Visitor Use Monitoring Program for Golden Gate National Recreation Area






Images: National Park Service, Golden Gate National Recreation Area

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CHAPTER 1: INTRODUCTION

Overview

Background

This document presents the background, purpose, approach and methods for collection and analysis of visitor use monitoring data in selected units of Golden Gate National Recreation Area (GGNRA). According to the Park Purpose Statement (National Park Service 2015), GGNRA was established "to offer national park experiences to a large and diverse urban population, while preserving and interpreting the park's outstanding natural, historic, scenic, and recreational values." Carrying out this purpose effectively requires information on both visitation and resource conditions. The indicators and measures described in this document are the foundation of a monitoring program to support the sustainability and long-term management of park recreational resources and visitor experiences at GGNRA, as well as to protect visitors, staff, and wildlife. The monitoring program was designed in part to document compliance with existing Code of Federal Regulations (CFRs) and other applicable policies in GGNRA, as well as to monitor visitor behaviors that could lead to unacceptable impacts[1] or impairments[2] to park resources and values.

> *"Monitoring can generally be defined as the repetitive measurement of a specified set of variables at one or more locations over an extended period of time according to prearranged schedules in space and time." (Vos et al. 2000, p. 318)*

Through a multi-year process, beginning in 2016, our team (Oregon State University faculty and key personnel from GGNRA) developed an exhaustive list of conditions of interest and potential indicators, matched issues and indicators to specific park units, and explored the feasibility and utility of different measures for each indicator. Ultimately, we selected a limited set of indicators and measures that could enable park staff to determine if the park is approaching unacceptable impacts or eventual impairments to selected park values and resources. Data from this monitoring can be used by park management and law enforcement personnel to determine when, where, and how to prioritize actions to efficiently and effectively address

[1] According to the NPS (USDI, 2006), "the impact threshold at which impairment occurs is not always readily apparent. Therefore, the Service will apply a standard that offers greater assurance that impairment will not occur. The Service will do this by avoiding impacts that it determines to be unacceptable. These are impacts that fall short of impairment, but are still not acceptable within a particular park's environment. Park managers must not allow uses that would cause unacceptable impacts; they must evaluate existing or proposed uses and determine whether the associated impacts on park resources and values are acceptable" (p. 12).

[2] According to the NPS (USDI, 2006), "the impairment that is prohibited by the Organic Act and the General Authorities Act is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values. Whether an impact meets this definition depends on the particular resources and values that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts" (p. 11).

noncompliance and to prevent impacts from approaching unacceptable levels that later could lead to impairment. The protocols are also adaptable for use at other park units.

This document is intended to provide a complete presentation of the process and results of work conducted between 2017 and 2022 to identify indicators, refine and test protocols, and establish a sampling plan for field data collection. It synthesizes extensive document reviews, meeting notes, and fieldwork results. A companion field guide with instructions for monitoring for each measure is presented in Hall et al. (2022). This overview of the monitoring program includes the following sections: in the remainder of Chapter 1, we briefly describe the geographic, ecological, recreational, and cultural contexts of GGNRA to help situate the monitoring program. This is followed by a discussion of the purpose of monitoring, the "indicators, measures, and threshold" approach used by the National Park Service (IVUMC 2019), and general requirements for rigorous and high-quality monitoring processes. The section ends with a discussion of the various tradeoffs involved with different approaches to monitoring. In Chapter 2, we describe the process used to select indicators and present the final list of indicators and measures. Further, we describe the process used to develop and validate the protocols, as well as general limitations of the monitoring program. Chapter 2 also provides an overview of the recommended approach to sampling. In Chapter 3, we explain the steps for collecting monitoring data, including field season preparation activities, data collection preparations, and field procedures. An overview and contextual details regarding each field protocol are discussed, including limitations associated with each measure. The chapter concludes with an overview of change management. In Chapter 4, we recommend practices for data entry and quality control. We also provide an overview of the use of software for data analysis, as well as a recommended reporting schedule and format of reports. A suggested template for a regular monitoring report is included as an Appendix.

Physical and Cultural Context of GGNRA

Golden Gate National Recreation Area is one of the world's largest urban national parks. The park hugs the California coastline for nearly 80 miles in and around San Francisco in 37 total units (nps.gov/goga). Established by Congress in 1972 as part of a movement known as "Parks to the People," the park has grown in size to more than 80,000 acres (NPS 2017a) and includes under its management two additional National Park Service units—Fort Point

The purpose of Golden Gate National Recreation Area is to offer national park experiences to all, including a large and diverse urban population, while preserving and interpreting the outstanding natural, historic, scenic, and recreational values of the park lands.

