2020 Kenai Beach Bacteria Monitoring Report

FY20-21 Final Report

Prepared for the Alaska Department of Environmental Conservation

Grant: ACWA-19-B11

Commented [ASJ(1]: The 2019 was covered in the report last year, so this report should primarily focus on the 2020 season. Results from the 2019 season can be included for comparisons/trends.

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Commented [ASJ(3]: Add following acknowledgement here or somewhere in the next few pages:
"This project has been funded wholly or in part by the United States EPA under assistance agreement number (BEACH-CU-00J71801) to the Department of Environmental Conservation through the Alaska Clean Water Actions (ACWA) program. The contents of this document do not necessarily reflect the views and policies of the EPA, nor does the EPA endorse trade names or recommend the use of commercial product mentioned in this document."

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The Kenai Watershed Forum is dedicated to successfully identifying and addressing the needs of the region by providing high quality education, restoration, and research programs.

"Working together for healthy watersheds on the Kenai Peninsula"

Draft report: February 25, 2021

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Table of Contents

List of Tables

List of Figures

Acronyms

ADEC – Alaska Department of Environmental Conservation
ADF&G – Alaska Department of Fish and Game
BEACH – Beaches Environmental Assessment and Coastal Health Act
BEACON – Beach Advisory and Closing Online Notification system
BMP – Best Management Practices
CFU – Colony Forming Unit
CoK – City of Kenai
EPA – Environmental Protection Agency
KWF – Kenai Watershed Forum
MST – Microbial Source Tracking
PUF – Personal Use Fishery
U.S. FWS – United States Fish and Wildlife Service

Executive summary

Under contracts with the City of Kenai, the Kenai Watershed Forum has worked with the Alaska Department of Environmental Conservation's Alaska Beach Program since 2010 to monitor bacteria concentrations at public recreational beaches at the outlet of the Kenai River in Kenai, Alaska. Bacteria monitored included fecal coliform and enterococci, both of which are found in the excrement of warm-blooded animals such as gulls, which are attracted to Kenai beaches by fish carcasses produced during the personal use dipnet fishery. To establish a baseline for bacteria concentrations, and inform the public when criteria are exceeded, Kenai Watershed Forum began monitoring pathogens from 2010-2014 at selected sites. In 2015, best management practices were implemented by the City of Kenai, which included clearing fish carcasses from the beaches at night during the personal use fishery to reduce attractants to gulls. To assess changes in bacteria concentrations post-implementation of best management practices, Kenai Watershed Forum conducted monitoring from 2018-2020 at sites located at the North and South Kenai Beaches; Warren Ames Memorial Bridge; and upstream and downstream of the gull rookery. Microbial source tracking was conducted prior to and during the in order to identify sources of these bacteria in 2019 and 2020.

In the 2020 monitoring season, data indicated instances of fecal coliform concentrations above advisory level for harvest of seafood for raw consumption at all sample sites, as well as some instances of enterococci concentrations above advisory level for contact recreation at South Kenai Beach. Genetic data using microbial source tracking indicated gulls as the primary species producing fecal matter at sites sampled in the lower Kenai River. The report makes recommendations for the continuation of successful beach monitoring efforts in conjunction with the use of the Environmental Protection Agency's Virtual Beach Model.

Commented [EL5]: this is good background information but not really and Executive Summary which typically summarizes the results similar to an Abstract. KWF could add a couple of sentences or a table here that summarized the 2020 results.

Commented [BM6R5]: Modified introduction.

Commented [BM7]: Since what year?

Commented [ASJ(8R7]: Based on the info I have, Kenai Beach monitoring started in 2010 (the AK BEACH program started in 2002). There was a break in monitoring in 2015-2017 to allow for BMPs to be implemented.

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Commented [MH9]: Confirm…2014?

Commented [ASJ(10R9]: I believe BMPs were developed in 2014, but were not implemented until the 2015 recreation season.

Commented [ASJ(11]: Will need to go through the document and clean up any titles that should be acronyms

Commented [BM12R11]: Thanks for chatting about this subject with me on the phone a week or two ago.

Editorial standards on acronym usage are pretty loose (for example, here's what American Psychological Association (APA) uses). Personally, I almost always tend to side towards using them less.

As per our phone conversation, in most cases I've written out acronyms in full only at their first appearance in each major section (intro, methods, etc). In figure and table captions I've fully written out acronyms so that figures and tables can be better understood without relying on preceding text.

The one section where I am pretty committed to minimizing acronyms is in the abstract/executive summary. There is good evidence to support this rule; for example: https://elifesciences.org/articles/60080

Thanks for your patience with my hang-ups on this topic! ☺

Introduction

The Kenai River is a glacially-fed river located on Alaska's Kenai Peninsula that begins at the outlet of Kenai Lake and flows into Cook Inlet, a branch of the Gulf of Alaska. Known internationally for its prolific fisheries, the Kenai River supports the Cook Inlet's largest population of wild Pacific Salmon. Each summer, thousands of recreationists participate in the Kenai River sport fishing season, which includes an Alaska resident-only personal use fishery (PUF) during much of July.

Since 1996, the Alaska Department of Fish and Game (ADFG) has managed the dipnet PUF for Alaska residents under the Kenai River Late-Run Sockeye Salmon Management Plan (5 AAC 21.350, 2020). The PUF is generally open from July 10th to July 31st starting from the Warren Ames Memorial Bridge between miles five and six of the Kenai River, to the mouth of the river, where the boundary extends along the North and South Kenai Beaches (Figure 1). While providing ample fishing and recreational opportunities for state resident recreationists, the PUF also bolsters the local economy and is highly valued by many throughout the state. However, the fishery annually results in accumulation of fish carcass waste along the North and South Kenai beaches from fish cleaned on site by users.

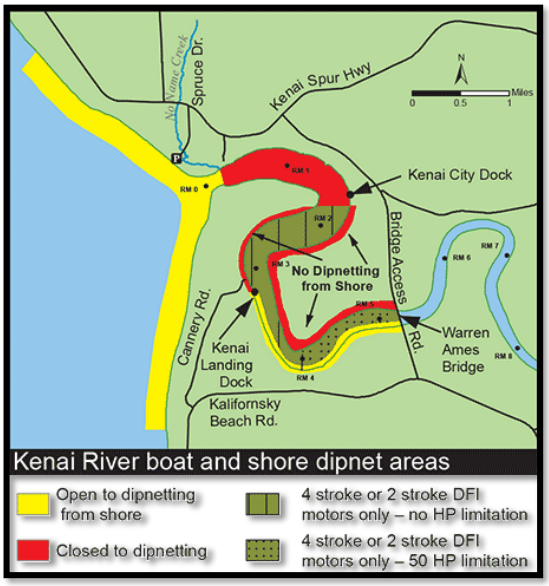

Figure 1 - Kenai River and Kenai Beach dipnet personal use fishery access locations (Alaska Department of Fish and Game, 2018).

Common practice of recreationists within the dipnet PUF involves processing fish and discarding the waste along the beaches or within nearshore ocean water. It is also common to store freshly caught fish on the beaches before processing them. The fish and resulting waste exposed along the beaches draws thousands of gulls from an established upstream gull rookery to the area each day to feed. The excrement from these gulls carries bacteria including fecal coliform bacteria and enterococci, which affect water quality along the North and South Kenai Beaches. When in exceedance of State of Alaska Water Quality Standards (18 AAC 70), these bacteria can be indicative of water containing concentrations of other bacteria that could induce human illness.

Monitoring for fecal coliform and enterococci bacteria was initiated in 2010 as part of the Alaska Beach Monitoring Program, part of the Environmental Protection Agency's (EPA) BEACH Program, a national effort to decrease the incidence of water-borne illnesses at public beaches under the federal Beaches Environmental Assessment and Coastal Health Act (BEACH). Throughout the 2010-2014 monitoring seasons, bacteria concentrations were found to periodically exceed the state standards throughout this timeframe. In response, the City of Kenai (CoK) developed best management practices (BMPs) in 2014, and implemented them during the 2015 recreational season. These BMPs included nightly clearing of fish carcasses from North and South Kenai Beaches and installing portable toilets during the PUF season. Such practices were executed with the goal of reducing sources of bacteria, thereby minimizing the exposure of recreationists and fishermen. Bacteria monitoring was paused during this period to allow for the implementation of BMPs.

Starting in 2018, Kenai Watershed Forum (KWF), contracted through the CoK, worked with ADEC to sample for fecal coliform bacteria and enterococci concentrations. The sampling objective was to monitor changes in these bacteria concentrations post-BMP implementation. Weekly bacteria sampling was conducted from May-September 2019 and 2020 at the North and South Kenai Beaches, two sites near the upriver gull rookery, and near the Warren Ames Memorial Bridge (Figure 2).

Potential sources of terrestrial feces (gull, human, and dog) were examined using microbial source tracking (MST) (Green et al., 2019), a method used to identify sources of fecal contamination based on species-specific genetic markers (e.g. DNA) present in samples. MST analysis is able to detect trace amounts of DNA in a sample, and in this study was used to quantify the proportional contribution from each animal species to fecal matter concentrations. MST analyses were conducted in 2019 and 2020 before and during the PUF.

Water quality exceedances of both fecal coliform and enterococci were identified throughout the 2018-2020 recreational seasons, particularly at the North and South Kenai Beach sampling locations. In response, KWF collaborated with the CoK and ADEC to conduct public outreach

Commented [ASJ(13]: Add citation for 18 AAC 70

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Commented [ASJ(15]: You can move this around – should state somewhere that this monitoring is part of the EPAs BEACH program. BEACH is a national effort to decrease the incidence of water-born illnesses at public beaches under the federal Beaches Environmental Assessment and Coastal Health Act (BEACH).

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Commented [MH17]: confirm

Commented [BM18]: Is there a rationale for why monitoring would need to be paused during these years? I'm not seeing how ongoing monitoring would interfere with implementing BMPs.

Commented [ASJ(19]: Add a few sentences on how MST sampling works – i.e., qPCR, RNA/DNA. Does not need to be detailed methods, just enough to give the reader some idea of what this tool is doing.

Commented [BM20R19]: Modified. The reference provides a better description of microbial source tracking.

and education centered on preventative measures the public could take in order to avoid contact with contaminated water.

This report focuses on the 2020 monitoring season. Some results from the 2019 are included for comparison. A complete analysis of the 2019 and 2018 field seasons are included in a previously published report (Harings, 2020).

In addition to examining data from the recent field season in detail, all available data related to bacteria sampling 2010 – 2020 were downloaded and prepared for use in the EPA Virtual Beach model. ADEC intends to employ the Virtual Beach model in monitoring bacteria concentrations in the lower Kenai River in future field seasons.

Methods

Prior to monitoring each sampling season, the Alaska Department of Environmental Conservation's (ADEC) BEACH Water Quality Monitoring and Pathogen Detection Quality Assurance Project Plan (QAPP) was revised for sampling at five predetermined sites within the lower reaches of the Kenai River as well as along the North and South Kenai Beaches. Kenai Watershed Forum (KWF) personnel were trained in sampling techniques using the methods outlined in the QAPP and sampling was supervised by senior personnel throughout the summer for consistency and technique. ADEC also joined for one sampling event each season for quality assurance.

Monitoring locations

All five monitoring locations (Table 1 and Figure 2) are located within the lower six miles of the Kenai River. During peak recreation and fishing periods in July and August, this area experiences high pressure from both commercial and personal-use power boats as well as bank fisherman during the dipnet personal use fishery (PUF) from July 10th - July 31st. The most upstream site, Warren Ames Memorial Bridge, receives little pressure from fishermen and was chosen as a monitoring site for background pathogen concentrations. Further downstream near the Kenai River outlet is a large gull rookery located on river left that plays host to thousands of gulls in summer. The North and South Kenai Beaches located near the Kenai River outlet draws twenty to thirty thousand dipnetters annually during the personal use fishery season (ADFG, 2021). Sampling site photographs can be found in Appendix A: Site Photographs.

Commented [ASJ(21]: Are there specific times/seasons? Are the gulls there during migration/nesting periods? Year round? "at times" is very vague.

Commented [BM22R21]: Modified text. I was unable to find data specific to seasonal migration or population size of lower Kenai River gulls. But we know that at least some of them do migrate long distances (eg. Ahlstrom et al. 2021. Fig 2). And, we know for sure there are thousands of them there at least in summer, so I left it at that.

Commented [ASJ(23]: Do the CoK PUF annual provide number ranges that could be added here?

Commented [BM24R23]: Added reference

Table 1 - 2019-2020 Kenai beach bacteria monitoring site locations and descriptions.

