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Th10b

ANNUAL INFORMATIONAL BRIEFING ON THE NATIONAL PARK SERVICE'S IMPLEMENTATION OF THE WATER QUALITY STRATEGY FOR MANAGEMENT OF RANCHING OPERATIONS

CD-0006-20 (NATIONAL PARK SERVICE)

APPENDICES

Table of Contents

United States Department of the Interior

NATIONAL PARK SERVICE
Point Reyes National Seashore
1 Bear Valley Road
Point Reyes Station, CA 94956
Department of the Interior Region 10

IN REPLY REFER TO:
A.1.A

October 26, 2023

Dr. Kate Huckelbridge, Executive Director
California Coastal Commission
455 Market Street, Suite 300
San Francisco, CA 94105

Subject: Agenda Item 10b. CD-0006-20, Annual Informational Briefing on Implementation of the 2022 Water Quality Strategy.

Dear Dr. Huckelbridge:

The National Park Service (NPS) is pleased to submit the 2023 Annual Report (Annual Report) for the Water Quality Strategy for Management of Ranching Operations (Strategy). The Annual Report summarizes progress on the Elements and Objectives set forth in the Strategy and approved by the Commission during the September 8, 2022 hearing regarding the General Management Plan Amendment (GMPA) for Point Reyes National Seashore and North District Golden Gate National Recreation Area. As part of the Annual Report, the NPS has prepared a Water Quality Monitoring and Assessment report covering all monitoring efforts conducted from December 2021 through September 2023. This comprehensive water quality analysis of the monitoring programs conducted under this Strategy is prepared as a stand-alone document and is included in this submittal as Appendix A to the Annual Report.

Since the last hearing, the NPS has continued to coordinate with San Francisco Bay Regional Water Quality Control Board staff regarding monitoring and compliance of dairy operations and grazing operations under the Tomales Bay Watershed Total Maximum Daily Load Conditional Waiver of Waste Discharge Requirements for Grazing Operations, as well as Marin County Environmental Health Services staff for actions related to ranch septic systems. The Annual Report documents actions taken over the past year and demonstrates NPS commitment to meeting the intent of the Strategy. Not including regular ongoing management and oversight of the range management programs, NPS expended approximately $50,000 for implementation of the Strategy's water quality monitoring elements from October 2022 to September 2023 (Water Year 2023). The NPS will be conducting dairy inspections in early November to ensure preparation for the winter season are in place. Water quality monitoring will be conducted consistent with the Strategy for Water Year 2024.

As you are aware, there is currently active litigation related to the implementation of the GMPA. The Center for Biological Diversity, Western Watersheds Project, Resource Renewal Institute,

the National Park Service, and the rancher intervenor groups are continuing with the confidential mediation process initiated in the summer of 2022. The parties held productive in-person mediation discussions in July and September of 2023. In addition to the ongoing biweekly discussions, further in-person meetings are scheduled for November 2023. In their October 16, 2023 filing to the Court, parties identify that the mediation discussions continue to be productive. The Court approved continuance of the matter and set the date for the next Case Management Conference for March 15, 2024.

The NPS appreciates the Commission staff engagement and review of this program and Annual Report and looks forward to the Information Briefing to the Commission on November 16, 2023.

Sincerely,

ANNE ALTMAN Digitally signed by ANNE ALTMAN Date: 2023.10.26 09:45:32 -07'00' acting for

Craig Kenkel
Superintendent

Enclosures:

- Annual Report 2023 – Water Quality Strategy for Management of Ranching Operations
- Appendix A – Water Quality Monitoring and Assessment – Water Years 2022-2023.

Annual Report - 2023

Water Quality Strategy for Management of Ranching Operations

CD-0006-20

for
General Management Plan Amendment for
Point Reyes National Seashore and
North District Golden Gate National Recreation Area

Prepared for:

California Coastal Commission
455 Market St, Suite 300
San Francisco, CA 94105-2219

By:

Point Reyes National Seashore
National Park Service
U.S. Department of the Interior
1 Bear Valley Road
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October 2023

Introduction

On September 8, 2022, the California Coastal Commission (Commission) approved the First Year Version of the Water Quality Strategy for Management of Ranching Operations under the General Management Plan Amendment (GMPA) for Point Reyes National Seashore and the North District of Golden Gate National Recreation Area (Strategy) with modifications approved during the hearing. The First Year Strategy presented to the Commission included a number of elements and programs that would be conducted by the National Park Service (NPS). This report addresses progress on the elements agreed to in the Strategy and further addresses modifications agreed to during the September 8, 2022 hearing as identified below.

Items agreed to as modifications to the First Year Version of the Strategy were agreed to in two parts. Items 1-3 (below) were agreed to by the NPS prior to the September 2022 hearing. Items 4-8 were agreed to be provided during the September 2022 hearing. These items are numbered sequentially below and are addressed directly in the section "Actions on September 2022 Modifications."

Items agreed to prior to the September 2022 hearing:

1) NPS will update the Strategy and timeline on an annual basis.
2) NPS will include all previous year monitoring results in its annual reports.
3) NPS is committed to maintaining the Recreational Beach Monitoring Program in partnership with the Environmental Action Committee of West Marin (EAC). Should EAC discontinue this partnership, NPS will maintain the program independently.

Items agreed to during the September 2022 hearing:

4) Progress on implementation of the Strategy and specific actions taken and planned to address water quality issues. [Objectives 3 and 4]
5) A discussion of the funding approach being used by NPS and update on how effectively NPS is funding implementation of the Strategy.
6) Summary of enforcement efforts/investigations by the NPS enumerating alleged violations, actions taken by the agencies, and the responses and current statuses of those violations. In addition, NPS will report on the status of its leases and any violations, actions taken by NPS, any response, as well as the result (withdrawal, non-renewal, or revocation of leases) and current status of each lease. [Objectives 1, 2, and 5]
7) Description of the best management practices and ranching measures implemented in the previous year. For example, this reporting should include miles of fencing installed or repaired, number of stream crossings constructed or improved, installation of dairy-related infrastructure or practices to address manure management, reduction in herd sizes and other ranching-related measures installed, and their locations and efficacy. [Objective 5]
8) Updated report on progress of the Climate Action Plan prepared by NPS to address ranching activities.

Commission staff also confirmed that they would directly consult with the San Francisco Bay Regional Water Quality Control Board, and Marin County Environmental Health Services and report any inspection/alleged violations, actions taken by the agencies, and the responses and current statuses of those violations.

This report to the Commission includes two primary elements – reporting on actions implemented during the past year (fall 2022 – October 2023) and a water quality monitoring report that summarizes all monitoring conducted under the Strategy spanning December 2021 through September 2023 (including data going back to October 2020 for recreational beach monitoring). The Water Quality Monitoring and Assessment report is included as Appendix A.

2023 Strategy Update and Summary of Actions

The Strategy uses an iterative approach to identify and address management issues. The first-year implementation prioritized short-term management actions, focused inspections and assessment monitoring of ranches, and expanded water quality monitoring. The program is informed by implementation of watershed enhancement efforts conducted over more than two decades in the Tomales Bay Watershed and reflects current conditions of existing operations. The Strategy focuses first on visual assessment of operations and activities and implementation of operational and structural changes, with the water quality monitoring component designed to inform prioritization of where to target further actions, as well as track long-term progress. Details regarding specific actions taken and planned are included below.

During the first year of the Strategy, the NPS prioritized expansion of existing water quality monitoring programs to include the Point Reyes Peninsula. This included updating and adapting protocols, standing up an extensive assessment monitoring regime, staffing coordination and training, development of laboratory contracts for analysis, ensuring prompt attention to data for triggered monitoring responses and timely annual reporting, and devoting management effort to tracking the complexities of six individual monitoring programs. Following the triggered monitoring approach identified under the Strategy to ensure actions are responsive to results, the first-year monitoring efforts focused primarily on active dairy operations.

NPS staff continued to coordinate recreational beach sampling with EAC. During the monitoring period for this report, approximately 99% of samples at the two sites were below the contact recreation benchmark for enterococci utilized by the Marin County Ocean and Bay Water Quality Testing Program.

NPS reinitiated monthly coastal watershed monitoring under Strategy Monitoring Program 2 beginning in December 2021. During the sampling period, core parameters (pH, dissolved oxygen, and specific conductance) were generally under or within benchmark ranges of values for most sites. A number of sites exhibited low to no flow during summer and fall (some with associated low dissolved oxygen and elevated fecal indicator bacteria concentrations in small volumes of water). Triggered monitoring was conducted at five sites based on exceedance of fecal indicator bacteria benchmarks, and at two sites based on observations that could indicate presence of biostimulatory substances. Given the observed variability in fecal indicator bacteria concentration results, additional monitoring data will be necessary to determine where management actions may be required for locations where there were benchmark exceedances.

Preliminary assessment monitoring of coastal watersheds was also conducted in 2023. Sixteen sites primarily downstream of leased ranching operations were visited once a week for six consecutive weeks in winter and summer. Core parameters, fecal indictor bacteria, and ammonia

(as N) (downstream of leased dairy operations) were collected. This data was used to further target monitoring efforts and corrective actions at certain locations where results exceeded benchmarks. Collection of additional assessment monitoring data next water year (each water year spans October 1 to September 30) will provide necessary information to allow for more informed management actions where results are determined to regularly exceed benchmarks.

Based on the winter assessment monitoring, synoptic monitoring of *Escherichia coli* (*E. coli*) at multiple locations in subwatersheds that drain through four active dairy ranches was conducted during or directly following periods of rainfall greater than one inch, and spring baseflow conditions during a relatively wet water year. Monitoring downstream of five dairies following three rainfall events was also conducted consistent with regulatory requirements to allow for responsive corrective actions if benchmark exceedances were detected in runoff. With the exception of single pH and specific conductance measurements at one site during the first winter monitoring event, samples met benchmarks established under the San Francisco Bay Regional Water Quality Control Board's General Waste Discharge Requirements for Confined Animal Facilities. These monitoring activities coupled with on the ground inspections and review of required reporting led to development of several additional short-term corrective actions and have informed long-term planning for improvements on dairies.

Since Commission approval of the Strategy in 2022, NPS staff continued to coordinate with the San Francisco Bay Regional Water Quality Control Board (Regional Water Board) and Marin County Environmental Health Services (EHS) to follow up on inspections and required actions identified in the Strategy. Implementation of annual fall dairy inspections, follow up coordination for regulatory reporting and corrective action plans, site visits, and additional short-term corrective actions responsive to ongoing monitoring were completed during this reporting period. NPS plans to conduct the upcoming annual dairy inspection in late fall 2023.

NPS and EHS conducted inspections of septic systems at 14 residential ranch operations to verify actions in summer and fall 2022. Through this process, EHS and NPS identified priority actions to be conducted by ranch operators on a system-by-system basis. NPS and EHS follow up and reinspection activities were conducted through fall 2022 and summer 2023.

There is currently active litigation related to the implementation of the GMPA. The Center for Biological Diversity, Western Watersheds Project, Resource Renewal Institute, the National Park Service, and the rancher intervenor groups are continuing with the confidential mediation process initiated in the summer of 2022. The parties held productive in-person mediation discussions in July and September of 2023. In addition to the ongoing biweekly discussions, additional in-person meetings are scheduled for November 2023. In their October 16, 2023 filing to the Court, parties acknowledged that the mediation process has also included certain other consultants who have agreed to the strict mediation confidentiality agreement that all other parties have entered, and that the mediation discussions continue to be productive. The Court approved continuance of the matter and set the date for the next Case Management Conference for March 15, 2024.

The Strategy emphasizes the necessity, responsibility, and requirements of lessees to adequately monitor and maintain their ranch operations and infrastructure to meet the conditions of lease

and regulatory permits. All ranch operations, excepting the two life estates are operating under two-year interim leases issued in September 2022. The Interim Leases are in effect until September 2024 and publicly available on the NPS website (available at: https://www.nps.gov/pore/getinvolved/planning-gmp-amendment-leases-permits.htm).

Actions on September 2022 Modifications

1) Annual Strategy and timeline update:
   The preliminary monitoring and actions taken under the Strategy have provided information on next steps. The upcoming year of efforts under the Strategy will continue monitoring as outlined in year one, with prioritization of activities on dairies. This will include the addition of synoptic monitoring at active dairy locations (as weather permits), building on what was collected in water year 2023 (October 1, 2022 to September 30, 2023), to increase understanding of site dynamics and further target corrective actions. Given what was learned in year one, examining an additional full water year encompassing winter and summer dynamics will aid in prioritizing the most effective management decisions. NPS will consult with the Regional Water Board to identify if other measures may be appropriate to better understand water quality sampling results (e.g. consideration of groundwater monitoring or additional investigation of dairy waste management infrastructure).

   NPS proposes that the timeline for annual review allow for summary and analysis of data by water year in order to facilitate adaptive management. The NPS suggests that the timing of an Annual Report to the Commission be considered for the period of February or March. This would allow for consolidation of all WY data, as well as timely reporting of the annual information due to the NMFS and USFWS on December 31 of each year.

2) Data availability:
   Previous monitoring data is available through the National Water Quality Monitoring Council Water Quality Portal (available at: https://www.waterqualitydata.us/). Beach monitoring data is also available through the State Water Resources Control Board (https://www.waterboards.ca.gov/water_issues/programs/beaches/search_beach_mon.html). Analysis of previous data is presented in the park's General Management Plan Amendment Final Environmental Impact Statement under Appendix L (available at: https://parkplanning.nps.gov/document.cfm?documentID=106632), in Voeller et al. 2021 (available at: https://doi.org/10.1016/j.rama.2021.02.011), and in Lewis et al. 2019 (available at: https://doi.org/10.3390/su11195516). As the purpose of the Strategy is to focus on, and address current conditions, the 2023 annual report focuses on the water quality data collected since 2021 conducted consistent with the Commission approved Strategy. The Strategy establishes a systematic monitoring approach that will help identify priority water quality issues so they may be addressed through the GMPA agricultural lease program.

3) Recreational Beach Monitoring:
   Recreational beach monitoring was conducted in coordination with EAC throughout water years 2021, 2022, and 2023. NPS covers costs of all laboratory analysis with field collection shared between NPS and EAC. Staff communicate regularly to schedule sampling personnel and discuss any pertinent changes (e.g. beach closures to protect elephant seals),

observations, or anomalous results. NPS and EAC plan to meet next in late October 2023 to discuss logistics for water year 2024, beginning with monthly sampling from November through March of water year 2024. NPS appreciates the continued engagement of EAC in this monitoring effort.

4) Specific actions taken and planned to address water quality issues:
Specific actions relevant to the overall implementation of the Water Quality Strategy are discussed in detail in the reporting elements for Objectives 1-5 below.

In addition to dairy specific items addressed under Objective 1 below, NPS participated in planning for updates to the Regional Water Board Grazing Waiver (currently for the Tomales Bay Watershed) that are anticipated to be expanded to all grazing operations within Point Reyes National Seashore, and hosted an inspection of two grazing operations in July that are currently enrolled under the Grazing Waiver. NPS also collaborated with Marin Resource Conservation District as the lead agency to submit a proposal for 319h grant water quality improvements, to address high priority projects on dairies in the Drakes Bay Watershed, which is expected to be awarded.

NPS and ranchers have also coordinated with other entities on projects within the NPS ranch allotments. For example, SPAWN has coordinated with ranchers, NPS, Marin Resource Conservation District for a project on two Golden Gate National Recreation Area ranches to relocate, decommission and improve multiple ranch roads identified as sediment sources to Lagunitas Creek. Riparian exclusion fencing to reduce pressure on sensitive riparian habitat is currently being installed, with road decommissioning and improvements scheduled for spring 2024. Additionally in fall 2023, a park rancher completed a livestock water system update to better distribute cattle away from surface water resources in the Tomales Bay Watershed.

5) Funding Approach:
NPS prioritized implementation of the Strategy in water year 2023 using existing staff to conduct field collection. A multi-year contract to support ongoing laboratory analyses was awarded in March 2023. This contract will allow NPS to continue to conduct monitoring under the Strategy. Not including the substantial investment of staff time, NPS expended approximately $50,000 for implementation of the Strategy's water quality monitoring elements from October 2022 to September 2023.

6) Summary of lease status and correspondence:
All ranch operations, excepting the two life estates are operating under two-year Interim Leases issued in September 2022. The Interim Leases are in effect until September 2024 and publicly available on the NPS website (available at: https://www.nps.gov/pore/getinvolved/planning-gmp-amendment-leases-permits.htm). Among other things, the Interim Leases incorporate and update monitoring and reporting requirements identified through Biological Opinions issued by US Fish and Wildlife Service and National Marine Fisheries Service, as well as the Regional Water Quality Control Board.

NPS coordinated with the Regional Water Board and Marin County Environmental Health Services to ensure actions identified through inspections were acted upon by ranch operators.

While Table 1 represents the elements of formal correspondence, NPS staff were also in regular communication with ranch operators as described below.

Table 1: Summary of NPS correspondence related to inspection and monitoring under Strategy Objectives 1 through 5.

Topic	**Distribution**	**Period of time**
Issuance of two-year Interim Leases	All ranch operations	September 2022
Ranch Specific Authorization for maintenance and management actions on ranches under Interim Leases	Multiple Ranch operations	Fall 2022-Fall 2023
Septic System Inspection Findings and Required Actions.	All Residential Ranch Operations	Summer-Fall 2022
NPS Follow up on Dairy Inspection Action Items pertaining to July 2022 Regional Water Board Inspection Reports	5 dairies	September 2022
Notice of dairy inspections to be conducted on November 7, 2022	5 dairies	October 2022
Dairy Corrective Action Plan requirements based on November inspections by NPS and RWQCB	3 dairies	December 2022
Response to emergency winter irrigation requests	2 ranches	January 2023
RDM Monitoring Results and next steps	All ranch operations	March 2023
Notification of late payment and unauthorized activities	One ranch - late payment with interest received	May 2023
RDM follow up and reporting requirements	Multiple ranches	May-June 2023
Follow up septic inspection notification and required actions	Specific operations where additional review was requested by Marin County Environmental Health Services	Summer 2023

7) Management Actions Implemented:
Reporting under Water Quality Strategy objectives, and specifically Objective 5 (below) illustrates the range of activities conducted during the past year.

8) Climate Action Plan:
Since approval by the Commission, NPS continued to prioritize substantial resources to stand up the Water Quality Monitoring Program and inspection elements of the Strategy. Implementation of the Water Quality Strategy will remain the NPS priority in 2024. As stated during earlier hearings, the park anticipated that a system-wide framework would be issued for National Park Service units with respect to Climate Action. In conjunction with the September 28, 2023 announcement by Secretary of the Interior Deb Haaland of new policies to strengthen climate adaptation and resilience efforts, NPS released a Climate Change Response Strategy 2023 Update, which supersedes the 2010 Climate Change Response Strategy.

The 2023 Response Strategy organizes 12 goals around 4 cornerstones of action. Goals include implementation of adaptation actions to manage cultural and natural resources under conditions of continuous change and reducing carbon emissions to net zero by 2045 through commitment to environmentally sustainable operations and practices. The park will support planning and implementation of climate smart agricultural practices and infrastructure, which aligns with updated California Climate Adaptation Strategy priorities, actions, and goals for agriculture. It is anticipated that the greatest potential to address greenhouse gas emissions is through technological means on the concentrated dairy operations. Methods are articulated in the state's climate-smart agricultural approaches and incentives for dairy methane reduction and nutrient management.

While many of the climate response strategies related to the permitted ranch activities may include use of technology to change waste management strategies, the GMPA has also identified expansion of riparian and sensitive resource protection areas. Implementation actions to establish and expand the Resource Protection Subzone will enhance productive riparian and wetland habitat which are documented to address adverse climate change effects including increased water and air temperature, as well as sequester carbon, which aligns with the Response Strategy goal of identifying opportunities to increase carbon storage. As the park continues to monitor and address water quality impacts, NPS will require ranch operators to incorporate actions to improve the operational infrastructure into Ranch Operating Agreements. Specifically for dairies, it is anticipated that these structural improvements will be focused on waste management and containment, including both runoff to the land and emissions to the air. NPS intends to work with the Commission to streamline coastal permitting processes for restoration/nature-based solutions, another action identified in the state strategy.

Annual Progress on Water Quality Strategy Objectives

The Water Quality Strategy provides a framework for assessing, implementing, tracking and monitoring ranching activities on lands managed by Point Reyes National Seashore with the intent of limiting sources of water pollution and improving water quality conditions.

This Annual Report (Element 3) incorporates the 2023 reporting for Element 1 – Inspection, Implementation and Adaptive Management included in this document and the stand-alone Water Quality Monitoring and Assessment Report (Appendix A) which constitutes Element 2 of the annual reporting requirement.

The goal for infrastructure and operations is to ensure water quality Best Management Practices (also referred to as Management Activities) are identified, incorporated and maintained for all ranches. The water quality goals are to protect public health in high recreation areas, meet regulatory requirements, and limit exceedances of established water quality benchmarks in waterways. The Strategy identifies six objectives under Element 1 to achieve the goals.

Objective 1: Complete initial inspections of all ranch operations to identify required immediate actions for improvement by November 1, 2022.

[Objective Met]

October 2023 Status:

- Regional Water Quality Control Board
    - Site inspections November 7, 2022 in advance of storms to confirm annual preparations and short-term corrective actions taken and in place.
    - Further review and response of Corrective Action Plan (CAP) elements.
    - Follow up discussions on site specific locations in winter 2022-23 with specific actions identified in narrative for Winter 2022-23 responses taken below.
- Marin County Environmental Health Services
    - Multiple meetings and correspondence related to inspections and findings in advance of winter 2022-2023. This included approval of temporary pump and haul for select sites.
    - NPS completed site review and authorization for one replacement septic system.
    - Summer 2023 reinspection conducted at 6 ranches to either close out or reassess site conditions and update findings.

Regional Water Board Inspection and Follow Up Actions: NPS and Regional Water Board staff conducted follow-up inspection of dairy operations on November 7, 2022 to evaluate operators' progress in completing the short-term Action Items identified in the Dairy Inspection Reports. Short-term actions initially identified and implemented included reduction in dairy animals at one dairy, improvements at creek crossings on two dairies, improvements and runoff control on livestock travel lanes at two dairies, and restricting cattle from concentration areas with winter runoff at four dairies.

Prior to November 2022 dairy inspections, NPS discussed requirements with dairy operations that were required to submit CAPs by the Regional Water Board. The three dairy operations subsequently submitted their CAPs to the Regional Water Board as required. The Regional Water Board staff provided feedback on the CAPs submitted by dairy operators and identified follow up actions to be completed by operators with respect to their previous submittals. Monthly photo monitoring was also required at a number of these locations as identified in the CAPs by the Regional Water Board. In December 2022, NPS issued letters to three dairies mandated to complete CAPs requiring that they work with the NPS to develop a mutually agreeable plan for implementation of the needed corrective actions. NPS met with the three dairy operators in January 2023 to further discuss updates to CAPs, and one dairy operator pursued planning and funding opportunities for long-term corrective actions with multiple outside agencies. Coordination with respect to CAPs is ongoing between dairy operators, Regional Water Board, and the NPS.

All dairies submitted 2022 annual reports required by the Regional Water Board General WDR for Confined Animal Facilities in November 2022. The Regional Water Board conducted follow-up correspondence with several dairies to ensure the reports met requirements, and all additional

documents were submitted by the end of January 2023. Three dairies have indicated that they are updating their Comprehensive Nutrient Management Plans for completion in 2023.

NPS coordination with Regional Water Board staff included eight meetings throughout the year track and discuss progress on these water quality components. NPS will require the dairies to continue existing short-term corrective actions and expects to require at least three additional short-term corrective actions on three dairies for winter of 2023. NPS will inspect dairies in fall of 2023 to ensure identified short-term corrective actions and winter preparations are in place.

Runoff from Satellite Feeding Area: Regional Water Board inspections were focused on the core areas of the dairy operations. Runoff from a satellite feeding area on J Ranch above Kehoe Beach Trail was discovered on January 15, 2023. NPS conducted follow up inspections of J Ranch satellite feeding areas and manure storage areas on January 18, 2023. Short-term corrective actions were taken by the operator within the next week to buffer, disperse and filter runoff at the satellite feeding area, including temporary electric fencing and wattles, as well as rotation of animals. Management of accumulated manure surrounding the feeding bunker was also increased in subsequent weeks during the rainy season. These actions were documented and reported to Regional Water Board and Commission staff in late January and early February 2023.

In early March 2023 dairy heifers were removed from satellite feeding areas and pastures where concerns were previously identified. By the end of March 2023, the remaining dairy heifers were removed from the ranch to further reduce concentration of cattle during the continued late winter/early spring rain events.

NPS will conduct inspections of satellite feed areas for all dairy operations as part of fall inspections to ensure areas are prepared for the winter conditions.

Liquid spray irrigation: Due to higher-than-average rainfall and numerous atmospheric river events, emergency irrigation to lower levels of waste storage lagoons during unsaturated winter conditions was requested by two dairies and implemented by one. NPS determined that allowing for irrigation during dry periods was appropriate to prevent the potential for these waste storage areas to overtop in anticipation of additional extreme winter weather events. NPS sent a letter specifying conditions and requesting response with details related to the proposed liquid spray operations that were required for review and approval. Only one operation responded and was authorized to conduct the winter season land application. Authorization required that land application be conducted in accordance with the facility Ranch Water Quality or Nutrient Management Plan and “shall not occur in areas where standing water is present and must be fully completed at least 72 hours prior to the next forecasted rain event.” NPS conducted several site visits to the second dairy that did not irrigate and no overtopping of the manure pond on was observed.

As is standard practice, all operations must prepare for winter conditions by removing liquid and waste from ponds. Waste management system preparedness will be evaluated during fall inspections to ensure they are prepared for the winter conditions.

Objective 2: Implement a recurring ranch inspection process to track compliance, maintenance, as well as document conditions, including infrastructure and riparian exclusion fencing by April 2023.

[Actions under this objective are ongoing. NPS continues development of a system for tracking and reporting, as well as an annual inspection checklist and process that will be incorporated into Ranch Operating Agreements issued under long-term leases.]

October 2023 Status:
NPS completed issuance of two-year Interim Leases in mid-September 2022. As noted, Interim Leases are publicly available and posted to the park website. Interim Leases require lessees to report monitoring and maintenance of riparian fencing and other actions by November 1 annually. These metrics are tied to the Biological Opinion reporting requirements of the US Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS). While Interim Leases with associated reporting metrics were only in place for a short period, NPS worked with lessees to meet the November 1 reporting goals for 2022. NPS submitted reports the USFWS and NMFS for the 2022 reporting period. NMFS acknowledged review and receipt of the report noting that it "thoroughly and adequately covers all reporting items." USFWS did not provide feedback on the report.

Interim Leases also added other reporting requirements, including monthly stocking and distribution of livestock. Monthly reporting is tracked by the NPS on an ongoing basis and will be considered as a lease performance element. NPS has received reporting for this element from all ranch operators. Monthly reporting is used to inform field observations, as well as water quality and residual dry matter (RDM) monitoring. Currently NPS is working to develop a standardized system with templates to ensure lessee reporting is more robust and completed in a timely fashion. NPS expects to begin using the reporting template in 2024.

In 2023, dairy operations were prioritized for evaluation and identification of infrastructure needs. NPS met regularly with Regional Water Board staff to review dairy requirements and follow-up actions to ensure compliance. Regional Water Board had quarterly check-ins with dairy operators that were assigned CAPs. Coordination and review of next steps for dairy operations continue as identified in Objective 1. Under Objective 2, NPS efforts also focused on conducting short-term and synoptic monitoring in dairy watersheds, and ongoing implementation of the RDM monitoring and reporting program on all NPS ranch allotments.

Following winter 2023 six-week water quality assessment (see Appendix A – summary on Short-term Assessment [Monitoring Program 1]) NPS prioritized dairy ranch specific synoptic sample events along waterways at four active dairies.[1] Synoptic monitoring for *E. coli* concentration was conducted at multiple sites within each ranch to assist with bracketing and isolating potential source areas. Each operation was sampled twice as part of this effort: once immediately

[1] It is noted that synoptic sampling was not conducted below the dairy operation draining to Station PAC5. NPS has observed that no dairy cattle have been present on the premises since late summer 2022, and results of the 6-week assessment for *E. coli* did not exceed the geometric mean water quality threshold (Appendix A – Table 11 – Station PAC5).

following a substantial rain event, and once after at least 7 days with no precipitation events greater than 1 inch.

On March 15, 2023 following 1.48 inches of precipitation (measured at Point Reyes Station), synoptic monitoring of *E. coli* was conducted at J Ranch along Kehoe Creek and the western coastal drainage on C Ranch that runs from the ranch complex to Drakes Beach to aid in determining potential source areas. On April 4, 2023 a second synoptic monitoring event for *E. coli* was conducted at both J Ranch and C Ranch after seven days with no precipitation events greater than 1 inch. On March 29, 2023 following 1.52 inches of precipitation (measured at Point Reyes Station), synoptic monitoring of *E. coli* was conducted at B Ranch and A Ranch along the coastal drainages that run from the ranch complexes to Drakes Beach to aid in determining potential source areas. On April 6, 2023 a second synoptic monitoring event for *E. coli* was conducted at both B Ranch and A Ranch after nine days with no precipitation events greater than 1 inch. Results of this effort is presented in the Synoptic Monitoring summary of the Water Quality Monitoring and Assessment Report (Appendix A). While the results of the synoptic effort provide indication that further monitoring is necessary and appropriate in order to fully understand site dynamics and develop effective corrective actions, the NPS has identified several additional short-term actions (e.g. additional monitoring and site-specific adjustments based on observations) that will be required for implementation in the upcoming water year.

NPS completed RDM monitoring in fall of 2022, and RDM analysis and reporting in winter 2022. In aggregate, the RDM results reflect efforts that were made to address impacts of the drought. While the 2022 season started in exceptional and extreme drought conditions and remained in severe drought during 2022, 85% of visually mapped areas (14,200 of 16,728 acres) and 68% of transects on active grazing leases (26 out of 38) sustained RDM at or above the 1,200 pound per acre standard maintained by the park. Allotment specific reports and recommendations were sent to ranchers in spring 2023. For operations where RDM values did not meet NPS objectives, NPS staff met with the ranch lessee to review practices and determine required operational changes for 2023.

Objective 3: Conduct initial water quality assessment monitoring of major waterways flowing from ranches to coastal waters in winter and summer of 2022-2023 to document conditions, with additional monitoring and adaptive management actions triggered by results consistently above monitoring benchmarks.

[Objective Met]

October 2023 Status:
As described in detail in the Water Quality Monitoring and Assessment Report (Appendix A), NPS conducted extensive water quality monitoring within Point Reyes Peninsula watersheds. Implementation of this program was a substantial effort. Work included updating and adapting protocols, standing up an extensive assessment monitoring regime, staffing coordination and training, development of laboratory contracts for analysis, ensuring prompt attention to data for triggered monitoring responses and timely annual reporting, and devoting management effort to tracking the complexities of six individual monitoring programs. The program was fully operable and implemented for water year 2023. NPS is continuing implementation of the program for water year 2024.

Under Strategy Monitoring Program 1 (short-term assessment), six-week winter assessment monitoring was conducted at 16 sites beginning January 3, 2023 and ending February 8, 2023. The summer six-week assessment was conducted between June 28, 2023 and August 2, 2023 at the same 16 sites (if they sustained summer flow). All core parameters were collected each week as described under Monitoring Program 2 (monthly coastal watershed sampling). Grab samples were also collected for laboratory analysis of fecal indicator bacteria (*E. coli* except at Abbotts Lagoon site ABB4 where enterococci were used as the indicator due to a salinity >1ppth more than 5% of the time). Additionally, staff collected samples weekly for laboratory analysis of ammonia (as N) at sites below all authorized dairy operations during the six-week winter and summer sample periods.

For 2023 winter assessment monitoring, sites generally returned higher results during or following the larger atmospheric river rainfall events that occurred during the first two weeks of monitoring in the series (see Appendix A, Table 11, Figure 24). These events caused county-wide increases in surface water flow and runoff. During the winter assessment, dissolved oxygen and pH were within the benchmark range, with the exception of two pH results. Specific conductance and turbidity results were higher during weeks where high rainfall and runoff conditions were observed, but all specific conductance results were below the benchmark. All sites in the Drakes Bay Watershed below dairy operations exceeded the *E. coli* contact recreation water quality benchmark of 100 MPN/100mL for the six-week geomean. In the Kehoe Creek watershed, three sites exceeded the *E. coli* benchmark: PAC2 and PAC3, downstream of portions of both a dairy and grazing operation, and PAC2B, downstream of a portion of a dairy operation. For the five sites below dairy operations sampled for ammonia (as N), all results were below the benchmark of 1.0 mg/L. Site DBY1 had the highest ammonia (as N) result each week while site PAC5 had the lowest result each week (Appendix A, Table 12). Based on analysis of the field and lab collected data, NPS concluded that all sites monitored also met the benchmark for un-ionized ammonia. As noted above, these winter results triggered the synoptic dairy monitoring summarized above in Objective 2, and in more detail under Appendix A – Synoptic Monitoring.

Observations of site conditions and subsequent development of follow up actions were also completed based on the winter assessment and synoptic monitoring efforts.

For 2023 summer assessment monitoring, five of the stream sites did not maintain flow through the sample period and were not monitored during no flow conditions. While water was present at the remaining monitoring locations, observations and results indicated low flow conditions with limited areas of influence around many of the sample sites. With the exception of station PAC1, a site with low flow and high cover of aquatic and riparian vegetation, and one dissolved oxygen result at PAC2, pH and dissolved oxygen were within benchmark ranges. All freshwater specific conductance results were also below the benchmark. All but two turbidity results were below 25 NTU. However, with the exception of Abbotts Lagoon site ABB4, NPS monitoring indicated high *E. coli* at nearly all stations that maintained flow through the summer series. Six-week contact recreation geomean benchmark exceedances were observed at all remaining sampled sites, including the reference site PAC4, which is located adjacent to McClures Beach trail, within the tule elk reserve. Consistent with the winter assessment, ammonia (as N) was collected at sites below dairy operations that maintained flow during the summer series, for which only PAC2 maintained flow for the full six weeks. All results were well below the 1.0 mg/L benchmark. Summer results are likely driven by localized influence at each site, accentuated by the low flow conditions. However, more investigation to understand the behavior of *E. coli* in the environment is necessary before conclusions are drawn from the summer results.

Under the Water Quality Strategy, NPS set triggers for action that initiate collection of additional grab samples as soon as possible after review of results above certain thresholds, with the intent of narrowing or bracketing an area of concern. In addition to the synoptic monitoring events conducted on drainages at four dairies summarized under Objective 2 above, triggered sampling was conducted at a total of five monitoring locations following persistent elevated *E. coli* observations. NPS also conducted triggered sampling of nutrients at two sites based on observed algae cover over 30% and low dissolved oxygen to evaluate for potential presence of biostimulatory substances. Details for each of the Triggered Sample Events are documented in the Appendix A Water Quality Monitoring and Assessment report.

It is noted that during summer assessment monitoring, the results exceed many of the triggered event thresholds for *E. coli*. Staff have conducted site visits to identify potential reasons for these elevated results. Due to influence of low flow on conditions at many of the sites, and the cessation of flow at a number of sites, triggered sampling was not conducted in all cases, except at ABB2 which had the persistently highest *E. coli* results. The visual observations at this location are inconclusive, and have not found association of results with direct access by cattle, deficiencies in infrastructure, or other activities. Summer and fall exceedances at the McClures Creek site PAC4 outside the influence of ranching activities indicate that numerous factors may contribute to the observed exceedances of Water Quality Strategy benchmarks. Future monitoring to determine annual and seasonal variability will allow for better understanding of dynamics at these sites and allow for more informed management decisions if results continue to regularly exceed benchmarks.