NPS. 2017a. Foundation Document Overview: Golden Gate National Recreation Area

National Historic Site and Muir Woods National Monument. The park's lands are located in three counties—Marin, San Francisco, and San Mateo – with inholdings held by other agencies and private owners incorporated in the park's boundaries. Some units are quite urban and surrounded by residential neighborhoods, while others are more remote and contain large expanses of relatively undeveloped natural habitat.

GGNRA is part of the United Nations-designated Golden Gate Biosphere Reserve. It includes world-renowned visitor destinations such as Alcatraz Island and Muir Woods. Other destinations of regional and national importance include the Marin Headlands, Stinson Beach, Fort Mason, Ocean Beach, and Mori Point, as well as newly acquired lands at Phleger Estate and Rancho Corral de Tierra. For this monitoring project, we focused on 20 park units based on managerial need, which will be discussed later in this document.

For those who live and work in the Bay Area, the park is their "backyard" national park: the place where they surf, walk the dog, go for a run, or bring their kids to explore nature. The park also attracts visitors from across the country and around the world; prior to the COVID-19 pandemic, a total of more than 15 million people annually (National Park Service 2023)—third most among all national parks in the country—were drawn to the unparalleled recreational opportunities, stunning natural beauty, and riveting stories.

Parks in the San Francisco Bay region, including Golden Gate, house an amazing richness of biological diversity due to the variety of habitats and unique geology of the area. The 19 types of ecosystems represented in GGNRA support more than 1,200 plant and animal species, including more than 250 bird species (National Park Service 2015). There are 37 federally threatened and endangered species within Golden Gate's legislative boundaries, including the endangered mission blue butterfly, the endangered San Bruno elfin butterfly, and the federally threatened western snowy plover, which overwinters at Ocean Beach and Crissy Field marsh.

The GGNRA's decades-long habitat restoration programs engage interested individuals, corporations, and youth groups in conservation projects, such as invasive plant removal, natural area revegetation, and native horticulture, to bring back native vegetation and ecological functioning. Efforts have been concentrated on wetland and dune communities, and some projects – like the Crissy Field marsh restoration – have been very extensive. This work is described in more depth under individual site descriptions in Chapter 2.

In recognition of their diverse ecosystems, historic and cultural resources, and range of recreational opportunities, the units were zoned in the General Management Plan (NPS 2014) to provide different facilities, levels of development, and protection of natural and cultural resources (Table 1).

Table 1. Resource Zones and Characteristics of GGNRA Park Units

Resource Zone	Summary of Setting Characteristics	GGNRA Locations
Diverse Opportunities Zone	Provides a range of settings and facilities, with a wide range of educational, interpretive, and recreational opportunities. Rare natural resources are preserved.	Fort Funston trails North Ocean Beach Great Meadow Stinson Beach Tennessee Valley Trailhead Oakwood Valley Trailhead Bobcat/Miwok/Rodeo Trailhead
Scenic Corridor Zone	Trails, roads, coastlines provide sightseeing and relaxation. Resources can be modified.	Nearshore Bay & Ocean Conzelman Road Panoramic Highway Milagra Ridge -- ridgetop
Evolved Cultural Landscape Zone	Preserves significant historic, archaeological, architectural, and landscape features while being adaptively reused for contemporary needs.	Kirby Cove Lands End & Fort Miley Upper Fort Mason Seacoast Fortifications
Historic Immersion Zone	Preserves historic sites, structures, and landscapes. Immerses visitors in the historic setting and provides direct contact with cultural resources.	Alcatraz Island Nike Missile Launch Site
Natural Zone	Retains natural, wild, and dynamic characteristics and functions of ecosystems. Preserves resource integrity, while providing backcountry types of experiences. Offers modest facilities, and in some cases access is controlled.	Tennesee Valley Gerbode Valley Alta Slacker Ridge Muir Beach Rancho Corral de Tierra Ocean Beach: south Oakwood Valley Fort Funston (perimeter, N beach) Milagra Ridge -- lower Sweeney Ridge Mori Point
Sensitive Resources Zone	Monitors and protects highly sensitive natural resources under the highest level of protection. Access highly controlled.	Rodeo Beach Lagoon Muir Beach Lagoon Selected Coastal Areas Crissy Field WPA
Park Operations Zone	Provides developed facilities for park and partner operations and maintenance. Visitor access is controlled and limited	Upper Fort Mason East Fort Miley Fort Funston – SE corner

Source: NPS (2015). *General Management Plan. Summary Edition*. Note that Baker Beach, Fort Baker, and Sutro Heights were not associated with zones within the GMP and therefore are not included in the table.

