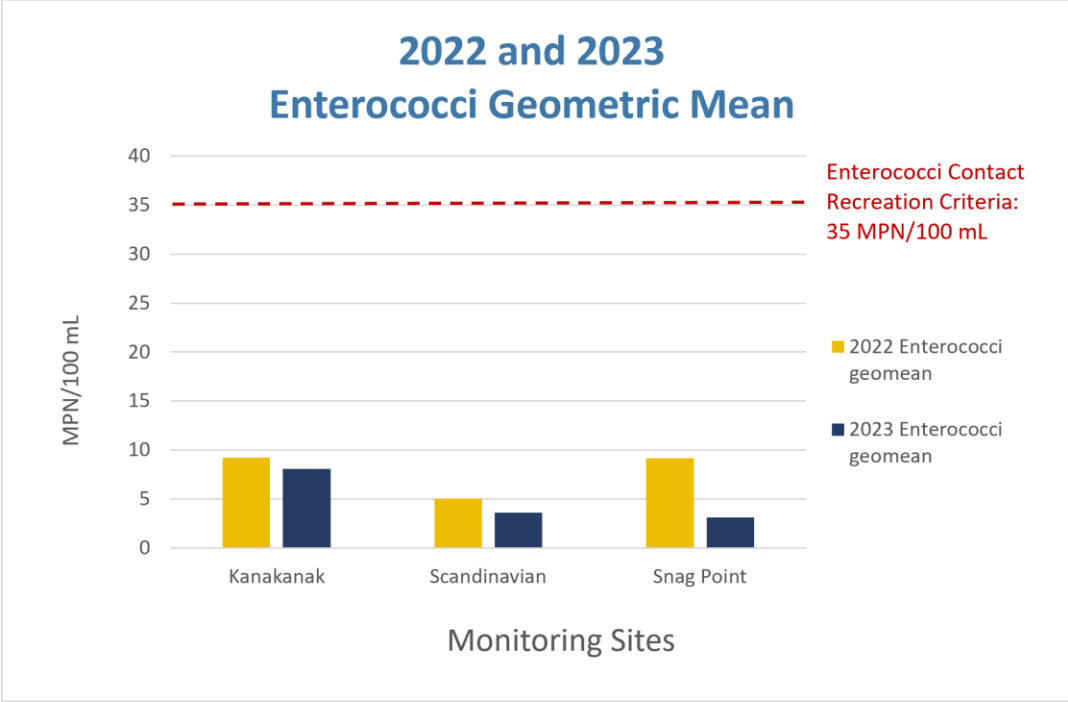


Figure 9. 2022 and 2023 geometric mean results for enterococci, all sites.