Objective 4: Continue long-term, regulatory, and beach recreational water quality monitoring, with additional monitoring and adaptive management actions triggered by results consistently above monitoring benchmarks.

[Objective Met]

October 2023 Status:
Results of all sampling conducted under the Water Quality Strategy are documented in the Water Quality Monitoring and Assessment Report (Appendix A). Brief summaries of the water quality monitoring actions taken in since August 2022 are included below. It is noted that data collected in Point Reyes Peninsula coastal watersheds between 2000 and 2013 has been previously reported, including in Appendix L of the GMPA, as well as Voeller et. al. 2021. In the Tomales Bay Watershed, previous reporting on collected data is included in Lewis et al. 2019 and summary reports issued by the NPS San Francisco Bay Area Inventory and Monitoring Program.

In addition to the Monitoring Program 1 - short-term assessment sampling (described in Objective 3 above), NPS conducted the following:

- Monitoring Program 2 – coastal watersheds, long-term
    - monthly sampling at 8 sites (year-round),
- Monitoring Program 3 – confined animal facilities, regulatory
    - Three storm events sampled at 5 sites downstream of dairies in water year 2023
- Monitoring Program 4 - recreational beaches
    - 2 sites sampled in coordination with EAC
    - weekly summer sampling (April – October) as part of countywide program
    - Additional monthly winter sampling (November – March)
- Monitoring Program 5 - Tomales Bay Watershed, long-term
    - Monthly sampling at 6 Olema Creek watershed sites (year-round)
    - Conducted by the NPS Inventory and Monitoring Program (I&M Program). Data collection, management and reporting for those stations is managed through the I&M Program and will be reported separately as part of that program.
- Monitoring Program 6 – Tomales Bay Pathogen Total Maxium Daily Load, regulatory
    - 5-week winter and 5-week summer sampling at 6 Olema Creek Watershed sites in coordination with Regional Water Board watershed-wide monitoring program.

Monitoring Program 2 (coastal watersheds): Monthly monitoring to characterize conditions and evaluate long-term trends was conducted at 8 sites, 7 of which were also monitored from 2000-2013. NPS and partner staff measured core parameters (water temperature, dissolved oxygen, pH, salinity, conductivity, and specific conductance) directly with a handheld multiparameter instrument. Staff also collected grab samples which were analyzed for turbidity and *E. coli* concentration directly following each monthly field visit. Results for all parameters for the sampling period including December of water year 2022 through water year 2023 are presented in detail in the Water Quality Monitoring and Assessment Report - Appendix A.

A brief summary of results for field collected parameters during this first reporting period (December 2021 - September 2023) is included here. As indicated above, a number of triggered sample events were conducted based on results collected under Monitoring Program 2.

Water Temperature (*no benchmark*):

- Median water temperature varied slightly between most sites. Sites generally were cooler in the winter months and warmer in the summer and fall.

Dissolved Oxygen (DO) (*minimum benchmark of 5.0 mg/L for warm water habitat, 7.0 mg/L for cold water habitat, maximum benchmark of 13.0 mg/L*):

- 81% (116 of 144) of measured DO values fell within the benchmark range.
- Low DO is common during the summer and fall months, when stream reaches begin to disconnect and isolated pools warm up and fill with decomposing leaves, aquatic vegetation, and algae. Twenty-two of the results below the minimum benchmark were in the Kehoe Creek Watershed, with sixteen out of those twenty two recorded at site PAC1, where outside of substantial winter rain events there is often a combination of slow moving water and areas of dense aquatic vegetation, decaying vegetation, and periodic algae accumulation.

pH (*benchmark range between 6.5-8.5*):

- 92% (122 of 132) of measured pH values fell within the benchmark range.
- Most of the results that did not meet the benchmark were at site PAC1, where pH was typically low, and where low DO was also observed (see note above).

Specific Conductance (*benchmark 2000 µS/cm*):

- >99% (141 of 144) of measured specific conductance values were below the benchmark.
- The 3 values above the benchmark were at Kehoe Lagoon site PAC3, which receives periodic tidal influence (conductivity increases as salinity increases).

Turbidity (*no benchmark*):

- 90% (114 of 144) of turbidity measurements were below 25 NTU, and over 96% were below 55 NTU.
- The highest recorded turbidity values were associated with the primary first flush event for water year 2023 on December 6, 2022.
- The majority of higher turbidity results were from sites PAC2 (North Kehoe Creek) and PAC4 (McClures Creek outside ranching area).

Fecal Indicator Bacteria (*contact recreation benchmark for E. coli 320 MPN/100mL, enterococci 110 MPN/100mL*):

- 69%% (97 of 141) of *E. coli* results were below the contact recreation benchmark.
- 4% (5 of 141) of *E. coli* results were non-detections (<1 or <10 MPN/100mL) and no results were above the upper quantification limit.
- 90% (19 of 21) enterococci results for site ABB4 were below the contact recreation benchmark. The median result was 10 MPN/100mL.
- Most sites showed elevated *E. coli* results in samples collected during a precipitation and primary first flush event on December 6, 2022.
- Site PAC2 (North Kehoe Creek) was consistently high for *E. coli* with the median result in excess of the contact recreation benchmark.

Monitoring Program 3 (dairy regulatory): the five dairy operations are required to conduct regulatory monitoring downstream of their facilities to meet the Regional Water Board's General

Waste Discharge Requirements for Confined Animal Facilities (General WDR). According to the General WDR, sampling is to occur after at least 1 inch of rain per 24 hours. Surface water sampling was conducted during the winter rainy season during or directly following three storm events. Stations were sampled using a handheld multiparameter instrument to measure pH, specific conductance and temperature. Grab samples were taken for laboratory analysis of ammonia (as N). Un-ionized ammonia was calculated using collected parameters.

Requirements under the General WDR were met, with the exception of site DBY2 on December 11, 2022, where pH and specific conductance were both above the established values (Appendix A -Table 20).

Monitoring Program 4 (recreational beaches): fecal indicator bacteria sampling was conducted in coordination with the Environmental Action Committee of West Marin weekly from April - October and monthly November - March at two sites during the reporting period October 14, 2020 through September 25, 2023. Grab samples were collected and analyzed for enterococci and *E. coli* concentration directly following each monthly field visit.

Approximately 99% of the results were below the 104 MPN/100mL single day sample contact recreational benchmark for enterococci utilized by the Marin County Ocean and Bay water Quality Testing Program (71 of 72 at DRK1 and 86 of 87 at DRK2). Both exceedances were recorded on October 25, 2021 following multiple consecutive days of precipitation totaling over 13 inches between October 20-October 24 (including 8.5 inches of rain on October 24) at the Mount Barnaby weather station.

Elephant seals: In early 2023, NPS responded to public inquiries regarding concern that agricultural runoff from park ranches may be affecting elephant seals in the Drakes Beach area. As reported to CCC staff and others at that time, the NPS has been collaborating with researchers at the Marine Mammal Center to understand whether there may be impacts of agricultural runoff to coastal locations where marine mammals regularly haul out. In 2022, the park and The Marine Mammal Center conducted a pilot study to better understand potential exposure of elephant seals to pathogens associated with agricultural runoff. The study focused on weaned pups at three sites: Drakes Beach and Chimney Rock, both within Point Reyes National Seashore, and Año Nuevo State Park. Results showed a relatively low incidence of intestinal bacteria and no subjective difference in body condition or behavior for the seals at all sample sites. These results are consistent with earlier studies of elephant seals on the California coastline, which demonstrate that marine mammals in more remote areas such as Point Reyes are less likely to test positive for pathogens considered markers for fecal contamination than marine mammals along more urbanized coastlines.

Additional elephant seal sampling efforts were completed in 2023. Preliminary analysis of the results of the 2023 bacterial composition samples by time, location, and sex, suggests that the only factor that contributes to much microbiome variation is sex. This is consistent with findings by some of our collaborators conducting work in other areas. More advanced analysis may be required to account for other factors but, initial observation of bacterial testing does not appear to show a difference between locations along Drakes Beach.

Monitoring Program 6 (Tomales Bay Watershed TMDL): six sites in the Olema Creek Watershed were visited weekly for a five-week period in both winter and summer in coordination with the Regional Water Board watershed wide TMDL monitoring effort. Grab samples were taken for laboratory analysis of fecal coliform and the five-week geomean for each site was compared to the TMDL geomean benchmark for Tomales Bay tributaries of 200 MPN/100mL. During 2022 monitoring did not take place during the winter, but the six sites were visited in the summer, while in 2023 sites were visited in both winter and summer.

In summer of 2022, five out of six sites returned geomean results below the five-week fecal coliform geomean benchmark. Site OLM11 at Bear Valley Road bridge, exceeded the TMDL five-week geomean benchmark (Appendix A, Table 30). In winter of 2023 four of six sites had geomean results below the benchmark, while the geomeans for the two sites furthest downstream (OLM11 and OLM10B) exceeded the benchmark. These sites had relatively higher readings of 920 MPN/100mL in the first week of sampling as compared to the subsequent weeks, a pattern also observed at five of the six sampled sites (Appendix A, Table 31). Daily precipitation recorded nearby at Mount Barnaby on the January 9, 2023 sample date was greater than two inches, and it was preceded by two additional greater than two inch rain events on January 4 and January 7, with lesser extents of rain on the days in between. The two sites with exceedances of the five-week geomean are located downstream of development in the town of Olema, CA.

In summer of 2023, all six sites returned geomean results below the fecal coliform benchmark (Appendix A, Table 32). Unlike the drought conditions of summer 2022, flow persisted at all sites throughout the summer 2023 sample period.

Objective 5: Integrate specific GMPA Record of Decision (ROD) changes and updates to mandatory requirements for continuing ranch operations into current NPS management to ensure expeditious implementation of priority actions to protect water quality and sensitive resources. Primary elements include allotment-specific changes identified in the GMPA ROD, updated requirements for all ranches continuing operations under 2-year Interim Leases, active implementation of improvement projects, and adaptive management on an ongoing basis.

[Objective Met]

October 2023 Status:
Interim Leases integrating a number of action and reporting elements, were issued to all ranch operations effective September 15, 2022. The expiration date of these two-year Interim Leases is September 14, 2024. Interim Leases are posted on the NPS website (available at: https://www.nps.gov/pore/getinvolved/planning-gmp-amendment-leases-permits.htm).

Primary elements added under the Interim Leases include expanded reporting requirements to meet Regional Water Board and Biological Opinion Requirements and standardization of operational requirements across permits. Interim Leases for dairy operations also established locations where land application of manure would be authorized by ranch, ensuring more oversight and protection of habitat and resources within the Ranchland zone. Consistent with the ROD, Interim leases for G, H, and I Ranch include articles that require operators to initiate phase out of silage production by September 2026.

Ranchers are required to report items responsive to Biological Opinions annually by November 1 of each year so that NPS may report to the agencies before the end of the calendar year. Reports covering 2022 were submitted to the NMFS and USFWS and include the following key elements:

- Fencing was installed on three ranch allotments, including approximately 5,217 feet of exclusion fencing (along Drakes Estero, north Home Ranch Creek, and a tributary to Abbotts Lagoon) and 3,090 feet of pasture fencing.
- Livestock Water Supply extension and drought resilience projects were completed on four ranch allotments including approximately 130 feet of pipeline, 2 troughs and 4 storage tanks.
- Pond Restoration projects were completed on two ranch allotments (1 pond on each) with removal of an estimated 2,936 cubic yards of accumulated sediment and total temporary disturbance of approximately 0.83 acres. Accumulated material was placed to reinforce the levy of each pond.
- Upland and Riparian Vegetation Management and Planting occurred on two Golden Gate National Recreation Area ranch allotments.
    - Along approximately 465 linear feet of a tributary to Lagunitas Creek, 123 total native plants including willow (*Salix* sp.), common rush (*Juncus* sp.), coffeeberry (*Frangula californica*) and California live oak (*Quercus agrifolia*) were planted, and 3 patches of invasive blackberry (*Rubus armeniacus*) were removed with hand tools.

    - Along approximately 190 linear feet of Lagunitas Creek, 80 total native plants including coast live oak, common rush, white alder (*Alnus rhombifolia*), and big leaf maple (*Acer macrophyllum*) were planted.

Additional activities conducted in 2023 (to be included in 2023 annual reports to USFWS and NMFS) included the following:

- 370 feet of exclusion fencing was installed on one ranch allotment to protect a tributary to Lagunitas Creek.
- Livestock Water Supply extension was installed on one ranch allotment consisting of approximately 5,025 feet of pipeline, 2 troughs, and 2 storage tanks.
- Upland and Riparian Vegetation Management and Planting on two Golden Gate National Recreation Area ranch allotments.
    - Along approximately 200 linear feet of Cheda Creek, 46 total native plants including live oak, buckeye (*Aesculus californica*), coyote brush (*Baccharis pilularis*), coffeeberry, common rush, and coast twinberry (*Lonicera involucrate*) were planted, and invasive blackberry was removed with hand tools. Approximately 75 linear feet of riparian fencing was repaired.
    - Along approximately 230 linear feet of a tributary to Olema Creek, 56 total native plants including willow, live oak, buckeye, and coffeeberry were planted, and invasive blackberry was removed with hand tools.

Objective 6: Complete Ranch Operating Agreements (ROAs) tied to longer-term leases for each ranch operation that incorporate progress and information obtained during implementation of Objectives 1-5 in an iterative process for continued management to improve water quality. Executed leases/ROAs will allow for full implementation of Strategy components through the GMPA. ROAs will identify and track ranch-specific mandatory requirements related to water quality protection.

[Objective in Process]

October 2023 Status:
As identified above, there is currently active litigation related to the implementation of the GMPA. The Center for Biological Diversity, Western Watersheds Project, Resource Renewal Institute, the National Park Service, and the rancher intervenor groups are continuing with the confidential mediation process initiated in the summer of 2022. The parties held productive in-person mediation discussions in July and September of 2023. In addition to the ongoing biweekly discussions, additional in-person meetings are scheduled for November 2023. In their October 16, 2023 filing to the Court, parties acknowledged that the mediation process has also included certain other consultants who have agreed to the strict mediation confidentiality agreement that all other parties have entered, and that the mediation discussions continue to be productive. The Court approved continuance of the matter and set the date for the next Case Management Conference for March 15, 2024.

Appendix A

Annual Report - 2023

Water Quality Strategy for Management of Ranching Operations

CD-0006-20

Water Quality Monitoring and Assessment
Point Reyes National Seashore

Water Years 2022 - 2023

Prepared for:

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October 2023

This report was prepared for the California Coastal Commission by the U.S. National Park Service. Data in this report were collected and analyzed using methods outlined in the peer reviewed *San Francisco Bay Area Network Freshwater Quality Monitoring Protocol* (Cooprider and Carson 2006). The report has received limited peer review by the National Park Service Pacific West Region Aquatic Ecologist.

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Executive Summary

This report summarizes several years of water quality monitoring data spanning winter of Water Year 2022 (WY2022) through Water Year 2023 (WY2023), collected under the *Water Quality Strategy for Management of Ranching Operations* (referred to as the "Strategy"). The overarching monitoring framework under the Strategy, which was presented to the California Coastal Commission and approved in September of 2022, consists of six individual programs that assess conditions or characterize a baseline for water quality in Point Reyes National Seashore and North District Golden Gate National Recreation Area water bodies. Where applicable, water quality results are compared to water quality benchmarks. The overarching goals established under the Strategy are to protect public health in high recreation areas, meet regulatory requirements, and limit exceedances of established water quality benchmarks in waterways.

Core Parameters
Water temperature
pH
Dissolved oxygen
Specific conductance
Turbidity
Fecal Indicator Bacteria
E. coli or Enterococci

Under Monitoring Program 2, implementation of monthly coastal watershed monitoring under the draft Strategy began in December 2021 with six sites and expanded to eight sites in the early months of 2022. Selection of sites and parameters are described in the Strategy. These eight surface water quality monitoring sites occur in two watersheds: six in the Abbotts Lagoon-Frontal Pacific Ocean Watershed, and two in the Drakes Estero Watershed.

The monthly sampling regime included collection of core parameters: water temperature, pH, dissolved oxygen, and specific conductance, with water samples analyzed for turbidity once returning from each field visit. In addition, collection of water samples was conducted at monitoring sites for laboratory analysis of fecal indicator bacteria concentration (*Escherichia coli* in freshwater and Enterococci in brackish or salt water. During the sampling period, core parameters were generally under or within benchmark ranges of values for most sites; a number of sites exhibited low to no flow during summer and fall (some with associated low dissolved oxygen and elevated fecal indicator bacteria concentrations in small volumes of water). Fecal indicator bacteria results were variable and will continue to be investigated as described in the Strategy based on future monitoring under the individual programs. Triggered monitoring was also conducted at five sites based on exceedance of fecal indicator bacteria benchmarks, and at two sites based on observations that could indicate presence of biostimulatory substances, which included laboratory analysis of samples for the nutrient parameters ammonia (as nitrogen [N]) and nitrate (as nitrogen [N]). Future monthly monitoring of core parameters and fecal indicator bacteria to determine annual and seasonal variability will allow for better understanding of dynamics at these sites.

A preliminary assessment of coastal watersheds was conducted in WY2023. Sixteen sites primarily downstream of leased ranching operations were visited once a week for six consecutive weeks in winter and summer. Core parameters, fecal indictor bacteria, and ammonia (as N) (downstream of leased dairy operations) were collected. This data was used to further target monitoring efforts and corrective actions at certain locations where results exceeded benchmarks.

Collection of additional assessment monitoring data next water year will provide necessary information to allow for more informed management actions where results are determined to regularly exceed benchmarks.

Monitoring pH, specific conductance, ammonia (as N), and unionized ammonia (calculated) downstream of five dairies following three rainfall events with a magnitude greater than one inch in 24 hours was also conducted to assist in meeting regulatory requirements and allow for responsive corrective actions if benchmark exceedances were detected in runoff. Samples met benchmarks established under the San Francisco Bay Regional Water Quality Control Board's General Waste Discharge Requirements for Confined Animal Facilities with the exception of pH and specific conductance during the first winter sample event at one site.

Based on winter assessment monitoring, synoptic monitoring of *Escherichia coli* at multiple locations in subwatersheds that drain through four active dairy ranches was conducted during or directly following periods of rainfall greater than one inch, and spring baseflow conditions during a relatively wet water year. These monitoring activities coupled with on the ground inspections and reporting requirements aid the National Park Service in determining areas to target with management actions to improve water quality conditions.

Recreational beach monitoring was conducted at two high public use locations (Drakes Beach and Drakes Estero) weekly from April to October and monthly from November to March during Water Year 2021 (WY2021), WY2022, and WY2023 (based on staff availability and periodic closures for protection of wildlife or construction) to ensure fecal indicator bacteria concentrations remain below levels set for protection of human health. During the WY2021 - WY2023 monitoring period, approximately 99% of samples at each site were below the contact recreation benchmark for enterococci utilized by the Marin County Ocean and Bay Water Quality Testing Program.

Regulatory monitoring of fecal indicator bacteria as part of the Tomales Bay Pathogen Total Maximum Daily Load was conducted for five consecutive weeks in summer of WY2022, winter of WY2023, and summer of WY2023 at six sites within the Olema Creek Watershed. The geometric mean benchmark for the five weeks was met at most sites. There were exceedances at one site downstream from the town of Olema in summer 2023, and two sites downstream of the town of Olema in winter 2023.

Point Reyes National Seashore and partners have implemented management practices intended to improve water quality conditions upstream of many of these water quality sites. Along with restoration efforts, consistent water quality monitoring plays a key role in assessing and improving the health of natural systems in Point Reyes National Seashore and North District Golden Gate National Recreation Area. These monitoring efforts will continue next water year to allow for determination of baseline conditions, long-term analysis of trends, and well-informed management decisions based on sufficient data.

Acknowledgments

This monitoring would not be possible without assistance from Point Reyes National Seashore Association staff, Environmental Action Committee of West Marin, and National Park Service staff.

The coastal watershed monitoring programs would not be possible without the technical assistance of hydrologic technician Alex Iwaki of the San Francisco Bay Area Inventory and Monitoring Network.

Introduction

Background

This report presents water quality monitoring data measured during various intervals under five of six monitoring programs coordinated through Point Reyes National Seashore's *Water Quality Strategy for Management of Ranching Operations* (Strategy; NPS 2022). It represents a first effort under the Strategy to tie together the multiple programs under one reporting framework. The monitoring period includes Water Year 2021 (WY2021), Water Year 2022 (WY2022), and Water Year 2023 (WY2023) for recreational beach monitoring, WY2023 for short-term assessment and dairy regulatory monitoring, and partial WY2022 through WY2023 for monthly coastal watershed and Olema Creek Watershed regulatory monitoring. The reporting start dates are based on whether programs were new or reinitiated.

- Monitoring Program 1 (short-term assessment) entails six-week fecal indictor bacteria assessment monitoring, core parameters, and ammonia as N (for dairies), with six consecutive samples collected once a week for six weeks in winter and summer, primarily downstream of ranch operations.
    - *Reporting period includes WY2023: January 3, 2023 (initiation of program) to August 2, 2023.*
- Monitoring Program 2 (coastal watersheds) continues long-term monthly monitoring of core parameters and fecal indicator bacteria in coastal watersheds on the Point Reyes Peninsula.
    - *Reporting period includes partial WY2022 and WY2023: December 7, 2021 (re-initiation of program) to September 5, 2023.*
- Monitoring Program 3 (dairy regulatory) continues regulatory monitoring of temperature, pH, specific conductance, ammonia as N, and un-ionized ammonia (calculated) during three wet season storm events below dairy operations under the Regional Water Board's General Waste Discharge Requirements for Confined Animal Facilities.
    - *Reporting period includes WY2023: - December 11, 2022 to March 10, 2023.*
- Monitoring Program 4 (recreational beaches) continues fecal indicator bacteria sampling (*E. coli* and enterococci) at recreational beach locations weekly from April - October and monthly during November - March to ensure protection of public health.
    - *Reporting period includes WY2021 - WY2022, partial WY2023: October 14, 2020 (re-initiation of program) and September 25, 2023.*
- Monitoring Program 5 (Tomales Bay Watershed) involves long-term monthly monitoring by the NPS San Francisco Bay Area Inventory and Monitoring program in Olema and Lagunitas Creek watersheds to characterize water quality in priority streams, as part of a regional NPS monitoring program.
    - *These efforts are documented in separate reports released through the Inventory and Monitoring Program.*
- Monitoring Program 6 (Olema Creek Watershed regulatory) continues five-week fecal coliform assessment monitoring (five consecutive samples collected once a week for five weeks) in winter and summer from upper to lower Olema Creek watershed as part of a

larger ongoing monitoring effort in coordination with the Regional Water Quality Control Board and other stakeholders throughout the Tomales Bay Watershed as part of the Tomales Bay Pathogen Total Maximum Daily Load (TMDL).

- *Reporting period includes WY2022 - WY2023: July 5, 2022 to August 2, 2023.*

At most stations sampled under Monitoring Program 2, fecal indicator bacteria concentration data (*E. coli* and fecal coliform) was collected from approximately 2000 - 2013 within Point Reyes National Seashore coastal watersheds. An analysis of that data is presented in the park's General Management Plan Amendment Final Environmental Impact Statement under Appendix L (NPS 2022) and in Voeller et al. (2021). Monthly coastal watershed sampling under Monitoring Program 2 was reinitiated in December of 2021 by the National Park Service. For recreational beach sampling under Monitoring Program 4, *E. coli* and enterococci concentration data collection was conducted from 2006 to 2013 by the National Park Service and was reinitiated in October of 2020 in partnership with the Environmental Action Committee of West Marin.

Future reporting should be based on the full Water Year (October 1 – September 30) for more consistent comparison over time. Reports prepared under Monitoring Program 5 for the Tomales Bay Watershed are collected and managed through the National Park Service Inventory and Monitoring Program and will be included as completed. Results of the program are not presented in this preliminary report.

Additional information regarding monitoring program methodology, rationale and protocols can be found under Element 2 of the Strategy. Much of the work draws from and references the *San Francisco Bay Area Freshwater Quality Monitoring Protocol* (Cooprider and Carson 2006) and associated standard operating procedures as adapted for each Monitoring Program.

Goals and Objectives

The water quality goals established under the Strategy are to protect public health in high recreation areas, meet regulatory requirements, and limit exceedances of established water quality benchmarks in waterways. Monitoring Program 1 (short-term assessment) is carried out in pursuit of Strategy Objective 3: Conduct initial water quality assessment monitoring of major waterways flowing from ranches to coastal waters in winter and summer of 2022 - 2023 to document conditions. Monitoring Program 2 (coastal watersheds), Monitoring Program 3 (dairy storm monitoring), Monitoring Program 4 (recreational beach), Monitoring Program 5 (Tomales Bay watershed), and Monitoring Program 6 (Olema Creek TMDL) are being carried out to accomplish Strategy Objective 4: Continue long-term, regulatory, and beach recreational water quality monitoring. Under these objectives, additional monitoring and adaptive management actions are undertaken when results are consistently above monitoring benchmarks. Objectives 1, 2, 5, and 6 of the Strategy involve ranch inspections and implementation of mandatory requirements, corrective actions, and adaptive management under authorizations for continued ranch operations. These objectives are informed by the water quality monitoring documented in this report.

The monitoring programs in this effort focus on characterizing core parameters, bacteria, and nutrients, and comparing these data to established benchmarks. Though the long-term monitoring is intended to support trend analysis over time, these data also serve as a warning system to detect changes and trigger responses to conditions outside of established benchmarks.

Monitoring Area

A detailed description of the monitoring area watersheds can be found in Appendix A. Monitoring Programs 1 through 4 are conducted in three coastal watersheds on the Point Reyes Peninsula: the Abbotts Lagoon-Frontal Pacific Ocean Watershed, which includes Kehoe Creek and Abbotts Creek; the Drakes Estero Watershed, which includes Home Ranch Creek and Schooner Creek;, and the Drakes Bay Watershed, which includes waterways draining off the eastern half of the Point Reyes Headlands. Monitoring Programs 5 and 6 are conducted in the Tomales Bay Watershed which includes Olema Creek and Lagunitas Creek (Figure 1).

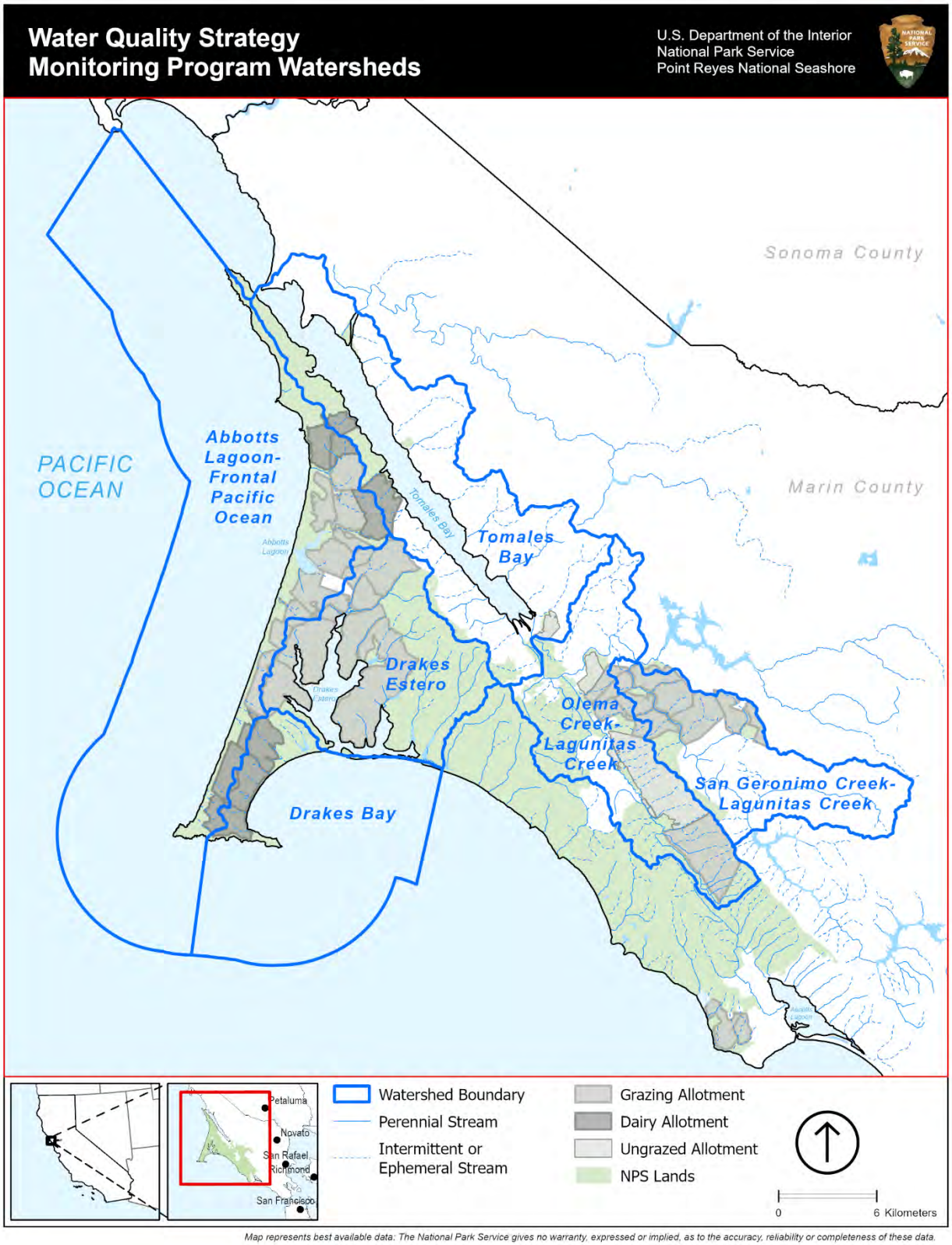


Figure 1. Water Quality Strategy Monitoring Program watersheds and ranch allotments at Point Reyes National Seashore and Golden Gate National Recreation Area.

Methods

A detailed description of methods is presented in the Strategy and Appendix B.

Water Quality Benchmarks

Surface waters within Point Reyes National Seashore and Golden Gate National Recreation Area fall under the regulatory jurisdiction of the San Francisco Bay Regional Water Quality Control Board (RWQCB). In its Water Quality Control Plan for the San Francisco Bay Region (Basin Plan), the RWQCB defines beneficial uses for waters under its jurisdiction and sets numeric and narrative objectives to meet these uses (RWQCB 2023). Water bodies in the monitoring area that are listed in the Basin Plan include the following: Pacific Ocean, Abbotts Lagoon, Drakes Estero, East Schooner Creek, Home Ranch Creek, Tomales Bay, Lagunitas Creek, Olema Creek, and Devils Gulch Creek. Beneficial uses for all of these include wildlife habitat, contact-recreation, and non-contact recreation, while other applicable aquatic life uses vary by water body.

Many states and agencies commonly refer to established water quality *standards, criteria, or objectives*; this report will refer to water quality *benchmarks*. Failures to meet numeric benchmarks are referred to as *exceedances* throughout this report. In the Basin Plan, the RWQCB has set specific objectives for un-ionized ammonia, pathogenic indicator bacteria, pH, and dissolved oxygen. Standards, criteria, and objectives for water quality fall into two categories: ecological objectives for water bodies and drinking water standards for human consumption. Ecological or environmental objectives can target desired water quality conditions for wildlife habitat, non-contact recreation, and contact recreation. Benchmarks utilized for comparison in this report are presented in Table 1.

There are no national or state water quality benchmarks for temperature, specific conductance, or turbidity. However, under its General Waste Discharge Requirements for Confined Animal Facilities, the RWQCB has set a benchmark for specific conductance, which will be utilized in this report (RWQCB 2016).

The pH of water affects the solubility and bioavailability of chemical constituents, such as nutrients and heavy metals. pH can vary naturally due to local geology and daily fluctuations in photosynthesis, decay of vegetation, and inputs from runoff. The Basin Plan lower and upper benchmarks for pH intended for protection of aquatic life will be utilized in this report.

Waters that contain large amounts of algae or aquatic vegetation can exhibit swings in dissolved oxygen concentrations. Concentrations can become low (especially at night) or rise above fully saturated levels during daytime. These conditions can harm fish or affect other aquatic life (US EPA 2023a). The Basin Plan benchmarks for minimum concentrations of dissolved oxygen in cold and warm water habitat will be utilized in this report. A maximum dissolved oxygen concentration benchmark will also be utilized to screen for oxygen supersaturation related to biostimulatory substances (see Worcester et al. 2010).

Neither the State of California nor the San Francisco Bay RWQCB have set ecological objectives for nitrates or phosphates in streams and lakes. Ammonia can have toxic effects on aquatic life

and is indicative of human or animal waste. The U.S. Environmental Protection Agency (US EPA) has developed both acute and chronic Aquatic Life Ambient Water Quality Criteria for ammonia in freshwater, which are based on pH and temperature as the fraction of total ammonia that is un-ionized varies with these parameters. (US EPA 2013). The RWQCB General Waste Discharge Requirements for Confined Animal Facilities (CAF General WDR) sets a total ammonia nitrogen storm event benchmark for single samples of below 1 mg/L (RWQCB 2016). The benchmark for un-ionized ammonia (calculated) is much lower to protect from acute toxicity. While the total ammonia nitrogen and un-ionized ammonia results are not directly tied to beneficial uses, if exceeded, they do require investigation to determine the reason for the elevated result. These protective benchmarks will be utilized to trigger actions and evaluate nitrogen data collected under the monitoring programs.

Fecal indicator Bacteria (FIB) such as *E. coli* and enterococci have been shown to be reliable at indicating contamination of water from humans and animals and are the primary indicators recommended by the US EPA (US EPA 2012). There are numerous established benchmarks for FIB. As described in the Strategy, Monitoring Programs 1 and 2 will use the statewide water contact recreation benchmarks defined in the RWQCB Basin Plan. Individual regulatory programs have specific objectives that take precedence over Basin Plan objectives. Monitoring Program 4 will use benchmarks established by the California Department of Public Health for the statewide recreational beach monitoring program (17 C.C.R. §7958; Cal. HSC §115880). Monitoring Program 6 will use benchmarks established under the Tomales Bay Watershed Pathogens TMDL (RWQCB 2023).

The RWQCB Basin Plan (2023) defines water contact recreation (REC1) as: "*Uses of water for recreational activities involving body contact with water where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, whitewater activities, fishing, and uses of natural hot springs.*" It should be noted that criteria required to protect this use are more stringent than those for more casual water-oriented Noncontact Water Recreation (REC2), defined by the Basin Plan as: "*Uses of water for recreational activities involving proximity to water, but not normally involving contact with water where water ingestion is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.*" As such, comparison to the REC1 benchmark for FIB may set a higher bar than intended for existing uses of some of the water bodies sampled under the monitoring programs presented in this report.

Table 1. Numeric benchmarks for surface waters utilized for water quality Monitoring Programs.