Site Name	Site ID	Latitude	Longitude	Site description
Warren Ames Memorial Bridge	BRG1	60.5259	-151.20647	Farthestmost upstream site on Kenai River, receiving little use by fishermen; provides data for background levels of bacteria in river
Kenai River Gull Rookery 2	KRGR2	60.5518	-151.244	Upstream of gull rookery on the Keanai River; provides data for bacteria levels above influence of rookery
Kenai River Gull Rookery 1	KRGR2	60.5366	-151.254	Downstream of gull rookery on the Kenai River; provides data for bacteria levels below rookery
North Kenai Beach 4	NKB4	60.54978	-151.26804	One of two sites on North Kenai Beach, receiving high dipnetting pressure during PUF; fish carcassess from PUF attract hundreds of gulls present during certain days of PUF; provides data for bacteria levels before, during, after PUF
South Kenai Beach 3	SKB3	60.54332	-151.26532	One of two sites on South Kenai Beach, receiving high dipnetting pressure during PUF; fish carcassess from PUF attract hundreds of gulls present during certain days of PUF; provides data for bacteria levels before, during, after PUF

Commented [ASJ(25]: Check your formatting so that captions and tables are not split across pages in the final version.

Commented [BM26R25]: Thanks. Sometimes the same Word doc shows up with different page spacing on two different computers. I'll send a PDF of this document also to display how it appears on my screen.

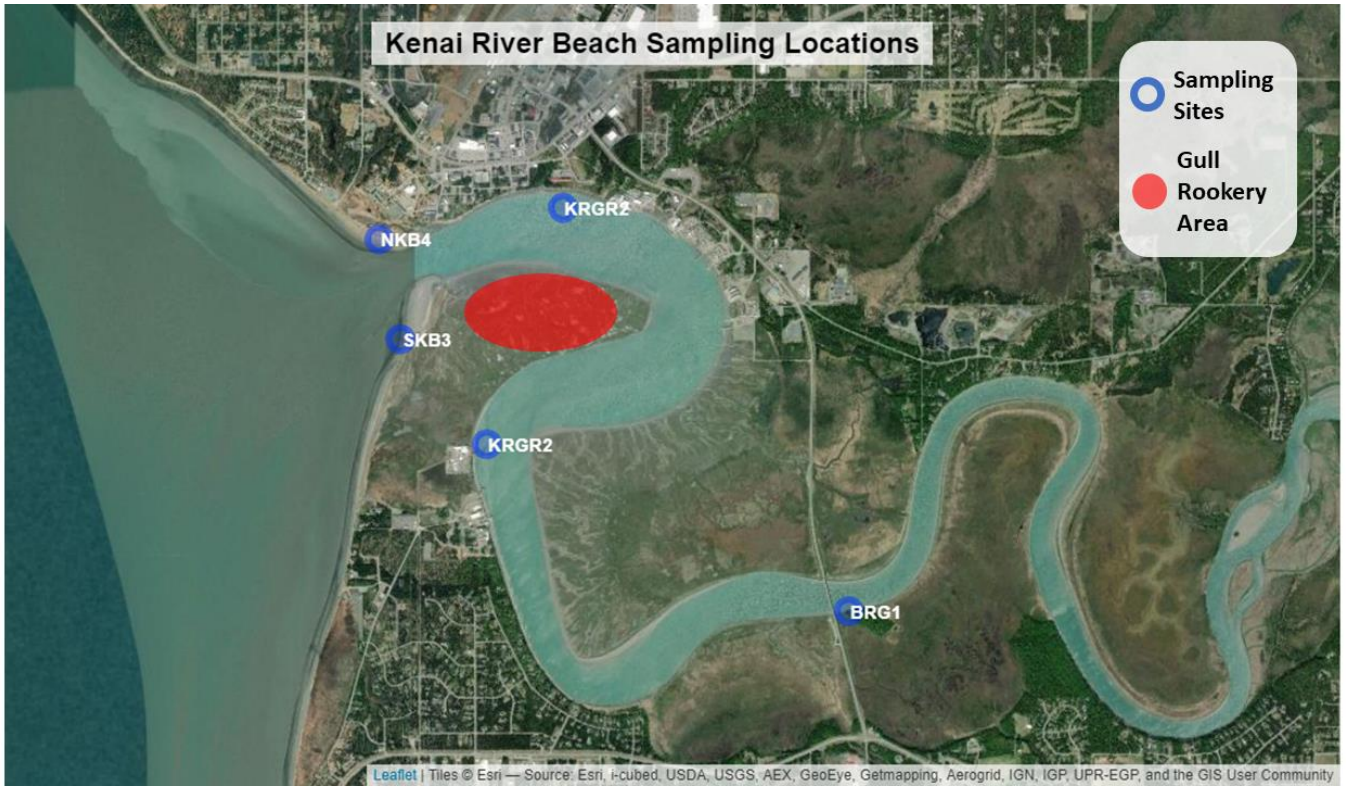

Figure 2. 2019-2020 Kenai River beach sampling sites and general gull rookery area. See Figure 1 for personal use fishery beach areas.

Commented [ASJ(27]: Can you provide an updated map? It's difficult to read "KRGR2" and "NKB4" on this version. Also the red polygon is confusing – what is the shape highlighting? It might be beneficial to add the PUF beach fishing locations as well to this map.

Commented [BM28R27]: Remade map in leaflet, modified label text and legend format. I attempted to also highlight beach areas open to the PUF, but makes the figure kind of busy, so instead referred to Fig 1 in caption

Sampling design

Sites selected for monitoring throughout the 2019 and 2020 sampling seasons remained consistent with those used in previous year and consisted of the Warren Ames Memorial Bridge (BRG1), above and below the gull rookery in the Kenai River (KRGR1 and KRGR2, respectively), and two different areas on both the North (NKB4) and South (SKB3) Kenai Beaches (Figure 2).

During sampling events, site visits were conducted within a few hours of high tide, as it was necessary to time boat launch and retrieval at the City of Kenai docks with high water conditions. Sites near the gull rookery were accessed by boat while all other sites were accessed by foot. At each site, two 100-mL grab samples of water were collected from the river: one for fecal coliform bacteria and one for enterococci. A set of replicate samples was collected for quality control during each sampling event, rotating between the North and South Kenai Beach sampling sites. In-situ air and water temperatures were collected using an YSI 650 MDS or YSI Pro 20 multiprobe meter; local observations were made regarding the weather, tides, beach, activity noted on the beach, and potential sources of contamination (gulls, boats, etc.). Wave height and turbidity were also assessed in 2020 at the Warren Ames Memorial Bridge and both North and South Kenai Beaches using a yard stick and Hach 2100Q Portable Turbidimeter, respectively. For the purpose of quantifying and referencing observed fishermen, campers, and other beachgoers, the all-encompassing term "recreationists" will be used throughout this report. All field observations were recorded on an EPA Marine Beach Sanitary Survey found in Appendix D: Marine Beach Sanitary Survey.

All grab samples were packaged and shipped on ice with a chain-of-custody form (see Appendix C: Chain-of-Custody) within six hours of sampling via commercial air carrier to ADEC-certified laboratory, SGS North America Inc., for analyses in Anchorage. As required by the project QAPP, the quantity of fecal coliform bacteria per 100-mL sample was determined using analytical method ID SM-9222D while the quantity of enterococci per 100-mL sample was determined using analytical method ID D6503-99 (ADEC: Division of Water, 2012). Results of these analyses were reported by the laboratory to KWF and ADEC within 48 hours of receiving the samples. If exceedances were present, ADEC would issue a notice of exceedance to stakeholders (Appendix B: Press Releases). Ongoing outreach efforts by CoK and KWF included sign postings, and an on-site public information booth during the PUF.

2019-2020: Microbial source tracking

Sampling for MST was conducted at all five Kenai River bacteria monitoring locations in 2019 and 2020. MST methodology was employed to test for the presence of dog, human, and gull fecal matter- all of which are potential sources contributing to bacteria concentrations in the Kenai River system. In 2019, the first sampling event occurred prior to start of the PUF on June

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Commented [BM30R29]: reworded

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Commented [BM32R31]: Modified text. "Atypical" might have referred to one of the 24 hr sampling events as done in 2018.

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Commented [ASJ(33]: Why?

Commented [BM34R33]: High tide conditions were necessary to use the boat launch.

Commented [ASJ(35]: Marine mammals, horses, ungulates, are other potential sources that were not tested for – so "all" potential sources is not appropriate. Dogs, humans, and gulls are believed to be the most likely, and had available MST markers at the time.

Commented [BM36R35]: Agreed. Had intended to communicate "dogs, humans and gulls are all potential sources…" Hopefully clearer now.

4th and on August 1st, 2019. In 2020, MST sampling events took place on June 23rd and July 20th.

All sampling events for MST corresponded with a standard bacteria sampling event. Prior to each sampling event, five 500-mL sterile sampling bottles were packaged individually wrapped in paper towels and stored in zip lock bags. Once in the field, personnel cleaned hands and wore new disposable gloves. Sample bottles remained closed until immediately prior to sample collection. Each bottle was labeled with sampling location, sample type (MST), date, and time. One grab sample was taken per monitoring location and subsequently packaged and shipped on ice with a corresponding chain-of-custody form (Appendix C: Chain-of-Custody) within six hours of sampling via commercial air carrier to the ADEC-certified laboratory, SGS North America Inc. (SGS), in Anchorage. To concentrate bacteria within the samples, SGS processed all samples via a sterile, vacuum filtration method. All resulting filters were stored in a freezer until notified by KWF to overnight mail the frozen samples with a temperature blank to ADEC-approved Source Molecular in Miami, Florida, where the bacteria source was identified by genetic markers using quantitative polymerase chain reaction (qPCR) and Digital PCR technologies.

Quality assurance and quality control

Monitoring methods and data were reviewed for quality control and assurance by the ADEC Project Manager as well as the KWF Project Quality Assurance Officer.

Quality control samples were taken for both fecal coliform and enterococci analyses. These samples alternated between the North and South Kenai Beaches each week. When duplicate sample values existed, only the higher of the two values were used in data summary and analyses presented in this report. Using only the higher of two replicate is a more conservative approach that is appropriate in this application because data pertains to public health and safety.

All data was uploaded to the state Ambient Water Quality Monitoring System (AQWMS) by ADEC, and later to the national EPA Beach Data repository (EPA, 2021a), publicly accessible using the online Beach Advisory Closing Online Notification (BEACON) tool (EPA, 2021b).

Water quality standards

Fecal coliform and enterococci analyses results from the 2020 monitoring seasons were evaluated based on the Alaska Water Quality Standards for marine water (18 AAC 70 (14)) (Appendix G). Results were evaluated against in-season management criteria, as well as post-season retrospective criteria. When two sub-criteria are specified (i.e., geometric mean and 10% of samples in a season), both criteria must both be met or the site fails the standard. When in-

Commented [ASJ(37]: CoK is the grantee – but the PQA officer was Maggie/ the KWF Biologist

Commented [BM38R37]: Thanks for the clarification

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Commented [BM39]: Communicated with Gretchen Augat to confirm this was the case in mid-February while Sarah was out of the office

Commented [BM40]: I have re-evaluated all data and re-generated all figures and tables based on the clarifications we discussed over email and phone in the week of Feb 8.

Commented [BM41R40]: The text here describing water quality standards is a more verbose version of the table that was in the original draft I inherited (Appendix G).

While I always prefer the more pithy option in writing, in this case I feel the lengthier and more detailed text description is important to describe how I interpreted the regulatory language.

season geometric mean values are calculated, a minimum of five samples spaced over thirty days were used.

Results were evaluated in the context of (18 AAC 70 (14)) water quality standards as follows:

Fecal coliform
Fecal coliform exceedances were determined based on standards set for:

1) Secondary water recreation (18 AAC 70 (14)(B)(ii))
   a) In-season exceedances for secondary contact recreation were identified when
      i) Individual fecal coliform sample values exceeded 400 CFU/100 mL, or
      ii) The geometric mean of fecal coliform samples exceeded 200 CFU/100 mL over a 30 day period.
   b) Post-season site exceedances were identified if 10% of fecal coliform sample values from the entire season exceeded 400 CFU/100 mL.
2) Harvesting raw aquatic life for consumption (18 AAC 70 (14)(D))
   a) In-season exceedances for harvesting raw aquatic life for consumption were identified when
      i) Individual fecal coliform samples exceeded 31 CFU/100 mL
   b) Post-season site exceedances were identified when
      i) 10% of fecal coliform samples from season exceeded 31 CFU/100 mL, or
      ii) The geometric mean of fecal coliform samples from the season exceeded 14 CFU/100 mL.