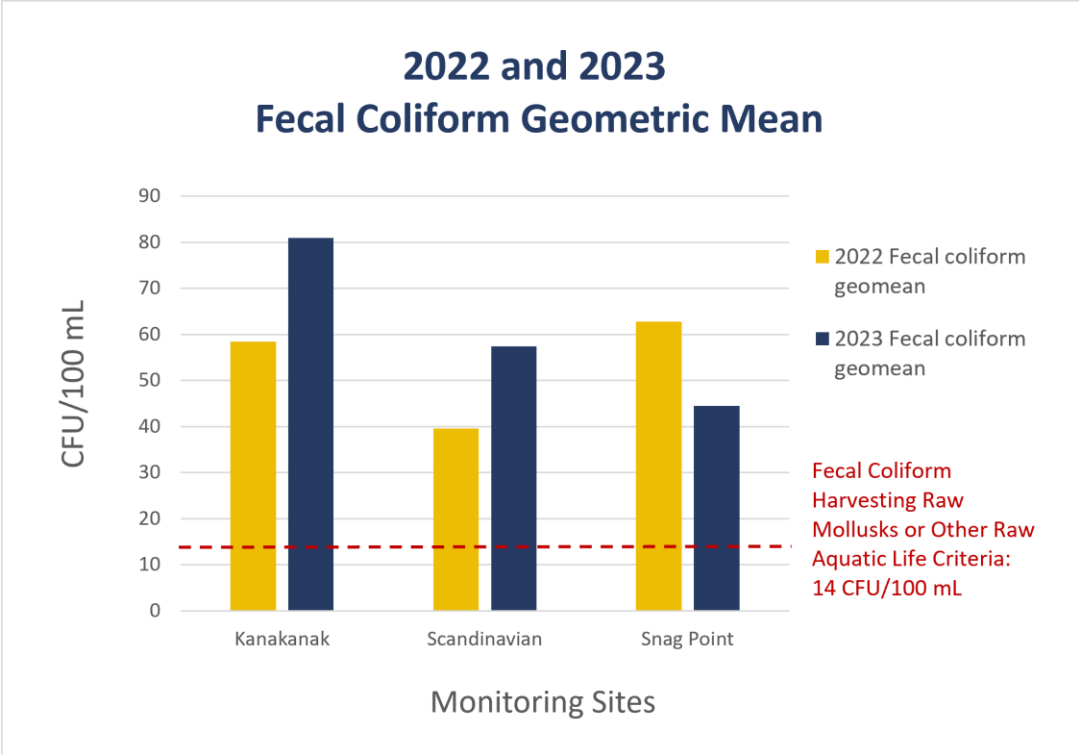


Figure 10. 2022 and 2023 geometric mean results for fecal coliform, all sites.

During both seasons, two MST samples were collected at each of the three monitoring sites during high public and commercial use in June or July. Samples were analyzed for human and gull DNA markers in 2022, and human, bird, and dog DNA markers in 2023. The 2022 MST analysis detected the presence of a human marker at Snag Point, though in concentrations lower than the quantifiable limit. Gull markers were detected at all three beaches throughout the season with a quantifiable result of 6.43E+02 at Scandinavian Beach (Table 5). The vast majority of the 2023 MST results were Non-Detect (ND) except for the 7/19/2023 Scandinavian Beach sample in which avian DNA was detected, but not quantifiable (Table 6).

Table 5. 2022 MST analysis results.

Site	Bacteroidetes	Analysis	2022 Results	
			6/28	7/12
Snag Point	Human	Human_HF183	DNQ	ND
	Human	Human_HumM2(EPA)	ND	ND
	Gull	Gull_Gull-4	DNQ	DNQ
Scandinavian Beach	Human	Human_HF183	ND	ND
	Human	Human_HumM2(EPA)	ND	ND
	Gull	Gull_Gull-4	6.43E+02	DNQ
Kanakanak Beach	Human	Human_HF183	ND	ND
	Human	Human_HumM2(EPA)	ND	ND
	Gull	Gull_Gull-4	DNQ	DNQ

ND = Not detected; DNQ = Detected, not quantifiable

Table 6. 2023 MST analysis results.

Site	Bacteroidetes	Analysis	2023 Results	
			7/05	7/19
Snag Point	Human	Human_HF183	ND	ND
	Bird	Bird_GFD	ND	ND
	Dog	Dog_BacCan-UCD	ND	ND
Scandinavian Beach	Human	Human_HF183	ND	ND
	Bird	Bird_GFD	ND	DNQ
	Dog	Dog_BacCan-UCD	ND	ND
Kanakanak Beach	Human	Human_HF183	ND	ND
	Bird	Bird_GFD	ND	ND
	Dog	Dog_BacCan-UCD	ND	ND

ND = Not detected; DNQ = Detected, not quantifiable



During each sampling event at each location, samplers recorded environmental parameters including air temperature, water temperature, and pH in 2022, with the addition of conductivity and salinity in 2023 (Table 7).

Table 7. 2022 and 2023 in-situ measurements summary.

Parameter	Site	2022			2023		
		Mean	Median	Range	Mean	Median	Range
Air Temperature (°C)	Snag Point	16.06	15.5	8.5	13.89	12.25	11.4
	Scandinavian Beach	14.55	14.7	6.2	13.87	12.65	7.9
	Kanakanak Beach	14.33	13.7	6.8	13.51	12.35	8.5
Water Temperature (°C)	Snag Point	13.53	13.8	6.58	12.84	14.7	9.74
	Scandinavian Beach	13.77	13.6	4.88	13.08	13.4	5
	Kanakanak Beach	14.12	15	6.18	11.77	12.2	10.24
pH	Snag Point	8.34	8.3	1.2	7.9	7.5	1.2
	Scandinavian Beach	8.1	8.1	1.2	7.5	7.5	.8
	Kanakanak Beach	7.59	7.5	1	7.24	7.2	.9
Conductivity (µS/cm)	Snag Point				593.33	375	1250
	Scandinavian Beach		N/A		793.67	335	2850
	Kanakanak Beach				1150.33	825	3270
Salinity (psu)	Snag Point				.31	.19	.65
	Scandinavian Beach		N/A		.42	.17	1.55
	Kanakanak Beach				.36	.22	.55