Parameter	Water Quality Benchmark
Dissolved oxygen (non-tidal waters)	5.0 mg/L minimum, warm water habitat (RWQCB Basin Plan) 7.0 mg/L minimum, cold water habitat (RWQCB Basin Plan) Less than 13.0 mg/L (Worcester et al. 2010) *Ecological*
pH	Not depressed below 6.5 nor raised above 8.5 pH units (RWQCB Basin Plan) *Ecological*
Specific conductance (non-tidal waters)	Below 2000 µS/cm (RWQCB CAF General WDR) *Ecological*
Ammonia (as N)	Below 1 mg/L and meets calculated un-ionized ammonia benchmark (RWQCB CAF General WDR) *Ecological*
Un-ionized ammonia (as N)	0.025 mg/L (RWQCB CAF General WDR; Basin Plan) *Ecological*
Nitrate (as N)	Maximum of 10 mg/L (40 CFR §141.50) *National Primary Drinking Water Standard Regulation*
E. coli (when salinity ≤ 1 ppth 95% or more of the time)	No more than 10% of samples to exceed 320 MPN/100mL in a calendar month Not to exceed a geometric mean of 100 MPN/100mL for six weekly samples (RWQCB Basin Plan) Not to exceed a geometric mean of 200 MPN/100mL for five weekly samples (17 C.C.R. §7958; Cal. HSC §115880) Not to exceed 400 MPN/100mL for a single day sample (17 C.C.R. §7958; Cal. HSC §115880) *Recreational - for reasonable protection of human health*
Enterococci bacteria (when salinity > 1 ppth 95% or more of the time)	No more than 10% of samples to exceed 110 MPN/100mL in a calendar month (RWQCB Basin Plan) Not to exceed a geometric mean of 30 MPN/100mL for six weekly samples (RWQCB Basin Plan) Not to exceed a geometric mean of 35 MPN/100mL for five weekly samples (17 C.C.R. §7958; Cal. HSC §115880) Not to exceed 104 MPN/100mL for a single day sample (17 C.C.R. §7958; Cal. HSC §115880) *Recreational - for reasonable protection of human health*
Fecal coliform bacteria	No more than 10% of samples to exceed 400 MPN/100mL in a 30-day period (RWQCB Basin Plan - Tomales Bay TMDL) Not to exceed a log mean of 200 MPN/100mL for five weekly samples (RWQCB Basin Plan - Tomales Bay TMDL) *Recreational - for reasonable protection of human health*

Site Selection

The Strategy (NPS 2022) describes water quality monitoring sites within Point Reyes National Seashore and North District Golden Gate National Recreation Area (Table 2; Figure 2) many of which were established under previous or ongoing monitoring efforts. Site selection was targeted rather than randomized. Site selection for preliminary assessment monitoring presented in this report prioritized watersheds containing active dairy operations. Thus, due to field logistics and staff constraints, an assessment site was not monitored downstream of every ranching operation. The NPS may continue to select specific watersheds or ranches for monitoring efforts on a rotating priority basis dependent on staff capacity. Stations may be added or retired over time based on monitoring results.

Most of the water quality monitoring sites are downstream of ranching operations; a few are located in areas with minimal or no influence from ranching operations. Dairies have regulatory and assessment monitoring sites within major waterways downstream of each operation's developed ranch core. Two coastal watershed dairies also have long-term monitoring sites downstream in at least one location. Major recreational beaches and lagoons downstream of ranching operations have long-term monitoring stations to evaluate public health risk. The two beach sample locations are where creek mouths feed into Drakes Beach (when connected) or Drakes Estero. Two additional sample stations are located at popular coastal lagoons which are fed by major waterways (Abbotts Creek and Kehoe Creek) that drain ranching areas and become connected to the ocean during breach events from storm flows and wave overtopping events (see Table 2; Figure 2). Several long-term sampling locations have been moved slightly as a result of environmental or land use changes. An additional monitoring site outside the influence of ranching activities was also established in 2022 to provide context in an adjacent coastal watershed above its confluence with the Pacific Ocean.

While data and sample collection methods remain consistent with those recommended by the *San Francisco Bay Area Freshwater Quality Monitoring Protocol* (Cooprider and Carson 2006), sampling design follows methods identified in the Strategy. Current practices have been adopted for the monitoring efforts described in this report. More details on methods are included in the Strategy and Appendix B.

Table 2. Water quality sites monitored during WY2022-WY2023 (and WY2021 for recreational beach).

Watershed	Station ID	Description	Monitoring Type	Monitoring Frequency
Kehoe Creek	**PAC1**	South Kehoe Creek mainstem downstream of a dairy, and portions of two grazing operations; flows north through an ungrazed marsh area upstream of monitoring site.	Long-term Assessment	Monthly 6-Week (Winter & Summer)
	PAC2	North Kehoe Creek mainstem downstream of a dairy and a beef cattle operation upstream of culvert under Pierce Point Road.	Long-term Assessment Dairy Regulatory (General Waste Discharge Requirement)	Monthly 6-Week (Winter & Summer) Winter (3 Storms)
	PAC2B	Branch of North Kehoe Creek at culvert under dairy ranch road downstream of ranch building complex.	Assessment	6-Week (Winter & Summer)
	PAC3	Kehoe Creek lagoon adjacent to Pacific Ocean. This coastal lagoon at the mouth of Kehoe Creek becomes connected to the Pacific Ocean during breach events from storm flows and wave overtopping.	Long-term Assessment	Monthly 6-Week (Winter & Summer)
	PAC4^	McClures Creek upstream of confluence with Pacific Ocean, outside of the Ranchland Zone adjacent to McClures Beach Trail.	Long-term Assessment	Monthly 6-Week (Winter & Summer)
	PAC5	Upper tributary of South Kehoe Creek just downstream of a dairy ranch boundary.	Assessment Dairy Regulatory (General Waste Discharge Requirement)	6-Week (Winter & Summer) Winter (3 Storms)
Abbotts Lagoon	**ABB1**	Perennial stream mainstem downstream of tributaries on a beef cattle ranch; a branch of the headwaters is located on a dairy, but the mainstem then flows through an ungrazed area upstream of the monitoring site.	Long-term Assessment	Monthly 6-Week (Winter & Summer)
	ABB2	Tributary downstream of former dairy corrals on a grazing operation with ungrazed wetlands and ponds directly upstream of the monitoring site.	Assessment	6-Week (Winter & Summer)
	ABB4*	Abbotts Lagoon west of trail crossing bridge between lagoon chambers, adjacent to Pacific Ocean. This brackish coastal lagoon at the mouth of Abbotts Creek becomes connected to the Pacific Ocean during breach events from storm flows and wave overtopping.	Long-term Assessment	Monthly 6-Week (Winter & Summer)
	ABB5	Tributary on a beef cattle ranch below stock ponds and above confluence with Abbotts Lagoon.	Assessment	6-Week (Winter & Summer)

Watershed	Station ID	Description	Monitoring Type	Monitoring Frequency
Drakes Estero	**DES1A**	Creamery Bay Creek on beef cattle ranch upstream of confluence with Creamery Bay.	Assessment	6-Week (Winter & Summer)
	DES2^	East Schooner Creek upstream of Sir Francis Drake crossing with ranching activities only in small, uppermost and predominantly intermittent tributaries.	Long-term Assessment	Monthly 6-Week (Winter & Summer)
	DES3	Home Ranch Creek below beef cattle operation ranch building complex.	Long-term Assessment	Monthly 6-Week (Winter & Summer)
	DRK2 - Drakes Estero*	Drakes Estero at Schooner Bay recreational access point where the tidal marsh opens into Drakes Estero.	Recreational Beach	Weekly (Apr - Oct) Monthly (Nov - Mar)
Drakes Bay	**DBY1**	Coastal drainage downstream of dairy ranch building complex.	Assessment Dairy Regulatory (General Waste Discharge Requirement)	6-Week (Winter & Summer) Winter (3 Storms)
	DBY2	Coastal drainage downstream of dairy ranch building complex.	Assessment Dairy Regulatory (General Waste Discharge Requirement)	6-Week (Winter & Summer) Winter (3 Storms)
	DBY3A	Coastal drainage downstream of dairy ranch building complex.	Assessment Dairy Regulatory (General Waste Discharge Requirement)	6-Week (Winter & Summer) Winter (3 Storms)
	DRK1 - Drakes Beach*	Pacific Ocean at confluence with coastal drainage below a dairy ranch.	Recreational Beach	Weekly (Apr - Oct) Monthly (Nov - Mar)

*Beach or lagoon sampling locations with salinity > 1 ppth more than 5% of the time
^Reference station with limited or no upstream influence from ranching activities

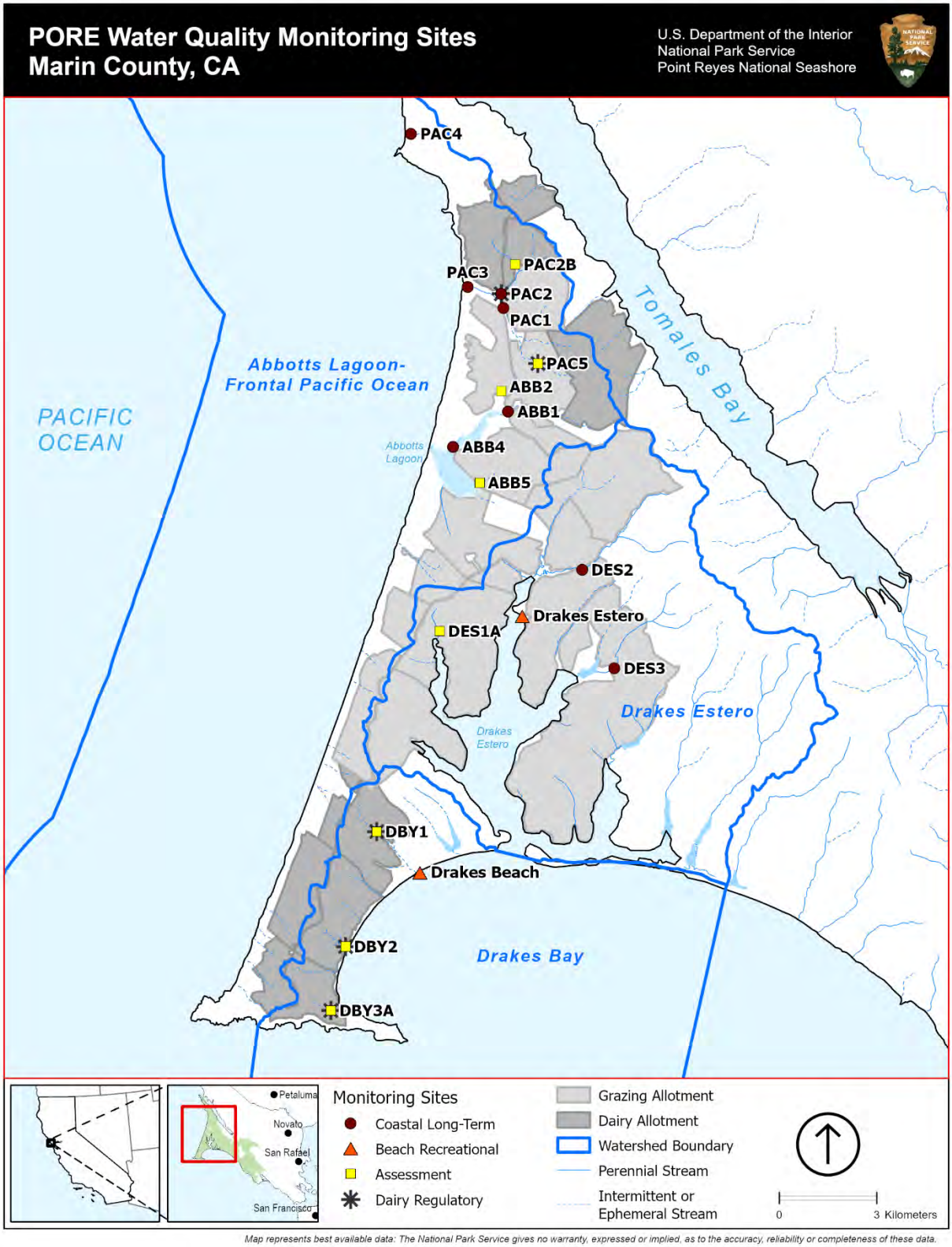


Figure 2. Water quality monitoring sites sampled in WY2022 and WY2023 on the Point Reyes peninsula by watershed.

Sample Regime

Staff conducted Monitoring Program 1 six-week winter assessment monitoring across 16 sites January 3 to February 8, 2023, typically on the same two consecutive days within each week. Six-week summer assessment was conducted across the same 16 sites from June 28 to August 2, 2023, typically on the same day of each week. Each Monitoring Program 2 water quality site was visited monthly, typically on the same day of the week, except the Abbotts Lagoon site (ABB4) which was coordinated with sampling dates for Monitoring Program 4 (beach recreational monitoring) due to salinity being greater than 1 part per thousand more than 5% of the time. Monitoring Program 3 involved sampling at the five sites downstream of dairies during storm events greater than 1-inch in 24-hours, which in one case overlapped with the winter six-week series under Monitoring Program 1. Under Monitoring Program 4, beaches were visited once monthly from November to March, except at Drakes Beach where closures (for construction or to protect elephant seals) prevented access, and weekly from April to October. Monitoring Program 6 (Tomales Bay Watershed TMDL) winter five-week sampling was conducted January 9 to February 6, 2023, and summer five-week sampling was conducted July 5 to August 2, 2023.

Whenever possible, staff visited sites in the same order and at approximately the same time of day during each sampling event to limit diel variation. Under Monitoring Programs 1 and 2, monthly sampling overlapped with six-week samples on the first week of each month, and sampling in the same order was not logistically possible do to the higher number of sites being covered under Monitoring Program 1.

Sample Parameters

On-site field data measurements and collection of samples for laboratory analysis are conducted during sampling events. The suite of parameters collected under each Monitoring Program varies as described in the Strategy (Table 3).

Table 3. Parameters collected from water quality sites during the reporting period.

Analytical Group	Parameters Collected	Analytical Method	Monitoring Program(s)
Core Parameters	Water temperature, specific conductance, dissolved oxygen, pH, salinity	On-site measurement with handheld meter	1,2,3,5
	Turbidity	NPS-laboratory analysis of sample	
Bacteria	*Escherichia coli* or enterococci Total coliform	Laboratory analysis of sample	1,2,4,5
	Fecal coliform		6
Nutrients	Ammonia as N	Laboratory analysis of sample	1,3
	Nitrate as N		1 (if triggered), 5

Refer to Appendix B for more detailed descriptions.

Results and Discussion

This report includes preliminary results as water quality monitoring programs 1, 2, 3, and 6 were being initiated or continued spanning WY2022 and WY2023 from December 2021 through September 5, 2023. For recreational beach sampling under Monitoring Program 4, results are included from October 2020 to September 25, 2023. A number of freshwater monthly monitoring sites exhibited low to no flow transitioning from summer to fall. Site PAC2 transitioned from low to no flow conditions and therefore was not sampled from August to October 2022, or September of 2023. Site ABB1 exhibited no flow in August 2022 but samples were taken. For assessment sites, five of the freshwater locations did not maintain flow through the summer 2023 sample period. Site DBY2 was not flowing for the entirety of the summer series, sites ABB5 and DBY1 were only flowing during the first week of the series, site DBY3A exhibited no flow conditions after the first three weeks of the series, and site PAC5 exhibited no flow conditions in the last week of the series.

Weather data was obtained from the MesoWest databases maintained by the University of Utah and the Western Region of the National Weather Service, and from the Marin County Flood Control and Water Conservation District databases maintained by the County of Marin. In WY2021, 14.39 inches of cumulative precipitation were measured at the Mount Barnaby (BBEC1) Remote Automatic Weather Station (RAWS) (with daily data from Marin County's Point Reyes Station site 38029 substituted when there was no data for BBEC1). In WY2022, 39.35 inches of cumulative precipitation were measured, with 18.19 inches falling before December 1, 2022, the month when the sampling period began under Monitoring Program 2. In WY2023, 60.39 inches of cumulative precipitation were measured (Figure 3, Figure 4). The winter of 2023 was characterized by more frequent rainfall during numerous atmospheric river events; from December 25 through January 16 there were approximately six storm systems with 27.00 inches of rain recorded at BBEC1. Similarly, from February 22 to April 7 there were 20.00 inches of precipitation recorded. The WY2023 cumulative rainfall total exceeded all of WY2022 by February 24, 2023 (Figure 3; Figure 4). WY2021 was characterized by low rainfall and severe to exceptional drought (National Drought Mitigation Center 2023). The drought conditions continued into WY2022, which included notable early season rainfall where greater than 1-inch of precipitation was recorded each day at BBEC1 between October 20 and October 23, and 8.50 inches were recorded in a single day on October 24, 2021. Table 4 summarizes sampling frequency at water quality sites under Monitoring Programs 1, 2, and 3 during WY2022 - WY2023. Table 5 summarizes sampling frequency at recreational beaches under Monitoring Program 4 between WY2021 - WY2023.

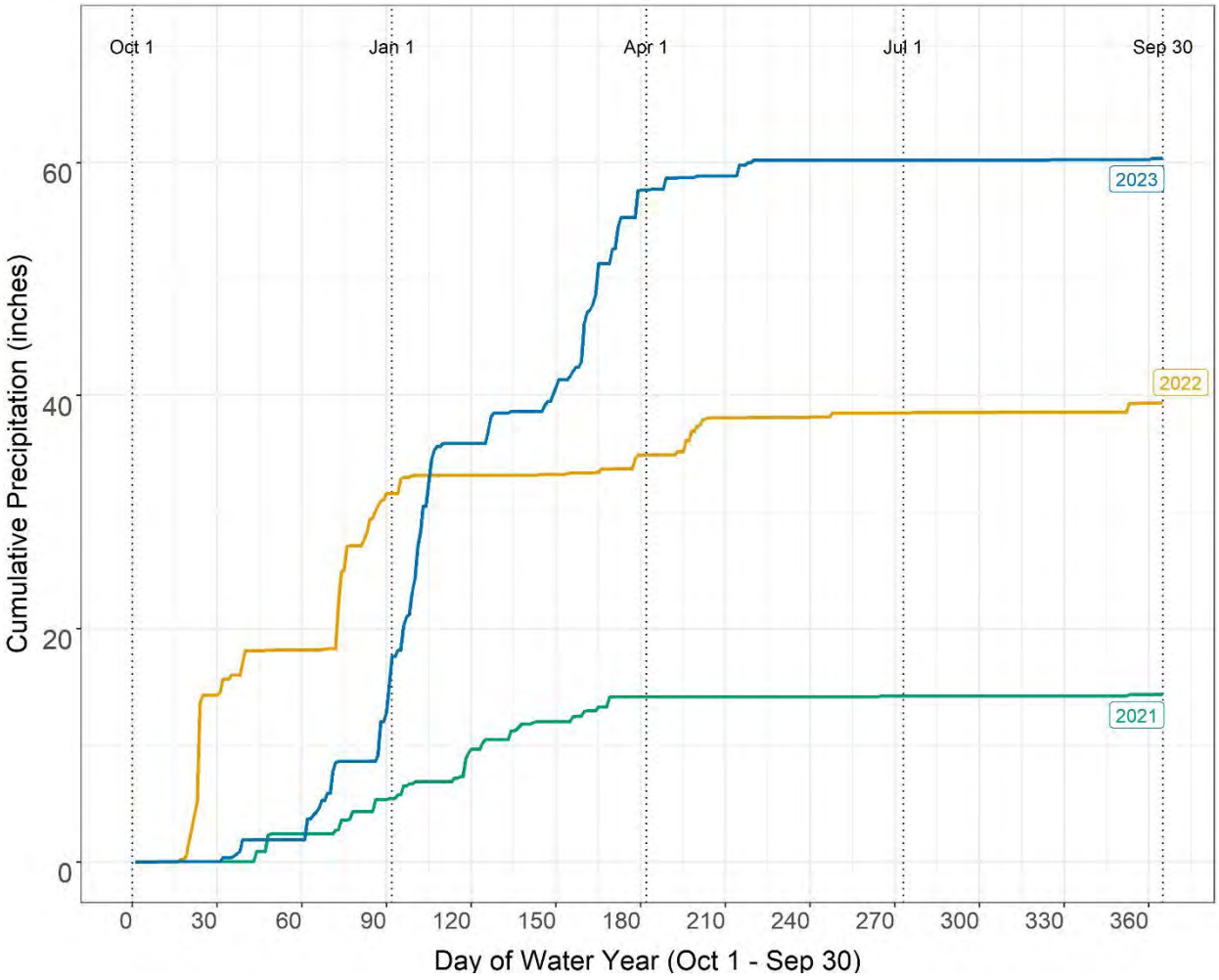


Figure 3. Cumulative precipitation (inches) recorded near Point Reyes Station, CA for WY2021 (green line), WY2022 (orange line) and WY2023 (blue line).

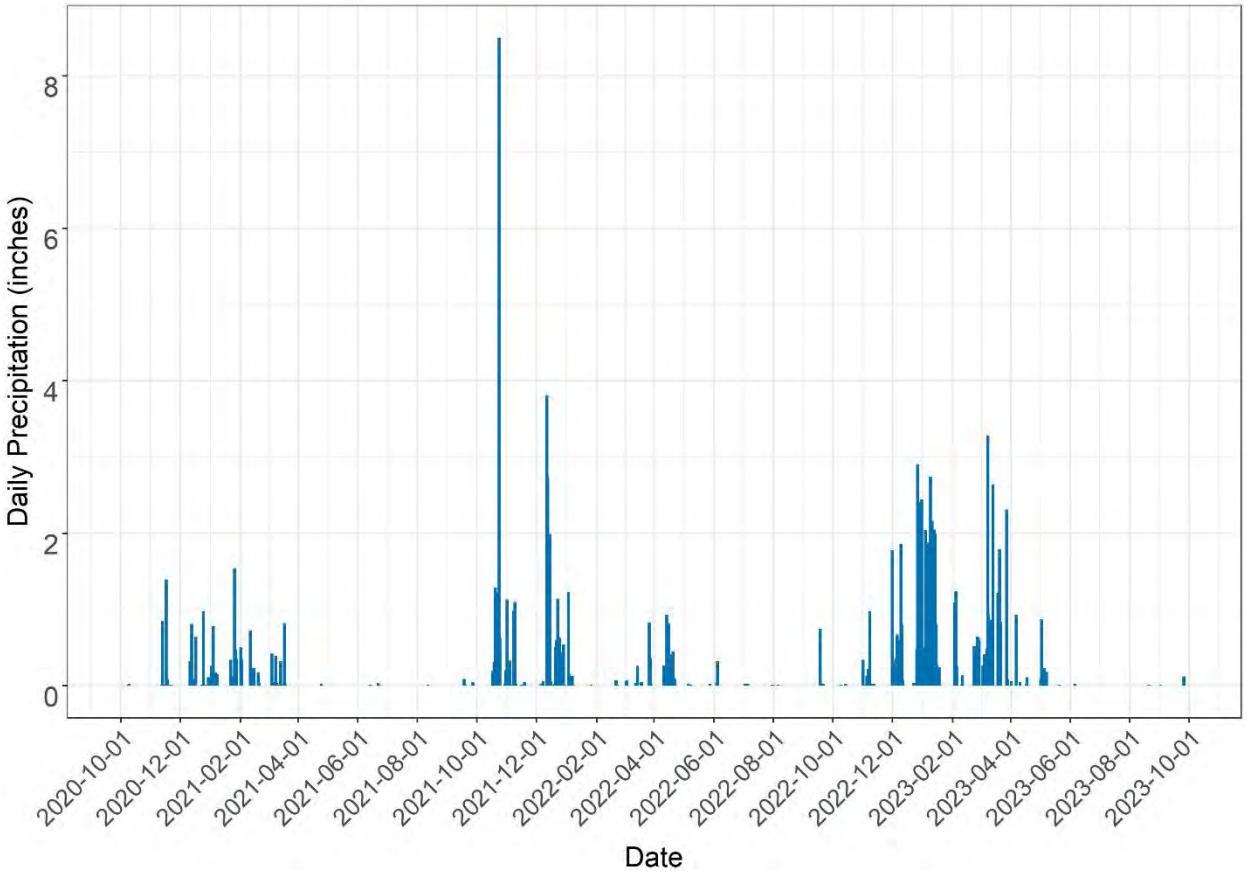


Figure 4. Daily precipitation (inches) during the sampling period WY2021 - WY2023 recorded near Point Reyes Station, CA.

Table 4. Water quality sites and sampling frequency for Monitoring Programs 1,2, and 3 during WY2022 - WY2023. ["M'' - monthly samples collected from this site; "W" – weekly samples collected from this site; "S" – storm samples (>1" rainfall in 24 hrs) collected from this site; "T" – triggered sample event; "~" – monitoring station was completely dry, had no flow, or flow was too low to sample]. Blank cells indicate no sampling conducted. The assessment period under Monitoring Program 1 is indicated in light blue.

Water Year	Watershed	Kehoe Creek/Frontal Pacific Ocean						Abbotts Lagoon				Drakes Estero			Drakes Bay		
	Site ID	PAC1	PAC2	PAC2B	PAC3	PAC4	PAC5	ABB1	ABB2	ABB4*	ABB5	DES1A	DES2	DES3	DBY1	DBY2	DBY3A
2022	Oct																
	Nov																
	Dec	M	M					M					M	M			
	Jan	M	M					M					M	M			
	Feb	M	M		M			M		M			M	M			
	Mar	M	M		M			M					M	M			
	Apr	M	M		M	M		M		M			M	M			
	May	M	M		M	M		M		M			M	M			
	Jun	M	M		M	M		M		M			M	M			
	Jul	M	M		M	M		M		M			M	M			
	Aug	M	~		M	M		M		M			M	M			
	Sep	M	~		M	M		M~		M			M	M			
2023	Oct	M,T	~		M	M		M		M			M	M			
	Nov	M,T	M		M	M,T		M,T		M			M,T	M			
	Dec	M	M,S,T		M	M	S	M		M			M,T	M	S	S	S
	Jan	W,M	W,M,S	W	W,M	W,M	W,S	W,M	W	W,M	W	W	W,M	W,M	W,S	W,S	W,S
	Feb	W,M	W,M	W	W,M	W,M	W	W,M	W	W,M	W	W	W,M	W,M	W,M	W	W
	Mar	M	M,S,T	T	M,T	M	S	M		M			M	M	S,T	S,T	S,T
	Apr	M	M,T	T	M,T	M		M		M			M	M	T	T	T
	May	M	M		M	M		M		M			M	M			
	Jun	W,M	W,M	W	W,M	W,M	W	W,M	W	W,M	W	W	W,M	W,M	W	~	W
	Jul	W,M	W,M	W	W,M	W,M	W	W,M	W	W,M	~	W	W,M	W,M	~	~	W~
	Aug	W,M	W,M	W	W,M	W,M	W	W,M	W	W,M	~	W	W,M	W,M	~	~	~
	Sep	M	~		M	M		M		M	~		M	M	~	~	~

*Lagoon sampling location with salinity > 1 ppth more than 5% of the time

Table 5. Water quality sites and sampling frequency for Monitoring Program 4 during WY2021 - WY2023. ["M'' – monthly samples collected from this site; "W" – weekly samples collected from this site; "T" – triggered sample event]. Blank cells indicate no sampling conducted.

Water Year	Watershed	Drakes Bay	Drakes Estero	Water Year	Drakes Bay	Drakes Estero	Water Year	Drakes Bay	Drakes Estero
	Site ID	DRK1	DRK2		DRK1	DRK2		DRK1	DRK2
2021	Oct	W	W	2022	M	W	2023	W	W
	Nov	M	M		M	M		M	M
	Dec	M	M					M	M
	Jan								M
	Feb		M		M	M		M	M
	Mar				M				M
	Apr	W	W		W	W		W	W
	May		W		W	W		W	W
	Jun		W		W	W		W	W
	Jul		W		W	W		W	W
	Aug		W		W	W		W	W
	Sep	W	W		W	W		W	W

Coastal Watersheds - Monthly (Monitoring Program 2)

This preliminary report covers the period of December 2022 - September 2023 for most sites; it is important to note that summary statistics span greater than one water year but do not encompass the entirety of WY2022. Core parameters are presented first, followed by results from laboratory analysis of field collected samples.

Summary statistics of all data collected during WY2022 - WY2023 are displayed in detail below the boxplot figure for each parameter. Since all summary statistics are based on instantaneous measurements routinely collected around the same time of day in most cases, the summary tables presented do not reflect the minimum and maximum values of diel variation. In the discussion of results, we focus mainly on noteworthy findings; data that were within the expected range of variability are not typically noted in the narrative discussion. Parameters with benchmarks have horizontal dashed lines to indicate the threshold values in the boxplots. To provide a temporal context to the results, raster charts accompany summary statistics for each parameter. An asterisk in a cell of the raster chart indicates that the result exceeded the applicable benchmark.

As precipitation and associated runoff can influence water quality parameters, the timing of monthly site visits during the WY2022 - WY2023 sample period are indicated in context of daily precipitation in Figure 5.

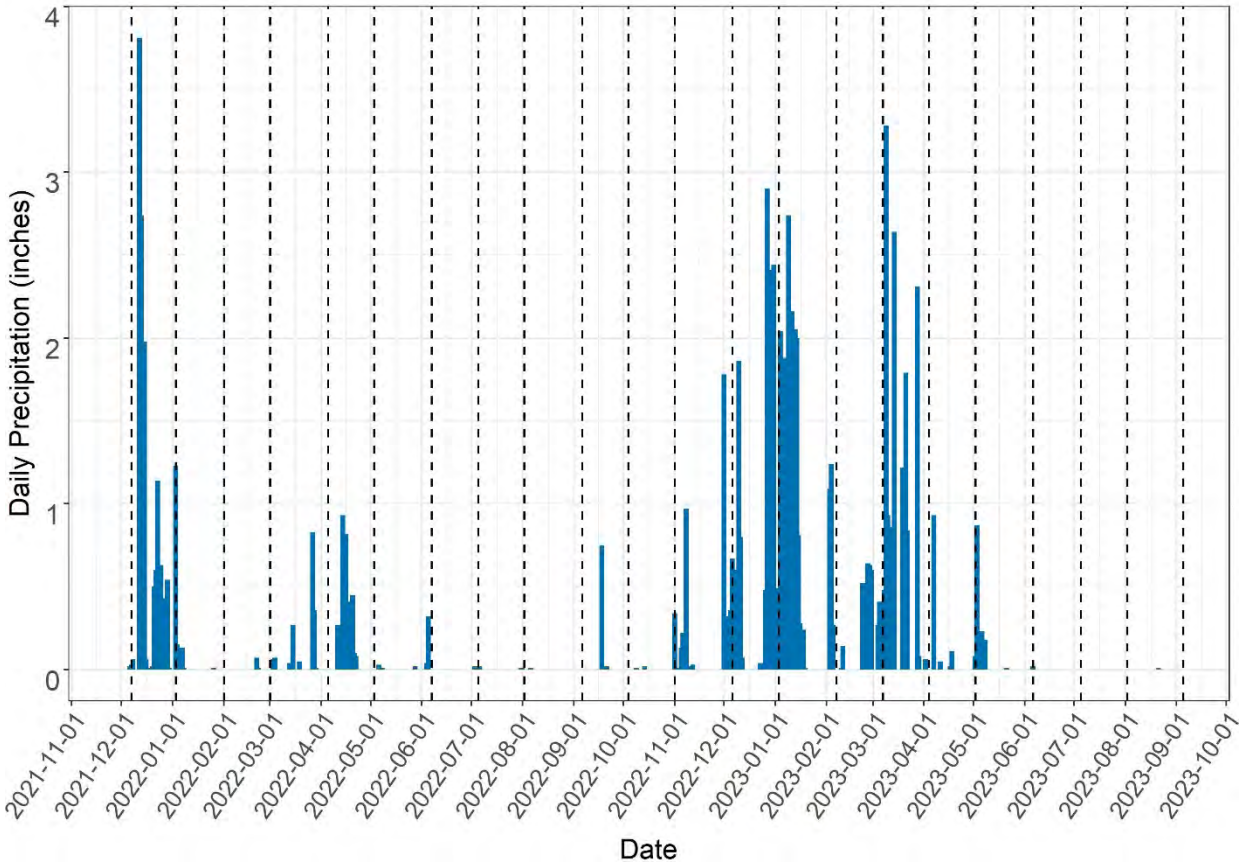


Figure 5. Daily precipitation (inches) during the sampling period WY2022 - WY2023 recorded near Point Reyes Station, CA with monthly site visit dates shown as dashed vertical lines.

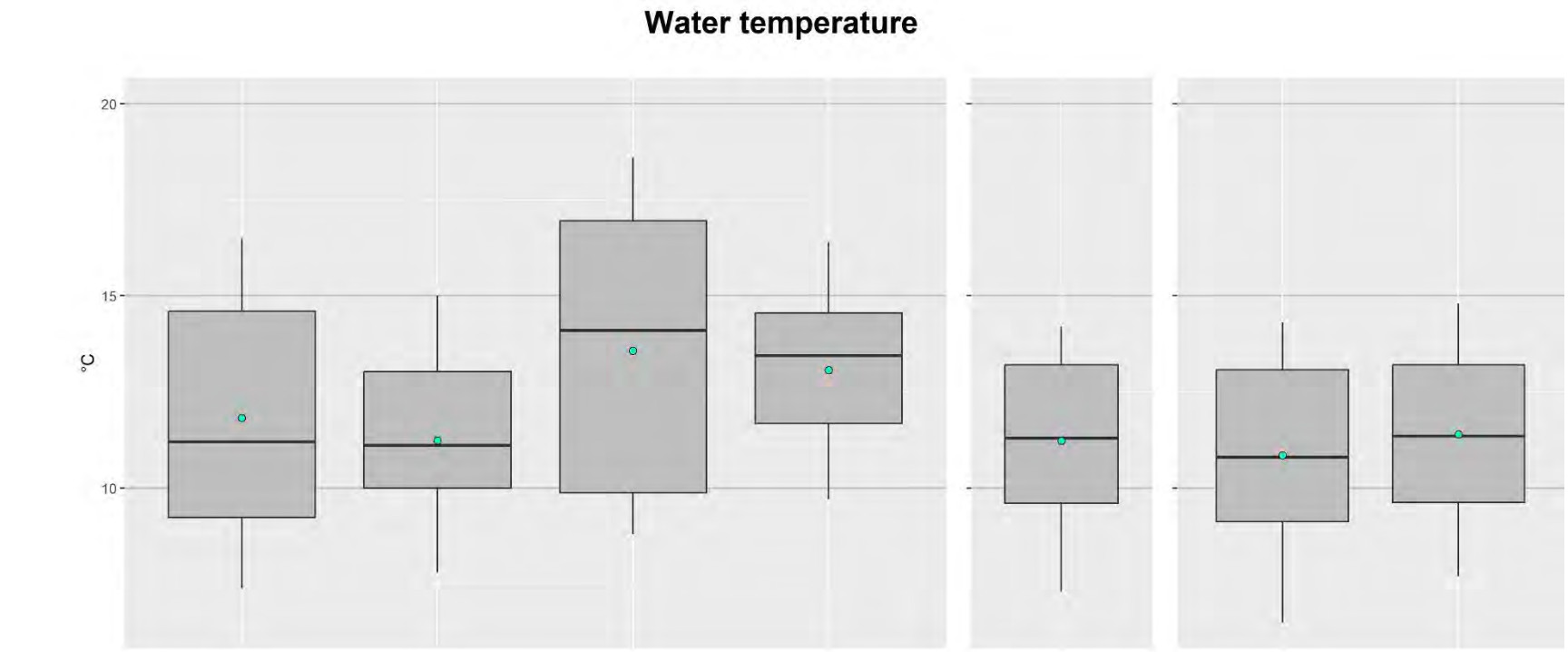
Core Parameters

Under Monitoring Program 2 (coastal watersheds), NPS and partner staff measured core parameters (water temperature, dissolved oxygen, pH, salinity, conductivity, and specific conductance) directly at each site monthly with a handheld multiparameter instrument. Staff also collected grab samples and analyzed them for turbidity in the NPS water quality lab directly following each monthly field visit.