In addition to its rich natural heritage, the park chronicles thousands of years of history, from Native American culture (primarily Coastal Miwok and Ohlone), the Spanish Empire frontier and the Mexican Republic, to maritime history, the California Gold Rush, the evolution of American coastal fortifications, and the growth of urban San Francisco (National Park Service

2017a). The park contains five National Historic Landmark Districts, 13 properties on the National Register of Historic Places, seven National Register-eligible properties, nine documented cultural landscapes, 365 identified and over 500 predicted archeological sites, and one of the largest museum collections in the National Park Service. A Park Archives and Records Center is available to the public by appointment or during regular walk-in research hours.

Recreational Context of GGNRA

The variety of park resources within San Francisco and the greater Bay Area provides an abundance of recreational and educational opportunities. Since its designation, GGNRA was envisioned as a park to provide a national park experience and resources to an underserved urban population (NPS 2014). GGNRA draws visitors from around the Bay Area and increasingly internationally (Solop 2019). In addition, GGNRA acts as a neighborhood park for those who live adjacent to park lands. GGNRA offers a range of recreational opportunities, from hiking and mountain biking single track trails, to surfing and kite boarding, to touring historic structures.

Educational facilities and activities are supported at several sites, including Fort Funston, Crissy Field, and Rodeo Beach (Fort Cronkhite). These offer robust schedules of programs for K-12 youth, including both day and overnight excursions. When using GGNRA sites for educational activities, these programs often encounter recreational visitors.

Permanent vehicle counters are installed at several GGNRA sties, giving information on the absolute and relative amounts of use at them. Table 2 presents data on traffic counts collected in 2019, for those GGNRA sites with traffic counters, from the National Park Service's Visitor Use Statistics program (NPS 2023). The numbers have been adjusted to represent only entering vehicles. In addition to recreational vehicles, these numbers include employee and non-recreational vehicles, although those make up a very minor portion of overall visitation. Inspection of the data shows that vehicular visitation to the individual park units varies considerably, though all receive more than 100,000 vehicles per year. (Additionally, some of the sites experience high levels of visitation from people entering from adjacent neighborhoods by foot or bicycle, which is not captured in the data.) Use tends to be high through much of the year (Figure 1), though it drops off in winter months of November to February.

Table 2. Annual Traffic Count at Selected GOGA Locations, 2019

Location	Traffic Count
East Beach Parking (Crissy)	505,125
East Fort Baker Bunker Road	497,941
East Fort Baker East Road	271,212
Fort Funston	387,472
Muir Beach Entrance	133,732
Muir Beach Overlook	110,993
Rodeo Valley Bunker Road	416,368
Rodeo Valley Conzelman Road	448,076
Stinson Beach	186,644
Tennessee Valley Road	187,139
West Bluff Parking Lot (Crissy Field)	277,860
Baker Beach	363,517

Source NPS. (2023). Visitation Numbers. https://www.nps.gov/aboutus/visitation-numbers.htm