Enterococci
Enterococci exceedances were determined based on standards set for:

1) Contact recreation (18 AAC 70 (14)(B)(i))
   a) In-season exceedances for contact recreation were identified when
      i) Individual enterococci samples exceeded 130 CFU/100 mL
      ii) The geometric mean of enterococci samples exceeded 35 CFU/100 mL over a 30 day period.
   b) Post-season site exceedances were identified when 10% of enterococci samples exceeded 130 CFU/ 100 mL

The above standards as described in Alaska Water Quality Standards for Marine Water (18 AAC 70 (14)) appear in Appendix G.

ADEC issued a general public notice at the start of the 2020 recreation season, posted weekly updates/advisories on the ADEC Facebook page, and emailed the weekly results to an email listserv of community stakeholders. When an exceedance for harvesting raw aquatic life for consumption occurred, ADEC seafood monitoring personnel were notified along with other stakeholders through the Alaska Beach Program email listserv.

Public outreach

Public outreach remained a critical component of effective bacteria monitoring during the 2019 and 2020 monitoring seasons. ADEC and the CoK partnered with Stream Watch, a KWF and U.S. Forest Service program specializing in angler education and outreach, to disseminate information on ways to avoid contact with bacteria and proper fish handling at North Kenai Beach. Education was provided in the form of brochures and personal communication. Booth visitors verbally expressed their appreciation for handouts including fin clippers and dog bags, which aim to help reduce the fecal bacteria contributed by dogs along the beach. Volunteer participation metrics were recorded in 2020 and include staffing a booth for 59 hours during which volunteers conducted peer-to-peer education with 383 recreationists, as well as a total of 93 pounds of trash collected.

In 2019 and 2020, ADEC issued educational radio ads that were played four times per week during the PUF. In addition, weekly water quality status updates were posted to the ADEC Facebook page (Appendix B).

The ADEC Beach Webpage was updated to include interactive maps, and provided information on beach monitoring and guidelines for minimizing contact with bacteria. In 2019 stakeholders were emailed weekly updates on Kenai Beach monitoring. In 2020, a beach notification listserv was developed to replace the previous notification system.

Data for Virtual Beach model

The EPA Virtual Beach model is a decision support tool that constructs site-specific statistical models to predict fecal indicator bacteria (FIB) concentrations at recreational beaches (EPA 2021c). The model may be parameterized with field observations of bacteria concentrations and environmental data. In preparation for employing the Virtual Beach model, all available historical data with potential application in the model was downloaded and prepared for use in Virtual Beach. All available beach sampling data was downloaded as a csv file from the EPA BEACON repository using the "reports" function (https://watersgeo.epa.gov/BEACON2/reports.html) in December 2020. The file contained all archived data 2010 – 2020 related to beach sampling in the lower Kenai River including bacteria concentrations, water temperature, wave height, and others. The data required extensive preparation to ensure consistent measurement units, site names, and time format. Ten resulting

Commented [ASJ(42]: We're not issuing public notices for the 31 FC – raw shellfish consumption since BEACH monitoring is focused on recreation use. It was included in past public notices if it coincided with a recreation standard exceedance.
We do notify/share this information with the ADEC seafood monitoring group, and its posted online.

Commented [BM43R42]: Modified this whole section after our phone conversations and emails, let me know what you think.

Commented [ASJ(44]: Check that spacing is consistent throughout document

Commented [ASJ(45]: Could you move these links to the references section? Or hyperlink the text instead of including the entire url

Commented [BM46R45]: Replaced links with hyperlinked text

Commented [ASJ(47]: Provide a screenshot of a Kenai beach FB post instead of a link. FB post are quickly buried. I'll see if I can find one and send it to you.

Commented [BM48R47]: Added example FB post to Appendix B

Field Code Changed

csv files were generated, each containing all data associated with each of the five sample sites in Figure 2, organized by bacteria type. The resulting spreadsheets are found in the project GitHub repository linked at the end of this report under "output/virtual_beach_data."

Results

Bacteria concentrations monitoring 2019 – 2020

A total of 161 enterococci samples and 162 fecal coliform sample concentrations, including replicates, are present in the 2019-2020 data set. Figure 3 presents the range of sample concentration values from both years for comparison.

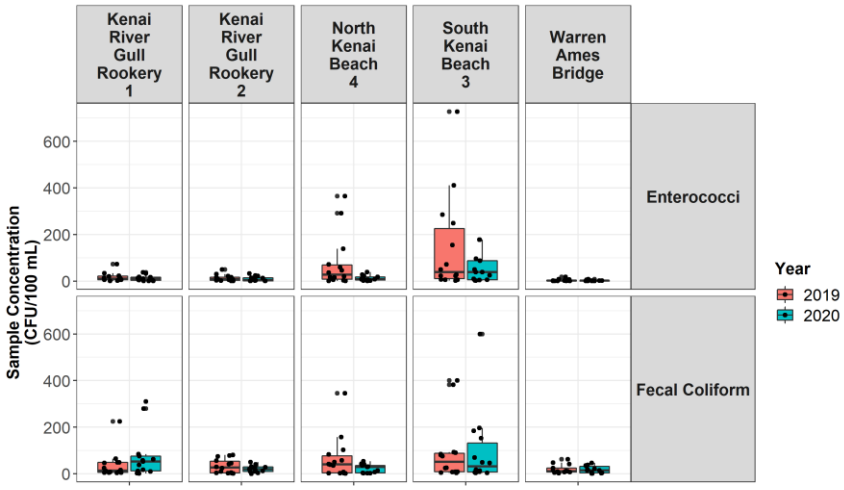

Figure 3 – Bacteria sample concentration values from 2019 and 2020.

Figure 3 indicates that sample concentrations occupied roughly similar ranges in both 2019 and 2020 at most sites. Notably, at both North Kenai Beach and South Kenai Beach, enterococci concentrations occupied a higher range of values in 2019 relative to 2020.

Table 2 presents summary statistics (mean ± standard error, minimum, and maximum) from the 2020 sampling season for both individual sample values and thirty-day geometric mean sample values.

Fecal coliform individual sample values overall in 2020 ranged 1 – 600 CFU/100 mL, and were highest on average at the South Kenai Beach site (147.16 ± 71.09 CFU/100 mL, mean ± std. error). Thirty-day geometric mean fecal coliform values overall in 2020 ranged 1.00 – 94.87 and

Commented [ASJ(49]: Its fine to combine/ make a general comparison between 2019 and 2020 here, but the following paragraphs get confusing, are too generalized.

Focus on the 2020 season since Maggie covered 2019 in the last report. The comparisons between years are valuable/interesting, and I think you do a good job overall, it just gets confusing in a few places as its currently written.

Commented [BM50R49]: I restructured the entire results section to a.) first, go through a general description of sample results, and then b.) go through each separate standard in the 18 AAC 70 language, point by point.

Focus is now almost exclusively on 2020 results; except for the MST data, which includes both years

were highest on average at the Kenai River Gull Rookery 1 site (61.09 ± 41.62 CFU/100 mL, mean ± std. error).

Enterococci individual sample values overall in 2020 ranged 0.5 – 178 CFU/100 mL, and were highest on average at South Kenai Beach site (74.12 ± 25.96 CFU/100 mL, mean ± std. error). Thirty-day geometric mean enterococci values were also highest on average at South Kenai Beach (29.09 ± 25.96 CFU/100 mL, mean ± std. error).

Variation between 2020 replicate samples averaged 40.58 ± 7.03 % (mean ± std. error) for enterococci and 24.12 ± 4.40 % (mean ± std. error) for fecal coliform samples (Table 3).

For complete 2020 data applied in determining threshold criteria exceedance see Appendix E: 2020 Sample Values and Exceedances. Raw analytical results can also be found at the ADEC BEACH program Kenai River page, and from 2010 – present in the EPA BEACON data base.

Commented [ASJ(51]: Id direct the reader to the BEACON database also

Commented [BM52R51]: Added hyperlinks for BEACH and BEACON.

Table 2 - Summary statistics by site and bacteria species for the 2020 sampling season; individual sample concentrations and thirty-day geometric mean values. All sample result values are in CFU/100 mL.

Bacteria	Location	Individual Sample Mean ± Std. Error	Individual Sample Min	Individual Sample Max	30 Day Geometric Mean Value Mean ± Std. Error	30 Day Geometric Mean Value Min	30 Day Geometric Mean Value Max
Enterococci	Kenai River Gull Rookery 1	15.19 ± 4.79	0.50	37.00	7.84 ± 4.79	4.02	10.37
Enterococci	Kenai River Gull Rookery 2	11.62 ± 4.52	0.50	33.00	4.52 ± 4.52	2.83	8.24
Enterococci	North Kenai Beach 4	10.81 ± 4.6	0.50	38.00	6.05 ± 4.6	2.61	10.02
Enterococci	South Kenai Beach 3	74.12 ± 25.96	3.00	178.00	29.09 ± 25.96	14.54	39.75
Enterococci	Warren Ames Bridge	2.25 ± 0.88	0.50	8.00	1.48 ± 0.88	1.00	1.89
Fecal Coliform	Kenai River Gull Rookery 1	109.88 ± 41.62	3.00	310.00	61.09 ± 41.62	33.52	94.87
Fecal Coliform	Kenai River Gull Rookery 2	24.16 ± 5.5	3.30	50.00	18.9 ± 5.5	12.62	24.43
Fecal Coliform	North Kenai Beach 4	23.02 ± 6.21	2.00	43.00	12.84 ± 6.21	7.03	20.33
Fecal Coliform	South Kenai Beach 3	147.16 ± 71.09	5.70	600.00	47.01 ± 71.09	13.05	79.44
Fecal Coliform	Warren Ames Bridge	16.46 ± 5.99	1.00	46.00	11.22 ± 5.99	6.01	15.92

Table 3 - Mean percent difference between replicate sample values, all 2020 replicate samples.

Bacteria	Replicate Samples	% Difference Between Replicates (Mean ± Standard error)
Enterococci	26	40.58 ± 7.03 %
Fecal Coliform	26	24.12 ± 4.40 %

Water quality standards analysis

Bacteria monitoring efforts in 2020 revealed some instances of exceedance for both in-season and post-season criteria based on the Alaska Water Quality Standards. Timing of in-season criteria exceedances are summarized for all standards in Figure 4 and overall seasonal criteria exceedances are summarized by site in Table 4.

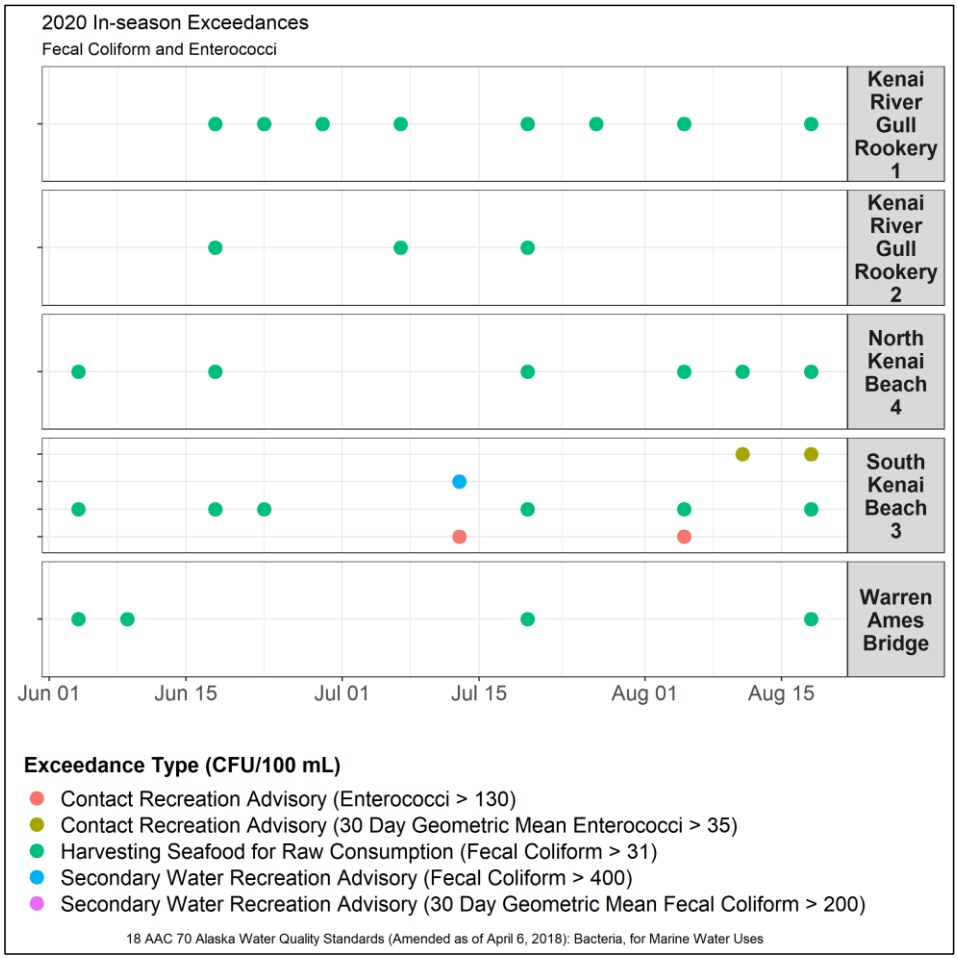

Figure 4 – Timing of fecal coliform and enterococci sample exceedances in 2020 of criteria described in 18 AAC 70 Alaska Water Quality Standards.