Water Temperature

There is no established numeric objective for water temperature in area surface waters. Atmospheric conditions, topography or geographical setting, stream discharge (e.g., mixing of water from different sources), and groundwater inputs are the main groups of factors influencing overall water temperature. Mean daily temperature generally increases from upstream to downstream; however, site-specific factors such as sun exposure, vegetation cover and flow velocity can override that pattern (Caissie 2006). Water temperature affects all other core parameters and can have a significant impact on the toxicity of certain pollutants.

For the preliminary reporting period, median water temperature varied slightly between most sites, with PAC3 and PAC4 having the highest values, likely due to lack of riparian cover (Figure 6, Figure 7). The range in individual results during WY2022 - WY2023 fluctuated greatly, but sites generally were cooler in the winter months and warmer in the summer and fall. Sites in the Kehoe Creek Watershed exhibited the widest range from a high of 18.6°C in September 2022 at PAC3 to a low of 7.4°C in March 2023 at PAC1.



	PAC1	PAC2	PAC3	PAC4	ABB1	DES2	DES3
n	22	18	20	18	22	22	22
Min	7.4	7.8	8.8	9.7	7.3	6.5	7.7
Max	16.5	15.0	18.6	16.4	14.2	14.3	14.8
Med	11.2	11.1	14.1	13.4	11.3	10.8	11.3
Mean	11.82	11.24	13.57	13.07	11.23	10.85	11.39
SD	3.15	2.05	3.65	1.93	2.16	2.41	2.20

Figure 6. Water temperature results for monthly monitoring under Monitoring Program 2 sites in all watersheds, WY2022 - WY2023. Boxplots present the interquartile range of each dataset; whiskers are 1.5 times the interquartile range while data beyond that range are outliers and plotted individually with an asterisk; blue circles represent the mean of the dataset; n = number of samples; Min = minimum value; Max = maximum value; Med = median value; and SD = standard deviation. All means and standard deviations presented in this table are rounded to one more decimal place than the least precise value (least number of decimal places) of each corresponding dataset.

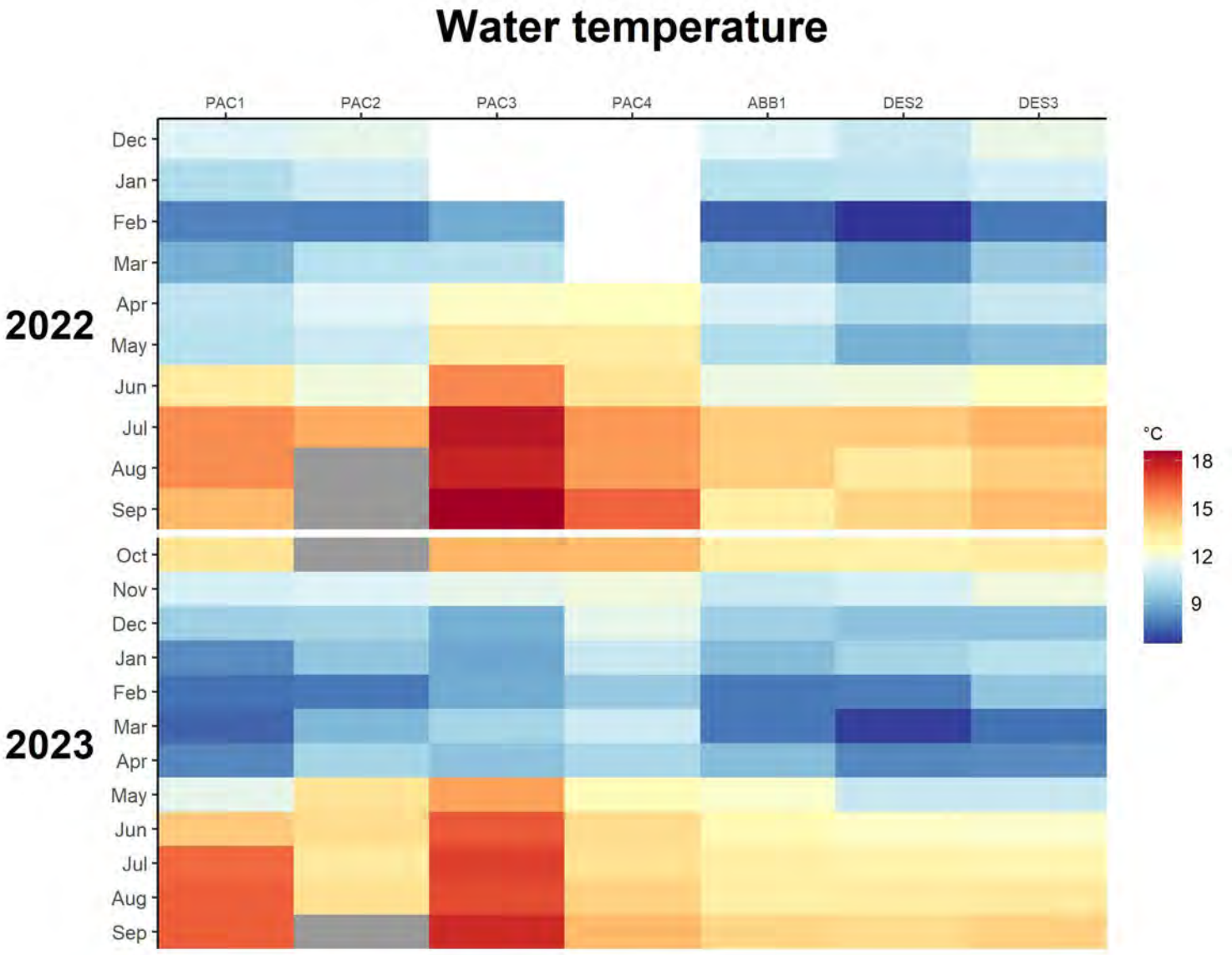
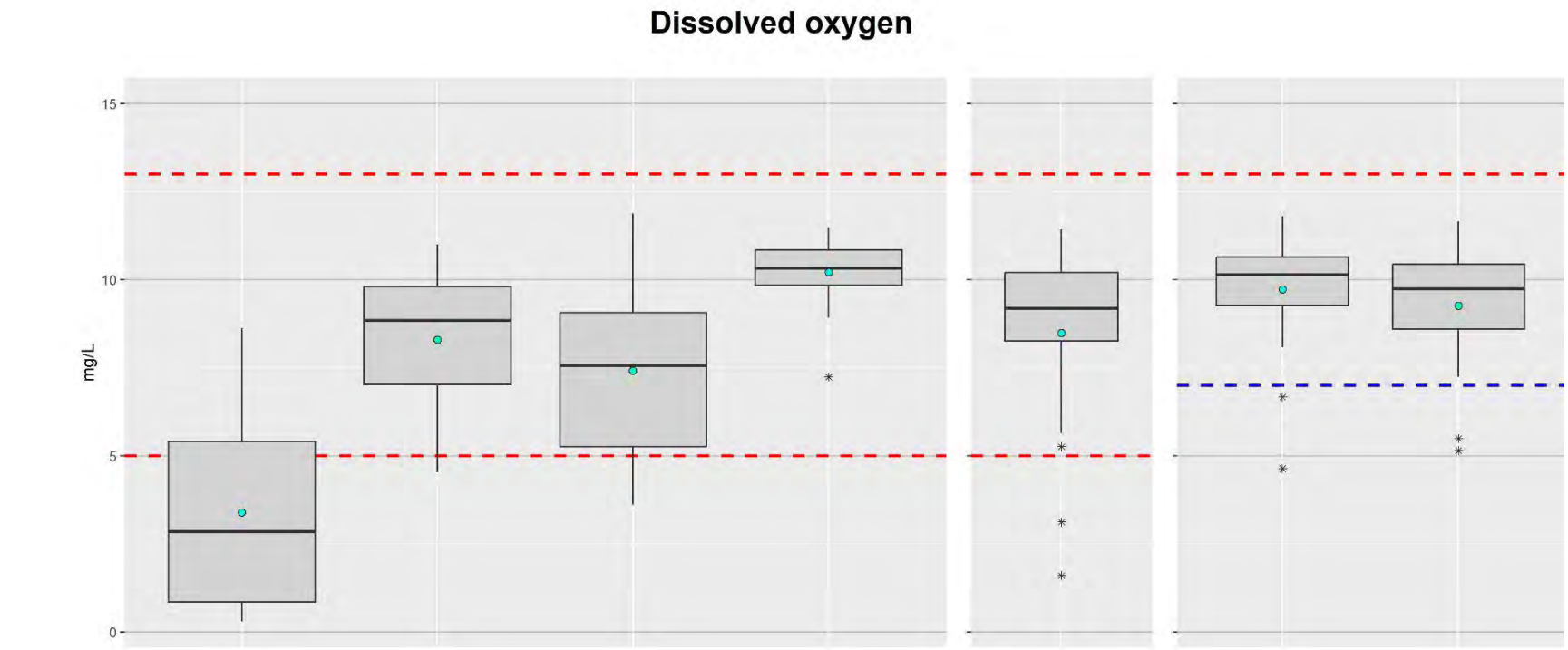


Figure 7. Water temperature by month for Monitoring Program 2 monitoring sites in all watersheds, WY2022 - WY2023. Each cell represents a sampling event. Dark grey cells represent no sampling due to dry or no flow conditions. Unfilled cells represent no sampling during that month.

Dissolved Oxygen

The Basin Plan (RWQCB 2023) established a dissolved oxygen (DO) minimum benchmark of 5.0 mg/L for warm water habitat, and 7.0 mg/L for cold water habitat, and a maximum benchmark of 13.0 was established through the Strategy. Approximately eighty one percent (116 of 144) of all DO results from WY2022 - WY2023 fell within the benchmark range, while the remaining nineteen percent (28 of 144) failed to meet the applicable minimum benchmark (Figure 8, Figure 9).

Low DO is common during the summer and fall months, when stream reaches begin to disconnect and isolated pools warm up and fill with decomposing leaves, aquatic vegetation, and algae. Twenty two of the results below the minimum benchmark were in the Kehoe Creek Watershed, with sixteen out of those twenty two recorded at site PAC1, where outside of substantial winter rain events there is often a combination of slow moving water and areas of dense aquatic vegetation, decaying vegetation, and periodic algae accumulation. Kehoe Lagoon (PAC3) also exhibited periodic low monthly dissolved oxygen, and all sites that maintained fall flow but the perennial stream site PAC4 (which maintained high DO levels throughout the monitoring period) fell below the benchmark in September and October of 2022.



	PAC1	PAC2	PAC3	PAC4	ABB1	DES2	DES3
n	22	18	20	18	22	22	22
Min	0.30	4.53	3.62	7.24	1.60	4.64	5.15
Max	8.62	11.00	11.89	11.48	11.43	11.80	11.65
Med	2.85	8.84	7.55	10.32	9.19	10.13	9.73
Mean	3.394	8.294	7.417	10.209	8.484	9.727	9.257
SD	2.866	2.089	2.337	1.024	2.640	1.724	1.785

Figure 8. Dissolved oxygen results for monitoring sites in all watersheds, WY2022 - WY2023. Boxplots present the interquartile range of each dataset; whiskers are 1.5-times the interquartile range, while data beyond that range are outliers and plotted individually with an asterisk; blue circles represent the mean of the dataset; n = number of samples; Min = minimum value; Max = maximum value; Med = median value; SD = standard deviation. All means and standard deviations presented in this table are rounded to one more decimal place than the least precise value (least number of decimal places) of each corresponding dataset. Dashed red lines represents the 5.0 mg/L minimum warm water (where applicable), and 13.0 mg/L maximum benchmarks. Dashed blue line represents the minimum 7.0 mg/L cold water benchmark (applicable for DES2 and DES3).

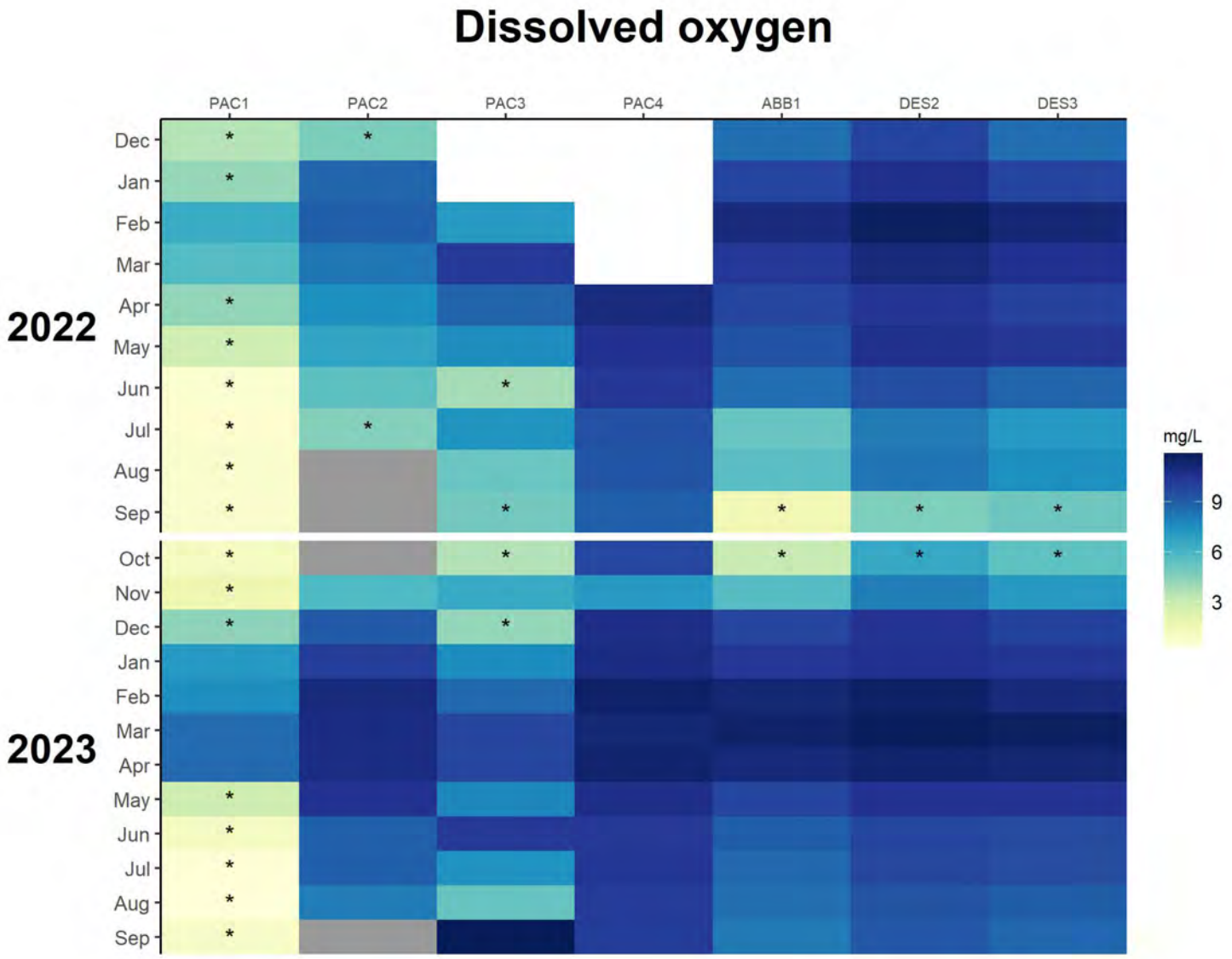


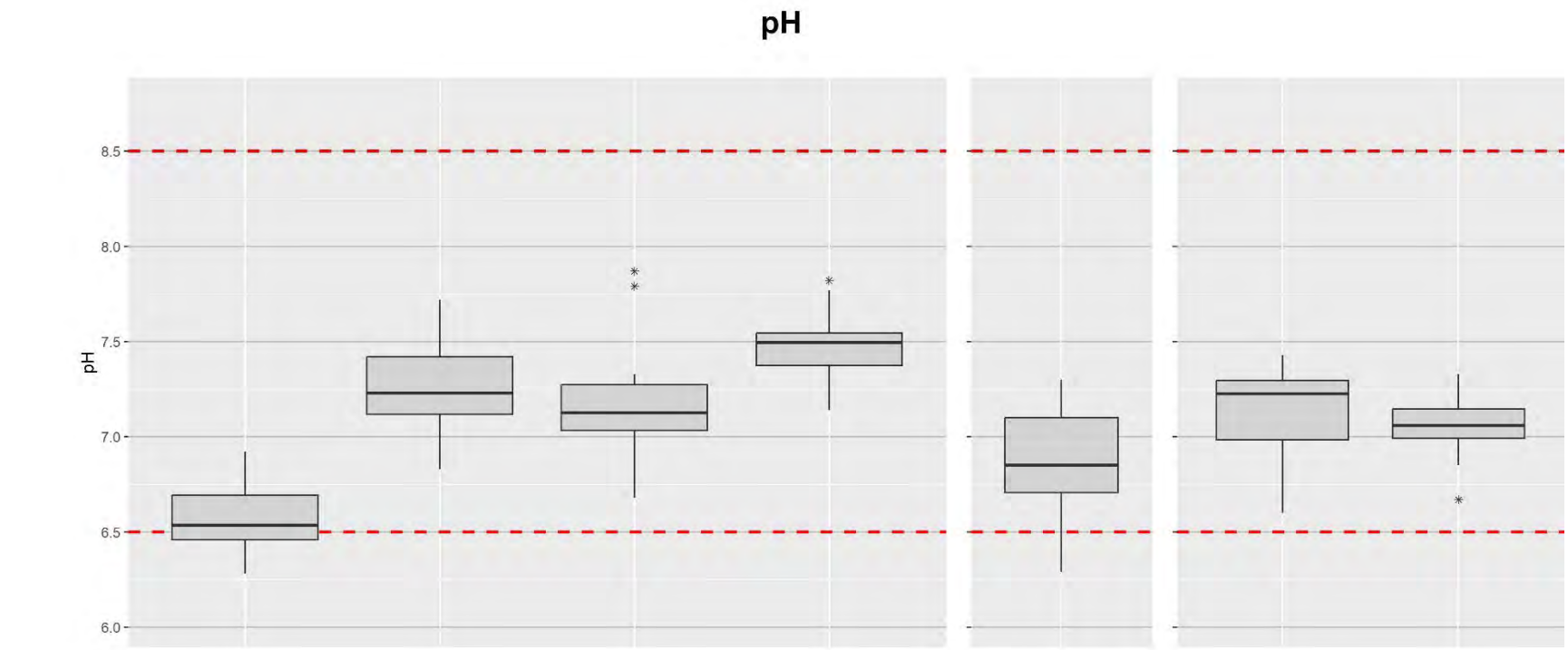
Figure 9. Dissolved oxygen by month for monitoring sites in all watersheds, WY2022 - WY2023. Each cell represents a sampling event. White cells represent no sampling that month. Dark grey cells represent no sampling due to dry or no flow conditions. Cells marked with an asterisk (*) represent results that were below (failed to meet) the minimum objective of 5.0 mg/L, or 7.0 mg/L (for sites DES2 and DES3).

pH

In aquatic ecosystems, processes that increase dissolved carbon dioxide or dissolved organic carbon decrease pH (i.e., acidify surface water). Nonpoint sources such as dairies can generate acidic runoff from manure if not controlled adequately. Instream oxidation-reduction processes also may influence pH. For example, nitrification and respiration both produce hydrogen ions, so nutrient concentrations may play a significant role in pH dynamics (US EPA 2023b). Decomposition of plant material may also increase the acidity of water.

The RWQCB Basin Plan has a benchmark range for pH between 6.5 - 8.5 pH units based on the conditions necessary to support aquatic life (RWQCB 2023). Ninety two percent of all measured pH values (122 of 132) during WY2022 - WY2023 fell within the benchmark range, while eight percent (10 of 132) failed to fall within this range (Figure 10, Figure 11). Most of the results that did not meet the benchmark were at site PAC1, where pH was typically low, and where low DO was also observed. Outside of substantial winter rain events there is often a combination of slow moving water and areas of dense aquatic vegetation, decaying vegetation, and periodic algae accumulation at site PAC1.

During February and March 2022 monthly sampling for all sites, pH data was collected, but rejected since it did not meet the acceptance criteria (post-field drift check).



	PAC1	PAC2	PAC3	PAC4	ABB1	DES2	DES3
n	20	16	18	18	20	20	20
Min	6.28	6.83	6.68	7.14	6.29	6.60	6.67
Max	6.92	7.72	7.87	7.82	7.30	7.43	7.33
Med	6.54	7.23	7.12	7.50	6.85	7.22	7.06
Mean	-	-	-	-	-	-	-
SD	-	-	-	-	-	-	-

Figure 10. pH results for monitoring sites in all watersheds, WY2022 - WY2023. Boxplots present the interquartile range of each dataset; whiskers are 1.5 times the interquartile range while data beyond that range are outliers and plotted individually with an asterisk; n = number of samples; Min = minimum value; Max = maximum value; Med = median value. Dashed red lines represent the 6.5 - 8.5 benchmark range.

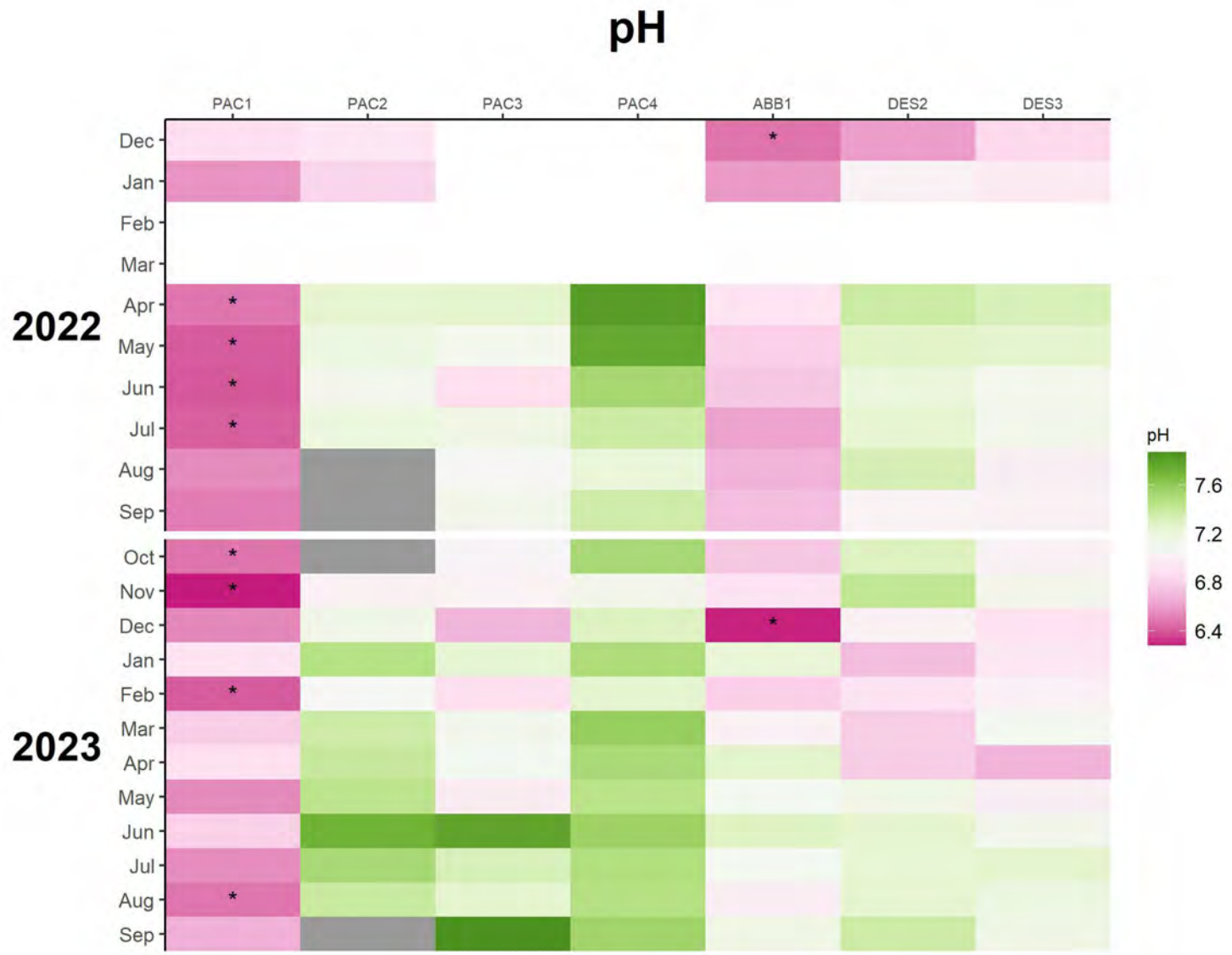


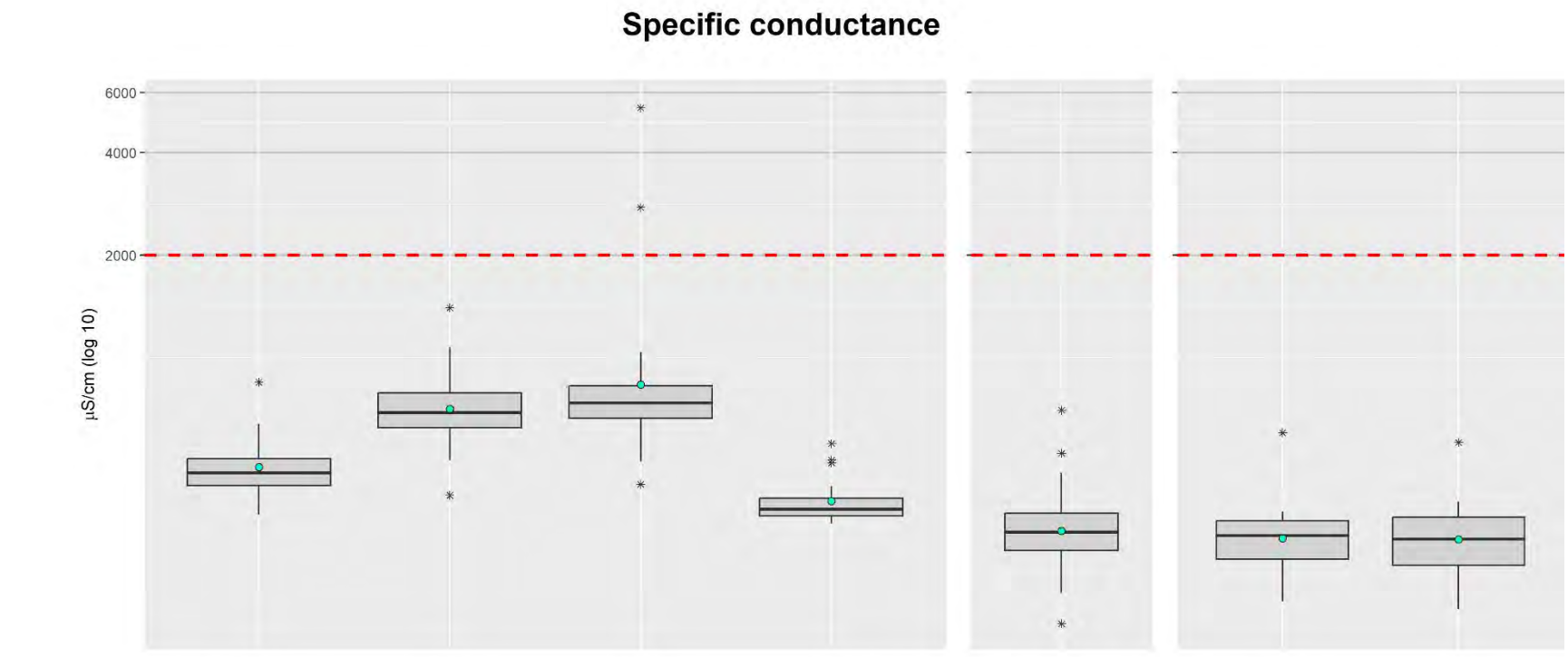
Figure 11. pH by month for monitoring sites in all watersheds, WY2022 - WY2023. Each cell represents a sampling event. White cells represent no sampling that month or rejected data due to failure to meet acceptance criteria (Feb - March 2022). Dark grey cells represent no sampling due to dry or no flow conditions. Cells marked with an asterisk (*) represent results that were outside the benchmark range of 6.5 - 8.5 pH units.

Specific Conductance

Conductivity, the ability of a solution to conduct an electric current, is an indicator of the presence of dissolved solids and can be influenced by the geology of an area as well as runoff from human activities. Since conductivity varies depending on water temperature (temperature and conductivity are positively correlated), a value of "specific conductance" is calculated using the water temperature (simultaneously measured), to yield a conductivity value corrected to 25 °C. Conductivity also increases as salinity increases, since dissolved salts and other inorganic chemicals conduct electrical current.

The RWQCB Basin Plan does not include an objective for specific conductance, however, the RWQCB CAF General WDR sets a benchmark of below 2000 µS/cm (RWQCB 2016). Specific conductance values can be affected by stormwater, agricultural runoff, flow dynamics (e.g., disconnected flow during summer), tidal influence, and geology, but the typical range for freshwater streams is 100 - 2000 µS/cm (CA State Water Resources Control Board 2004).

During WY2022 - WY2023, greater than 99% of measured specific conductance values were below the benchmark (141 of 144). Only three measurements above 2000 µS/cm were recorded (Figure 12, Figure 13) at site PAC3, a lagoon that periodically experiences tidal influence of salt water. Salinity measured during the three site visits ranged from 1.44 to 16.7 ppth, indicative of brackish water. In contrast, the WY2023 results at PAC3 in the month following observed high readings returned specific conductance of 756 and 778 µS/cm, and salinity of 0.37 and 0.38 ppth. The Notable Events and Activities section provides further information regarding the winter 2023 breach of Kehoe Lagoon.



	PAC1	PAC2	PAC3	PAC4	ABB1	DES2	DES3
n	22	18	20	18	22	22	22
Min	346	395	426	326	166	193	183
Max	848	1403	27389	560	702	603	565
Med	460	692	746	359	308	300	294
Mean	488.3	738.8	2381.9	384.7	327.9	303.7	302.6
SD	109.2	234.2	5993.4	66.4	119.1	80.9	82.3

Figure 12. Specific conductance results for monitoring sites in all watersheds, WY2022 - WY2023. Boxplots present the interquartile range of each dataset; whiskers are 1.5 times the interquartile range while data beyond that range are outliers and plotted individually with an asterisk; blue circles represent the mean of the dataset; n = number of samples; Min = minimum value; Max = maximum value; Med = median value; SD = standard deviation. All means and standard deviations presented in this table are rounded to one more decimal place than the least precise value (least number of decimal places) of each corresponding dataset. Dashed red line represents the 2000 µS/cm benchmark. Site PAC3 has periodic tidal influence, which causes high specific conductance; the outlier max result value of 27389 is omitted from the boxplot.

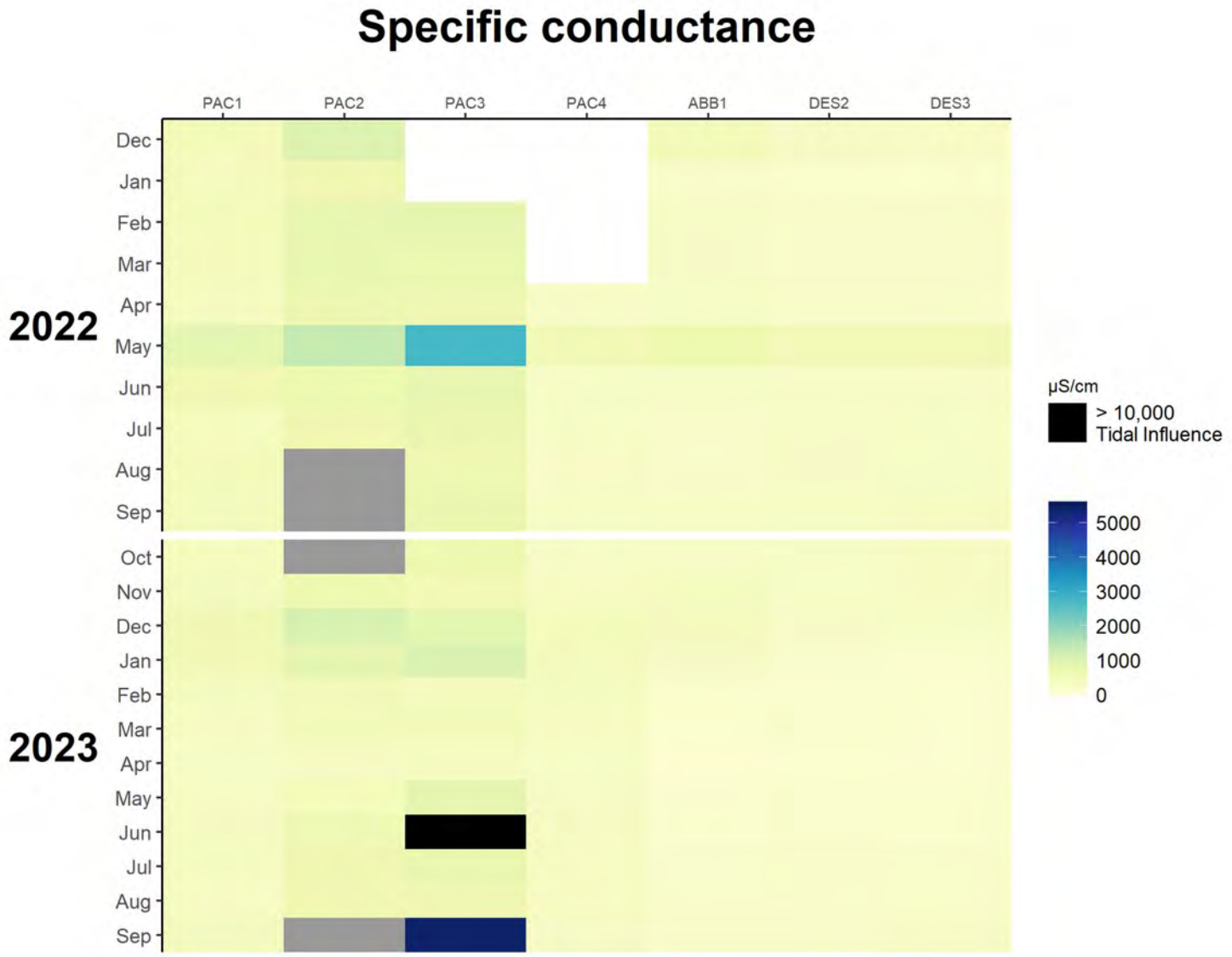
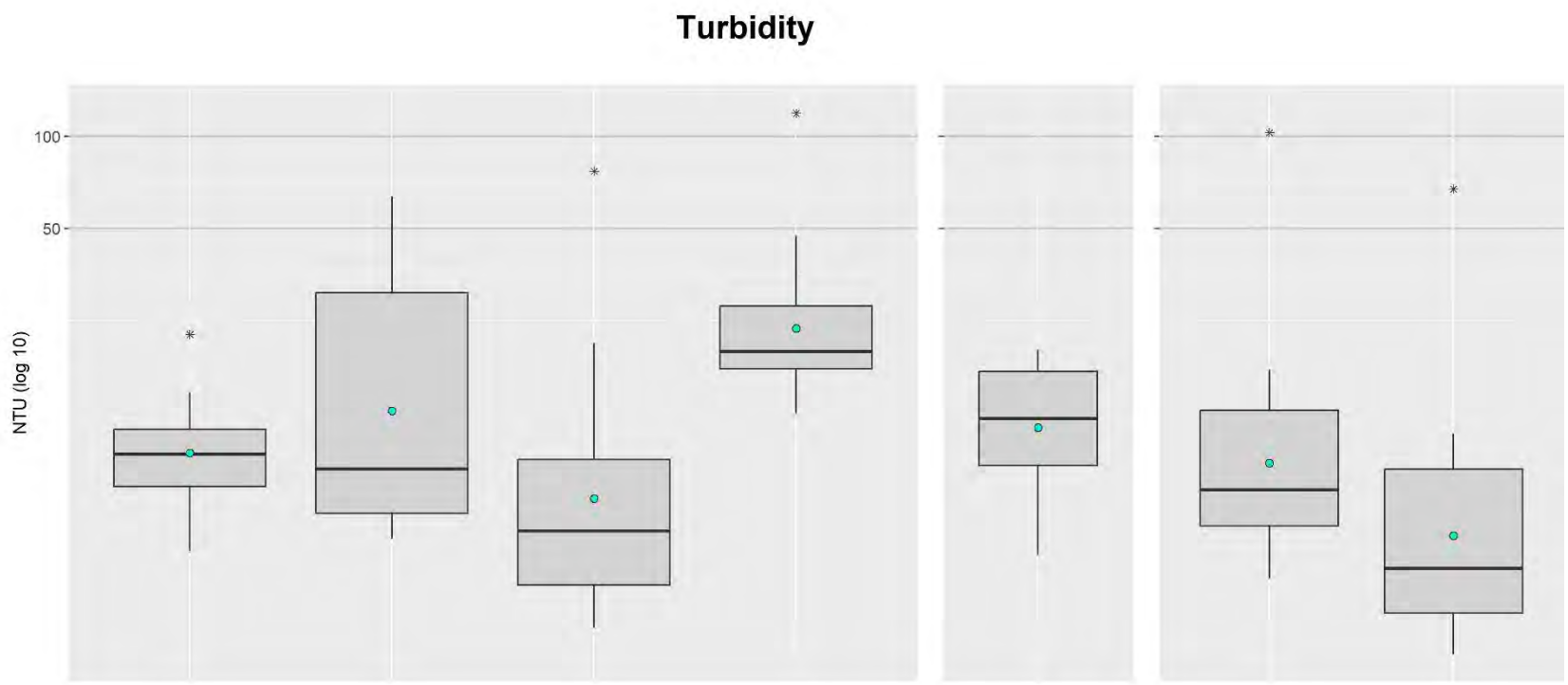


Figure 13. Specific conductance by month for monitoring sites in all watersheds, WY2022-WY2023. Each cell represents a sampling event. White cells represent no sampling that month. Dark grey cells represent no sampling due to dry or no flow conditions. Site PAC3 has periodic tidal influence, which causes high specific conductance. Results above 10,000 µS/cm are indicated in black.