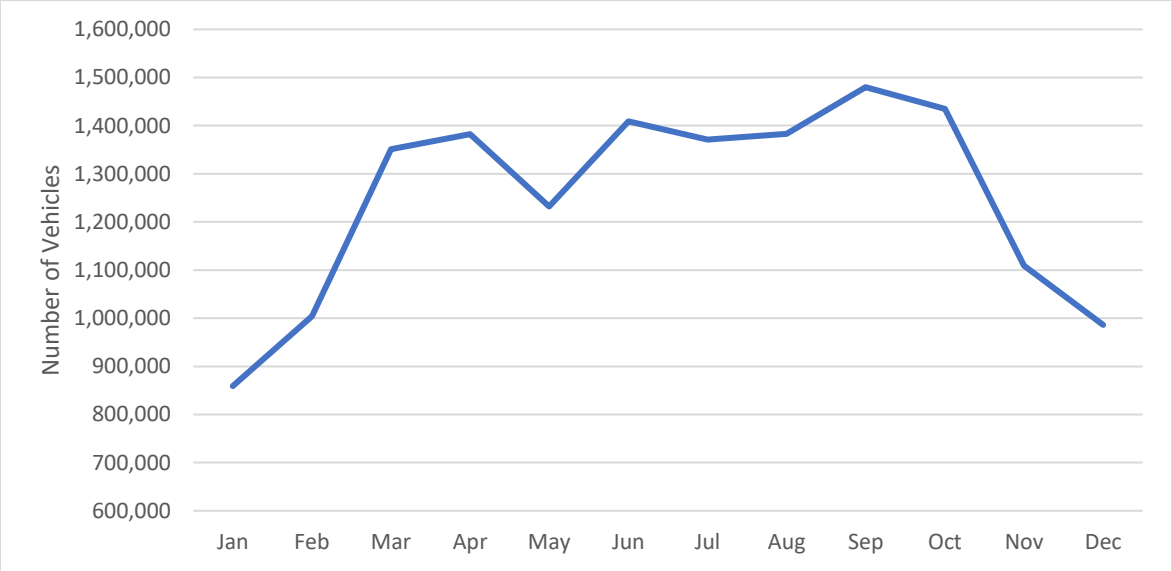


Figure 1. Golden Gate NRA Recreation Visits, by Month, 2019.
Source NPS. (2023). Visitation Numbers. https://www.nps.gov/aboutus/visitation-numbers.htm

A particularly unique aspect of GGNRA compared to other National Park units is its openness to managed dogs. Indeed, GGNRA's website touts its reputation as "the most dog-friendly National Park" in the United States. Dogs are permitted in many units, and in some cases are not required to be on leash. Additionally, GGNRA permits licensed commercial dog

walkers to bring dogs to any sites in Marin and San Francisco Counties where dogs are permitted. Commercial handlers may have up to six dogs per handler at any given time. Not surprisingly, then, dogs are quite commonly encountered in GGNRA sites, particularly locations with water access (like Crissy East Beach) or open areas for dogs to run (like Fort Funston). All dogs must be under voice control at all times in all locations and must be on leash in all parking lots and picnic areas. Additionally, handlers are required to remove dog waste. Table 3 presents the specific regulations and closures by county and site, as of 2023.

Most Dog-Friendly National Park ›

Learn more about where you can enjoy the park with your furry friends.

Source: https://www.nps.gov/goga/index.htm

Table 3. Dog Regulations within GGNRA Park Units

Regulation		
Closed to access	On-leash only	On-leash OR Voice Control
Marin County		
• Muir Beach Lagoon • Fort Baker – Chapel Steps Trail, Pier, Battery Yates • Rodeo Beach Lagoon	• Muir Beach – Kaashi Way & Coastal Trail • Oakwood Meadow Trail • Fort Cronkhite • Fort Baker • Coastal Trail – Hill 88 to Muir Beach • Miwok Trail • South Rodeo Beach Trail	• Alta Trail • Muir Beach – beach area • Oakwood Valley Trail • Rodeo Beach • Slacker Trail • Homestead Valley • Orchard Trail • Wolf Ridge Loop
San Francisco County		
• Crissy Field – Marsh and signed areas • Fort Funston – Habitat protection area • Torpedo Wharf	• Baker Beach – trail, picnic areas, beach access • Crissy Field – picnic areas, Wildlife Protection Area (seasonal) • Ocean Beach – south (snow plover protection area; seasonal) • Fort Mason • Sutro Heights	• Baker Beach – beach area • Crissy Field – airfield, east beach, central beach, promenade • Crissy Field – east lawn • Fort Funston • Lands End • Ocean Beach -- north
San Mateo County		
• Sweeney Ridge – Notch Trail	• Milagra Ridge trails • Mori Point trails • Rancho Corral de Tierra	

Overview of Monitoring Objectives and Approach

Development of this monitoring program focused on a variety of issues identified across GGNRA units. These will be described in more depth in Chapter 2, but in summary, they included visitor safety, compliance with regulations, resource damage in sensitive areas, and interruption of educational programming. Our approach to refining issues and recommending measures took into account the following considerations: the variety of user activity types at the park (especially pedestrians, bicyclists, equestrians, and dog walkers), the matrix of regulations within which the park works (e.g., site closures, dog waste pickup, and leash requirements), the natural resources at the park (e.g., vegetation and sensitive wildlife species), and the quality of user experiences (e.g., the potential for crowding or conflict, or non-compliance with regulations).