## Conclusion






Alaska Water Labs completed two summers of marine pathogen monitoring at three recreational beaches in Dillingham, AK. The results indicate that contact recreational activities are not negatively affected by high bacteria loads; however, results exceeded criteria for the harvesting of raw aquatic life for consumption at all sites. Potential human-caused bacteria sources include pet feces, a small boat harbor, wastewater treatment discharge, on-site septic systems, and stormwater drain outfalls. Fish processing plant discharges may also be attracting gulls to the area. MST analysis detected a non-quantifiable human marker in 2022 at Snag Point; the remaining detections were gull or avian, widely seen in the 2022 samples at every site with one quantifiable level at Scandinavian Beach. The final results indicate varying bacteria levels during both years, with no persistent human-caused bacteria pollution. The primary suspected source is naturally occurring from gulls.

## Appendix A—Monitoring Site Photos

2022	Kanakanak	Snag Point	Scandinavian
5/25/22			
6/21/22			
6/28/22			
6/29/22			
7/6/22			
7/12/22			



8/9/22			
2023	Kanakanak	Snag Point	Scandinavian
5/24/23			
6/26/23			
7/5/23			
7/13/23			
7/19/23			

7/24/23			
8/7/23		Photo not available	

## Appendix B— AAC 70(14) Water Quality Standards amended as of November 13, 2022

Designated Use Class	Use Subclass	Criteria
(A) Water Supply	(i) aquaculture	For products normally cooked, the geometric mean of samples taken in a 30-day period may not exceed 200 fecal coliform/100 mL, and not more than 10% of the samples may exceed 400 fecal coliform/100 mL. For products not normally cooked, the geometric mean of samples taken in a 30-day period may not exceed 20 fecal coliform/100 mL, and not more than 10% of the samples may exceed 40 fecal coliform/100 mL.
	(ii) seafood processing	In a 30-day period, the geometric mean of samples may not exceed 20 fecal coliform/100 mL, and not more than 10% of the samples may exceed 40 fecal coliform/100 mL.
	(iii) industrial	Where worker contact is present, the geometric mean of samples taken in a 30-day period may not exceed 200 fecal coliform/100 mL, and not more than 10% of the samples may exceed 400 fecal coliform/100 mL.
(B) Water Recreation	(i) contact recreation	In a 30-day period, the geometric mean of samples may not exceed 35 enterococci CFU/100 mL, and not more than 10% of the samples may exceed a statistical threshold value of 130 enterococci CFU/100 mL.
	(ii) secondary recreation	In a 30-day period, the geometric mean of samples may not exceed 200 fecal coliform/100 mL, and not more than 10% of the samples may exceed 400 fecal coliform/100 mL.
(D) Harvesting for consumption of raw mollusks or other raw aquatic life		The geometric mean of samples may not exceed 14 fecal coliform CFU/100 mL; and not more than 10% of the samples may exceed 31 fecal coliform CFU/100 mL



## Appendix C –Pathogen Results

Table 8. 2022 bacteria results, all sites.

Analyte	Sample Event Date	Snag Point Beach	Scandinavian Beach	Kanakanak Beach
Enterococci (MPN/100 mL)	5/25/2022	<MDL	1	<MDL
	6/21/2022	<MDL	32.3	5.1
	6/28/2022	105.2	6.2	101
	6/29/2022	9.8	2	<MDL
	7/6/2022	2	4.1	19.5
	7/12/2022	6.3	2	13.2
	8/9/2022	1.5	2	2
Fecal coliform (CFU/100 mL)	5/25/2022	100	181.82	127.2
	6/21/2022	45.45	10	63.63
	6/28/2022	40	60	40
	6/29/2022	109.09	50	27.27
	7/6/2022	36.36	54.55	63.64
	7/12/2022	135.14	59.41	154.55
	8/9/2022	144.14	40	80

MDL=Method Detection Limit

Table 9. 2023 bacteria results, all sites.