Table 4 - Overall seasonal criteria exceedances for fecal coliform and enterococci by site for the 2020 sampling season.

	Fecal Coliform			Enterococci
	Secondary Water Recreation (18 AAC 70(14)(B)(ii))	Harvesting Raw Aquatic Life for Consumption (18 AAC (70)(14)(D))		Contact recreation (18 AAC 70 (14)(B)(i))
Site	10% of sample values from season > 400 CFU/100 mL	10% of sample values from season > 31 CFU/100 mL	Overall Season Geometric Mean > 14 CFU/100 mL	10% of sample values from season > 130 CFU/100 mL
Kenai River Gull Rookery 1	pass	fail	fail	pass
Kenai River Gull Rookery 2	pass	fail	pass	pass
North Kenai Beach 4	pass	fail	pass	pass
South Kenai Beach 3	pass	fail	fail	fail
Warren Ames Bridge	pass	fail	pass	pass

The following sections describe fecal coliform and enterococci sample values from the 2020 sampling season in greater detail, in context of 18 AAC 70 regulations.

Fecal Coliform

Fecal coliform sample values from 2020 are interpreted in context of 18 AAC 70 Alaska Water Quality Standards as follows:

Secondary Water Recreation

- In-season criteria (Figure 5)
  - One individual fecal coliform sample of > 400 CFU/100 mL was observed at one site (South Kenai Beach) on one date.
  - Thirty-day geometric mean fecal coliform values of >200 CFU/100 mL were not observed at any sites.
- Post-season criteria (Table 5)
  - At no sites were 10% of all fecal coliform samples from the season > 400 CFU/100.

Harvesting Raw Aquatic Life for Consumption

- In-season criteria (Figure 5)
  - At all five sites, on various dates, individual fecal coliform samples exceeding 31 CFU/100 mL were observed.
- Post-season criteria

- At all five sites 10% of all fecal coliform samples from a season exceeded 31 CFU/100 mL (Table 5).
- The overall seasonal geometric mean of fecal coliform samples exceeded 14 CFU/100 mL at two sites (South Kenai Beach, and Kenai River Gull Rookery 1) (Table 6)).

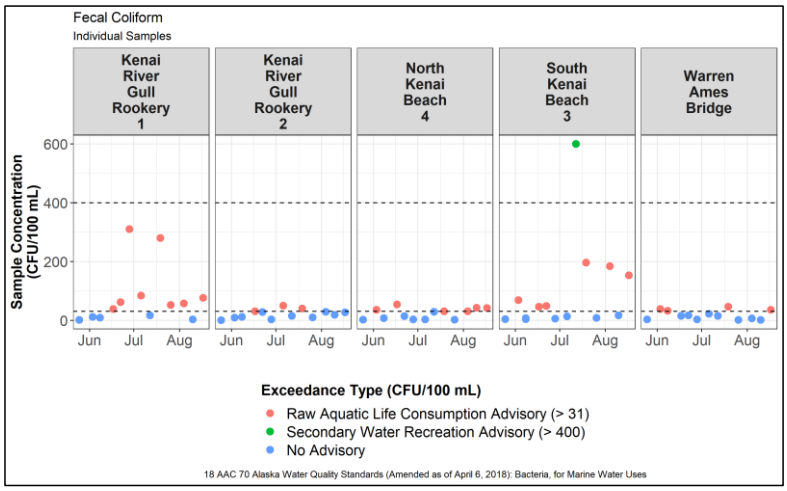

Figure 5 – Fecal coliform concentrations from lower Kenai River sites in 2020, color coded by exceedance standard criteria. Dotted lines indicate criteria thresholds for individual samples of 31 CFU/100 mL and 400 CFU/100 mL.

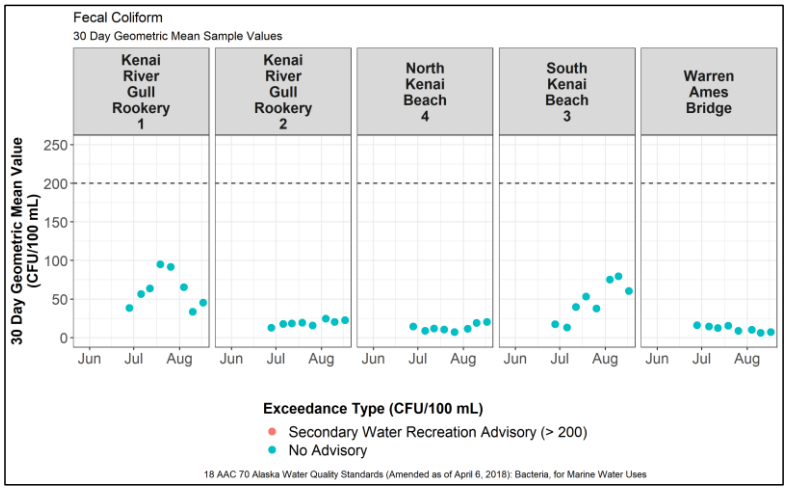

Figure 6 – Thirty day geometric mean values of fecal coliform samples from lower Kenai River sites in 2020, color coded by exceedance standard criteria. Dotted line indicates criteria threshold for geometric mean sample values.

Table 5 – Percent of fecal coliform samples from the 2020 sampling season that exceeded a specified criteria standard.

Location	Standard (CFU/100 mL)	% of Fecal Coliform Samples Above Standard	Pass/Fail
Kenai River Gull Rookery 1	31	61.5%	fail
Kenai River Gull Rookery 2	31	23.1%	fail
North Kenai Beach 4	31	46.2%	fail
South Kenai Beach 3	31	42.9%	fail
Warren Ames Bridge	31	30.8%	fail
Kenai River Gull Rookery 1	400	0.0%	pass
Kenai River Gull Rookery 2	400	0.0%	pass
North Kenai Beach 4	400	0.0%	pass
South Kenai Beach 3	400	7.1%	pass
Warren Ames Bridge	400	0.0%	pass

Table 6 – Seasonal geometric mean values of fecal coliform samples from the 2020 sampling season in the lower Kenai River.

Location	Overall Seasonal Geometric Mean Fecal Coliform Value (CFU/100 mL)	Standard (CFU/100 mL)	n	Pass/Fail
Kenai River Gull Rookery 1	30.75	14	13	fail
Kenai River Gull Rookery 2	13.89	14	13	pass
North Kenai Beach 4	13.29	14	13	pass
South Kenai Beach 3	30.70	14	14	fail
Warren Ames Bridge	10.51	14	13	pass

Enterococci

Contact Recreation

- In-season criteria
  - At one site (South Kenai Beach) on two dates, individual enterococci values exceeded 130 CFU/100 mL (Figure 7).
  - At one site (South Kenai Beach) on two dates, thirty-day geometric mean enterococci values exceeded 35 CFU/100 mL on two dates (Figure 8).
- Post-season criteria
  - At once site (South Kenai Beach), > 10% of enterococci samples exceeded 130 CFU/ 100 mL (Table 7).

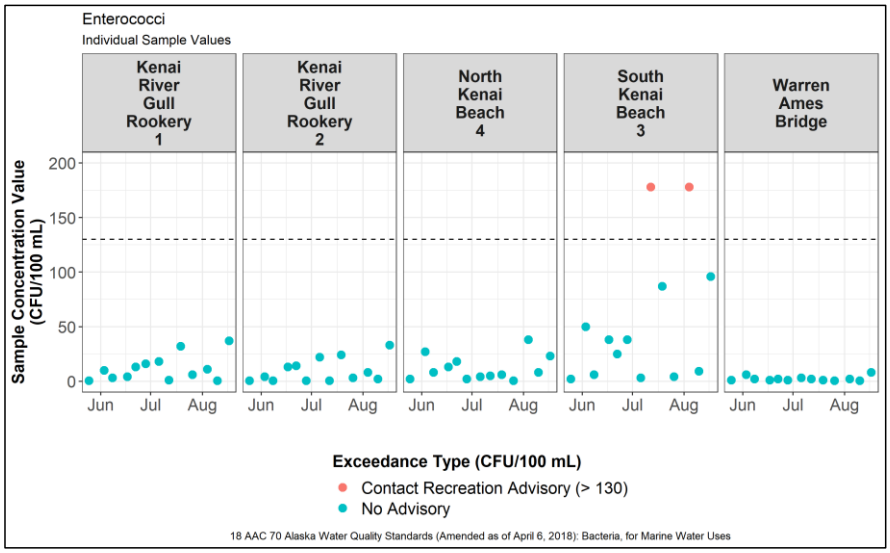

Figure 7 – Enterococci sample concentrations from lower Kenai River sites in 2020, color coded by exceedance standard criteria. Dotted lines indicates the criteria thresholds for individual samples of 130 CFU/100 mL.

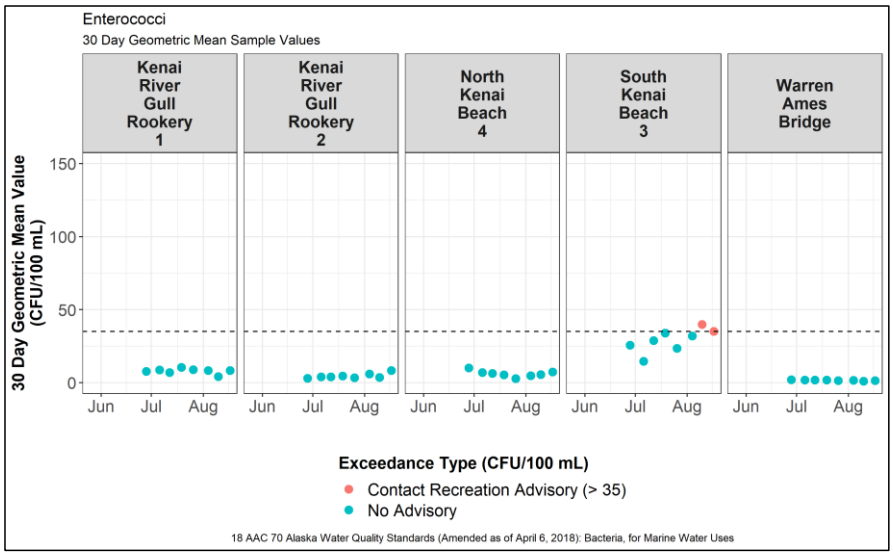

Figure 8 - Thirty day geometric mean values of enterococci samples from lower Kenai River sites in 2020, color coded by exceedance standard criteria. The dotted line indicates criteria threshold of 35 CFU/100 mL for thirty day geometric mean sample values.

Table 7 - Percent of enterococci samples from the 2020 sampling season that exceeded the criteria standard of overall geometric mean of 130 CFU/100 mL.

Location	Standard; Overall Geometric Mean Enterococci, (CFU/100 mL)	% of Samples Above Standard	Pass/Fail
Kenai River Gull Rookery 1	130	0.0%	pass
Kenai River Gull Rookery 2	130	0.0%	pass
North Kenai Beach 4	130	0.0%	pass
South Kenai Beach 3	130	15.4%	fail
Warren Ames Bridge	130	0.0%	pass

2019 - 2020 Microbial Source Tracking Data

Sample results for microbial source tracking (MST) were available for two sampling events for each of the 2019 – 2020 sampling seasons. In general, gulls were indicated as the overwhelming source of fecal matter at most sampling events (Figure 9). Concentrations of dog and human feces were detected in some cases, but in general were much lower relative to concentrations of gull feces. Human fecal matter was detected at one site in 2019 (KRG1) and three sites in 2020 (KRG2, NKB4, SKB3), while dog fecal matter was detected only at the North and South Kenai Beach sites. Concentrations (copies biomarker gene/100 mL) overall ranged from not detected to 28,200 for gulls, not detected to 4,660 for dogs, and not detected to 1,220 for humans.