Draft indicators and their associated measures were developed to address the full range of visitor use and park resource management goals. The indicators themselves reflect national-level policy objectives articulated in the NPS's 2006 *Management Policies* (NPS 2006), the GGNRA General Management Plan (NPS 2014), the 1979 Pet Policy (NPS 1979), and relevant CFRs. However, they also reflect the professional judgment and priority concerns of GGNRA resource specialists and law enforcement personnel.

Best Practices in Monitoring

> *"Designing a monitoring project is like getting a tattoo: you want to get it right the first time because making major changes later can be messy and painful." (Oakley et al. 2003, p. 1000)*

Land managers have an obligation to evaluate changes in conditions of the lands they steward, as well as to assess the effects of management actions they take (Fancy et al. 2009; Kachergis et al. 2022). For recreational lands, such monitoring should typically include both social and biophysical conditions, particularly where founding legislation or agency policy calls for protection of natural resources and provision of high-quality recreational opportunities. According to the Interagency Visitor Use Management Council, "managing visitor access and use for recreational benefits and resource protection is inherently complex . . . It requires that managers analyze not only the number of visitors but also where they go, what they do, their impacts on resources and visitor experiences, and the underlying causes of those impacts" (https://visitorusemanagement.nps.gov/VUM/WhatIsIt). Such analysis requires data generated through systematic, repeatable monitoring of key variables. The monitoring program presented in this document provides GGNRA with a clear and consistent monitoring program and field protocols for implementation.

Well designed monitoring provides scientifically defensible and transparent information to guide management (Field et al. 2007; Levine et al. 2014; Oakley et al. 2003). Monitoring programs are one important way for managers to inform stakeholders and the public about the

status and trends in valued resources and experiences (Fancy & Bennetts 2012). Nevertheless, sustaining long-term monitoring is notoriously challenging, and success requires sustained buy-in and support from all levels within organizations (Fancy & Bennetts 2012). Fortunately, many case studies and reviews have converged on a suite of recommendations for establishing effective, efficient, and meaningful monitoring programs through a process of setting goals and objectives, identifying key attributes related to those objectives, establishing robust measures and field protocols, and creating procedures for analysis and reporting, as well as long-term adaptive management (see for example, IVUMC 2019; McCord et al. 2022; Reynolds et al. 2016; Stauffer et al. 2022).

Management objectives are broad, narrative statements defining the desired park resource and visitor experience conditions that a public land management agency wishes to be provided and maintained, which are often described in its land use plans (Manning et al. 2011). These include the condition of natural and cultural resources, the type and intensity of appropriate recreational experiences, and the type and degree of management actions. The zone descriptions from GGNRA's General Management Plan (Table 1) provide an initial, high-level overview that guided development of specific monitoring objectives. Chapter 2 goes into depth about the specific desired conditions and indicators developed for GGNRA.

Management objectives are broad, narrative statements defining the desired park resource and visitor experience conditions that a public land management agency wishes to be provided and maintained.

Recommended Approach to Developing a Monitoring Program

Defining the problem: Establishing goals and objectives. Managers are often tempted to "monitor everything" or simply amass easily collected data (Lindenmayer & Likens 2009; Vos et al. 2000). Such approaches rarely, and only by happenstance, lead to meaningful information that informs management. Instead, ample initial effort should go into defining why a monitoring effort is needed and how data generated from it might be used (IVUMC 2019; Stauffer et al. 2022). Typically, this involves establishing broad goals and specific objectives nested within them. It is often necessary to confer with resource specialists to understand the concerns and constraints associated with specific resources, such as endangered species (Fancy et al. 2009; Reynolds et al. 2016). It is also important to consider both public and agency views on the importance of different potential goals and objectives (Fancy & Bennetts 2012). As the initial, broad list of potential objectives is developed, refining it to a small number of key objectives may require consultation with statisticians and policymakers (Lindenmayer & Likens 2009). Both can help articulate sideboards related to the practicality of monitoring (e.g., sample size requirements that might be impractical or the public acceptability of taking action on a particular issue). Additionally, consulting the published literature can be very informative for

helping prioritize objectives and understand what monitoring protocols and data already exist (Manning et al. 2011).