Analyte	Sample Event Date	Snag Point Beach	Scandinavian Beach	Kanakanak Beach
Enterococci (MPN/100 mL)	5/24/2023	1	Not sampled	277.4*
	6/26/2023	1	5	11
	7/5/2023	9.3	13.45	92.6
	7/13/2023	1	2	<MDL
	7/19/2023	1	2	13.1
	7/24/2023	31.7	3.1	5.2
	8/7/2023	7.3	6.2	1
Fecal coliform (CFU/100 mL)	5/24/2023	30	Not sampled	100*
	6/26/2023	99.1	30	60
	7/5/2023	72.07	63.06	162.16
	7/13/2023	<MDL	10	30
	7/19/2023	20	110	170
	7/24/2023	272.73	300	70
	8/7/2023	30	30	40

MDL=Method Detection Limit

\*Sample rejected due to sediment fouling

## Appendix D—RPD Calculations

Table 10. 2022 Relative percent difference calculations, exceedances in red.

Location/Date	Enterococci (MPN/100ml)			Fecal Coliform (cfu/100ml)		
	Duplicate	Sample-Routine	RPD (%)	Duplicate	Sample-Routine	RPD (%)
<b>5/25/2022</b>						
Kanakanak	0	0	0	90	127.2	34
Scandinavian	-	1			181.82	
Snag Point	-	0			100	
<b>6/21/2022</b>						
Kanakanak	-	5.1			63.63	
Scandinavian	-	32.3			10	
Snag Point	3.1	5*	47	54.54	45.45	18
<b>6/28/2022</b>						
Kanakanak		101			40	
Scandinavian	2	6.2	102	50	60	18
Snag Point		105.2			40	
<b>6/29/2022</b>						
Kanakanak	0	0		27.27	27.27	0
Scandinavian		2			50	
Snag Point		9.8			109.09	
<b>7/6/2022</b>						
Kanakanak		19.5			63.64	
Scandinavian		4.1			54.55	
Snag Point	2	2	0	50	36.36	32
<b>7/12/2022</b>						
Kanakanak		13.2			154.55	
Scandinavian	3.1	2	43	118.81	59.41	67
Snag Point		6.3			135.14	
<b>8/9/2022</b>						
Kanakanak	2	2	0	50	80	46
Scandinavian		2			40	
Snag Point		1.5			144.14	

\*Used ½ detection limit for calculations where result is <MDL

Table 11. 2023 Relative percent difference calculations, exceedances in red.

Location/Date	Enterococci (MPN/100ml)			Fecal Coliform (CFU/100ml)		
	Duplicate	Sample-Routine	RPD (%)	Duplicate	Sample-Routine	RPD (%)
<b>5/24/2023</b>						
Kanakanak	147.8**	277.4**	61	>200,000**	100**	>200
Scandinavian						
Snag Point		1			30	
<b>6/26/2023</b>						
Kanakanak		11			60	
Scandinavian		5			30	
Snag Point	0.5*	1	67	40	99.1	85
<b>7/5/2023</b>						
Kanakanak	201.2	92.6	74	126.13	162.16	25
Scandinavian		13.45			63.06	
Snag Point		9.3			72.07	
<b>7/13/2023</b>						
Kanakanak		0.5*			30	
Scandinavian	1	2	67	500	10	192
Snag Point		1			4.5*	
<b>7/19/2023</b>						
Kanakanak		13.1			170	
Scandinavian		2			110	
Snag Point	3	1	100	110	20	138
<b>7/24/2023</b>						
Kanakanak		5.2			70	
Scandinavian	7.6	3.1	84	300	300	0
Snag Point		31.7			272.73	
<b>8/7/2023</b>						
Kanakanak	27.9	19.9	33	81.82	40	69
Scandinavian		6.2			30	
Snag Point		7.3			30	

\*Used ½ detection limit for calculations where result is <MDL

\*\*Samples rejected due to sediment fouling