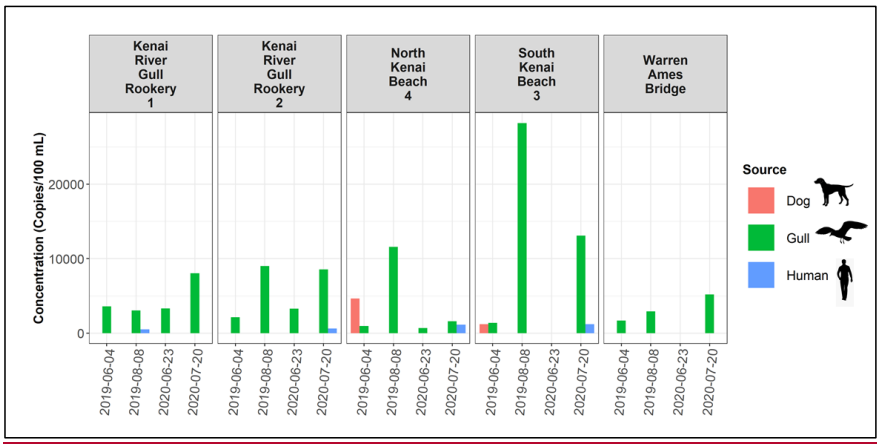

Figure 9: Results from microbial source tracing (MST) analyses from the dive sites sampled for bacteria in the lower Kenai River, 2019 – 2020. Values are copies of biomarker gene per 100 mL. Where colored bars are absent, genetic material was either not detected or detected but not quantifiable. See Appendix F for data used to generate this figure.

Commented [ASJ(53]: Split into years – only at KRGR1 in 2019 and KRGR2, KNB, and SKB in 2020.

Commented [BM54R53]: Modified text

Deleted: all sites except

Deleted: the Warren Ames Bridge,

While human and dog fecal matter were generally much lower relative to gull fecal matter in most sampling events, several exceptions are noted. Sampling events on June 4, 2019 indicated dog feces as the majority source of fecal contamination at North Kenai beach and as a substantial source, proportionately, at South Kenai Beach. Additionally, on July 7, 2020 at North Kenai beach, fecal matter concentrations for gulls and humans were within a similar range of values, with 1590 marker copies/100 mL for gulls and 1140 marker copies/100 mL for humans (Figure 6). Complete MST data is found in Table 8 (Appendix F: Microbial Source Tracing Data).

Discussion

2020 Kenai beach bacteria monitoring

Enterococci and fecal coliform exceedances occurred in 2020 for in-season criteria as well as overall seasonal criteria.

Commented [ASJ(55]: Of just the raw shellfish harvesting or recreation contact also?

Commented [BM56R55]: Modified most of the discussion text based on new updated interpretation of regulations.

Individual fecal coliform sample exceedances (> 31 CFU/100 mL) for secondary water recreation were observed at all five sites throughout the 2020 sampling season. Only the South Kenai Beach saw any additional in-season fecal coliform exceedances, which consisted on one secondary water recreation advisory for > 400 CFU/mL. Regarding overall seasonal standards for fecal coliform, all five sites failed one of the overall seasonal standards for harvesting raw aquatic life for consumption (10% of fecal coliform samples > 31 CFU/100 mL), and two out of five sites (Kenai River Gull Rookery 1 and South Kenai Beach) failed the other seasonal standard (overall geometric mean fecal coliform value > 14 CFU/100 mL).

Individual enterococci sample exceedances (> 130 CFU/100 mL) for contact water recreation were observed at South Kenai Beach on two dates in the 2020 sampling season, as well as two dates where the thirty-day geometric mean enterococci value was > 35 CFU/100 mL. Regarding overall seasonal standards for enterococci, one site failed on the overall seasonal standard for contact recreation (10% of enterococci samples > 130 CFU/100 mL).

The elevated concentrations of bacteria at South Kenai Beach relative to other locations can likely be attributed to the increase in fish carcasses and gull fecal matter during the dipnet personal use fishery in July. Though various factors influence the magnitude of bacteria concentrations in the lower Kenai River, the size and timing of the late-run sockeye population and dipnet personal use fishery (PUF) participation are likely among the largest. When more fish carcasses are disposed of on the beach, greater quantities of gull fecal matter contribute to bacteria growth unless mitigated. Annual participation in the Kenai River dipnet personal use fishery (PUF) continues to grow (Figure 10), thus monitoring and assessment of bacteria concentrations in the lower Kenai River will continue to remain essential. Even in spite of the travel challenges posed by the COVID-19 pandemic in summer 2020, overall revenue from –

Commented [ASJ(57]: Didn't COK increase parking fees in 2020? Are the numbers corrected for this?

and thus participation in – the dipnet PUF in 2020 was up relative to 2019 ($367,982 in 2019, $456,411 in 2020) (Ostrander, 2020). Although the 2020 harvest was likely lower than 2019 due to the late arrival of a substantial portion of the late-run sockeye in 2020 (Figure 11), in general there is a close relationship between dipnet fishing effort and total annual harvest (Cenek and Franklin, 2017).

An especially valuable exploration of this data would include evaluating the effects of mitigation actions, such as beach raking, on bacteria concentrations, in order to allow managers to most effectively implement this management tool (e.g. Kinzelman et al. 2004). It is important to remember that assessments of best management practices (BMPs) and their effect on frequency and magnitude of exceedances should be evaluated in the context of the growing popularity of the dipnet PUF (Figure 10).

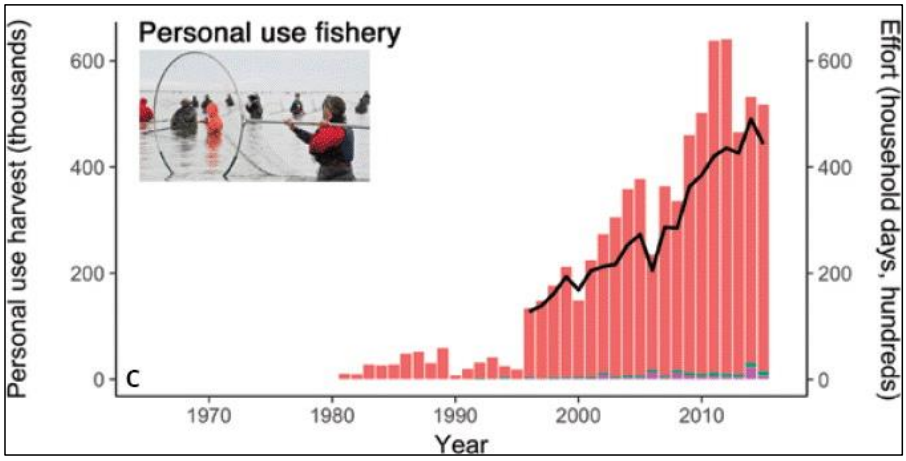

Figure 10 - Growth of the Kenai River personal use fishery in harvest (left axis) and effort (right axis). The fishery has historically captured almost exclusively sockeye salmon (red color), through small numbers of other salmon species are also captured, represented by other colors stacked at the bottom of each bar. Data from ADF&G; figure adapted from Schoen et al. 2017 with author's permission.

Commented [ASJ(58]: So if participation was up in 2020, and more participation = more fish captured = more birds = more bacteria, then why were 2020 pathogen numbers lower on average than in 2019? Just to be clear, I agree with a lot of the relationships you're proposing, but I'd be cautious about making definitive statements without some statistical backing.

Commented [BM59R58]: Agreed

Commented [BM60]: Modify this sentence as appropriate once 2020 PUF participation numbers are avail

Commented [ASJ(61]: Has ADFG published 2020 PUF harvest? If not, you could probably ask them for these numbers.

Commented [BM62R61]: Contacted Adam St. Saviour with ADFG; he says 2020 harvest numbers will be available in March 2021.

Simplest option is to just wait until his data is available and just modify as appropriate once we have it. If we need a final published draft before then, I think the text as is still reads as sensible as it is. Happy to modify though.

Deleted: The limited time span of data (2019-2020) addressed in this report makes ranking the importance of various factors that contribute to bacteria exceedances to challenging. A future analysis that includes a full assessment of all available bacteria concentrations data from 2010 - present in the context of likely predictors (e.g. size and timing of fishery harvest, river flow volume, water temperature, mitigation actions, etc.) may permit attribution of frequency or duration of exceedances to specific predictors.

Commented [ASJ(65]: Yes, absolutely – this is key information that would be great to provide to the City of Kenai. These BMPs are expensive, and I'm sure they'd love to know if these methods are effective or not.

Commented [ASJ(66R65]: I ended up deleting the first half of this paragraph because it was essentially describing VBeach. I think the second half of this paragraph is fantastic and could be expanded upon.

Commented [BM67R65]: Works for me.

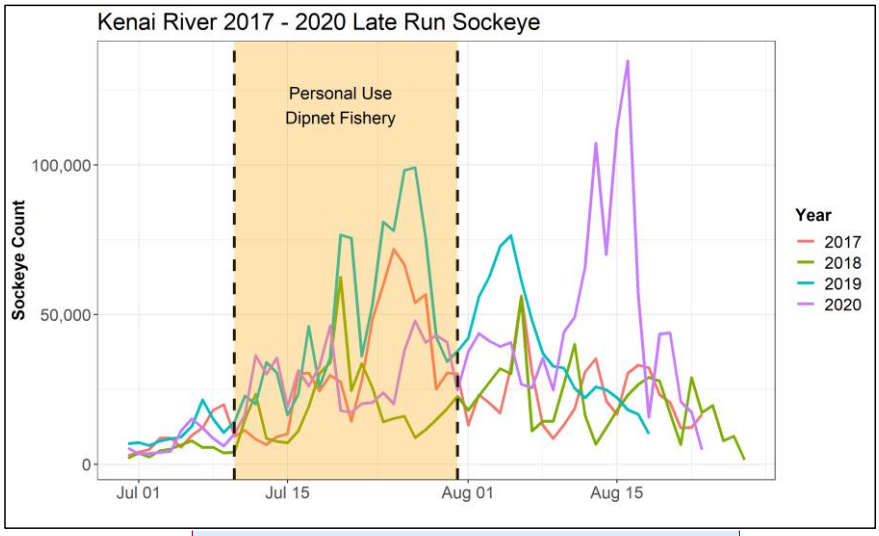

Figure 11 - 2017 – 2020 late run sockeye salmon counts on the Kenai River. Data sourced from Alaska Department of Fish and Game (ADF&G, 2020).

It is recommended that ADEC continue to work closely with the CoK to advise on best management practices based on dipnet personal use fishery attendance and beach carcass concentrations. A modification of best management practices to include disposal or compost of carcasses could be a more permanent, effective way to mitigate the effects on bacteria concentrations, and could be the focus of future efforts and partnerships.

Employing the full extent of all available management and environmental data from the lower Kenai River dipnet PUF will be increasingly important in subsequent years, as weekly monitoring of bacteria concentrations move towards less frequent in-situ weekly sample collection (S. Apsens (ADEC), personal communication, 2020a). An implementation of the Environmental Protection Agency's Virtual Beach Model (EPA, 2021c) is planned, and will be used to estimate in-river bacteria concentrations, supported by two to three in situ "spot checks" throughout the summer where physical samples are collected. Moving forward, it is recommended that the full extent of historical data be used to parameterize the Virtual Beach model, and that sufficient data continue to be collected in order to support it, and that the model is regularly evaluated using both in-season spot checks and comparison to hindcasted values.

Some evidence suggests that for this data set, thirty-day geometric means may be a more meaningful value to represent actual in-river conditions than individual sample values. Replicate grab samples of environmental media can be prone to inter- sample variation (Royal Society of Chemistry, 2014). In this report, difference among paired replicate samples averaged

Commented [ASJ(68]: I like this graph – could you add the approximate PUF dates? This would help show that the 2020 run was late relative to the PUF season.

Commented [BM69R68]: Modified plot.

Commented [ASJ(70]: DEC does not implement the BMPs – We can advise and encourage the continued implementation of BMPs by COK. DEC will primarily focus on public outreach, and periodic sampling to ensure that bacteria levels are acceptable/not increasing.

Commented [BM71R70]: Thanks; modified text.

Commented [ASJ(72]: So there are various hurdles to developing a mass collection system for carcasses. It's not impossible, in fact there was a commercial entity a few years ago that was testing carcass collection for composting. There's just lots of potential issues with removing fish from the river, collecting fish waste in a concentrated area, and dealing with any liquid runoff, animal attractants, etc… The Kenai Peninsula dump does have a carcass disposal bin during the PUF – its just most people process their fish on site.

This could be the focus of a future project, and/or collaboration with a agency or private group. You'd need cooperation/support from ADFG and COK for sure. Something worth thinking about.