Turbidity

Turbidity is the capacity of suspended solids in water to scatter light (Standard Methods Committee of the American Public Health Association et al. 2022). These solids can include clay, silt, finely divided organic and inorganic matter, soluble colored compounds, plankton, and microscopic organisms. Turbidity is typically measured in nephelometric turbidity units (NTU). Turbidity of greater than 5 NTU is usually visible and high turbidity is observed as cloudy or brown water. Inputs of solids occur due to erosion from stream banks, runoff from various source areas within a watershed, or re-suspension from the streambed during storm events. While erosion and sedimentation are natural processes, agriculture and land development can accelerate these processes and result in an imbalance in the amount of sediment in a stream system. Persistent and high concentrations of sediment can affect aquatic organisms across all life stages, though these impacts are often site-and species-specific (e.g. Shaw and Richardson 2011). Effects on growth of salmonids have been documented at turbidity above 25 NTU by Sigler et al. (1984) and 55 NTU by Martin et al. (2019). Although these thresholds can be utilized for comparative purposes, instantaneous levels do not typically determine negative ecological consequences, and single sample events likely did not observe peak daily values. Generally, longer durations of high turbidity levels are more likely to cause damage to fish and other aquatic organisms than shorter durations would (Newcombe and MacDonald 1991).

Approximately 90% (130 of 144) of turbidity measurements from coastal sites were below 25 NTU, and over 96% were below 55 NTU in WY2022 - WY2023. Ten percent of measurements (14 of 144) were above 25 NTU (Figure 14, Figure 15). Of these, five were from December 6, 2022, which followed 1.46” of precipitation recorded since midnight at the Point Reyes RCA RAWS weather station. Eleven out of the fourteen were from sites PAC2 and PAC4. Site PAC2 was characterized by low flow in the summer and fall, and ceased flowing for several months during August - October 2022, and September 2023. Site PAC4, which is not grazed by livestock, had the highest median value. The substrate at site PAC4 is sandy and the perennial flow is often accessed by wildlife such as elk, but may also be visited by humans that stray off the McClures Beach trail.



	PAC1	PAC2	PAC3	PAC4	ABB1	DES2	DES3
n	22	18	20	18	22	22	22
Min	4.4	4.8	2.5	12	4.3	3.6	2.0
Max	22	65	75	120	20	100	65
Med	9.2	8.2	5.1	20	12	7.0	3.9
Mean	9.9	19	11	28	12	13	7.9
SD	4.0	18	17	24	5.1	21	14

Figure 14. Turbidity results for monitoring sites in all watersheds, WY2022 - WY2023. Boxplots present the interquartile range of each dataset; whiskers are 1.5 times the interquartile range while data beyond that range are outliers and plotted individually with an asterisk; blue circles represent the mean of the dataset; n = number of samples; Min = minimum value; Max = maximum value; Med = median value; SD = standard deviation. All means and standard deviations presented in this table are rounded according to USGS standards for turbidity precision found here https://water.usgs.gov/owq/FieldManual/Chapter6/Section6.7_v2.1.pdf

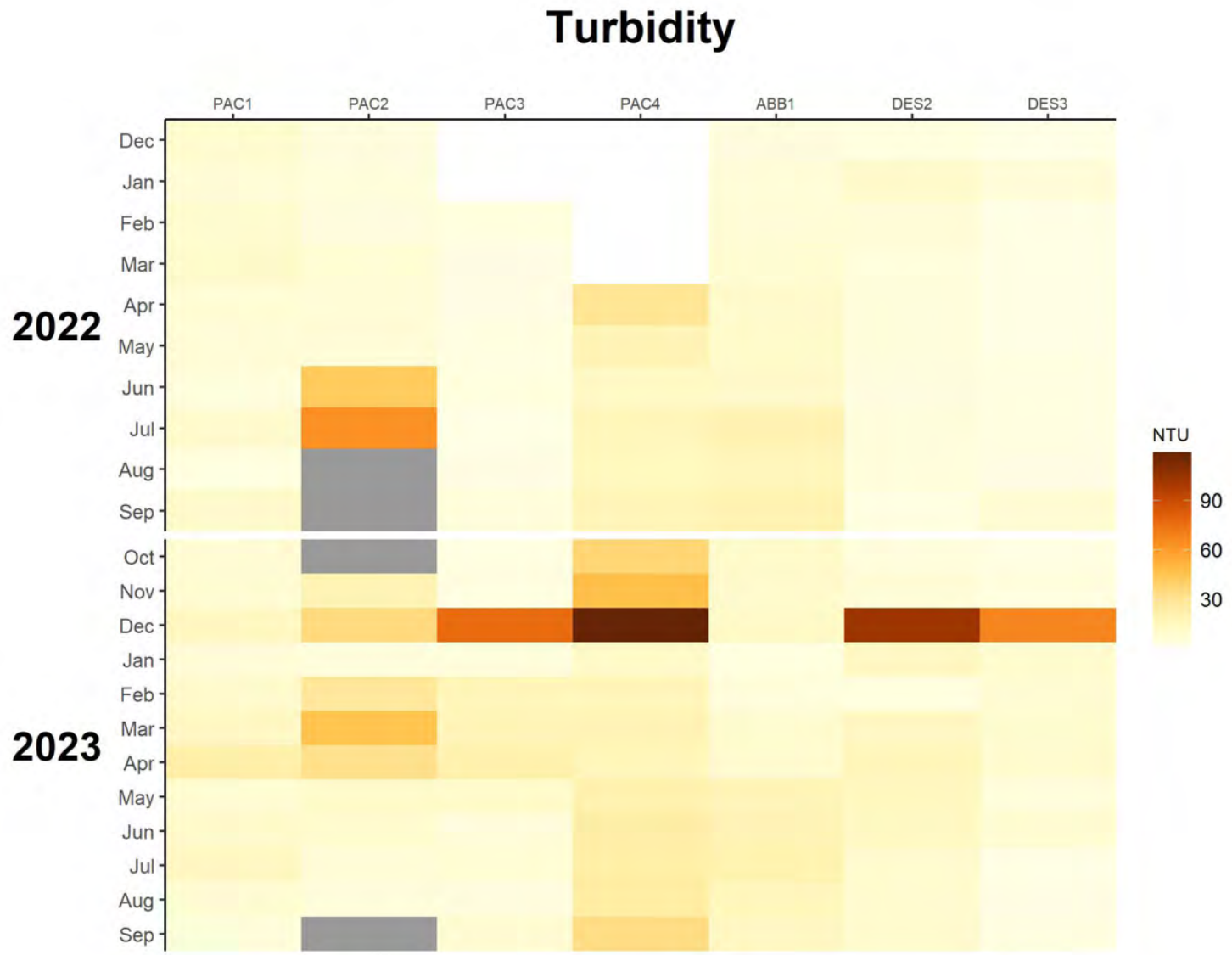


Figure 15. Turbidity by month for monitoring sites in all watersheds, WY2022 - WY2023. Each cell represents a sampling event. White cells represent no sampling that month. Dark grey cells represent no sampling due to dry or no flow conditions.

Fecal Indicator Bacteria

Fecal indicator bacteria (FIB) live in the intestinal tracts of warm-blooded animals, including humans. They are used as an indicator of contamination from areas such as septic systems or runoff from stormwater or pastures, but sources of FIB also include wildlife and other natural sources. Their presence in the environment indicates that pathogens *may* be present that can be detrimental to human health. Results are reported as MPN/100mL, which indicates most probable number of colony-forming units per 100 mL of sample volume. These results do not quantify the amount of bacteria in a body of water, but estimate concentrations of FIB.

The U.S. EPA uses *E. coli* and enterococci bacteria as indicators of risk to human health. *E. coli* is the recommended parameter for monitoring bacterial risk in freshwater, while enterococci are the recommended parameter in salt water (US EPA 2012). While total coliform bacteria results are typically reported along with *E. coli* and enterococci, total coliforms are not commonly used as a pathogenic indicator for human health concerns, and therefore results are not included as a parameter for monitoring and reporting under the Strategy.

During each site visit in WY2022 - WY2023, staff collected samples in sterile bottles and stored them immediately on ice. Samples were then processed at either a commercial laboratory or an in-house laboratory located at Golden Gate National Recreation Area utilized and maintained by the NPS Inventory and Monitoring Program. During WY2022 - WY2023, most monthly samples were processed at a 10x dilution factor, which resulted in a quantification range of 10 - 24190 MPN/100mL. Some were also processed without dilution, resulting in a quantification range of 1 - 2419 MPN/100mL. The bacteria data can be censored on either end due to the laboratory method used. In the tables below, “left censored” refers to results that were below the detection limit of (1 or 10 MPN/100mL), and “right censored” refers to results that were above the upper quantification limit of 2419 or 24190 MPN/100mL. When presenting summary statistics for bacteria data, a 30-day geometric mean is often used to evaluate results. While single bacteria samples collected monthly under the long-term monitoring program cannot be analyzed as a geometric mean, the collection of these data over a longer time period can be used to evaluate trends. Bacteria results can fluctuate widely (temporally and spatially), so means and standard deviations can be easily skewed by outliers. Therefore, we used the median as a measure of central tendency in our presentation and discussion of data.

Escherichia coli (E. coli)

The Basin Plan contact recreation benchmark of 320 MPN/100mL [1] is used for evaluation of the monthly single sample results. It should be noted that this benchmark may not be applicable to waters where contact recreation is not a beneficial use.

Approximately four percent (5 of 141) of WY2022 - WY2023 monthly *E. coli* results were non-detections (<1 or <10 MPN/100mL) and no results were above the upper quantification limit (right censored) for samples with either no dilution or a 10x dilution factor. Approximately 69% (97 out of 141) of *E. coli* results were below the 320 MPN/100mL contact recreation benchmark and 31% (44 of 141) were above this benchmark (Figure 16, Figure 17).

Site PAC2, downstream of portions of both a dairy operation and a cattle grazing operation, was consistently above the 320 MPN/100mL contact recreation benchmark. The site had the highest median value of the monthly sampling locations, and also produced the highest overall *E. coli* result of 17000 MPN/100mL from a sample collected during a precipitation and primary first flush event observed on December 6, 2022. Site PAC2 became stagnant with no flow and partially dry conditions observed during monthly site visits from August through October of 2022 and September 2023, during which time no samples were collected. All sites returned elevated results during the December 6, 2022 storm event, with the exception of PAC4, located above McClures Beach in an area ungrazed by cattle. However, PAC4 showed some exceedances of the contact recreation benchmark during the late fall during both WY2022 and WY2023, possibly due to use by wildlife or humans straying from the nearby McClures Beach trail, where evidence of both these uses was noted during site visits. Results from four of six sites sampled exceeded the contact recreation benchmark in September 2023. An uptick in tule elk use at site DES3 was noted beginning in June of 2022 (see Notable Events section).

Sites ABB1 and PAC1, both below grazing operations but with riparian protection fencing along the majority of lower sections returned the lowest median *E. coli* results, though both had exceedances of the contact recreation benchmark during the sampling period (four for PAC1 and six for ABB1), including samples taken during the December 06, 2022 storm event.

In January 2022, failure of laboratory equipment resulted in most samples not being processed, with only ABB1 and PAC1 reportable.

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[1] The 2023 RWQCB Basin Plan lists numeric water quality objectives for *E. coli* and enterococci in CFU/100mL, but notes that CFU/100mL and MPN/100mL are considered equivalent and both are valid measures of bacteria density. All laboratory analyses of fecal indicator bacteria in this report used MPN/100mL as the unit of measurement.

Enterococci

Due to salinity greater than 1 part per thousand, monthly samples collected at Abbotts Lagoon (site ABB4) were analyzed for enterococci. The Basin Plan contact recreation benchmark of 110 MPN/100mL is used for evaluation of the monthly single sample results. Approximately 43% (9 of 21) of WY2022 - WY2023 monthly enterococci results from site ABB4 were non-detections (<1 or <10 MPN/100mL) and no results were above the upper quantification limit (right censored) for samples with either no dilution or a 10x dilution factor. Approximately 90% (19 out of 21) enterococci results at site ABB4 were below the 110 MPN/100mL contact recreation benchmark and 10% (2 of 21) were above the benchmark (Figure 18, Figure 19). The median enterococci result value was 10 MPN/100mL. Monthly *E. coli* results are also collected for this site and presented for reference (Figure 20, Figure 21). Core parameters were only collected during assessment monitoring of site ABB4 and are presented under Assessment Monitoring.

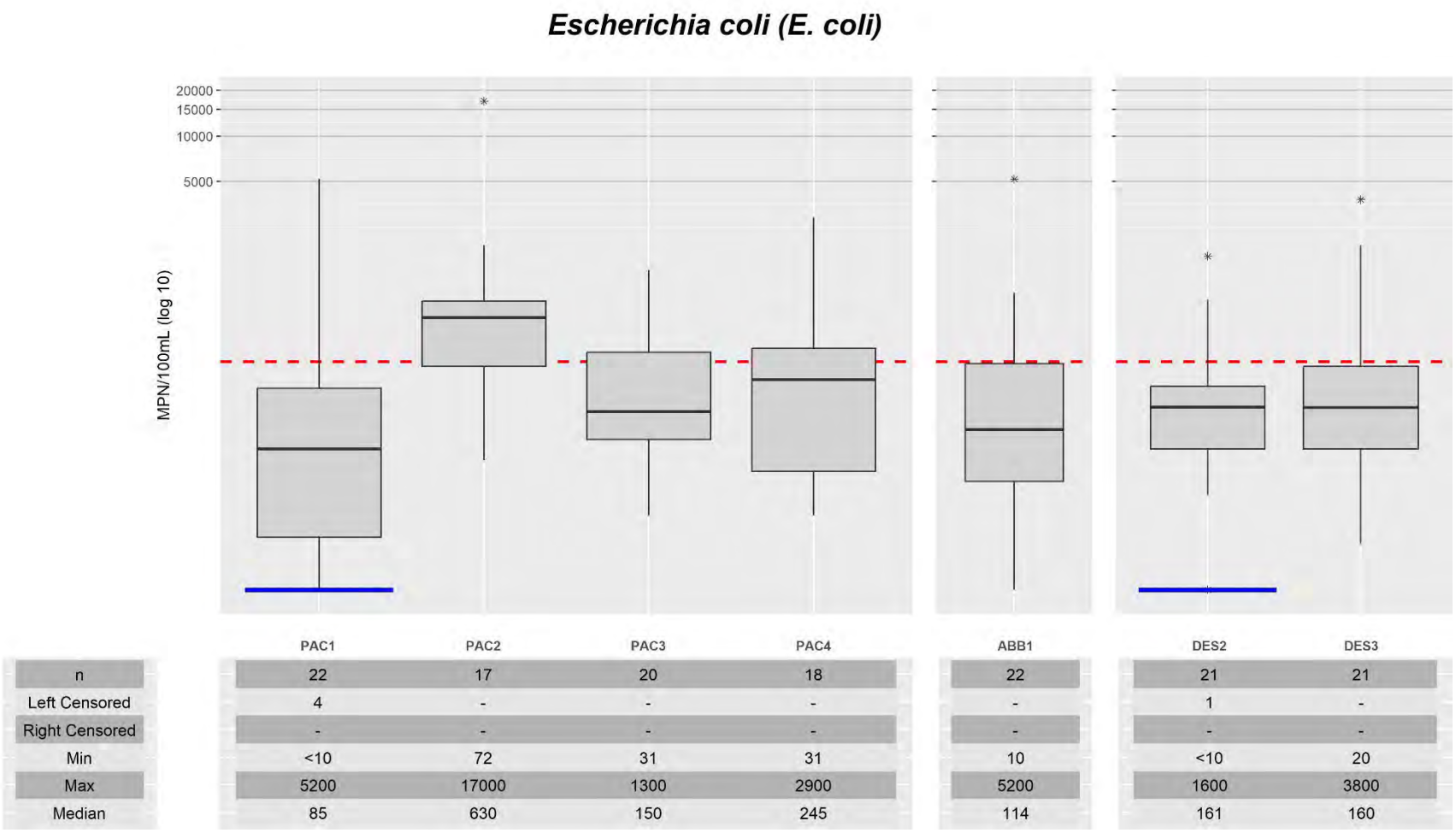

Figure 16. *Escherichia coli (E. coli)* results for monitoring sites in all watersheds, WY2022-WY2023. Boxplots present the interquartile range of each dataset; whiskers are 1.5 times the interquartile range while data beyond that range are outliers and plotted individually with an asterisk; n = number of samples; Left Censored = number of samples below detection limit; Right Censored = number of samples above quantification limit; Min = minimum value; Max = maximum value; Median = median value. Lower detection limit for these data is either 1 or 10 MPN/100mL. Upper detection limit for these data is either 2419 or 24196 MPN/100mL. Blue lines below boxplots represent portions of the dataset that were below the lower detection limit. Dashed red line represents the 320 MPN/100mL contact recreation benchmark.

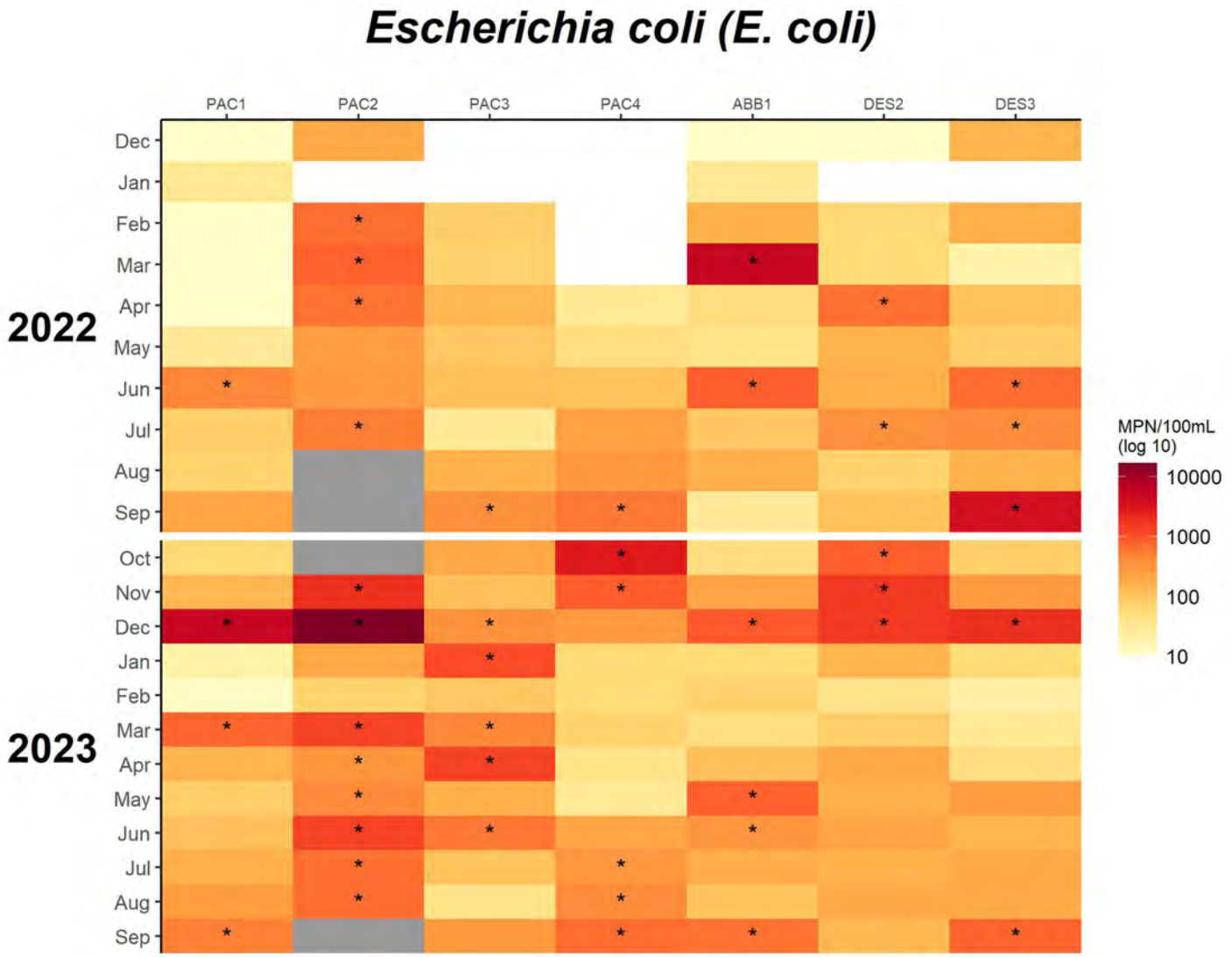

Figure 17. *Escherichia coli (E. coli)* by month for monitoring sites in all watersheds, WY2022-WY2023. Each cell represents a sampling event. White cells represent no sampling that month or unreportable data due to equipment failure (January 2022). Dark grey cells represent no sampling due to dry or no flow conditions. Cells marked with an asterisk (*) represent results that exceeded the contact recreation benchmark of 320 MPN/100mL.

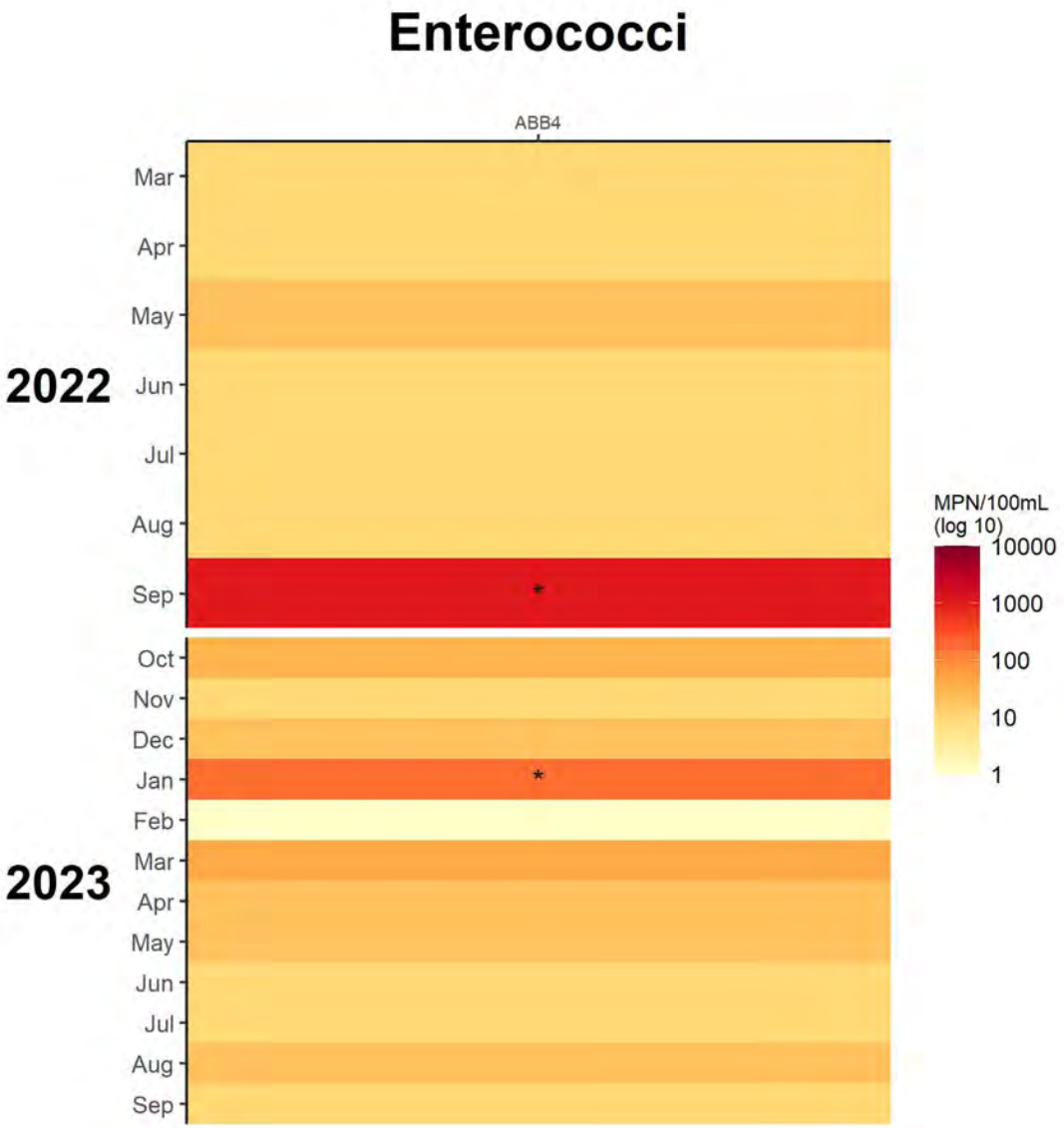

Figure 18. Enterococci by month for monitoring site ABB4 (Abbotts Lagoon), WY2022 - WY2023. Each cell represents a sampling event. White cells represent no sampling that month. Cells marked with an asterisk (*) represent results that exceeded the contact recreation benchmark of 110 MPN/100mL.

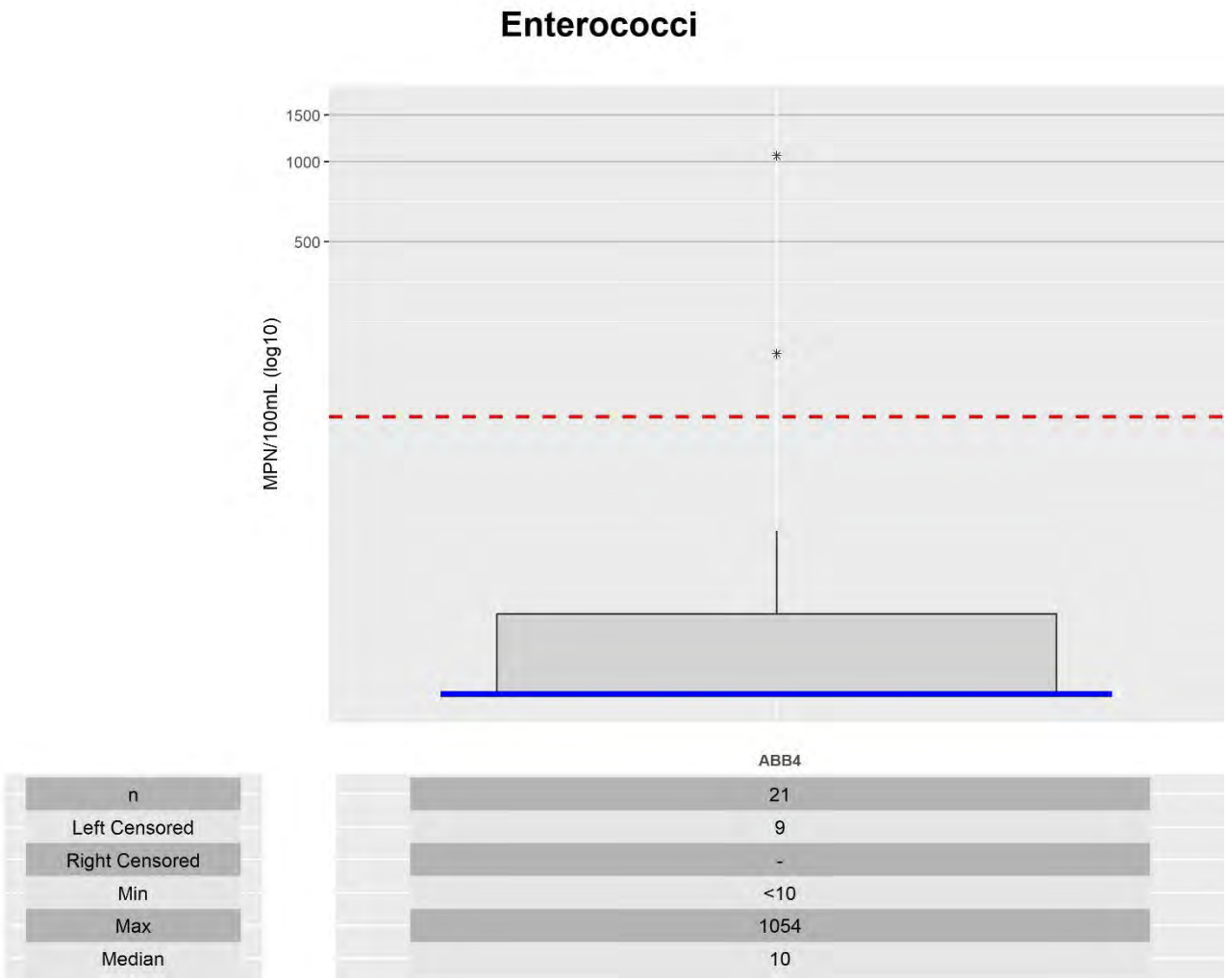

Figure 19. Enterococci results for monitoring site ABB4 (Abbotts Lagoon), WY2022 - WY2023. Boxplots present the interquartile range of each dataset; whiskers are 1.5 times the interquartile range while data beyond that range are outliers and plotted individually with an asterisk; n = number of samples; Left Censored = number of samples below detection limit; Right Censored = number of samples above quantification limit; Min = minimum value; Max = maximum value; Median = median value. Lower detection limit for these data is either 1 or 10 MPN/100mL. Upper detection limit for these data is either 2419 or 24196 MPN/100mL. Blue lines below boxplots represent portions of the dataset that were below the lower detection limit. Dashed red line represents the 110 MPN/100mL contact recreation benchmark.

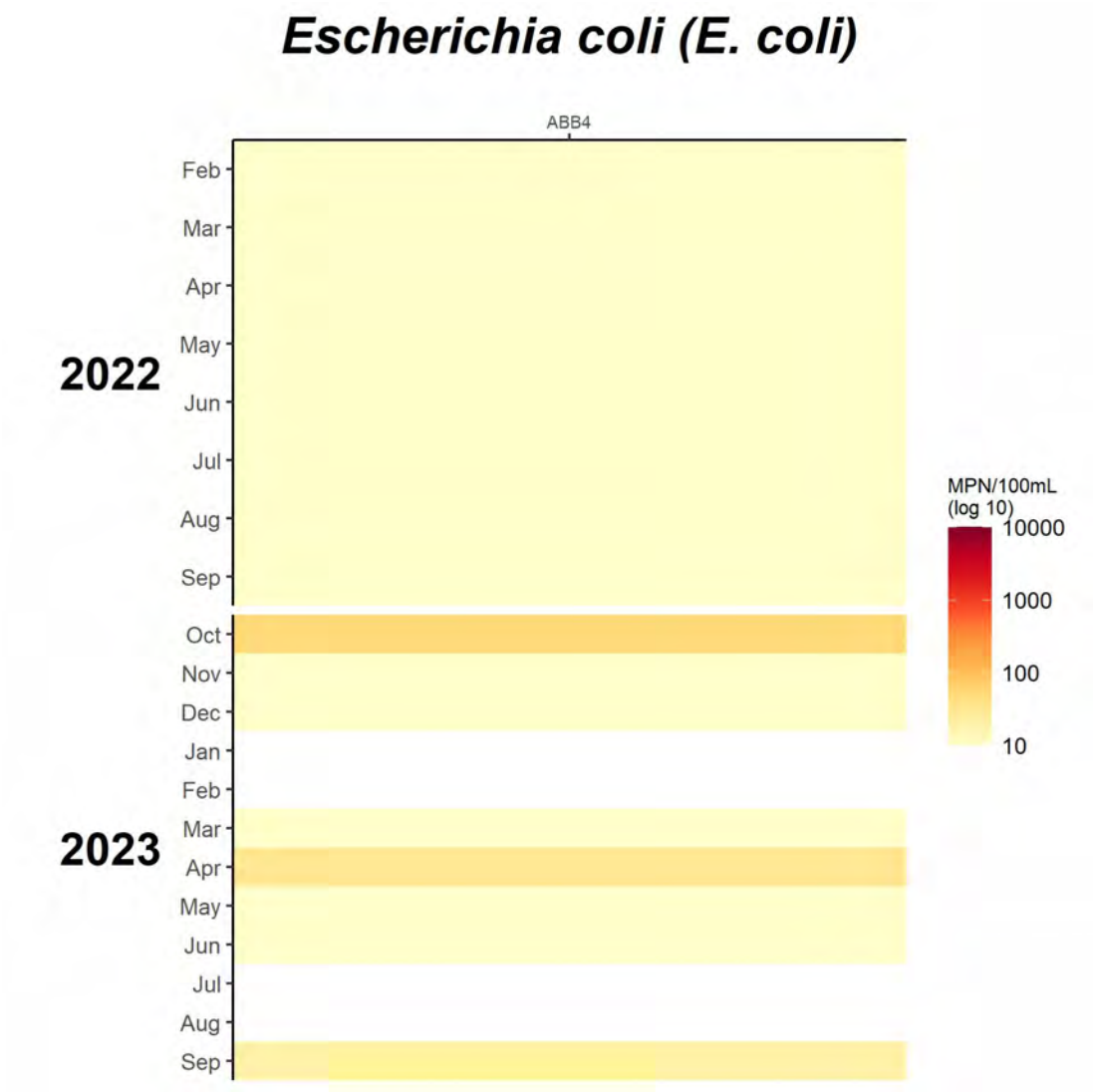

Figure 20. *Escherichia coli (E. coli)* by month for monitoring site ABB4 (Abbotts Lagoon), WY2022 - WY2023. Each cell represents a sampling event. White cells represent no sampling that month.