Commented [BM73R72]: Thanks. Yep, lots more that could be written. Let me know if this works for the purposes of this report at least.

Commented [ASJ(74]: Yes, bacteria samples can be "flashy" or highly variable between grab samples. Other state programs with more funding and staff can collect daily, or even hourly, samples to 'smooth' out bacteria data. Alaska does not have the monitoring resources, even though our criteria is written as if we do.

approximately 40% for enterococci and 24% for fecal coliform. Previous reports also indicate substantial variation among sample values within a relatively small time span. In 2013, at some sites on North and South Kenai Beach where samples exceeded thresholds, they did not do so when re-sampled twenty-four hours later (Guerron Orejuela, 2013). In 2018, North and South Kenai Beach sites were sampled at hourly intervals for one twenty-four hour cycle in July, and bacteria concentrations varied by an order of magnitude (Harings, 2019). In contrast, criteria that instead assess thirty-day rolling geometric mean values are less prone to short-term variations and thus more likely to represent actual in-river conditions. It is recommended that water quality criteria employing these standards for individual samples do so in the context of mean replicate variation, and be compared to standards that employ rolling geometric means.

Finally, continuing open communication with local stakeholders will remain a critical component of successful and meaningful bacteria monitoring. Emails to stakeholders summarizing weekly sampling results have shown to be effective for conveying data in a transparent manner. Public education and outreach events have also been proven effective, and should continue during future monitoring seasons. Public advisories have reached a broad audience of radio listeners and Facebook viewers. Going forward, it is recommended that the communication protocol is annually reviewed to maintain consistency in when advisories are issued and subsequently removed after two weeks of bacteria concentrations below exceedance threshold (Figure 3 in ADEC, 2020b).

Commented [ASJ(75]: I'd like to think so, but we can only assume. Maybe change to "have reached a broader audience" or similar.

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2019-2020 Microbial source tracking (MST)

Limited MST data had been gathered during previous Kenai bacteria monitoring events prior to 2019 - 2020. Historically, sample analysis for MST was conducted in 2011 and 2014; results can be found at the ADEC Beaches Program webpage (ADEC, 2021). 4.

Commented [BM76]: Maggie had this link here in the draft outline I received; but I am unable to locate any historical MST data (pre-2018) at this link or links on this page. Also did not find it in the BEACON database (using the "reports" function), or elsewhere. Where else might it be? I will look further internally in KWF records if we are unsure.

MST samples analyzed from the 2019 - 2020 sampling events reported gull host markers at all five sampling sites. Among both years, the highest concentration of marker copies associated with gull fecal matter were detected at both North and South Kenai beach sites. This is likely due to the increase in the number of carcasses (and therefore gulls) along the beaches during the personal use dipnet fishery. For June 2020 MST sampling, both Kenai gull rookery sampling sites displayed higher levels of gull feces than any other site, likely due to their proximity to the rookery itself. Quantifiable results for gull feces were reported at all five sites in July during the dipnet PUF during which marker copies were one order of magnitude higher at South Kenai Beach than any other sampling site.

Commented [ASJ(77R76]: I'm guessing she's referencing data contained in previous beach reports that may or may not be on the beach page (all reports should be available on the DEC Water Reports Page. BEACON does not currently accept DEC MST data – we're in the process of developing a protocol with an EPA contractor, so it will on BEACON someday – hopefully soon! I've found old excel files that reference MST data from 2014 – I got those from Maggie – so the data must be buried in KWFs data files somewhere. *Update – I found the 2010-2014 beach report on the Beach webpage

Commented [BM78R76]: Thanks. Modified text to hyperlink.

For comparison among 2019 and 2020, concentration of gull marker copies was roughly twice as high at North and South Kenai Beaches in 2019 than in 2020, which may be attributable to the delayed run timing (and thus likely lower personal use fishery harvest and carcass disposal) of late-run sockeye in 2020.

Finally, it is critical to note that the mouth of the Kenai is a dynamic and ever-changing zone. Influenced by fluctuating river discharge, tides, wind, and boat traffic, patterns in water flow can vary by the minute. Therefore, each MST result is a snapshot of relative species contributions at that time and location.

Conclusions and recommendations

Data collected throughout 2019 and 2020 provide insight into some of the factors involved in the fluctuation of bacteria concentrations in the lower Kenai River and the sources of these bacteria throughout the summer months. Moving forward, the following recommendations should be taken into consideration:

1. In 2020, South Kenai Beach exhibited exceedances of greater frequency magnitude than any other site, with respect to standards for both recreation as well as harvesting seafood for raw consumption. Both North and South Kenai beaches are impacted by an increase in salmon carcasses and therefore gulls during the dipnet personal use fishery.
    a. A basic exploration of patterns in tidal currents and river outflow at the mouth of the Kenai River is recommended, as these patterns may inform the discrepancy in bacteria concentrations between North and South beaches. An examination of satellite imagery may be sufficient to describe patterns of sedimentation and currents at the mouth of the Kenai that influence bacteria concentrations.
    b. It is recommended that ADEC work with the City of Kenai to assess the effectiveness of current best management practices (BMPs) and modify if necessary. With a long-term time series, the effectiveness of BMPs may be evident in the data, though trends should be evaluated in the context of the growth of the personal use fishery in the past two decades. One modification of best management practices could include requiring the immediate disposal or composting of carcasses on the beach.
2. Consistent communication with stakeholders and user groups will remain critical to effective beach monitoring. Communication protocol should be annually reviewed to ensure consistency in when public advisories are issued and for what sites they are necessary.
3. In the future, annual reports should evaluate annual results in the context of available long-term data sets. Comparing new data to long term trends is essential to ensure that ecological trends are readily recognizable even as staff and personnel involved with monitoring may change.
4. Using the results of the Environmental Protection Agency's Virtual Beach Model, it is advised that a monitoring program be operated in perpetuity in order to issue public advisories when necessary.

These four actions would support educated management decisions, encourage preservation of environmental habitat, mitigate potential public health issues, and ensure transparency of the beach monitoring process.

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Commented [ASJ(79]: True, but could be said for most samples (including bacteria samples) collected in a tidally influenced river mouth. Also, for MST that why the quantification is important and not just presence/absence.

Commented [BM80R79]: Agreed. Modified text.

Deleted: -not necessarily a representation of the water in an area as a whole

Commented [BM81]: Shortened this section to focus on priorities

Commented [ASJ(82]: Need to distinguish between exceedances of recreation standards vs exceedances of harvest/consumption of raw seafood standards

Commented [BM83R82]: Agreed. Modified text based on new data interpretation and focus on 2020.

Commented [ASJ(84]: It's a good project idea, but what kind of new information would we potentially get with a high price tag monitoring effort? From Google Maps you can see potential patterns of sedimentation/currents at the mouth of the Kenai/ make some inference on net sediment/net tidal movement. Just something to think about – You don't need to have an answer for this report. I think it could be a cool project, just need to work on justification/needs.

Commented [BM85R84]: Agreed. Modified text.

Commented [ASJ(86]: See comment earlier about this – potential issues with composing on site, in addition to who would staff/maintain such an effort? Financial feasibility? Not impossible, but not easy, and potentia...

Commented [BM87R86]: Thanks. I think the comment stands even if we don't have the solution currently in ...

Commented [ASJ(88]: Better justification is needed for a costly analysis – what new information could be ...

Commented [BM89R88]: Agreed. This was text in the draft I inherited. Interesting but probably not a priority ...

Deleted: results from 2019-2020 provide a snapshot of bacteria marker copy concentrations at the time of ...

Commented [ASJ(90]: Agreed

Commented [ASJ(91]: We did include wave height in the 2020 field monitoring. Are there other parameters ...

Commented [ASJ(92]: There's not enough info here on how the model would provide that info… ...

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Data availability

All data and R programming scripts used in this analysis is available in a public repository at https://github.com/Kenai-Watershed-Forum/KWF_Beach_Sampling_2019_2020.

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Commented [ASJ(93]: Add references/links to the Kenai beach webpage

Commented [BM94R93]: added

Commented [ASJ(95]: You need to add the 2020 QAPP

Commented [BM96R95]: added

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Appendix A: Site Photographs

South Kenai Beach 3 sampling location looking toward the Kenai River outlet. North Kenai Beach can be seen in the background. Photo taken on July 27, 2020 during the personal use dipnet fishery season.

South Kenai Beach 3 sampling location depicting the highest gull count of the sampling season. Photo taken on July 20, 2020 during the personal use dipnet fishery season.

North Kenai Beach 4 sampling location. Photo taken on July 20, 2020 during the personal use dipnet fishery season.

North Kenai Beach 4 sampling location looking away from the Kenai River outlet. Photo taken on July 23, 2019 during the personal use dipnet fishery season.

Warren Ames Memorial Bridge 1 sampling location looking downstream on the Kenai River. Photo taken on July 20, 2020 during the personal use dipnet fishery season.

Warren Ames Memorial Bridge 1 sampling location on the Kenai River. Photo taken on July 20, 2020 during the personal use dipnet fishery season.

Kenai Gull Rookery 1 sampling location. The fish processing plant can be seen in the background. Photo taken on July 27, 2020 during the personal use dipnet fishery season.

Kenai Gull Rookery 1 sampling location looking across the Kenai River. Dipnetting boats can be seen along the far shore behind the mooring boat. Photo taken on July 20, 2020 during the personal use dipnet fishery season.

Kenai Gull Rookery 2 sampling location looking at river-right bank. Photo taken on June 18, 2020.

Kenai Gull Rookery 2 sampling location looking downstream toward Kenai River outlet and Cook Inlet. Photo taken on July 20, 2020 during the personal use dipnet fishery season.

Appendix B: Press Releases (Page 1 of 5)

Example of advisory notice post on the ADEC Alaska Facebook page.

Appendix B: Press Releases (Page 2 of 5)

DEC ISSUES ADVISORY FOR KENAI NORTH BEACH

Enterococci bacteria may indicate a health risk

FOR IMMEDIATE RELEASE — June 6, 2019
CONTACT: Nancy Sonafrank, Division of Water, 907-451-2726

SOLDOTNA, AK — The Alaska Department of Environmental Conservation (DEC) has announced an advisory for the Kenai North Beach due to elevated levels of enterococci bacteria and fecal coliform found in in recent samples of the marine water at this location.

Until sample results consistently meet water quality standards and DEC lifts this advisory, people should take precautionary measures when visiting the Kenai North Beach. DEC recommends beach users take normal precautions to avoid exposure, such as avoid swimming in the water, wash with clean fresh water after contact with marine water, and rinse fish with clean water after harvesting from the area. As always, people should cook seafood to a minimum internal temperature of 145 degrees Fahrenheit to destroy pathogens.

Water samples were collected on June 4. All of the other tested locations meet water quality criteria for enterococci bacteria and fecal coliform at this time. Water quality samples were collected at the following locations:

- North Kenai Beach
- South Kenai Beach
- Kenai River Gull Rookery 1 (60.53660N, 151.25400W)
- Kenai River Gull Rookery 2 (60.55180N, 15124400W)
- Warren Ames Bridge

As part of a statewide recreational beach monitoring program, marine water samples will be collected at the listed coastal areas to evaluate fecal coliform and enterococci bacteria levels weekly from May to September 2019. Monitoring locations maps and sampling information are shown on the Alaska BEACH Grant Program website.

Enterococci bacteria can come from any warm blooded animal, including birds, seals, and dogs, as well as humans. Potential sources of this bacteria on Kenai beaches are likely birds, but may include other wildlife, pets, and humans. Contact with water impacted by enterococci bacteria may cause stomach aches, diarrhea, or ear, eye, and skin infections.

The BEACH sampling program is funded and implemented by DEC. It is part of a nationwide effort to decrease the incidence of water-borne illness at public beaches under the federal Beaches Environmental Assessment and Coastal Health (BEACH) Act. Water samples have been collected periodically at Kenai River beaches since 2010.

For more information about the Alaska BEACH monitoring program, visit the Alaska BEACH Grant Program website.

Appendix B: Press Releases (Page 3 of 5)

DEC LIFTS ADVISORY FOR KENAI NORTH BEACH

FOR IMMEDIATE RELEASE — June 20, 2019
CONTACT: Nancy Sonafrank, Division of Water, 907-451-2726

SOLDOTNA, AK — The Alaska Department of Environmental Conservation (DEC) has lifted the beach advisory issued on June 6 for the Kenai North Beach due to elevated levels of enterococci found in the marine water. Two consecutive weekly samples have shown enterococci levels at safe levels.

Water samples were collected on June 11 and 18. All five of the monitoring locations met water quality criteria for enterococci bacteria. These levels indicate that contact recreation, such as wading and swimming are safe.