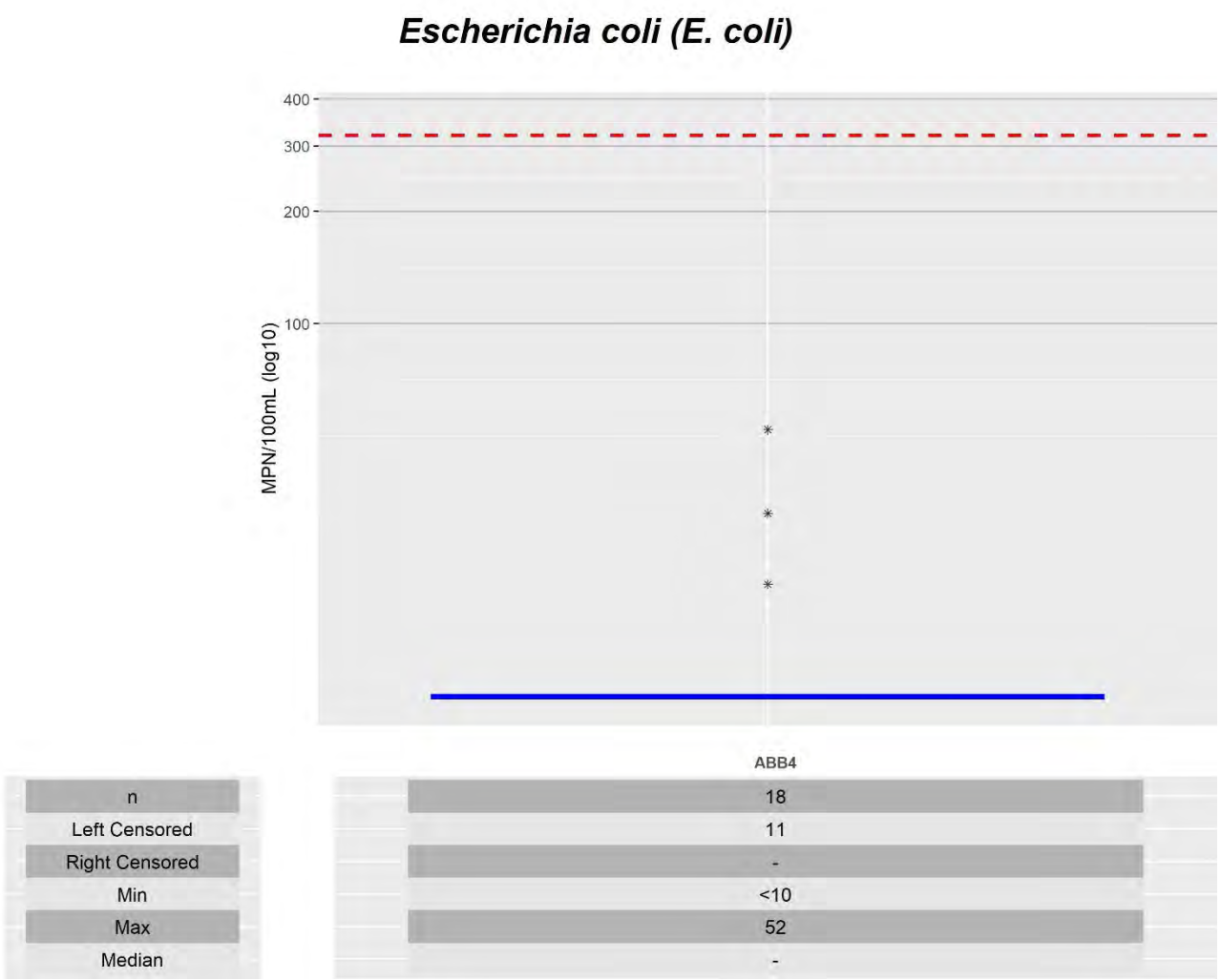

Figure 21. *Escherichia coli (E. coli)* results for monitoring site ABB4 (Abbotts Lagoon), WY2022-WY2023. Boxplots present the interquartile range of each dataset; whiskers are 1.5 times the interquartile range while data beyond that range are outliers and plotted individually with an asterisk; n = number of samples; Left Censored = number of samples below detection limit; Right Censored = number of samples above quantification limit; Min = minimum value; Max = maximum value; Median = median value. Lower detection limit for these data is either 1 or 10 MPN/100mL. Upper detection limit for these data is either 2419 or 24196 MPN/100mL. Blue lines below boxplots represent portions of the dataset that were below the lower detection limit. Dashed red line represents the 320 MPN/100mL contact recreation benchmark.

Recreational Beaches (Monitoring Program 4)

Under Strategy Monitoring Program 4 (recreational beaches) two locations are sampled as part of a Statewide monitoring program coordinated through Marin County where beach sampling is conducted weekly from April through October each year. This program was reinitiated in 2020 at two sites at Point Reyes National Seashore (Drakes Beach; DRK1, and Drakes Estero; DRK2) with expanded frequency to include monthly winter sampling. NPS worked with Environmental Action Committee of West Marin to implement this program. Under the weekly monitoring regime from April 1 to October 31, and monthly regime from November 1 to March 31, grab samples were taken for laboratory analysis of FIB concentration (*E. coli* and enterococci). Due to salinity, the applicable benchmark is for enterococci, however *E. coli* was also analyzed and results are presented for reference. Some site visits were missed due to beach closures or staffing constraints (Table 4, Figure 22, Figure 23). Northern elephant seals (*Mirounga angustirostris*) are present at Drakes Beach annually from approximately December to April. Variable beach closures have been implemented to protect the elephant seals, which sometimes extends up to the access road down to Drakes Beach and can limit the ability to conduct recreational beach sampling at this site. In 2021 the beach was closed January 13 - March 20 to protect elephant seals and Drakes Beach access road and parking lot was closed from May 3, 2021 through August 31, 2021 to complete parking lot remodel and wetland restoration work. In 2022 there were elephant seal closures from January 5 - 7 and March 11 - April 1. In 2023 the elephant seal closure occurred from January 4 - April 8, and monthly monitoring did not occur in January or March. Samples were not collected due to staff availability on July 31 or September 19 of 2023, and the August 28, 2023 sample from DRK2 was rejected by the lab due to a deficiency in the sample collection bottle.

During the WY2021 - WY2023 monitoring period, approximately 99% of samples at each site (71 of 72 at DRK1 and 86 of 87 at DRK2) were below the 104 MPN/100mL contact recreation benchmark for enterococci of utilized by the Marin County Ocean and Bay Water Quality Testing Program. There was only one exceedance of the benchmark at each site (1 out of 72 at DRK1 and 1 out of 87 at DRK2). Both occurred early in WY2022 on October 25 2021, with a result of 120 MPN/100mL at DRK1 and 6131 MPN/100mL at DRK2 (Figure 22). Prior to that sample event, greater than 1-inch of precipitation was recorded each day at the BBEC1 RAWS station between October 20 and October 23, and 8.50 inches was recorded on October 24, 2021. Upon receiving laboratory results, warning signage to alert the public was placed at both Drakes Beach and Drakes Estero following program protocol. Signs were removed after October 31 monthly results came back below the contact recreation benchmark used by the County program.

For *E. coli*, 2 of 72 results at site DRK1 and 2 of 87 results for *E. coli* at DRK2 over the Marin County program's benchmark of 400 MPN/100mL during the WY2021 - WY2023 sample period. At DRK1 these occurred on February 28 (471 MPN/100mL) and May 16 of 2022 (576 MPN/100mL) (Figure 23). The site was revisited the following week in each case and the result was below the benchmark (March 8, 2022, 20 MPN/100mL; May 16, 2022, 10 MPN/100mL). At DRK2, one exceedance occurred following the extreme October 2021 storm event described above (8664 MPN/100mL) and the other was on April 17, 2023 (6488 MPN/100mL). Public warning signage was posted for these detections and removed the following week when results fell below the contact recreation benchmark used by the County program.

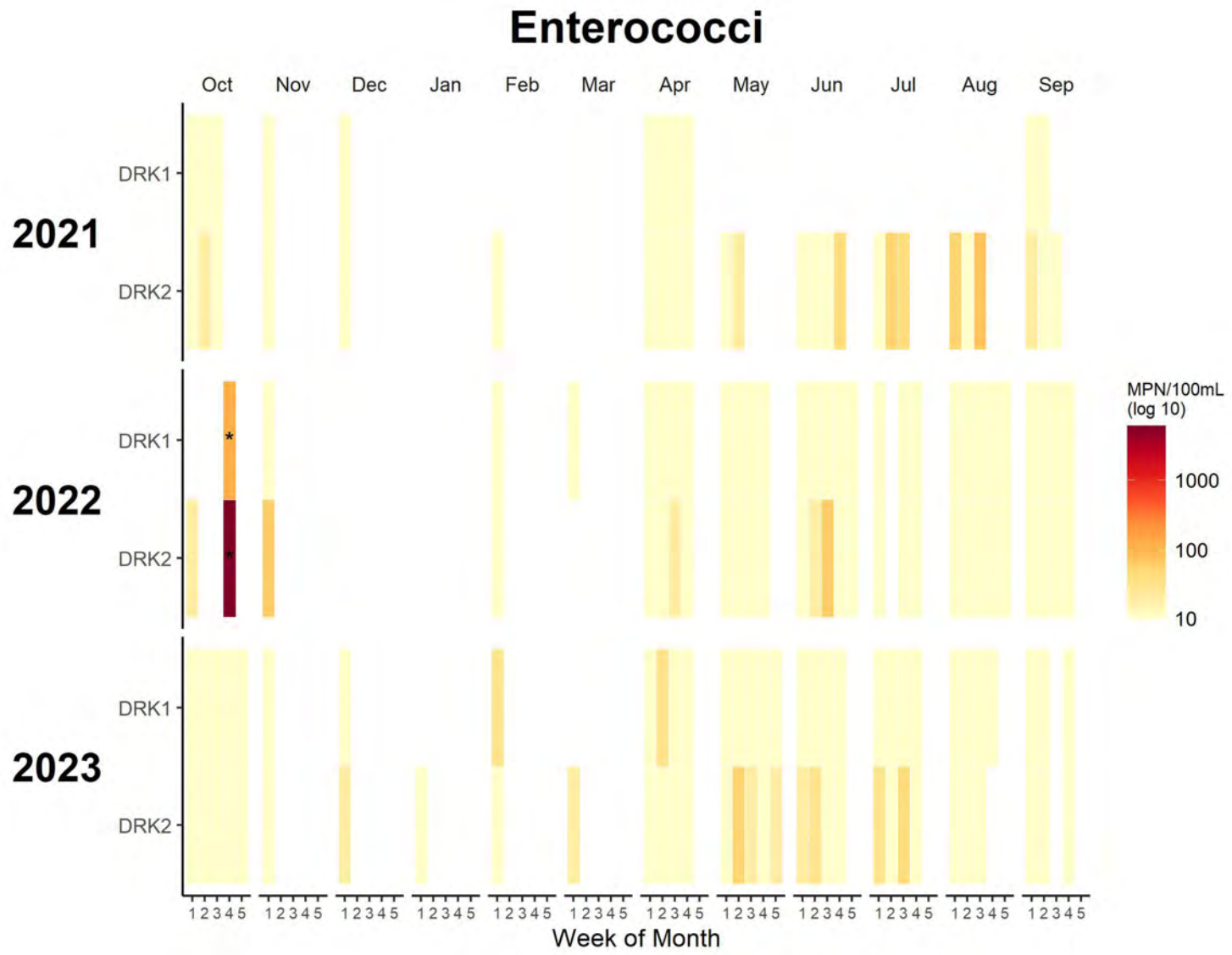

Figure 22. Enterococci concentration result by week of the month for beach recreational monitoring sites, WY2021 - WY2023. Each cell represents a sampling event. White cells represent no sampling that week. Cells marked with an asterisk (*) represent results that exceeded contact recreation benchmark of 104 MPN/100mL used by the Marin County Ocean and Bay Water Quality Testing Program.

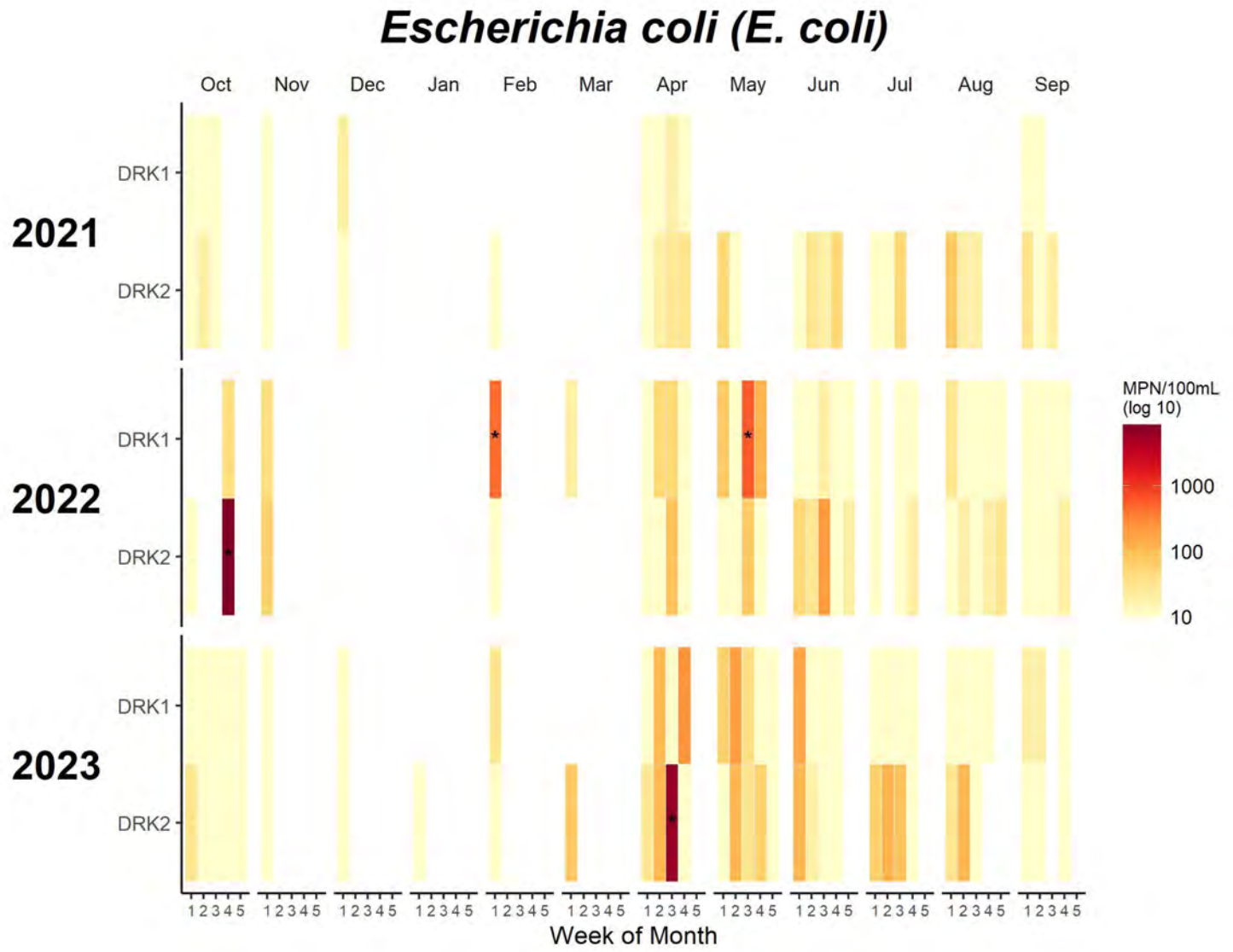

Figure 23. *Escherichia coli (E. coli)* concentration result by week of the month for beach recreational monitoring sites, WY2021 - WY2023. Each cell represents a sampling event. White cells represent no sampling that week. Cells marked with an asterisk (*) represent results that exceeded the contact recreation benchmark of 400 MPN/100mL used by the Marin County Ocean and Bay Water Quality Testing Program.

Short-Term Assessment (Monitoring Program 1)

Under Strategy Monitoring Program 1 (short-term assessment), 6-week winter assessment monitoring was conducted at 16 sites beginning January 3, 2023 and ending February 8, 2023. Six-week summer assessment sampling was conducted at the same stations beginning June 28, 2023 and ending August 2, 2023. Site selection prioritized watersheds where dairy operations were present. Sampling occurred on the same day for the majority of stations, but a second day was scheduled each week in winter to sample ABB4 and ABB5 due to the logistics of accessing those locations, and to accommodate enterococci FIB parameter analysis requirements for ABB4 due to salinity.

All core parameters were collected each week as described under Monitoring Program 2 (monthly coastal watershed sampling). Grab samples were also collected for laboratory analysis of FIB (*E. coli* except at site ABB4 where enterococci was used as the indicator due to a salinity >1ppth more than 5% of the time). In addition to the core parameters identified under Monitoring Program 2, staff collected ammonia (as N) samples during each visit to sites below dairy operations, and immediately stored samples on ice before transferring them to the contract laboratory for processing.

In addition to the core parameters identified under Monitoring Program 2, staff collected samples weekly for laboratory analysis of ammonia (as N) at sites below all authorized dairy operations during the six-week winter and summer sample periods. Samples were immediately stored samples on ice before transferring them to the contract laboratory for processing. The RWQCB's General Waste Discharge Requirements for Confined Animal Facilities lists a benchmark for ammonia of less than 1 mg/L, and a calculated un-ionized ammonia benchmark of 0.025 mg/L. The intent of this benchmark is to protect against the chronic toxic effects to aquatic life. Since un-ionized ammonia cannot be measured directly, the ammonia (as N) results are calculated based on pH, water temperature, and ionic strength (in the form of conductivity) (see American Fisheries Society 2023). The toxicity of un-ionized ammonia increases with increased pH and temperature.

Winter Assessment WY2023

Over the six-week winter sample period, water temperature ranged from 5.4 °C at site PAC1 to 12.3°C at site DES1A, which generally maintained higher temperatures than the other sites (Table 6). All dissolved oxygen results collected over the six weeks were within the benchmark range for this parameter (Table 7). For pH, only two results were outside the benchmark range: PAC1 was 6.41 on February 7, 2023 and DES2 was 6.37 on January 10, 2023 (Table 8). All specific conductance results were below the benchmark of 2000 µs/cm (site ABB4 contains brackish water, so the benchmark is not applicable). The first week of sampling returned specific conductance results that were generally higher than the subsequent weeks, and the Drakes Bay Watershed sites had higher weekly values than sites in the other watersheds (Table 9). The two weeks of January 10 and January 17 returned many of the highest turbidity results, with sites PAC1, PAC2, PAC3, PAC4, and DBY1 above 25 NTU for both weeks. The highest result was 93.1 NTU recorded at PAC4 on January 10, and site PAC2 had results above 25 NTU during four out of the six weeks (Table 10).

For *E. coli*, all sites in the Drakes Bay Watershed below dairy operations exceeded the six-week geomean contact recreation water quality benchmark of 100 MPN/100mL. In the Kehoe Creek Watershed, three sites exceeded the benchmark: PAC2 and PAC3, downstream of portions of both a dairy and grazing operation, and PAC2B, downstream of a portion of a dairy operation. Additional triggered assessment and synoptic monitoring was conducted at these locations (see Synoptic Monitoring section below). Generally, sites returned higher results during or following the larger atmospheric river rainfall events that occurred during the first two weeks of winter assessment monitoring (Table 11, Figure 24). These events caused county-wide increases in surface water flow and runoff. Above site PAC3, runoff from a feeding area was discovered on January 15, 2023, and short-term corrective actions were taken within the next week to buffer the area, and disperse and filter runoff, including temporary electric fencing and wattles, as well as rotation of animals. Management of accumulated manure surrounding the feed bunker was also increased in subsequent weeks during the rainy season. At site DBY2, elephant seals moved into the pond and drainage upstream of the sampling site, likely due to winter wave activity covering the beach. Over ten were noted as present in the pond above DBY2 on January 3, 2023, and their presence in the pond was also noted on January 24, 2023.

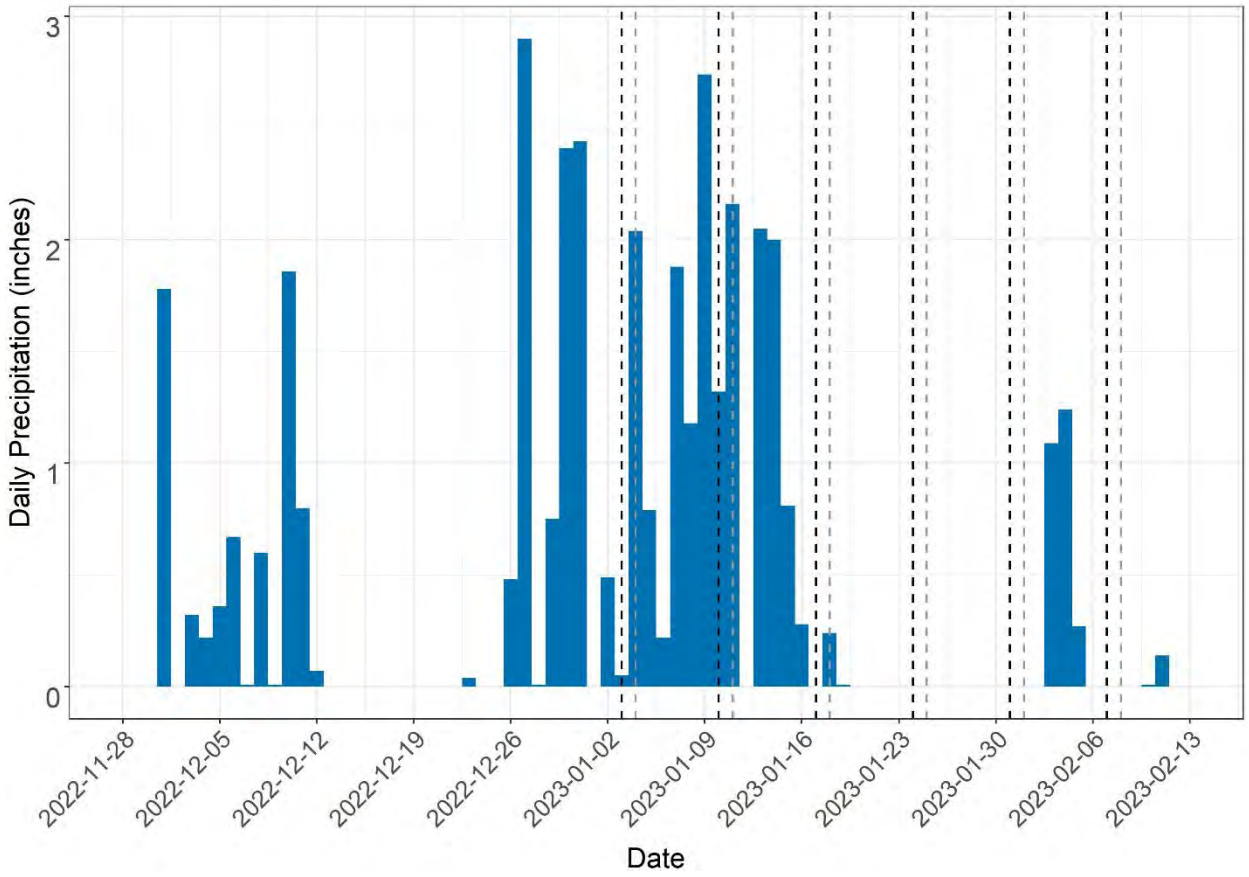

Figure 24. Daily precipitation (inches) during the winter six-week sampling period WY2023 recorded near Point Reyes Station, CA with weekly site visit dates shown as dashed vertical lines (black dashed line is for the majority of sites while the grey dashed line is for sites ABB4 and ABB5).

Sites ABB5 and DES1A, both located on small coastal drainages within cattle grazing operations, also exceeded the contact recreation geomean benchmark. At site ABB5, runoff from a livestock feed bunker area was noted to be entering the stream on the January 3, 2023 and January 11, 2023 site visits.

For the five sites below dairy operations sampled for ammonia (as N), all results were below 1.0 mg/L. Site DBY1 had the highest result each week while site PAC5 has the lowest result each week (Table 12). The dairy upstream of site PAC5 was not observed to be in active dairy production during the winter assessment period. The conversion from ammonia (as N) to un-ionized ammonia requires an actual numerical result, so it is not possible to calculate accurate un-ionized ammonia results using non-detected ammonia (as N) results. However, based on all these data under the lab's low reporting limit, we conclude that all sites monitored met the benchmark for un-ionized ammonia.

On January 24, 2023 core parameters were not collected at PAC3 due to field conditions with tidal influenced wave overtopping of the sample area. Concerns over field staff safety and potential damage of the handheld multiparameter instrument precluded collection of parameters for the sample event.

Summer Assessment WY2023

Five of the stream sites did not maintain flow through the sample period and were not monitored during no flow conditions. Site DBY2 was not flowing for the entirety of the summer series, sites ABB5 and DBY1 were only flowing during the first week of the series, site DBY3A exhibited no flow conditions after the first three weeks of the series, and site PAC5 exhibited no flow conditions in the last week of the series. Where measurements were conducted over the summer six-week sample period, water temperature ranged from 12.0 °C at site PAC2B to 19.8°C at Abbotts Lagoon (ABB4), which along with Kehoe Lagoon (PAC3) generally maintained higher summer temperatures than the other sites (Table 13). Site PAC1, with upstream ponding and low flow conditions had the next highest summer water temperature values. This site also had dissolved oxygen results well below the warm water habitat benchmark of 5.0 mg/L for all six weeks of sampling. All other dissolved oxygen results collected over the six weeks were within the benchmark range for this parameter with the exception of Site PAC2, which dipped below the dissolved oxygen benchmark during the fifth week of sampling, but otherwise maintained values above 8.1 mg/L (Table 14). For pH, only two results were outside the benchmark range at PAC1, which maintained the lowest pH of all sites sampled in the summer series (Table 15). All specific conductance results were below the benchmark of 2,000 µs/cm (site ABB4 contains brackish water, so the benchmark is not applicable) (Table 16). All but two turbidity results were below 25 NTU during the summer series; site PAC4 returned a value of 26.2 NTU during the fourth week, and a result of 184 NTU was reported from the week one sample at site DBY1 (Table 17). Site DBY1 was noted to be visually turbid with very low flow during the week one visit, and became disconnected with no flow (and thus no additional sampling was conducted) for the remainder of the summer series.

For *E. coli*, with the exception of Abbotts Lagoon (ABB4) which was well below the enterococci benchmark, sites that continued to flow through the summer series (and Kehoe Lagoon)

exceeded the six-week contact recreation geometric mean benchmark (Table 18). This includes McClures Creek (PAC4) within the Tule Elk Reserve at Tomales Point with no cattle influence in the watershed. In many of these small coastal watersheds, the streamflow conditions were low to stagnant, and results likely represent localized conditions. Single weekly samples at sites ABB5, and DBY3A during low flow conditions prior to cessation of flow at these locations also exceeded the single sample contact recreation benchmark. Though exceeding the six-week geomean, sites PAC3, ABB1, DES2, and DES3 maintained weekly sample FIB values below the single sample contact recreation benchmark with the exception of one week out of the six, and at site PAC1 all six weekly samples were below the single sample benchmark. Sites PAC5 and ABB2 exhibited elevated FIB levels throughout the summer series and had the highest geomeans (though PAC5 was not sampled the last week due to no flow conditions). Site PAC2 had the next highest geomean, with slightly more variable results observed upstream at site PAC2B, and a geomean close to the benchmark downstream at PAC3 (Kehoe Lagoon).

Because these results likely represented localized conditions, and due to cessation of flow at a number of sites, triggered sampling was not conducted in all cases, except at ABB2 which had the persistently highest *E. coli* results (see Triggered Sample Events and Synoptic Monitoring section below).

Ammonia (as N) was collected at sites below dairy operations that maintained flow during the summer series. Site DBY2 was not flowing on the first week of the summer assessment event (June 28, 2023) so the site was not sampled as part of the summer series. Other stations, DBY1, DBY3A, and PAC5 transitioned to no flow conditions during the 6 weeks of sampling. At PAC5 flow became too low to fill the sample bottle on the fifth week of the summer assessment (July 26, 2023). PAC2 was the only site that had persistent flow through the summer six-week series. From the samples that were collected, there were no single sample or geomean results that exceeded the RWQCB benchmark (Table 19). Half of the results were below the laboratory reporting limit, and the highest result was 0.19 mg/L at PAC2.

Table 6. Six week winter assessment water temperature results for water quality sites by watershed collected during WY2023.

Water Temperature (°C)

Watershed	Kehoe Creek/Frontal Pacific Ocean						Abbotts Lagoon				Drakes Estero			Drakes Bay		
2023	PAC1	PAC2	PAC2B	PAC3	PAC4	PAC5	ABB1	ABB2	ABB4	ABB5	DES1A	DES2	DES3	DBY1	DBY2	DBY3A
Jan 3-4	8.2	9.6	9.9	8.8	10.8	10	9.3	10.5	10	9.8	12.3	10	10.4	10.6	9.5	10.1
Jan 10-11	11.1	11.3	11.5	11.1	11.7	11.3	11	11.3	11.2	11.3	11.4	11.4	11.2	12	11.2	11.3
Jan 17-18	8.9	9.7	9.9	9.3	10.2	10.3	9.3	11	11	9.6	11.4	10.2	10.6	11.1	9.2	9.7
Jan 24-25	7.3	8.2	8.5	9.3	9.5	9.9	8.1	10	10.9	8.5	11.8	8.0	9.6	11.0	9.2	8.2
Jan 31-Feb 1	5.4	6.1	6.1	7.1	8.2	8.4	5.9	8.8	9.6	7.2	10.3	5.7	7.5	9.3	7.4	6.2
Feb 7-8	7.7	7.8	8.2	8.9	9.7	9.8	7.8	10.1	11.3	8.8	12.1	7.9	9.6	11	9.7	9.2

Table 7. Six week winter assessment dissolved oxygen results for water quality sites by watershed collected during WY2023.

Dissolved Oxygen (mg/L)

Watershed	Kehoe Creek/Frontal Pacific Ocean						Abbotts Lagoon				Drakes Estero			Drakes Bay		
2023	PAC1	PAC2	PAC2B	PAC3	PAC4	PAC5	ABB1	ABB2	ABB4	ABB5	DES1A	DES2	DES3	DBY1	DBY2	DBY3A
Jan 3-4	7.27	10.03	10.22	7.64	10.89	9.56	10.31	9	9.74	10.39	9.57	10.54	10.35	10.01	7.41	10.52
Jan 10-11	6.73	10.21	10.43	7.77	10.63	9.34	9.46	7.97	9.67	9.66	9.41	10.28	10.21	10.06	9.11	10.47
Jan 17-18	8.02	10.65	10.87	8.14	11.18	9.66	10.27	8.75	9.22	10.64	9.61	10.65	10.54	9.62	7.99	11.11
Jan 24-25	8.22	10.86	11.19	---	11.57	10.26	11	9.36	9.66	11.14	9.42	11.36	10.92	9.92	8.88	11.62
Jan 31-Feb 1	8.86	11.35	11.6	8.96	11.80	11.51	11.64	9.89	9.72	11.23	10.36	12.18	11.6	11.13	9.08	12.65
Feb 7-8	7.61	11	11.08	8.64	11.48	11.81	11.2	9.54	9.81	10.93	9.98	11.54	11.08	11.25	10.21	11.83

---Not collected

Table 8. Six week winter assessment pH results for water quality sites by watershed collected during WY2023.

pH

Watershed	Kehoe Creek/Frontal Pacific Ocean						Abbotts Lagoon				Drakes Estero			Drakes Bay		
2023	**PAC1**	**PAC2**	**PAC2B**	**PAC3**	**PAC4**	**PAC5**	**ABB1**	**ABB2**	**ABB4**	**ABB5**	**DES1A**	**DES2**	**DES3**	**DBY1**	**DBY2**	**DBY3A**
Jan 3-4	6.92	7.47	7.49	7.25	7.5	7.37	7.23	7.09	7.65	6.82	6.83	6.71	6.94	7.48	7.04	7.36
Jan 10-11	6.52	7.19	7.04	6.76	7.23	7.09	6.58	6.77	7.57	6.59	6.63	6.37[E]	6.86	7.07	7.04	7.29
Jan 17-18	7.14	7.19	7.61	6.79	7.54	7.2	6.7	6.84	7.42	6.72	6.51	6.56	6.69	6.67	6.71	7.17
Jan 24-25	6.69	7.28	7.28	---	7.35	7.3	6.88	6.95	7.44	6.88	6.59	6.84	6.76	6.94	6.89	7.5
Jan 31-Feb 1	6.57	7.13	7.08	7.07	7.04	7.38	7	6.92	7.36	6.97	6.77	7.31	7.05	7.16	6.99	7.61
Feb 7-8	6.41[E]	7.08	7.25	6.87	7.27	7.32	6.8	6.84	7.33	7.06	6.65	6.9	7.02	7.35	7.09	7.63

---Not collected
[E] Result outside benchmark range of 6.5-8.5

Table 9. Six week winter assessment specific conductance results for water quality sites by watershed collected during WY2023.

Specific Conductance (µs/cm)

Watershed	Kehoe Creek/Frontal Pacific Ocean						Abbotts Lagoon				Drakes Estero			Drakes Bay		
2023	**PAC1**	**PAC2**	**PAC2B**	**PAC3**	**PAC4**	**PAC5**	**ABB1**	**ABB2**	**ABB4***	**ABB5**	**DES1A**	**DES2**	**DES3**	**DBY1**	**DBY2**	**DBY3A**
Jan 3-4	582	836	953	1039	491.7	898	353.2	488	16359	413.3	302.9	262.6	249.1	1475	1766	1140
Jan 10-11	384.2	514	517	512	337.3	549	207.1	411.9	11802	279.5	298.1	186.5	169.1	700	852	737
Jan 17-18	363.8	432	439.3	587	402.5	514	186.1	415.1	15244	244.7	272.6	180.7	172.6	588	751	643
Jan 24-25	400.8	505	564	---	416	580	209.1	435.7	13533	271.8	272.6	214.5	203.3	784	1060	836
Jan 31-Feb 1	423.7	542	637	577	420.1	607	222.2	429.5	13825	293.2	265.1	228.8	219.2	910	1335	925
Feb 7-8	420.5	551	641	496.4	420.3	625	223	411.9	13748	302.8	273.9	229.1	212.9	981	1246	897

---Not collected
* Brackish water with salinity >1 ppth, benchmark not applicable

Table 10. Six week winter assessment turbidity results for water quality sites by watershed collected during WY2023.