Fecal coliform bacteria results were above state limits of 31 cfu/100ml set to protect humans from consumption of raw fish and shellfish at three monitoring locations (North Kenai Beach, South Kenai Beach and Kenai River Gull Rookery 1) with levels ranging from 46 to 84 cfu/100ml. DEC continues to advise that people take precautionary measures when fishing along the Kenai River Beaches by rinsing fish with clean water after harvesting from the area. As always, people should cook seafood to a minimum internal temperature of 145 degrees Fahrenheit to destroy pathogens.

Water quality samples were collected at the following locations:

- North Kenai Beach
- South Kenai Beach
- Kenai River Gull Rookery 1 (60.53660N, -151.25400W)
- Kenai River Gull Rookery 2 (60.55180N, -151.24400W)
- Warren Ames Bridge

As part of a statewide recreational beach monitoring program, marine water samples will be collected at the listed coastal areas to evaluate enterococci bacteria and fecal coliform levels weekly from May to September 2019. Monitoring locations maps and sampling information are shown on the Alaska BEACH Grant Program website.

Enterococci bacteria can come from any warm blooded animal, including birds, seals, and dogs, as well as humans. Based on microbial source testing for bacteria genetic identification, the primary source of this bacteria on Kenai beaches is gulls. Contact with water impacted by enterococci bacteria may cause stomach aches, diarrhea, or ear, eye, and skin infections.

The BEACH sampling program is funded and implemented by DEC. It is part of a nationwide effort to decrease the incidence of water-borne illness at public beaches under the federal Beaches Environmental Assessment and Coastal Health (BEACH) Act. Water samples have been collected periodically at Kenai River beaches since 2010. For more information about the Alaska BEACH monitoring program, visit the Alaska BEACH Grant Program website.

Appendix B: Press Releases (Page 4 of 5)

DEC ISSUES ADVISORY FOR KENAI RIVER

FOR IMMEDIATE RELEASE — July 5, 2019
CONTACT: Gretchen Pikul, Division of Water, 907-465-5023

SOLDOTNA, AK — The Alaska Department of Environmental Conservation (DEC) has issued a recreational beach advisory for the Kenai River mouth due to elevated levels of enterococci found in the marine water. This recreational advisory will remain in effect for personal use fishery (July 10-31). Following the personal use fishery, the advisory will be lifted when two consecutive weekly samples have shown enterococci levels at safe levels.

Water samples were collected on July 2. One of the five monitoring locations (South Kenai Beach) exceeded the water quality criteria for enterococci bacteria. To protect beach users, the other monitoring locations within the Kenai River mouth area (North Kenai River beach and Gull Rookery areas) are included in this recreational advisory. DEC recommends beach users take precautions to avoid exposure, such as avoiding swimming in the water, and washing after contact with the water. DEC advises that people take precautionary measures when fishing along the Kenai River Beaches by rinsing fish with clean water after harvesting from the area. As always, people should cook seafood to a minimum internal temperature of 145 degrees Fahrenheit to destroy pathogens.

Fecal coliform bacteria results were above state limits of 31 cfu/100ml set to protect humans from consumption of raw fish and shellfish at three monitoring locations (North Kenai Beach, South Kenai Beach and Kenai River Gull Rookery 1 and 2) with levels ranging from 49 to 141 cfu/100ml.

Water quality samples were collected at the following locations:

- North Kenai Beach
- South Kenai Beach
- Kenai River Gull Rookery 1 (60.53660N, -151.25400W)
- Kenai River Gull Rookery 2 (60.55180N, -151.24400W)
- Warren Ames Bridge

As part of a statewide recreational beach monitoring program, marine water samples will be collected at the listed coastal areas to evaluate enterococci bacteria and fecal coliform levels weekly from May to September 2019. Monitoring locations maps and sampling information are shown on the Alaska BEACH Grant Program website.

Enterococci bacteria can come from any warm blooded animal, including birds, seals, and dogs, as well as humans. Based on microbial source testing for bacteria genetic identification, the primary source of this bacteria on Kenai beaches is gulls. Contact with water impacted by enterococci bacteria may cause stomach aches, diarrhea, or ear, eye, and skin infections.

The BEACH sampling program is funded and implemented by DEC. It is part of a nationwide effort to decrease the incidence of water-borne illness at public beaches under the federal Beaches Environmental Assessment and Coastal Health (BEACH) Act. Water samples have been collected periodically at Kenai River beaches since 2010. For more information about the Alaska BEACH monitoring program, visit the Alaska BEACH monitoring program, visit the Alaska BEACH Grant Program website.

Appendix B: Press Releases (Page 5 of 5)

2020 RECREATIONAL BEACH MONITORING FOR KENAI BEACHES

FOR IMMEDIATE RELEASE — May 18, 2020
CONTACT: Sarah Apsens, Division of Water, 907-262-3411

KENAI, AK — The Alaska Department of Environmental Conservation (DEC) has announced the start of the 8th year of bacteria monitoring at Kenai North and Kenai South beaches. Water quality samples will be collected weekly at the two beach sites. Water quality samples will also be collected upstream and downstream of the nearby gull rookery and at the Warren Ames Memorial Bridge.

The Kenai Beach program is part of a statewide program which monitors bacteria levels at Alaska beaches May through September. Water samples are collected weekly starting May 25, and results are posted on the DEC BEACH webpage later that week. The program evaluates potential health risks indicated by fecal coliform and enterococci bacteria and notifies the public when bacteria levels exceed state standards. Based on bacteria source testing, seagulls and other birds are known to be a significant source of fecal waste on Kenai River beaches.

DEC's key message to the public is to reduce things that attract birds by properly disposing of fish waste and picking up trash off the beach.

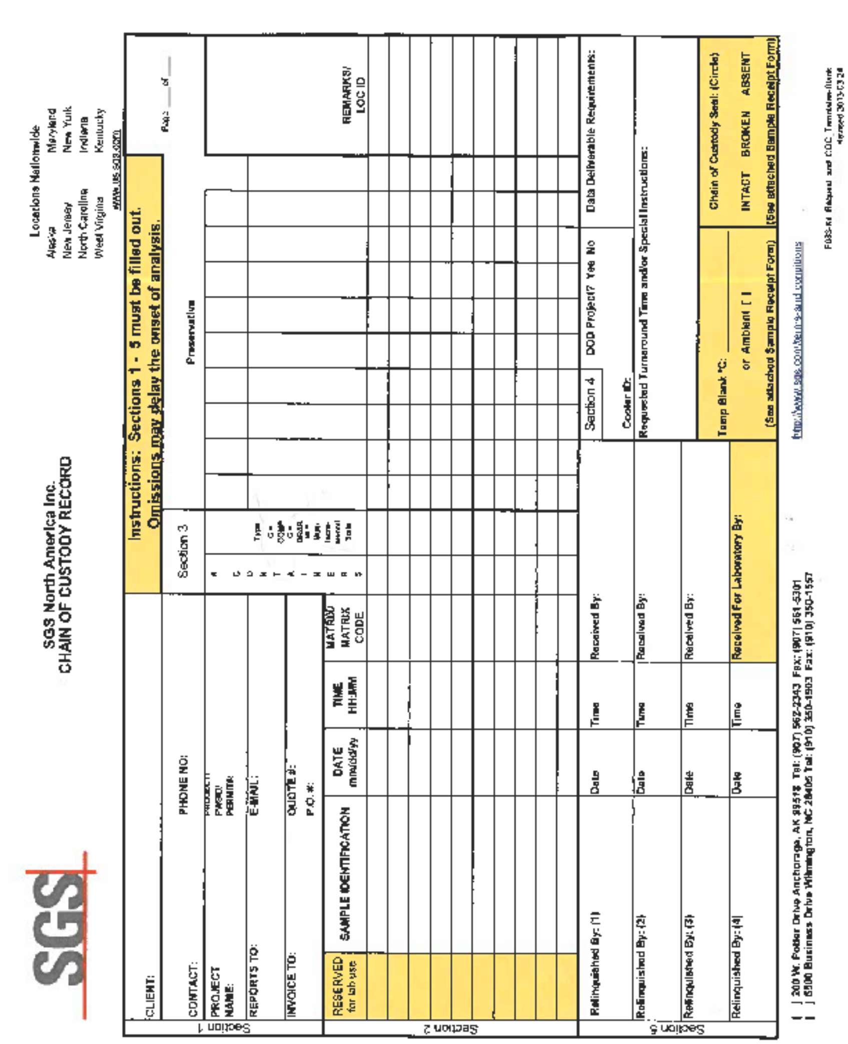
Beach goers can stay informed on the DEC Beach Program web page, where they will find answers to questions like: Which beaches have elevated bacteria levels? When was the last sample? How can I keep Kenai beaches clean while recreating? How can I protect my health while dipnetting?

The DEC BEACH Program website has an at-a-glance interactive map showing beach monitoring locations. You can sign up for the new list serve to get updates sent directly to you. You can also view past monitoring reports, and press releases.

DEC posts weekly updates on the DEC Facebook page, and is working with Anchorage, Mat-Su, and local radio stations to inform dipnetters to "Keep the Kenai Clean!" and to check the DEC BEACH web page for current water quality information and recommendations on keeping healthy while visiting Kenai beaches.

The DEC BEACH Program is part of a nationwide effort to decrease the incidence of water-borne illnesses at public beaches under the federal Beaches Environmental Assessment and Coastal Health (BEACH) Act. Water samples have been collected by the Kenai Watershed Forum at Kenai beaches since 2010. Protect your health and help keep our beaches clean this summer!

Appendix C: Chain-of-Custody


SGS North America Inc.
CHAIN OF CUSTODY RECORD

Locations Nationwide
Alaska Maryland
New Jersey New York
North Carolina Indiana
West Virginia Kentucky
www.us.sgs.com

Instructions: Sections 1 - 5 must be filled out.
Omissions may delay the onset of analysis.

Page ___ of ___

Section 1
CLIENT:
CONTACT: PHONE NO:
PROJECT NAME: PROJECT/ PWSID/ PERMIT#:
REPORTS TO: E-MAIL:
INVOICE TO: QUOTE #: P.O. #:

Section 3
Preservative

Section 2

RESERVED for lab use	SAMPLE IDENTIFICATION	DATE mm/dd/yy	TIME HH:MM	MATRIX/ MATRIX CODE	C O N T A I N E R S	Type C = COMP G = GRAB MI = Multi Incre-mental Soils								REMARKS/ LOC ID

Section 5

Relinquished By: (1)	Date	Time	Received By:	Section 4 DOD Project? Yes No	Data Deliverable Requirements:
				Cooler ID:	
Relinquished By: (2)	Date	Time	Received By:	Requested Turnaround Time and/or Special Instructions:	
Relinquished By: (3)	Date	Time	Received By:		
Relinquished By: (4)	Date	Time	Received For Laboratory By:	Temp Blank °C: ___ or Ambient [ ] (See attached Sample Receipt Form)	Chain of Custody Seal: (Circle) INTACT BROKEN ABSENT (See attached Sample Receipt Form)

[ ] 200 W. Potter Drive Anchorage, AK 99518 Tel: (907) 562-2343 Fax: (907) 561-5301
[ ] 5500 Business Drive Wilmington, NC 28405 Tel: (910) 350-1903 Fax: (910) 350-1557

http://www.sgs.com/terms-and-conditions

Appendix D: Marine Beach Sanitary Survey

Commented [ASJ(97]: This was modified for Kenai by ADEC in 2020

BEACH Monitoring Field Sheet — Modified Spring 2020

Name of Beach: _____ Date: _____
Beach Code: _____
Latitude N: _____ Longitude: _____

Samples

Sample(s) ID: _____ Time: _____
Replicate ID: _____ Time: _____
Field Blank ID: _____ Time: _____

Weather Conditions (circle one)

Sunny & Clear — Rain
Cloudy/Overcast — Fog
Other (describe): _____

Air Temp: _____ °C / °F
Wind Direction: _____ MPH
Wind Speed: _____ MPH
Precipitation in last 24 hrs.: _____ in

Tidal Conditions (circle one)

Low — Ebbing
High — Flooding

Tide Height: _____ ft / m
Time: _____ am / pm

Handheld Probe Values

Water temp: _____ °C / °F
pH: _____
TDS: _____
Conductivity: _____
Turbidity _____ NTU

Activity on Beach

Adults: _____ Dogs: _____
Children: _____ Other: _____
*est. number present

Condition of Water (circle one or more)

Clear — Cloudy/Murky — Oily Film
Other: _____

Potential Pollution Sources

Waterfowl Type: _____
Est. Number: _____
Other Sources (describe and provide number est.): _____

Beach Condition

	Debris	Vegetation (% coverage)
On Shore		
In Water		

Odors: Y / N _____
Stormwater Pipes: Y / N _____
Fish Processing: Y / N _____

Additional Comments:

Sampler(s) Name and Signature:

Name: _____ _____
Name: _____ _____
Name: _____ _____

Appendix E: 2020 Sample Values and Exceedances

(Page 1 of 6)

Bacteria	Location	Date	Individual Sample Value (CFU/100 mL)	30 Day Rolling Geometric Mean Value (CFU/100 mL)	Individual Sample Value Exceedance	30 Day Geometric Mean Exceedance
Enterococci	Kenai River Gull Rookery 1	5/26/2020	0.5			
		6/4/2020	10			
		6/9/2020	3			
		6/18/2020	4			
		6/23/2020	13			
		6/29/2020	16	7.6		
		7/7/2020	18	8.5		
		7/13/2020	1	6.8		
		7/20/2020	32	10.4		
		7/27/2020	6	8.9		
		8/5/2020	11	8.2		
		8/11/2020	0.5	4.0		
		8/18/2020	37	8.3		
	Kenai River Gull Rookery 2	5/26/2020	0.5			
		6/4/2020	4			
		6/9/2020	0.5			
		6/18/2020	13			
		6/23/2020	14			
		6/29/2020	0.5	2.8		
		7/7/2020	22	4.0		
		7/13/2020	0.5	4.0		
		7/20/2020	24	4.5		
		7/27/2020	3	3.3		
		8/5/2020	8	5.8		
		8/11/2020	2	3.6		
		8/18/2020	33	8.2		
	North Kenai Beach 4	5/26/2020	2			
		6/4/2020	27			
		6/9/2020	8			

Individual Enterococci Samples > 130 CFU/100 mL

30 Day Geometric Mean Enterococci Value > 35 CFU/100 mL

Appendix E: 2020 Sample Values and Exceedances

(Page 2 of 6)

Bacteria	Location	Date	Individual Sample Value (CFU/100 mL)	30 Day Rolling Geometric Mean Value (CFU/100 mL)	Individual Sample Value Exceedance	30 Day Geometric Mean Exceedance
Enterococci	North Kenai Beach 4	6/18/2020	13			
		6/23/2020	18			
		6/29/2020	2	10.0		
		7/7/2020	4	6.8		
		7/13/2020	5	6.2		
		7/20/2020	6	5.3		
		7/27/2020	0.5	2.6		
		8/5/2020	38	4.7		
		8/11/2020	8	5.4		
		8/18/2020	23	7.3		
	South Kenai Beach 3	5/26/2020	2			
		6/4/2020	50			
		6/9/2020	6			
		6/18/2020	38			
		6/23/2020	25			
		6/29/2020	38	25.5		
		7/7/2020	3	14.5		
		7/13/2020	178	28.6	> 130	
		7/20/2020	87	33.8		
		7/27/2020	4	23.4		
		8/5/2020	178	31.9	> 130	
		8/11/2020	9	39.7		> 35
		8/18/2020	96	35.1		> 35
	Warren Ames Bridge	5/26/2020	1			
		6/4/2020	6			
		6/9/2020	2			
		6/18/2020	1			
		6/23/2020	2			
		6/29/2020	1	1.9		

Individual Enterococci Samples > 130 CFU/100 mL

30 Day Geometric Mean Enterococci Value > 35 CFU/100 mL

Appendix E: 2020 Sample Values and Exceedances

(Page 3 of 6)

Bacteria	Location	Date	Individual Sample Value (CFU/100 mL)	30 Day Rolling Geometric Mean Value (CFU/100 mL)	Individual Sample Value Exceedance	30 Day Geometric Mean Exceedance
Enterococci	Warren Ames Bridge	7/7/2020	3	1.6		
		7/13/2020	2	1.6		
		7/20/2020	1	1.6		
		7/27/2020	0.5	1.2		
		8/5/2020	2	1.4		
		8/11/2020	0.5	1.0		
		8/18/2020	8	1.3		
Individual Enterococci Samples > 130 CFU/100 mL						
30 Day Geometric Mean Enterococci Value > 35 CFU/100 mL						

Appendix E: 2020 Sample Values and Exceedances

(Page 4 of 6)

Bacteria	Location	Date	Individual Sample Value (CFU/100 mL)	30 Day Rolling Geometric Mean Value (CFU/100 mL)	Individual Sample Value Exceedance	30 Day Geometric Mean Exceedance
Fecal Coliform	Kenai River Gull Rookery 1	5/26/2020	1			
		6/4/2020	12			
		6/9/2020	9.3			
		6/18/2020	38		> 31	
		6/23/2020	62		> 31	
		6/29/2020	310	38.2	> 31	
		7/7/2020	84	56.4	> 31	
		7/13/2020	17	63.6		
		7/20/2020	280	94.9	> 31	
		7/27/2020	52	91.6	> 31	
		8/5/2020	57	65.3	> 31	
		8/11/2020	3	33.5		
		8/18/2020	76	45.2	> 31	
	Kenai River Gull Rookery 2	5/26/2020	0.5			
		6/4/2020	9.3			
		6/9/2020	12			
		6/18/2020	31		> 31	
		6/23/2020	28			
		6/29/2020	3.3	12.6		
		7/7/2020	50	17.7	> 31	
		7/13/2020	15	18.5		
		7/20/2020	40	19.4	> 31	
		7/27/2020	10	15.8		
		8/5/2020	29	24.4		
		8/11/2020	19	20.1		
		8/18/2020	27	22.6		
	North Kenai Beach 4	5/26/2020	2			
		6/4/2020	36		> 31	
		6/9/2020	7.7			
		6/18/2020	54		> 31	
Individual Fecal Coliform Samples > 31 CFU/100 mL						
Individual Fecal Coliform Samples > 400 CFU/100 mL						

Appendix E: 2020 Sample Values and Exceedances

(Page 5 of 6)

Bacteria	Location	Date	Individual Sample Value (CFU/100 mL)	30 Day Rolling Geometric Mean Value (CFU/100 mL)	Individual Sample Value Exceedance	30 Day Geometric Mean Exceedance
Fecal Coliform	North Kenai Beach 4	6/23/2020	14			
		6/29/2020	2.9	14.3		
		7/7/2020	3.3	8.9		
		7/13/2020	29	11.6		
		7/20/2020	31	10.4	> 31	
		7/27/2020	2	7.0		
		8/5/2020	31	11.3	> 31	
		8/11/2020	43	18.9	> 31	
		8/18/2020	42	20.3	> 31	
	South Kenai Beach 3	5/26/2020	4			
		6/4/2020	69		> 31	
		6/9/2020	3.845			
		6/9/2020	7.7			
		6/18/2020	46		> 31	
		6/23/2020	49		> 31	
		6/29/2020	5.7	17.2		
		7/7/2020	13	13.1		
		7/13/2020	600	39.8	> 400	
		7/20/2020	196	53.2	> 31	
		7/27/2020	8.6	37.6		
		8/5/2020	184	75.3	> 31	
		8/11/2020	17	79.4		
		8/18/2020	153	60.4	> 31	
	Warren Ames Bridge	5/26/2020	3			
		6/4/2020	38		> 31	
		6/9/2020	32		> 31	
		6/18/2020	15			

Indvidual Fecal Coliform Samples > 31 CFU/100 mL

Indvidual Fecal Coliform Samples > 400 CFU/100 mL

Appendix E: 2020 Sample Values and Exceedances

(Page 6 of 6)

Bacteria	Location	Date	Individual Sample Value (CFU/100 mL)	30 Day Rolling Geometric Mean Value (CFU/100 mL)	Individual Sample Value Exceedance	30 Day Geometric Mean Exceedance
Fecal Coliform	Warren Ames Bridge	6/23/2020	17			
		6/29/2020	3.3	15.9		
		7/7/2020	22	14.3		
		7/13/2020	15	12.3		
		7/20/2020	46	15.3	> 31	
		7/27/2020	1	8.7		
		8/5/2020	6.7	10.0		
		8/11/2020	1.7	6.0		
		8/18/2020	36	7.2	> 31	
Indvidual Fecal Coliform Samples > 31 CFU/100 mL						
Indvidual Fecal Coliform Samples > 400 CFU/100 mL						

Appendix F: Microbial Source Tracing Data

Table 8: Microbial source tracing data from five sites sampled for bacteria concentrations in the lower Kenai River, 2019 – 2020. Values are copies of biomarker gene per 100 mL.

Date	Location	Dog Feces	Gull Feces	Human Feces
6/4/2019	Kenai River Gull Rookery 1	ND	3610	DNQ
	Kenai River Gull Rookery 2	ND	2140	ND
	North Kenai Beach 4	4660	965	ND
	South Kenai Beach 3	1210	1380	ND
	Warren Ames Bridge	ND	1680	DNQ
8/8/2019	Kenai River Gull Rookery 1	ND	3040	525
	Kenai River Gull Rookery 2	DNQ	9010	DNQ
	North Kenai Beach 4	ND	11600	DNQ
	South Kenai Beach 3	ND	28200	DNQ
	Warren Ames Bridge	DNQ	2920	DNQ
6/23/2020	Kenai River Gull Rookery 1	ND	3320	ND
	Kenai River Gull Rookery 2	ND	3300	ND
	North Kenai Beach 4	ND	688	ND
	South Kenai Beach 3	ND	DNQ	ND
	Warren Ames Bridge	DNQ	DNQ	ND
7/20/2020	Kenai River Gull Rookery 1	ND	8050	DNQ
	Kenai River Gull Rookery 2	ND	8550	629
	North Kenai Beach 4	DNQ	1590	1140
	South Kenai Beach 3	DNQ	13100	1220
	Warren Ames Bridge	ND	5210	DNQ

ND = Not detected
DNQ = Detected but not quantifiable

Commented [ASJ(98]: Suggesting formatting – I was difficult to distinguish among the dates in the previous version. I also used "Auto Fit">"Auto Fit to Contents" and "Auto Fit to Window" to clean up the appearance

Commented [BM99R98]: Thanks; looks good to me.

Appendix G: ADEC Water Quality Standards

Alaska Department of Environment Conservation water quality standards for fecal coliform and enterococci in marine waters.

Water Quality Standards for Bacteria: Marine Water Uses		
	Fecal coliform	**Enterococci**
Water recreation: contact recreation, 18 AAC 70 (14)(B)(i)		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 (STV) of **130 enterococci CFU/100 ml.**
Water recreation: secondary recreation, 18 AAC 70 (14)(B)(ii)	In a 30-day period, the geometric mean of samples may not exceed 200 fecal coliform/100ml, and* not more than 10% of the samples may exceed **400 fecal coliform/100ml.**	
Harvesting for consumption of raw mollusks or other raw aquatic life, 18 AAC 70 (14)(D)	The geometric mean of samples may not exceed 14 fecal coliform/100 ml; and* not more than 10% of the samples may exceed; - 43 MPN per 100 ml for a five-tube decimal dilution test; - 49 MPN per 100 ml for a three-tube decimal dilution test; - 28 MPN per 100 ml for a twelve-tube single dilution test; ***- 31 CFU per 100 ml for a membrane filtration test (see note 14)******	
MPN = Most Probable Number. Unit equivalent to Colony Forming Unit (CFU).		
*For single-year analysis, "and" is replaced with "or".		
**Standard that was referenced based on analysis methodology used by the laboratory.		
***Note 14. When fecal coliform levels are monitored in waters designated as state approved shellfish harvesting and growing waters, these waters are also subject to 18 AAC 34.010(19).		
Bold text indicates values used to determine exceedances for public notices.		
Alaska Water Quality Standards for Marine Water (18 AAC 70 (14))		

Commented [ASJ(100]: For listing in the IR the "and" is interpreted as a new sentence/does not fall under the "In a 30 day period" clause at the start of the standard. So the 10% 130 STV is applied to the entire season (May through September) and is not confined to a rolling 30 day period.

I believe I interpreted/conveyed this incorrectly last time we talked, so no worries, its likely my fault on this one.

You'll need to go through and update the language in a few tables and make sure that you're applying the standards correctly. I think you've applied them correctly, its primarily the language clean up. You might need to update Figure 3 and the data tables in the appendices.

Here's some notes I got from the beach program manager for reference. Check these against the standards table that I'll include in the email:

- FC geomean >14 - uses the geomean of the entire recreational season data, not confined to 30-day period.
- FC 10% >31 – applies to the entire recreational season data.
- Entero Primary Rec Contact >35 - uses rolling 30-day geomean.
- FC Secondary Rec Contact 400 MPN/100ml – uses the rolling 30-day geomean
- Entero 10% >130- uses the entire recreational season data.

Only the highlighted standards use the rolling 30 day period.