Turbidity (NTU)

Watershed	Kehoe Creek/Frontal Pacific Ocean						Abbotts Lagoon				Drakes Estero			Drakes Bay		
2023	**PAC1**	**PAC2**	**PAC2B**	**PAC3**	**PAC4**	**PAC5**	**ABB1**	**ABB2**	**ABB4**	**ABB5**	**DES1A**	**DES2**	**DES3**	**DBY1**	**DBY2**	**DBY3A**
Jan 3-4	6.95	5.16	5.56	6.04	12.4	2.7	4.29	5.79	2.3	19.6	7.39	14.1	9.25	16.3	8.25	5.8
Jan 10-11	32.6	64.4	28.5	34.1	93.1	10.2	8.32	7.24	4.32	19.4	7.96	38.9	26.4	91.8	76.2	17.5
Jan 17-18	60.6	49.1	16.6	57.1	71.1	6.99	7.15	8.73	4.77	17.3	8.86	24.3	19.1	31.2	21.6	71.1
Jan 24-25	15.8	45	7.54	24.7	10.8	3.94	5.57	7.83	3.22	10	14.9	13.6	8.95	20.3	19.6	7.14
Jan 31-Feb 1	10.4	10.2	5.33	13.7	14.9	3.47	5.8	4.03	3.17	49.3	5.29	9.96	6.72	17.4	9.25	5.82
Feb 7-8	10.9	27.6	5.78	17.3	17.5	4.26	6.03	5.91	2.84	13	4.82	4.26	8.37	16.6	11.2	7.68

Table 11. Six week winter assessment *E. coli* results (enterococci for site ABB5) with six-week geometric means for water quality sites by watershed collected during WY2023.

Fecal Indicator Bacteria (MPN/100mL)

Watershed	Kehoe Creek/Frontal Pacific Ocean						Abbotts Lagoon				Drakes Estero			Drakes Bay		
2023	**PAC1**	**PAC2**	**PAC2B**	**PAC3**	**PAC4**	**PAC5**	**ABB1**	**ABB2**	**ABB4***	**ABB5**	**DES1A**	**DES2**	**DES3**	**DBY1**	**DBY2**	**DBY3A**
Jan 3-4	20	210	210	1100	60	130	60	130	190	2000^	370	150	61	>2419	220	330
Jan 10-11	280	1400	690	1400	44	120	150	68	120	580	820	410	250	>2419	2000	2400
Jan 17-18	54	160	96	370	68	42	23	88	21	180	84	110	28	2400	130	260
Jan 24-25	32	180	32	310	25	26	29	56	1	120	210	31	15	260	210	660
Jan 31-Feb 1	70	260	44	280	48	18	27	57	17	180	140	17	18	250	98	110
Feb 7-8	12	72	64	98	62	23	75	190	1	200	170	42	23	260	71	1300
Geomean:	**45**	**233[E]**	**104[E]**	**411[E]**	**49**	**44**	**48**	**88**	**14**	**311[E]**	**224[E]**	**73**	**37**	**787[E]**	**209[E]**	**519[E]**

* Enterococci result due to salinity > 1 ppth more than 5% of the time
^ Substitution of duplicate sample result as primary sample was >Upper Quantification Limit (ABB5 1/4/2023)
> Substitution of Upper Quantification Limit due to result being right-censored
[E] Geomean exceeds *E. coli* contact recreation benchmark of 100 MPN/100mL

Table 12. Six week winter assessment Ammonia (as N) results with six-week geometric means for water quality sites downstream of dairies by watershed collected during WY2023.

Ammonia as N (mg/L)

Watershed	Kehoe Creek		Drakes Bay		
2023	**PAC2**	**PAC5**	**DBY1**	**DBY2**	**DBY3A**
Jan 3	0.29	0.22	0.85	0.47	0.27
Jan 10	0.42	0.31	0.93	0.63	0.57
Jan 17	0.29	0.20	0.72	0.39	0.30
Jan 24	0.33	<0.20	0.79	0.49	0.63
Jan 31	0.45	0.24	0.70	0.52	0.34
Feb 7	0.44	<0.20	0.66	0.50	0.34
Geomean:	**0.36**	**0.23**	**0.77**	**0.50**	**0.39**

< Substitution of Lower Quantification Limit due to result being left-censored

Table 13. Six week summer assessment water temperature results for water quality sites by watershed collected during WY2023.

Water Temperature (°C)

Watershed	Kehoe Creek/Frontal Pacific Ocean						Abbotts Lagoon				Drakes Estero			Drakes Bay		
2023	**PAC1**	**PAC2**	**PAC2B**	**PAC3**	**PAC4**	**PAC5**	**ABB1**	**ABB2**	**ABB4**	**ABB5**	**DES1A**	**DES2**	**DES3**	**DBY1**	**DBY2**	**DBY3A**
Jun 28	15.5	13.0	12.0	15.5	13.4	13.2	12.5	13.7	17.3	15.3	13.8	12.2	12.2	13.3	No flow	13.5
Jul 5	16.3	13.4	12.7	17.1	13.7	13.8	13.2	14.0	17.8	No flow	14.7	13.0	12.9	No flow	No flow	13.6
Jul 12	16.4	13.5	12.9	16.6	13.7	13.7	12.9	14.0	18.1	No flow	14.4	12.7	12.7	No flow	No flow	14.3
Jul 19	16.6	13.1	12.6	17.2	13.8	13.7	13.1	13.9	18.8	No flow	14.5	13.0	13.1	No flow	No flow	No flow
Jul 26	17.3	14.7	13.2	18.1	14.1	15.2	13.7	14.6	19.8	No flow	14.9	13.5	13.7	No flow	No flow	No flow
Aug 2	16.5	13.7	13.1	16.9	14.1	No flow	13.2	14.1	18.9	No flow	14.5	13.3	13.4	No flow	No flow	No flow

Table 14. Six week summer assessment dissolved oxygen results for water quality sites by watershed collected during WY2023.

Dissolved Oxygen (mg/L)

Watershed	Kehoe Creek/Frontal Pacific Ocean						Abbotts Lagoon				Drakes Estero			Drakes Bay		
2023	PAC1	PAC2	PAC2B	PAC3	PAC4	PAC5	ABB1	ABB2	ABB4	ABB5	DES1A	DES2	DES3	DBY1	DBY2	DBY3A
Jun 28	0.31[E]	9.23	8.06	9.56	10.41	9.42	8.87	8.09	7.91	9.40	7.33	9.74	9.54	8.18	No flow	9.24
Jul 5	0.42[E]	8.90	7.89	7.47	10.34	8.88	8.67	8.07	8.42	No flow	7.16	9.74	9.60	No flow	No flow	9.58
Jul 12	0.47[E]	9.19	8.07	8.02	10.33	8.92	8.71	8.15	8.09	No flow	7.47	9.62	9.41	No flow	No flow	9.12
Jul 19	0.41[E]	8.69	7.29	6.57	10.23	8.12	8.60	8.21	8.39	No flow	7.09	9.48	9.20	No flow	No flow	No flow
Jul 26	0.25[E]	4.34[E]	8.00	5.85	10.14	7.93	8.42	8.04	8.14	No flow	7.01	9.47	9.15	No flow	No flow	No flow
Aug 2	0.30[E]	8.13	7.81	5.27	10.18	No flow	8.50	8.11	7.97	No flow	6.89	9.35	9.00	No flow	No flow	No flow

[E] Result below benchmark of 5.0 mg/L

Table 15. Six week summer assessment pH results for water quality sites by watershed collected during WY2023.

pH

Watershed	Kehoe Creek/Frontal Pacific Ocean						Abbotts Lagoon				Drakes Estero			Drakes Bay		
2023	PAC1	PAC2	PAC2B	PAC3	PAC4	PAC5	ABB1	ABB2	ABB4	ABB5	DES1A	DES2	DES3	DBY1	DBY2	DBY3A
Jun 28	6.56	7.53	7.32	7.64	7.43	7.51	7.04	7.03	7.68	7.33	6.69	7.34	7.26	7.23	No flow	7.67
Jul 5	6.55	7.52	7.38	7.33	7.49	7.51	7.10	7.11	7.71	No flow	6.60	7.24	7.28	No flow	No flow	7.71
Jul 12	6.58	7.58	7.45	7.65	7.57	7.50	7.14	7.13	7.74	No flow	6.60	7.37	7.28	No flow	No flow	7.64
Jul 19	6.46[E]	7.48	7.29	7.34	7.58	7.41	7.11	7.08	7.91	No flow	6.57	7.37	7.21	No flow	No flow	No flow
Jul 26	6.52	7.42	7.45	7.43	7.60	7.45	7.12	7.13	7.98	No flow	6.62	7.22	7.26	No flow	No flow	No flow
Aug 2	6.48[E]	7.40	7.46	7.28	7.48	No flow	6.98	6.96	8.02	No flow	6.56	7.26	7.19	No flow	No flow	No flow

[E] Result outside benchmark range of 6.5-8.5

Table 16. Six week summer assessment specific conductance results for water quality sites by watershed collected during WY2023.

Specific Conductance (µs/cm)

Watershed	Kehoe Creek/Frontal Pacific Ocean						Abbotts Lagoon				Drakes Estero			Drakes Bay		
2023	PAC1	PAC2	PAC2B	PAC3	PAC4	PAC5	ABB1	ABB2	ABB4*	ABB5	DES1A	DES2	DES3	DBY1	DBY2	DBY3A
Jun 28	419.3	662	944	1035	360.1	566	264.3	316.0	17623	514	257.1	276.2	273.9	1151	No flow	1232
Jul 5	419.0	675	967	756	369.5	577	270.6	316.5	9247	No flow	257.4	281.7	277.7	No flow	No flow	1235
Jul 12	412.6	676	1001	893	365.5	575	274.8	318.8	17522	No flow	251.9	277.5	273.4	No flow	No flow	1261
Jul 19	385.1	675	1048	669	365.5	578	256.5	316.8	7751	No flow	250.9	281.7	282.6	No flow	No flow	No flow
Jul 26	404.1	652	1086	673	365.9	582	277.3	311.7	18053	No flow	255.7	291.5	295.5	No flow	No flow	No flow
Aug 2	405.7	639	1117	670	361.6	No flow	276.8	314.0	7948	No flow	252.5	288.3	294.1	No flow	No flow	No flow

* Brackish water with salinity >1 ppth, benchmark not applicable

Table 17. Six week summer assessment turbidity results for water quality sites by watershed collected during WY2023.

Turbidity (NTU)

Watershed	Kehoe Creek/Frontal Pacific Ocean						Abbotts Lagoon				Drakes Estero			Drakes Bay		
2023	PAC1	PAC2	PAC2B	PAC3	PAC4	PAC5	ABB1	ABB2	ABB4	ABB5	DES1A	DES2	DES3	DBY1	DBY2	DBY3A
Jun 28	18.1	7.20	1.85	13.7	13.2	4.05	18.1	10.7	2.08	14.3	1.96	10.3	9.51	184	No flow	2.92
Jul 5	14.6	6.90	1.98	7.32	23.6	4.39	19.9	9.87	3.45	No flow	2.25	10.1	2.59	No flow	No flow	4.23
Jul 12	12.7	6.94	2.13	6.40	6.94	3.88	17.8	13.9	3.36	No flow	2.13	9.93	3.78	No flow	No flow	1.63
Jul 19	19.2	6.28	2.10	4.56	26.2	4.32	16.9	13.0	3.71	No flow	2.63	11.4	2.95	No flow	No flow	No flow
Jul 26	18.4	5.84	1.72	4.42	17.5	3.84	17.4	13.4	5.07	No flow	2.18	10.4	2.68	No flow	No flow	No flow
Aug 2	8.98	5.44	2.83	5.06	24.0	No flow	16.0	13.5	2.84	No flow	18.3	9.72	3.22	No flow	No flow	No flow

Table 18. Six week summer assessment *E. coli* results (enterococci for site ABB5) with six-week geometric means for water quality sites by watershed collected during WY2023.

Fecal Indicator Bacteria (MPN/100mL)

Watershed	Kehoe Creek/Frontal Pacific Ocean						Abbotts Lagoon				Drakes Estero			Drakes Bay		
2023	PAC1	PAC2	PAC2B	PAC3	PAC4	PAC5	ABB1	ABB2	ABB4*	ABB5	DES1A	DES2	DES3	DBY1	DBY2	DBY3A
Jun 28	275	1664	199	594	959	1017	336	3225	20	3225	457	216	3448	187	No Flow	414
Jul 5	173	683	213	109	323	15531	183	2359	10	No Flow	384	161	203	No Flow	No Flow	583
Jul 12	171	471	395	85	384	521	98	1239	<10	No Flow	450	201	185	No Flow	No Flow	727
Jul 19	175	323	161	134	794	487	203	2282	10	No Flow	121	85	279	No Flow	No Flow	No Flow
Jul 26	41	249	135	41	262	576	158	2909	<10	No Flow	292	1314	121	No Flow	No Flow	No Flow
Aug 2	285	683	1860	41	420	No Flow	109	1789	20	No Flow	171	201	199	No Flow	No Flow	No Flow
Geomean:	**160** [E]	**556** [E]	**296** [E]	**104** [E]	**467** [E]	**1182** [E]	**166** [E]	**2195** [E]	**13**	**--**	**280** [E]	**232** [E]	**309** [E]	**--**	**--**	**--**

< Substitution of Lower Quantification Limit due to result being left-censored
* Enterococci result due to salinity > 1 ppth more than 5% of the time
[E] Geomean exceeds *E. coli* contact recreation benchmark of 100 MPN/100mL

Table 19. Six-week summer assessment Ammonia (as N) results with six-week geometric means for means for water quality sites downstream of dairies by watershed collected during WY2023.

Ammonia as N (mg/L)

Watershed	Kehoe Creek		Drakes Bay		
2023	PAC2	PAC5	DBY1	DBY2	DBY3A
Jun 28	<0.10[H]	<0.10	<0.10	No Flow	<0.10
Jul 5	0.19	0.15	No Flow	No Flow	0.11
Jul 12	0.2	0.15	No Flow	No Flow	0.14
Jul 19	0.14	<0.10	No Flow	No Flow	No Flow
Jul 26	<0.10	Low Flow	No Flow	No Flow	No Flow
Aug 2	<0.10	No Flow	No Flow	No Flow	No Flow
Geomean:	**0.13**	**0.12**	**--**	**--**	**--**

< Substitution of Lower Quantification Limit due to result being left-censored
[H] Sample was analyzed out of hold time

Dairy Regulatory Monitoring (Monitoring Program 3)

Under Strategy Monitoring Program 3 (dairy regulatory) the five dairy operations are required to conduct regulatory monitoring downstream of their facilities to meet the Regional Water Board's General Waste Discharge Requirements for Confined Animal Facilities. Surface water sampling was conducted during the winter rainy season during or directly following three storm events. Stations were sampled using a handheld multiparameter instrument to measure pH, specific conductance and temperature. Grab samples were taken for laboratory analysis of total ammonia nitrogen. Un-ionized ammonia was calculated using collected parameters.

According to the General Waste Discharge Requirements, sampling is to occur after at least 1 inch of rain per 24 hours. However, for December 11, 2022 subsequent review of local rainfall data indicated less than 1 inch of precipitation was recorded within 24 hours on the Point Reyes peninsula (approximately 0.83 inches recorded at Point Reyes RCA RAWS monitoring station vs. 1.40 inches recorded in Point Reyes Station). Staff noted low flow conditions with small volumes of water observed during the site visits and the spillways of instream freshwater ponds were not overflowing.

Samples met benchmarks established under the San Francisco Bay Regional Water Quality Control Board's General Waste Discharge Requirements for Confined Animal Facilities with the exception of site DBY2 on December 11, 2022, where pH and specific conductance were both outside the benchmark values (Table 20). As noted, this was during low flow conditions with low volumes of water being sampled. Due to the spillway not yet flowing at site DBY2, a sample was collected from the compromised release culvert through which water flows before overtopping the spillway.

Dairies are required to inspect infrastructure and prepare operations for winter rains under the CAF General WDR. Inspections of dairy facilities were conducted by RWQCB and NPS staff in February of 2022 and requirements for short-term and long-term corrective actions to address identified deficiencies were issued in July 2022. Follow-up inspections were conducted in November of 2022 to ensure identified short-term corrective actions were in place.

Table 20. Storm sampling parameter results for three storm events in WY2023 at water quality sites downstream of dairies.

Parameter	Watershed	Kehoe Creek		Drakes Bay		
	2023	PAC2	PAC5	DBY1	DBY2	DBY3A
pH	Dec 11	7.29	7.36	6.64	6.16[E]	7.42
	Jan 10	7.19	7.09	7.07	7.04	7.29
	Mar 10	7.18	7.16	7.19	7.22	7.38
Specific conductance (µs/cm)	Dec 11	1168	1287	1472	3552[E]	1925
	Jan 10	514	549	700	852	737
	Mar 10	287.2	362.1	670	697	615
Ammonia as N (mg/L)	Dec 11	0.52	0.42	0.35	0.48	0.61
	Jan 10	0.42	0.31	0.93	0.63	0.57
	Mar 10	0.35	0.24	0.97	0.52	0.50
Un-ionized ammonia (mg/L)	Dec 11	0.0017	0.0016	0.00026	0.00012	0.0025
	Jan 10	0.0012	0.00072	0.0021	0.0013	0.0021
	Mar 10	0.0010	0.00064	0.0028	0.0016	0.0021

[E] Below pH 6.5 benchmark; above specific conductance 2000 µS/cm benchmark

Triggered Sample Events and Synoptic Monitoring

Beginning in September of 2022 after CA Coastal Commission approval of the Strategy, triggers for additional monitoring action were established when certain benchmarks are exceeded based on results from Strategy Monitoring Program 2 (Coastal Watersheds), Monitoring Program 4 (Recreational Beach Sampling) and Monitoring Program 5 (Tomales Bay Watershed).

The Strategy states that additional grab samples will be taken as soon as possible after review of the results triggering action to attempt to bracket an area of concern, moving upstream from the initial station and sampling at intervals adjacent to varying land uses in order to isolate area(s) where pollutants may be entering the waterway. This will be coupled with inspections of ranch operations to look for suspected pathways, during periods of runoff when possible, depending on the coincidence of the monitoring results with precipitation events. For triggered monitoring events observers noted any evidence for possible sources or causes of high values (e.g. presence of mammals, disturbance, runoff from high use areas).

Triggered sample events were conducted for *E. coli* observations above benchmarks at five sites, with additional synoptic monitoring conducted on drainages at four dairies during two different site visits. In addition, triggered sampling of nutrients was conducted at two sites based on observed algae cover over 30% and low dissolved oxygen to evaluate for potential presence of biostimulatory substances. Assessment monitoring was also utilized to determine need for additional sampling.

Escherichia coli (E. coli)

The Strategy calls for additional monitoring to be conducted if two consecutive monthly fecal indicator bacteria samples exceed a given benchmark, or a single non-storm event fecal indicator bacteria sample exceeds ten times the single sample benchmark in MPN/100ml.

At South Kehoe Creek site PAC1, the December 2022 monthly *E. coli* result exceeded ten times the contact recreation benchmark following rain during the week that continued into the day of sampling (Table 21). Six week winter assessment then occurred beginning in January 2023, and all single sample results, as well as the six-week geomean were below their respective contact recreation benchmarks (Table 11).

Table 21. *E. coli* results and subsequent triggered sampling at site PAC1 in WY2022-WY2023.

Site ID	Date	*E. coli* (MPN/100mL)	Trigger	Comment
PAC1	12/6/2022	5200	**Monthly sample >10x benchmark**	High flow from recent rain event
Six-week assessment occurs to further inform				

At North Kehoe Creek site PAC2, the contact recreation benchmark was exceeded for two consecutive months during early winter of 2022, with the monthly December 6, 2022 result well above ten times the benchmark at 17000 MPN/100mL following rain during the week that continued into the day of sampling. A triggered site visit was conducted on December 12, 2022 to resample site PAC2, with an *E. coli* result of 690 MPN/100mL and no unusual local conditions observed at the sample site (Table 22). Following this visit, the six-week winter assessment was conducted with a single sample exceedance of the contact recreation benchmark January 10, 2023 and exceedance of the benchmark six-week geomean (Table 11). The next two monthly samples in March and April of 2023 also exceeded the contact recreation benchmark. Synoptic monitoring was conducted to further assess this location in March and April of 2023 (see Synoptic Monitoring section below). Following synoptic monitoring, the May 2023 sample was also above the benchmark, so in June of 2023, upstream sites were sampled and investigated, with upstream site PAC2B returning a value of 85 MPN/100mL, and upstream site PAC2D noted as not flowing. Cows were observed grazing in the adjacent field upstream of site PAC2. Summer assessment monitoring was then conducted to further investigate this location, with results that exceeded the six-week contact recreation benchmark geomean (Table 18).

Table 22. *E. coli* results and subsequent triggered sampling at site PAC2 in WY2022 - WY2023.

Site ID	Date	*E. coli* (MPN/100mL)	Trigger	Comment
PAC2	11/1/2022	1900	**Monthly sample > benchmark 2 consecutive months >10x benchmark**	First time sampling in several months due to no flow conditions
	12/6/2022	17000		Turbid water, high flow from recent rain
PAC2	12/12/2022	690	> benchmark	No unusual local conditions observed
Six-week assessment occurs to further inform				
PAC2	3/7/2023	1300	> benchmark	Water brown, not clear
Conduct synoptic monitoring				
PAC2	4/4/2023	340	> benchmark	Water slightly turbid
Conduct synoptic monitoring				
PAC2	5/2/2023	430	> benchmark	Small amount of foam, algae on streambed
PAC2	6/6/2023	1300	> benchmark	Low flow, clear water, overgrown, cows in field upstream
PAC2B		85	< benchmark	No flow at PAC2D
Six week summer assessment begins to further inform				

At Kehoe Lagoon site PAC3, the contact recreation benchmark was exceeded for two consecutive months during March and April of 2023 (Table 23). Synoptic monitoring was conducted to further assess this location and upstream in the watershed in March and April of 2023 (see Synoptic Monitoring section below).

Table 23. *E. coli* results and subsequent triggered sampling at site PAC3 in WY2022 - WY2023.

Site ID	Date	*E. coli* (MPN/100mL)	Trigger	Comment
PAC3	3/7/2023	460	**Monthly sample > benchmark 2 consecutive months**	Outflow to ocean, lagoon breached and water level about 3 feet below former lagoon water line
	4/3/2023	1300		Outflow to ocean and breached lagoon
Conduct synoptic monitoring				

At McClures Creek site PAC4 (located above McClures Beach in an area ungrazed by cattle), the contact recreation benchmark was exceeded for two consecutive months during fall of 2022, triggering a site visit on November 15, 2022. *E. coli* results for this visit were 920 MPN/100mL at PAC4 and similarly, 980 MPN/100mL approximately 140 meters upstream. During the following monthly site visit in December, the *E. coli* result was below the contact recreation benchmark at 300 MPN/100mL (Table 24). Observations during the site visits included established trailing from both wildlife and humans, and evidence of tule elk activity, including scat beside the stream. Six week winter assessment then occurred beginning in January 2023, and all single sample results, as well as the six-week geomean were below their respective contact recreation benchmarks (Table 11). However, summer *E. coli* results above the contact recreation

benchmark were also observed at PAC4 in 2023 during five of the six summer assessment weeks (Table 18). Future monitoring may provide additional insight into the dynamics at this site.

Table 24. *E. coli* results and subsequent triggered sampling at site PAC4 in WY2022 - WY2023.

Site ID	Date	*E. coli* (MPN/100mL)	Trigger	Comment
PAC4	10/4/2022	2900	**Monthly sample > benchmark 2 consecutive months**	Wildlife trail above sample location, elk feces observed downstream, trailing from human activity
	11/1/2022	880		
PAC4	11/15/2022	920	> benchmark	Wildlife trails, elk feces observed at sample location, trailing from human activity
PAC4B		980	> benchmark	High amount of elk traffic at crossing
PAC4	12/6/2022	300	< benchmark	Elk trails and feces in area, hillslope erosion from recent rain, turbid water
Six-week winter assessment begins to further inform				

Site ABB2 had persistently high FIB results during the summer assessment series, triggering a follow-up site visit on August 23, 2023. *E. coli* results for this visit were above the contact recreation benchmark at site ABB2, as well as at one location upstream (ABB2-US; Table 25). Site ABB2 is downstream of a large pond utilized as a stock water source, and from which cattle are excluded. In this location, there were also no cattle reported present in the surrounding ABB2 subwatershed during the summer series sample period. While there were no specific observations as to potential contributors to the elevated results, a disturbance event in the form of mechanical removal of accumulated silt and vegetation from the upstream ranch pond was permitted and conducted in summer 2022. However, no results above the contact recreation benchmark were observed in the winter 2022 assessment series. Further future investigation may provide additional insight at this location.

Table 25. *E. coli* results and subsequent triggered sampling at site ABB2 in WY2022-WY2023.

Site ID	Date	*E. coli* (MPN/100mL)	Trigger	Comment
ABB2	6/28/2023 - 8/2/2023	1239 – 3225 (see Table 17)	**Weekly assessment returned persistently high values**	Highly vegetated small waterway downstream of ranch freshwater pond.
ABB2	8/23/2023	906	> benchmark	No unusual local conditions observed
ABB2 US		2064	> benchmark	Low flow

At East Schooner Creek site DES2, the contact recreation benchmark was exceeded for two consecutive months during fall of 2022, triggering a site visit on November 15, 2022. *E. coli* results for this visit were 390 MPN/100mL at DES2, while moving upstream, results were 110 MPN/100mL and 24 MPN/100mL at the culvert downstream of Mt. Vision Road (DES-MV) (Table 26). Wildlife trails and use were noted upstream of DES2 during this triggered site visit. In December of 2022 the *E. coli* result was again above the contact recreation benchmark for a third consecutive month following rain during the week that continued into the day of sampling.

A second triggered site visit occurred on December 12, 2022 and all results were below the contact recreation benchmark. Six week winter assessment then occurred beginning in January 2023, and all but one single sample result, as well as the six-week geomean were below their respective contact recreation benchmarks (Table 11). During assessment monitoring, it was noted that upstream of site DES2 runoff from a ranch stock pond spillway flowed down Estero Road following rain events, or adjacent to the road via a drainage ditch and into East Schooner Creek during the assessment period, which continued into May 2023. Sustained runoff was also observed on the opposite side of the road following rain events.

Table 26. *E. coli* results and subsequent triggered sampling at site DES2 in WY2022-WY2023.

Site ID	Date	*E. coli* (MPN/100mL)	Trigger	Comment
DES2	10/4/2022	830	**Monthly sample > benchmark 2 consecutive months**	No unusual local conditions observed
	11/1/2022	1600		
DES2	11/15/2022	390	> benchmark	Lightly used wildlife trail upstream
DES-EV		110	< benchmark	Between Mt. Vision Road and Estero Road. Wildlife trails to and across stream, sampled 100 m downstream of trails.
DES-MV		24	< benchmark	Downstream of Mt. Vision Road culvert. Tree damage from antler rubbing, extensive wildlife trailing downstream, some upstream.
DES2	12/6/2022	1600	**Monthly sample > benchmark 3 consecutive months**	No unusual local conditions observed
DES2	12/12/2022	96	< benchmark	No unusual local conditions observed
DES-ER		70	< benchmark	Upstream of Estero Road culvert. Some trails and willow damage upstream, with nearby cattle feces. Runoff entering downstream from Sir Francis Drake Boulevard drainage and upstream from Estero Road drainage.
DES-EV		39	< benchmark	Between Mt. Vision Road and Estero Road. Wildlife trails along roadside, no unusual conditions observed.
Six-week assessment begins to further inform				

At Home Ranch Creek site DES3, the September 2022 monthly *E. coli* result exceeded ten times the contact recreation benchmark, triggering a site visit on September 20, 2022. *E. coli* results for this visit were below the contact recreation benchmark at site DES3, as well as two locations upstream (Table 27). Wildlife trails and use were noted during the site visit. There was a general uptick in tule elk use surrounding site DES2 noted starting in June of 2022 (see Notable Events section for additional information).

Table 27. *E. coli* results and subsequent triggered sampling at site DES3 in WY2022-WY2023.

Site ID	Date	*E. coli* (MPN/100mL)	Trigger	Comment
DES3	9/6/2022	3800	**Monthly sample >10x benchmark**	Low flow, high aquatic vegetation cover, elk trail and evidence of bedding nearby
DES3	9/20/2022	200	< benchmark	Wildlife trails at station and upstream
Home1		200	< benchmark	Small wildlife trail downstream
Home2		130	< benchmark	No unusual local conditions observed
End triggered event				

Synoptic Monitoring

Based on six-week winter assessment results, synoptic monitoring for *E. coli* concentration was conducted on streams at four active dairy operations in order to assist with bracketing and isolating potential source areas.

On March 15, 2023 following 1.48 inches of precipitation (measured at Marin County Point Reyes Station site 38029), synoptic monitoring of *E. coli* was conducted at J Ranch along Kehoe Creek and the western coastal drainage on C Ranch that runs from the ranch complex to Drakes Beach to aid in determining potential source areas. On April 4, 2023 a second synoptic monitoring event for *E. coli* was conducted at both J Ranch and C Ranch after seven days with no precipitation events greater than 1 inch.

Seven samples were collected at J Ranch following the March 2023 rain event, with results greater than 1000 MPN/100mL in the main branches of North Kehoe Creek and 550 MPN/100mL downstream at Kehoe Lagoon. Results from smaller drainges with less volume of runoff varied, with a result of 310 MPN/100mL in surface water draining through a culvert from the western pasture area towards Kehoe Creek, and a result of 11000 at a culvert at the bottom of the pasture northwest of the ranch complex, containing manure holding ponds and dairy cattle. During subsequent non-storm conditions in April 2023, six samples were collleted at J Ranch. The small drainage below the northwest dairy pasture returned a result of 9100 MPN/100mL where flow volume had decreased to a small trickle, while results from the two locations sampled on main branches of North Kehoe Creek were 320 MPN/100mL and 340 MPN/100mL. At Kehoe Lagoon, results were somewhat higher, at 1300 MPN/100mL. two additional sites upstream of the J Ranch dairy and K Ranch grazing operations were also sampled, both returning results less than 200 MPN/100mL (Figure 25).

Eight samples were collected at C Ranch following the March 2023 rain event, with results ranging from 1800 to 2300 MPN/100mL in the two forks entering the main stock pond, a result of 6900 MPN/100mL directly downstream of the stock pond, and 2900 MPN/100mL further downstream at site DBY1. During subsequent non-storm conditions in April 2023 five samples were collected at C Ranch. Results ranged from 1500 to 2100 MPN/100mL in the two forks entering the main stock pond, while both downstream results were an order of magitude lower at

120 MPN/100mL. A site further downstream just the above Drakes Beach parking area was also sampled, with a result of 10 MPN/100mL (Figure 26).

On March 29, 2023 following 1.52 inches of precipitation (measured at Marin County Point Reyes Station site 38029), synoptic monitoring of *E. coli* was conducted at B Ranch and A Ranch along the coastal drainages that run from the ranch complexes to Drakes Beach to aid in determining potential source areas. On April 6, 2023 a second synoptic monitoring event for *E. coli* was conducted at both B Ranch and A Ranch after nine days with no precipitation events greater than 1 inch.

Ten samples were collected at B Ranch following the March 2023 rain event, with results from the south fork ranging from 4,900 MPN/100mL to 17000 MPN/100mL. In the north fork, results ranged from 290 to 3900 MPN/100mL, while downstream at site DBY2 the result was 6900 MPN/100mL. During subsequent non-storm conditions in April 2023 three samples were collected at B Ranch. In the south fork, the result was 3000 MPN/100mL while in the north fork the result was 62 MPN/100mL. The downstream result at site DBY1 was 860 MPN/100mL (Figure 27).

Seven samples were collected at A Ranch following the March 2023 rain event, with results from the north fork ranging from 10000 to 11000 MPN/100mL. To the south, results from the two main forks were 860 MPN/100mL and 470 MPN/100mL, while the result from channelized runoff from the holding paddocks was above the laboratory upper detection limit of 24190 MPN/100mL. The result was also above the upper detection limit of 24190 MPN/100mL downstream of where the two upper forks come together. Further downstream at site DBY3A the result was 1800 MPN/100mL. During subsequent non-storm conditions in April 2023 four samples were collected at A Ranch. Results from the north fork ranged between 1400 and 1600 MPN/100mL, and the result was 500 MPN/100mL downstream of where the two upper forks come together. Further downstream at site DBY3A the result was 200 MPN/100mL (Figure 28).

NPS staff inspected ranch areas to observe runoff patterns and operational use during the rain event synoptic monitoring visits which, along with the monitoring results, will inform additional short-term management actions to be implemented prior to next winter on dairy operations. The observations and results will also inform where to target additional monitoring in the upcoming water year to determine if similar conditions persist and to further isolate potential source areas.

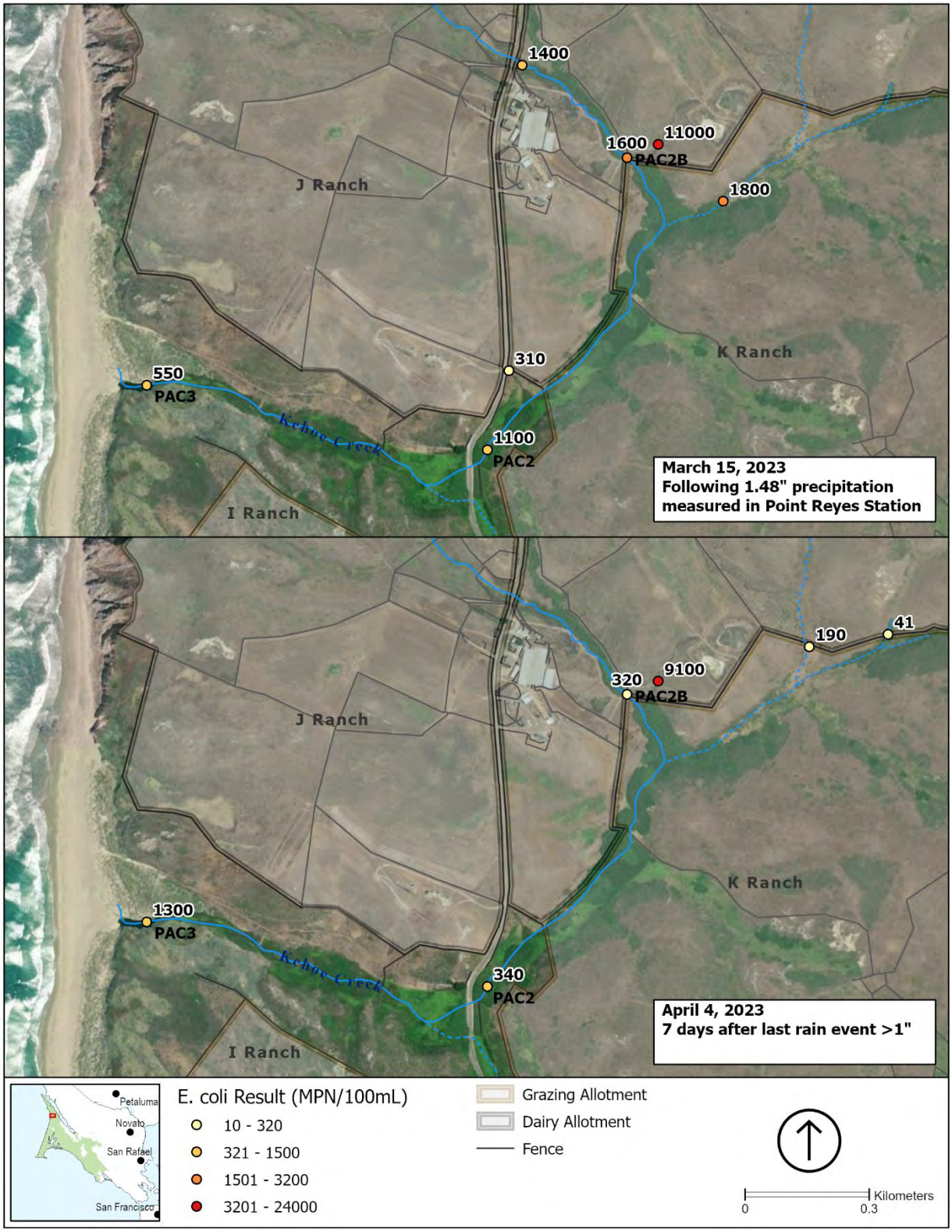

Figure 25. Synoptic monitoring results on Kehoe Creek during two sample events.

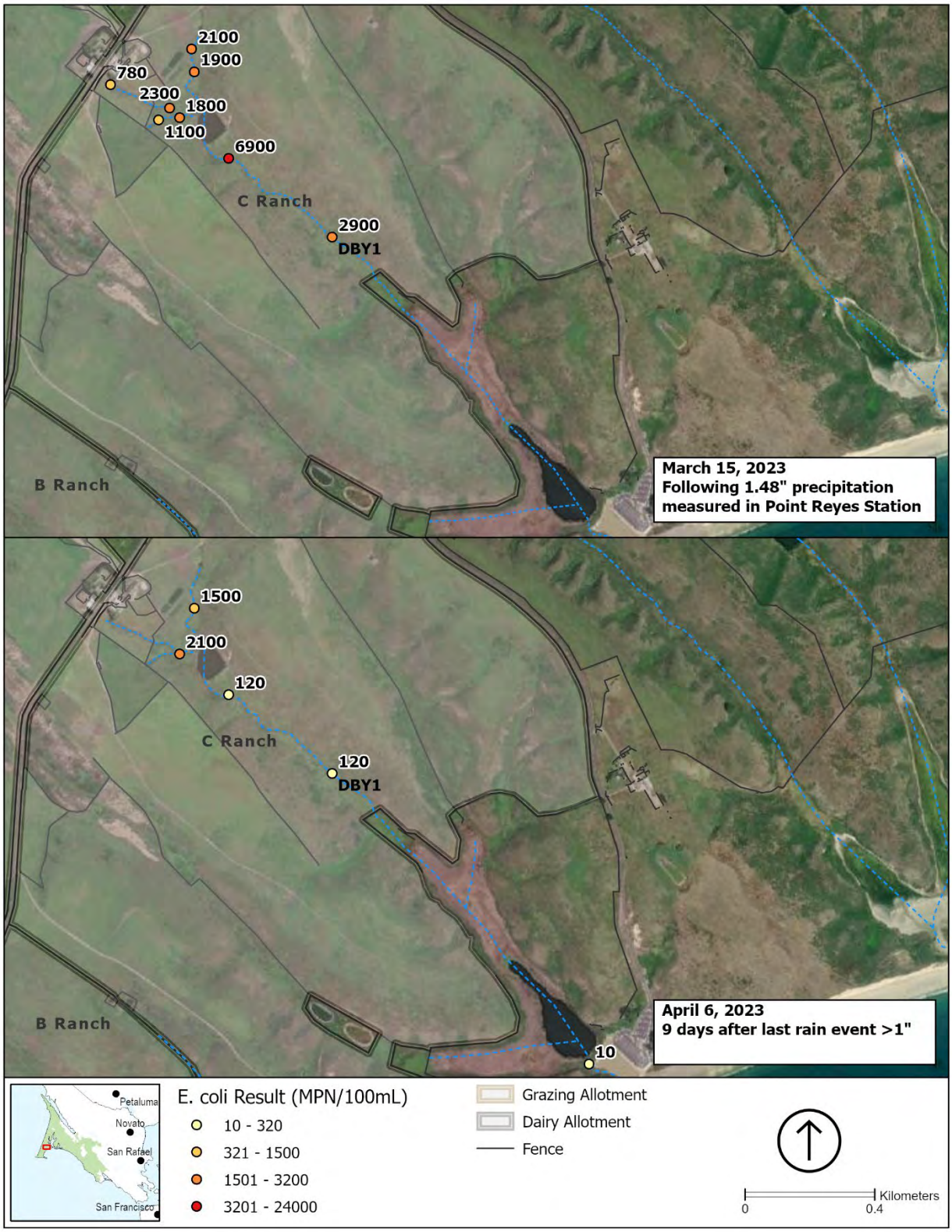

Figure 26. Synoptic monitoring results on C Ranch during two sample events.

Figure 27. Synoptic monitoring results on B Ranch during two sample events.

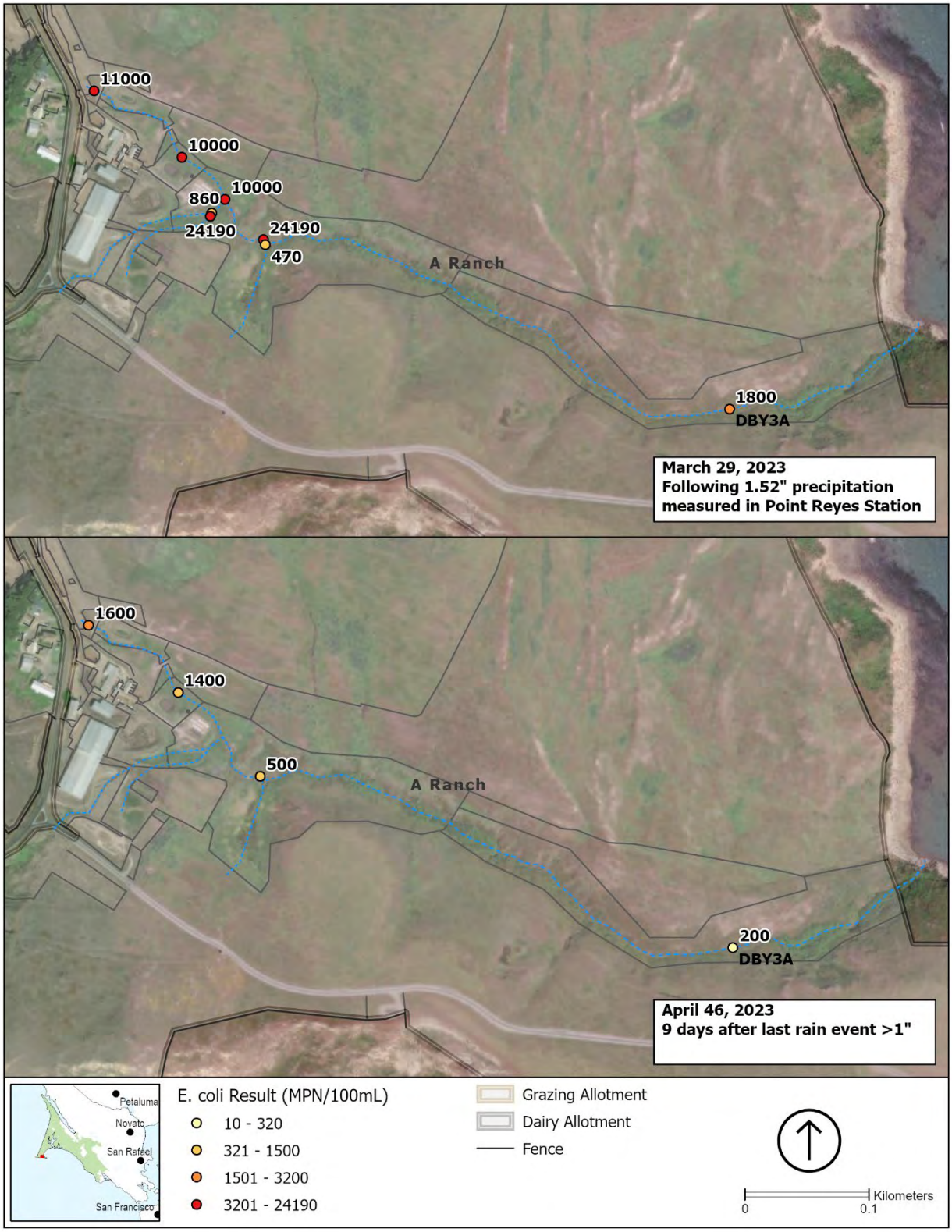

Figure 28. Synoptic monitoring results on A Ranch during two sample events. Note: Upper Quantification Limit of 24190 MPN/100mL is shown due to result being right-censored.

Biostimulatory Substances

The RWQCB Basin Plan (2023) states that *"Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses. Changes in chlorophyll a and associated phytoplankton communities follow complex dynamics that are sometimes associated with a discharge of biostimulatory substances. Irregular and extreme levels of chlorophyll a or phytoplankton blooms may indicate exceedance of this objective and require investigation."*

NPS committed to triggered nutrient monitoring based on evidence of persistent algal growth and resultant oxygen deficits under the Strategy. Specifically, the Strategy identified that if persistent algal blooms with visual benthic and surface algal cover >30% are encountered during more than two monthly station visits in conjunction with dissolved oxygen (DO) outside the benchmarks, synoptic nutrient monitoring (i.e., total nitrogen or chlorophyll a with DO monitoring) will be conducted. At station ABB4, DO monitoring will be initiated when the algal cover benchmark is exceeded. Stations that continue to fall outside of these benchmarks will trigger additional synoptic monitoring.

Nitrate as Nitrogen

Neither the state of California nor RWQCB have set ecological water quality objectives for nitrates; however, there are a range of recommendations available in the literature. A review of nitrate toxicity to aquatic animals suggests a maximum of 2 mg/L would be appropriate for protection of sensitive freshwater species (Camargo et al. 2005). Worcester et al. (2010) suggested a tentative guideline value of 1.0 mg/L nitrate (as N) to screen for aquatic life use protection in California central coast waters. For human health, the US National Primary Drinking Water Regulations establish a maximum contaminant level of 10 mg/L for nitrate (as N) (40 CFR §141.50), however Camargo et al. (2005) note that this level can affect freshwater invertebrates, fishes (including salmonids) and amphibians with long-term exposure.

Site PAC1 is characterized by slow moving water in summer, with decaying vegetation such as leaves at the site location, as well as extensive emergent aquatic vegetation and ponding upstream. During two consecutive months in fall 2022, staff observed algae cover greater than 30% and dissolved oxygen well below the 5 mg/L minimum benchmark at South Kehoe Creek site PAC1. Subsequent monitoring and sampling for analysis of nutrients was conducted during monthly site visits in October and December, as well as during a triggered assessment mid-November. Nitrate (as N) was below the laboratory detection limit of 0.40 mg/L in October and November, while ammonia (as N) exceeded the 1 mg/L benchmark and DO remained under the minimum benchmark for both sample events. This changed somewhat the following month with December 6, 2022 results for nitrate of 3.3 mg/L, ammonia down to 0.48 mg/L, and an increased DO reading of 4.37 mg/L (though still below the minimum benchmark). Algae cover also dropped below 30% in November 2022 and remained low through spring monthly sampling (Table 28). During subsequent six week assessment in January-February of 2023, site PAC1 DO results were all within the benchmark range.

Table 28. Algae cover estimates, dissolved oxygen, and nutrient results with subsequent triggered sampling at site PAC1 in WY2022-WY2023.

Site ID	Date	Dissolved Oxygen (mg/L)	Nitrate as N (mg/L)	Ammonia as N (mg/L)	Trigger	Comment
PAC1	8/2/2022	0.82			**Algae cover >30% < DO benchmark 2 consecutive months**	Very low flow, clear water, sulfur smell. Dense vegetation, algal growth on detritus in water.
	9/6/2022	0.71				Slow moving water regularly ponded upstream of site with dense aquatic vegetation
	9/20/2022	0.58				Sulfur smell, decomposing plant leaves and material in water
PAC1	10/4/2022	1.11	<0.40	1.7	< DO benchmark > Ammonia as N benchmark	Low flow conditions, clear water
PAC1	11/1/2022	1.69	<0.40	1.6	< DO benchmark > Ammonia as N benchmark	Algae cover <30%
PAC1	12/6/2022	4.37	3.3	0.48	Algae cover <30% < DO benchmark < Ammonia benchmark	No noticeable algae, stream not channelized
Six-week assessment begins to further inform						

< Substitution of Lower Quantification Limit due to result being left-censored

At Abbotts Creek site ABB1, algae cover greater than 30% and dissolved oxygen below the 5 mg/L minimum benchmark were recorded for two consecutive months in September and October of 2022 (Table 29). During this time, low flow conditions were present, with water pooled at the downstream end of the culvert under Pierce Point Road where samples are taken. In September no flow was evident at the site. Subsequent monitoring and sampling for analysis of nutrients was conducted during the next monthly site visit in November. Nitrate (as N) was below the laboratory detection limit of 0.40 mg/L and ammonia (as N) was below the laboratory detection limit of 0.20 mg/L, while DO had increased to 5.7 mg/L, which is above the minimum benchmark, though algae was still noted as present at cover greater than 30%. The following monthly DO result on December 6, 2022 was again within benchmark range at 9.81 mg/L and there was increased stream flow from rainfall with no visible algae. During subsequent six week assessment in January-February of 2023, site ABB1 DO results were all within the benchmark range.

Table 29. Algae cover estimates, dissolved oxygen, and nutrient results with subsequent triggered sampling at site ABB1 in WY2022-WY2023.

Site ID	Date	Dissolved Oxygen (mg/L)	Nitrate as N (mg/L)	Ammonia as N (mg/L)	Trigger	Comment
ABB1	9/6/2022	1.60			**Algae cover >30% < DO benchmark 2 consecutive months**	No flow exiting culvert, orange algae
	9/20/2022	3.62				Low flow, orange algae
ABB1	10/4/2022	3.12				Low flow, orange algae
ABB1	11/1/2022	5.7	<0.40	<0.20	Algae cover >30% > DO benchmark	Orange algae
ABB1	12/6/2022	9.81			Algae cover <30% > DO benchmark	High velocity, turbid, no visible algae
Six-week assessment begins to further inform						

< Substitution of Lower Quantification Limit due to result being left-censored

Tomales Bay TMDL (Monitoring Program 6)

Under Monitoring Program 6 (Tomales Bay watershed TMDL) six sites in the Olema Creek watershed are visited weekly for a five week period in both winter and summer (see Strategy for map and site descriptions). During WY2022 monitoring did not take place during the winter, but the six sites were visited in the summer, while in WY2023 sites were visited in both winter and summer. In summer of WY2022, one out of six sites, OLM11 at Bear Valley Road bridge, exceeded the TMDL five-week geomean benchmark for fecal coliform in Tomales Bay tributaries (Table 30). Staff were unable to sample site OLM18 on July 12, 2022 due to safety concerns surrounding an active wasp nest in the immediate vicinity.

In winter of WY2023 the two sites furthest downstream (OLM11 and OLM10B) did not meet the TMDL five-week geomean benchmark for fecal coliform. These sites had relatively higher readings of 920 MPN/100mL in the first week of sampling as compared to the subsequent weeks, a pattern also observed at five of the six sampled sites (Table 31). Daily precipitation recorded nearby at Mount Barnaby RAWS on the January 9, 2023 sample date was greater than two inches, and it was preceded by two additional greater than two inch rain events on January 4 and January 7, with lesser extents of rain on the days in between. The two sites with exceedances of the five-week geomean are located downstream of development in the town of Olema, CA. There was only one active grazing operation on NPS lands in the upper eastern portion of the watershed during the monitoring period.

For the summer 2023 five-week assessment the geomean was below the fecal coliform benchmark at all sites (Table 32). Unlike the drought conditions of summer 2022, flow persisted at all sites throughout the summer 2023 sample period.

Table 30. Five week summer assessment fecal coliform results with five-week geometric means for Olema Creek watershed water quality sites collected during WY2022.

Fecal coliform (MPN/100mL)

Watershed	Olema Creek					
2022	**OLM18 (WS11)**	**OLM1 (WS12)**	**OLM14 (WS13)**	**OLM6A (WS14)**	**OLM11 (WS15)**	**OLM10B (WS16)**
Jul 5	2.0	110	3300	2.0	540	49
Jul 12	---	4.5	79	33	540	79
Jul 19	1.8	11	46	26	350	<1.8
Jul 26	<1.8	7.8	110	9.3	240	No flow
Aug 2	79	<1.8	70	4	79	No flow
Geomean:	**5**	**9**	**156**	**9**	**287[E]**	**--**

---Not collected
< Substitution of Lower Quantification Limit due to result being left-censored
[E] Geomean exceeds TMDL fecal coliform benchmark of 200 MPN/100mL

Table 31. Five week winter assessment fecal coliform results with five-week geometric means for Olema Creek watershed water quality sites collected during WY2023.

Fecal coliform (MPN/100mL)

Watershed	Olema Creek					
2023	**OLM18 (WS11)**	**OLM1 (WS12)**	**OLM14 (WS13)**	**OLM6A (WS14)**	**OLM11 (WS15)**	**OLM10B (WS16**
Jan 9	540	130	350	540	920	920
Jan 17	240	110	49	70	220	79
Jan 23	79	79	130	130	140	240
Jan 30	49	79	240	170	130	240
Feb 6	70	240	170	49	170	110
Geomean:	**129**	**116**	**156**	**133**	**229[E]**	**215[E]**

[E] Geomean exceeds TMDL fecal coliform benchmark of 200 MPN/100mL

Table 32. Five week summer assessment fecal coliform results with five-week geometric means for Olema Creek watershed water quality sites collected during WY2023.

Fecal coliform (MPN/100mL)

Watershed	Olema Creek					
2023	**OLM18 (WS11)**	**OLM1 (WS12)**	**OLM14 (WS13)**	**OLM6A (WS14)**	**OLM11 (WS15)**	**OLM10B (WS16)**
Jul 5	170	2.0	33	33	130	33
Jul 11	240	7.8	240	23	170	110
Jul 18	79	17	79	11	350	34
Jul 25	13	2.0	46	17	79	79
Aug 2	11	22	22	9.3	4.5	13
Geomean:	**54**	**7**	**58**	**17**	**77**	**42**

Notable Events and Activities

WY2023 Lagoon Breach Events

Both Kehoe Lagoon (site PAC3) and Abbotts Lagoon (containing site ABB4) experienced breach events in winter of 2023. Though site ABB4 is in the outer chamber of Abbotts Lagoon, it is still over 0.5 kilometers (1/3 mile) from the westernmost edge of the lagoon at the breach point, which is not fully visible from the sample location. As such, this event was not well documented during water quality site visits (though it likely occurred during the early January 2023 atmospheric river events with similar timing to Kehoe Lagoon, and no later than January 15th based on local reports). In contrast, at Kehoe Lagoon which is much smaller, the connection to the ocean is visible from site PAC3. There, the lagoon breached in January before the site visit on the 10th and remained in this state until approximately May of 2023 when it began to build back into a lagoon (see Figure 29-Figure 32).

Figure 29. Site PAC3 looking west toward the Pacific Ocean on December 6, 2022.

Figure 30. Site PAC3 looking west toward the Pacific Ocean on January 10, 2023 after breach.

Figure 31. Site PAC3 looking west toward the Pacific Ocean on March 7, 2023.

Figure 32. Site PAC3 looking west toward the Pacific Ocean on June 6, 2023.

Tule Elk Activity at Site DES3

An uptick in tule elk use of the area surrounding site DES3 on Home Ranch Creek was noted beginning in June of 2022. Bedding near the area, scat, and animal trails crossing the stream were observed regularly during field visits, as well as other activities such as riparian tree scraping with antlers (see Figure 33-Figure 35 for examples). This area is not grazed by cattle.

Figure 33. Animal trail at site DES3 on Home Ranch Creek October 4, 2022.

Figure 34. Example of tree scraping and bedding near site DES3 on Home Ranch Creek observed August 2, 2022.

Figure 35. Tule elk just outside the riparian zone at site DES3 on Home Ranch Creek (left) observed June 6, 2023.

Conclusions

This preliminary period of water quality monitoring on the Point Reyes Peninsula will help characterize basic water chemistry, water clarity, pathogenic indicator bacteria and nutrients (for a subset of sites) within Point Reyes National Seashore streams and surface waters. Most of these results have allowed for comparisons of data to established objectives, regional reference values, or ecological thresholds, referred to as benchmarks in this report. Accumulation of these data will position managers to perform trends analyses in the future. Continued assessment monitoring in the Tomales Bay Watershed will also allow for determination of whether pathogenic indicator bacteria concentrations are meeting regulatory objectives under the TMDL.

During the preliminary sample period spanning WY2022 - WY2023, the monitoring programs produced a snapshot of water quality conditions in four Point Reyes National Seashore watersheds. Staff characterized existing ranges for the monitored parameters in the Abbotts Lagoon-Frontal Pacific Ocean, Drakes Bay, and Drakes Estero watersheds. Continued assessment monitoring also occurred at two recreational beach sites and six sites in the Tomales Bay watershed. Owing to variables such as annual rainfall fluctuations, and the implementation of management activities intended to improve water quality in some of these locations, additional years of monitoring will be required to perform robust analyses for trends in water quality, and to address the question of whether or not water quality in the Point Reyes National Seashore coastal watersheds is improving over time.

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APPENDIX A

Detailed Description of Monitoring Area Watersheds

Abbotts Lagoon-Frontal Pacific Ocean Watershed

Spanning the western portion of the Point Reyes Peninsula, the Abbotts Lagoon-Frontal Pacific Ocean watershed encompasses numerous small coastal drainages, as well as the subwatersheds of Abbotts Lagoon and Kehoe Creek, each of which contain larger perennial streams. Tomales Point includes several small spring fed perennial drainages, including McClures Creek. The watershed contains approximately 43.2 km^2 (10,677 acres) of land area managed by NPS, of which 59.8% (6,387 acres) is under grazing lease/permit. Drainages generally flow east to west emptying to the Pacific Ocean, with Abbotts Lagoon and Kehoe Lagoon forming at the outlets of these two larger coastal streams. Sustained flow occurs during winter, but drainages are subject to very low flow, ponding, and dry conditions in certain areas during the summer months. Groups of tule elk (*Cervus canadensis nannodes*) inhabit the Tule Elk Preserve on Tomales Point which includes McClures Creek, and small groups of males range across most of the remaining portion of the watershed outside the Preserve. There are a number of public trails in the watershed including McClures Beach Trail, Kehoe Beach Trail, and Abbotts Lagoon Trail. Visitors can access the Point Reyes Beach via parking areas at North Beach and South Beach, and the Point Reyes Lighthouse area on the southwestern tip of the peninsula is a popular visitor destination.

The Kehoe and Abbotts Lagoon watersheds consist primarily of mixed coastal grassland and scrub, areas of active agriculture such as cattle grazing and silage fields, and a small percentage of development associated with the ranch complexes, roadways and park trail heads. Dunes and coastal bluffs border the Pacific Ocean to the west. Inland of dunes, the most abundant soil types are Sirdrak sand, Kehoe loam, and Pablo-Bayview complex, with Rodeo clay loam predominating along drainages (USDA 2020). Portions of the drainages contain willow (*Salix* sp.) and California wax myrtle (*Morella californica*) riparian forest but are otherwise non-forested. The Abbotts drainages flow across gently sloping terrain, while the upper Kehoe and Tomales Point drainages are somewhat steeper, with areas of gullying.

Management changes in this watershed have included documented implementation of nearly 50 management activities on ranchlands, for the purpose of improving resource conditions, and closure of the McClure Dairy at I Ranch in summer 2021. Six of the eight long-term monthly coastal monitoring sites are located in the watershed.

Drakes Estero Watershed

Drakes Estero is the largest watershed in the monitoring area. It contains ranching activities and wilderness designation, encompassing the waters of the Estero and the lands in the eastern portion of the watershed. The watershed contains approximately 63.4 km^2 (15,670 acres) of land area managed by NPS, of which 50.6% (7,933 acres) is under grazing lease/permit. Major perennial waterways flowing north-south to Drakes Estero include Schooner Creek, Home Ranch

Creek, and Muddy Hollow Creek, which are habitat for the federally threatened steelhead trout (*Oncorhynchus mykiss*). These sub-watersheds contain steep bishop pine (*Pinus muricata*) forest and dense scrub in the upper portions, dominated by loamy soils or Pablo-Bayview complex, which drain to flatter willow and red alder (*Alnus rubra*) riparian forest on Rodeo clay loam and Tomales fine sandy loam (USDA 2020) surrounded by coastal grassland and open to dense scrub. Tule elk males range from the wilderness through to the Abbotts Lagoon-Frontal Pacific Ocean Watershed and small female groups have been seen regularly bedding down and grazing on Home Ranch, including the area adjacent to Home Ranch Creek. There are numerous public trails in the watershed including Estero Trail, Bull Point Trail, and Muddy Hollow Trail. The watershed also includes access to Drakes Estero for activities such as kayaking and Limantour Beach, a popular recreation area. Management changes in this watershed have included documented implementation of 28 management activities on ranchlands with the goal of improving resource conditions. Two of the eight long-term monthly coastal monitoring sites, as well as the Drakes Estero recreational sampling site are located in the watershed.

Drakes Bay Watershed

On the southeastern end of the Point Reyes Peninsula, the Drakes Bay watershed encompasses small coastal drainages that run west to east, three of which originate near the developed complex of dairy operations. The watershed contains approximately 13.0 km^2 (3,201 acres) of land area managed by NPS, of which 57.5% (1,842 acres) is under grazing lease/permit. The land area consists primarily of mixed coastal grassland and scrub and a small percentage of development associated with the ranch complexes, roadways and park trail heads. Coastal bluffs border Drakes Bay to the east. The most abundant soil types are Tomales-Sobega complex,, Tocaloma-McMullin complex, Tomales fine sandy loam, and Sirdrak sand, with Humaquepts seeped predominating along drainages (USDA 2020). Riparian forest, primarily willow (*Salix* sp.) is very limited in these small coastal drainages, which experience very low or no flow conditions in summer and fall. Popular visitor destinations include Drakes Beach and the Ken Patrick Visitor Center as well as Chimney Rock, on the southeastern tip of the peninsula. Tule elk inhabit the coastal grasslands above Drakes Beach, with males wandering further south along the peninsula. The beaches are inhabited by northern elephant seals (*Mirounga angustirostris*), which have been increasing in population since their return in the early 1970s. The largest concentrations occur during the winter birthing and mating season, as well as the spring molting season. Management changes in this watershed have included documented implementation of 10 management activities on ranchlands for the purpose of improving resource conditions. The Drakes Beach recreational sampling site is located in the watershed.

Tomales Bay Watershed

The Tomales Bay Watershed encompasses almost 140,800 acres. Tomales Bay itself is an approximately 12-mile-long flooded valley, covering 6,912 acres straddling the San Andreas Fault. Most of the freshwater delivered to Tomales Bay originates in two major subwatersheds: Lagunitas Creek and Walker Creek. The Lagunitas Creek watershed, which includes drainage from Olema Creek, represents 52% (73,216 acres) of the overall Tomales Bay watershed and delivers about 65% of the freshwater input to Tomales Bay (Carson 2013). Approximately 10% of the freshwater input to Tomales Bay is delivered by the small drainages that line the east and

west shores of the bay. These small drainages represent 13% (18,304 acres) of the overall Tomales Bay watershed area. Approximately 93% of the Tomales Bay watershed is located outside NPS lands and includes the Walker Creek watershed to the northeast of Tomales Bay. The Walker Creek watershed encompasses 49,280 acres, represents 35% of the Tomales Bay watershed area, and contributes 25% of the freshwater delivery to Tomales Bay (Carson 2013). Combined, ranches under or recently under lease/permit (several have ceased operations in recent years) on NPS lands cover just over 7% (10,000 acres) of the total Tomales Bay watershed, including Lagunitas Creek (3,900 acres), Olema Creek (5,200 acres), and direct drainage to Tomales Bay (1,060 acres). No developed dairy complexes are in the Tomales Bay watershed.

Vegetation in the Olema Creek and Lagunitas Creek watersheds where sampling occurs consists primarily of mixed evergreen forest including Douglas fir (*Pseudotsuga menziesii*), California Bay Laurel (*Umbellularia californica*), and Coast Live Oak (*Quercus agrifolia*), interspersed with annual grassland and scrub. The westernmost portion along Inverness Ridge is primarily forested, while elsewhere in the watershed grassland and scrub occupies the areas between forest-dominated drainages. The bottomland portions of these drainages contain more willow and in some areas are not as heavily vegetated with woody species. The dominant soil types are Cronkhite-Barnabe complex, Centissima-Barnabe complex, Tocaloma-Saurin association, and Palomarin-Wittenberg complex on the westernmost portion.

The RWQCB has listed Tomales Bay and its major tributaries, including Lagunitas Creek and Olema Creek, as impaired for nutrients, pathogens, and sedimentation/siltation under section 303(d) of the Clean Water Act. In 2005, the Tomales Bay Watershed pathogen TMDL was developed in response to monitoring that showed exceedances of the bacteria numeric standard for the uses of shellfish harvesting and recreation (Ghodrati and Tuden 2005). A TMDL for sediment in Lagunitas Creek and an implementation plan to achieve the numeric sediment targets was completed in 2014 (RWQCB 2023).

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APPENDIX B
Detailed Description of Methods

Sample Parameters

Sampling events included the measurement of field data on site by NPS staff and partners, and collection of samples for laboratory analysis depending on the Monitoring Program. Core parameters measured in the field included temperature (air and water), dissolved oxygen, pH, specific conductance, salinity, and turbidity. Pathogenic indicator bacteria types included *E. coli*, enterococci, and fecal coliform. Nutrient parameters included nitrate (as N) and ammonia (as N). Analysis methods for these parameters are listed in Table B-1. The sampling methodology was adapted from the San Francisco Bay Area Network Freshwater Quality Monitor Protocol (Cooprider and Carson 2006). In addition to these water quality parameters, field personnel recorded a qualitative observation of discharge and took a photograph at each site.

Table B-1. Water quality collection and analysis methods.

Parameter	Method
Core parameters	Measured on site with a YSI ProPlus or YSI ProDSS, with exception of turbidity (measured using Hach 2100P portable turbidimeter)
Escherichia coli	SM 9223B
Enterococci	SM 9230D
Fecal coliform	SM9221E
Ammonia (as N)	SM 4500-NH3 B,G
Nitrate (as N)	EPA method 300.0

Data Handling and Analysis

Shortly after collecting field data, staff reviewed datasheets and laboratory reports for errors and entered the proofed data into the NPSTORET database. NPSTORET is a Microsoft Access database created and maintained by the NPS Water Resources Division specifically for water quality data. Each database entry received quality control verification by a second staff member. (detailed description of the database available https://www.nps.gov/subjects/protectingwater/vital-signs-monitoring.htm).

Alpha Analytical Laboratories Inc., or McCampbell Analytical Inc. processed all nutrient samples. Any results reported as below the reporting detection limit (RDL) were entered into the database as “non-detect” and considered “censored” for data reporting. The laboratory RDLs for parameters (ammonia [as N], nitrate [as N]) fluctuated occasionally.

Cel Analytical Inc., or Alpha Analytical Laboratories Inc. processed most assessment fecal indicator bacteria samples. Samples collected under the recreational beach monitoring program were processed by the Napa-Solano-Yolo-Marin-Mendocino County Public Health Laboratory. NPS Inventory and Monitoring staff processed most monthly (Monitoring Program 2)

Escherichia coli samples (except during assessment monitoring periods) and some triggered samples with the Quanti-Tray system developed by IDEXX Laboratories, Inc. The Quanti-Tray method has a range of quantification of 1 - 2,419 MPN/100mL for undiluted samples, 10 - 24,190 MPN/100mL for samples run at a 10x dilution, and 100 - 241,900 MPN/100mL for a 100x dilution. These ranges are defined by the lower and upper quantification limits. Bacteria results reported as below the lower quantification limit (LQL) were entered into the database as "non-detect" while those reported as above the upper quantification limit (UQL) were entered as "present >QL". During the reporting period, NPS Inventory and Monitoring staff processed all samples at a 10x dilution.

Quality Control

Staff calibrated field equipment at the beginning of each sampling day, performing a three-point calibration (i.e., utilizing three buffers of different values) for all pH sensors, a one-point calibration for conductivity (specific conductance), and a one-point calibration for dissolved oxygen (utilizing the water-saturated air method). Staff performed calibration checks immediately following each calibration, and again at the end of the field day to monitor fouling and drift, and to ensure that the instruments stayed within the calibration acceptance criteria of each parameter (+/- 0.2 pH units, +/- 5% for dissolved oxygen saturation, and +/- 5% for specific conductance). If any parameter failed a post-field drift check, staff flagged all corresponding results from that entire field day as rejected.

To assess precision, staff collected samples for each parameter in duplicate, typically once per sampling event, with the exception of Monitoring Program 4, for which duplicates were collected monthly. The locations of duplicate samples were selected randomly for each day and duplicates were submitted to the laboratory as blind. NPS Inventory and Monitoring staff maintained detailed laboratory logs (paper and digital) to document sampling time, holding time, lab processing time/temperature details, incubation time, as well as bacteria quantification results. The laboratory quality control measures include chain of custody documentation for transfer of samples, matrix spikes, method blanks, laboratory control spikes, and the use of a variety of calibration standards. All data entered into NPSTORET were verified by a second staff person.

The Strategy adopted the quality control Standard Operating Procedures (SOPs) of the *SFAN Freshwater Quality Monitoring Protocol*; additional quality control information applicable to the Strategy can be found in this protocol and its corresponding Quality Assurance Project Plan (Cooprider and Carson 2006).

Measurement Quality Objectives

The Strategy has adopted the same measurement quality objectives (MQOs) that were established within the San Francisco Bay Area Network Freshwater Quality Monitor Protocol SOPs (Cooprider and Carson 2006). There are MQOs for calibration acceptance, precision, and systematic error. Measurement of systematic error (reported as percent recovery) is a measurement of the accuracy of the laboratory procedures and equipment, which is determined by conducting matrix spikes or laboratory control spikes, to test a known value of a particular

analyte. The MQO for systematic error varies for each parameter, as follows: 70 – 130% for ammonia and (as N); 75 – 125% for nitrate (as N).

The MQOs for precision are defined in the *SFAN Freshwater Quality Monitoring Protocol* (Cooprider and Carson 2006) as the acceptable thresholds of relative percent difference (RPD), calculated from the duplicated quality control sample sets. The precision MQO for nitrate (as N) and ammonia (as N) is +/- 30% RPD. The MQO for total coliform is +/- 60% RPD; an MQO was not established for *E. coli*, but it can be assumed to be 60% as well.