Determining what to monitor. Goals and objectives must be translated into standardized, quantifiable forms for the purposes of monitoring (Kachergis et al. 2022). In the ecological literature, these are sometimes referred to as "attributes" of a system, "indicators" or "measures." Put simply, an indicator captures the relationship between broad land management objectives and measurable variables that are indicative of those objectives. Broad mandates are impossible to measure without properly operationalizing their content into something observable, quantifiable, and reliably documentable. For instance, the NPS's *Management Policies* (NPS 2006) state that the creation of "an unsafe or unhealthful environment for visitors or employees" (p. 12) is an unacceptable impact. Without specifying empirically measurable ways to operationalize "unsafe" and "unhealthful," park managers would be unable to know if the lands under their management were safe and healthful. Therefore, the first step in the process of operationalization is to identify indicators that faithfully and meaningfully reflect the intent of management policies.

An indicator captures the relationship between broad land management objectives and measurable variables that are indicative of those objectives.

When considering indicators, it is useful to cast a wide net initially, so that all potential alternatives receive adequate discussion and vetting (Fancy et al. 2009; Keeney & Gregory 2005). Ultimately, however, the planning team must select indicators that adequately capture the key issues and objectives of interest, while remaining feasible to implement (IVUMC 2019). In selecting the suite of indicators, managers should consider the following (Manning et al. 2011):

1) the diversity within the entire system (e.g., do the indicators adequately capture important differences within or between park units?);
2) an appropriate balance between resource and social values when these may be in conflict (e.g., trade-offs between allowing recreational access and protecting sensitive habitat);
3) the feasibility of implementation, considering the full set of indicators (e.g., equipment costs, travel time, data processing, and reporting); and
4) the equitable distribution of costs and benefits that would be associated with actions taken based on results of monitoring (e.g., would certain social groups be more disadvantaged than others from actions taken to mitigate specific conditions).

For the purposes of this report, we make a distinction between "indicators" and "measures." Indicators are specific conditions that have the potential to tell us something about the priority conditions described in goals and objectives. However, they must be transformed into measures for the purposes of data collection (Reynolds et al. 2016). That is,

they must entail both a unit of observation (the thing that is measured) and a unit of analysis (the data point included in analysis). An example helps illustrate this important distinction. An indicator might be "visitor density," which can be assessed with multiple measures. For instance, one might count the number of groups with dogs on-leash and off-leash in a particular area over a 10-minute period, where the unit of measure is the group of people traveling together. These data might be transformed into the percent of groups with dogs (the unit of analysis). In this case, the total number of groups seen (say, 10 groups with dogs on-leash and 10 groups with dogs off-leash during 10 minutes) is converted into a single data point: 50% of groups had their dogs on-leash during that observation session.

Properties of good measures. Indicators often have multiple potential measures (Reynolds et al. 2016). For example, an indicator for *compliance with commercial dog walking regulations* could be measured by (1) the number of commercial dog walkers in restricted areas per hour, (2) the percent of observed commercial dog walkers who have more than 6 dogs per handler, or (3) the number (or percent) of commercial dog walkers with their commercial use permit displayed as required. Each of these is measurable and speaks to the indicator of *compliance with commercial dog walking regulations*. However, the choice of the best measure involves several trade-offs, and the aim is to optimize the extent to which the selected one meets the criteria elaborated in Table 4. These criteria have been discussed in depth in several review papers, including Fancy et al. (2009), Fancy and Bennetts (2012), Ferretti (2009), Keeney and Gregory (2005), Lindenmayer and Likens (2010), Manning et al. (2011), and Reynolds et al. (2016). The choice of measure ultimately affects the cost of data collection, the skill required of data collectors and analysts, and the amount of data required (Reynolds et al. 2016).

Each potential measure should be explored in terms of each of the criteria in Table 4. Some will fulfill many of the criteria, while others may be better in some respects than in others. In our experience, the trade-off between what is easy to collect and what is meaningfully related to the condition of interest becomes an important point for discussion. For instance, visitors' perceptions of crowding cannot reliably be inferred from counts of people present, even though such counts are generally easy and inexpensive to make. Instead, the most directly related measure for crowding would be a survey question to query visitors directly about their experiences. However, surveys are expensive and time consuming, and in the case of federal agencies, require a lengthy approval process. Therefore, managers may sometimes decide – especially for initial monitoring – to use a measure that is coarser or less clearly related to the condition of interest than would be desirable. This is consistent with the "sliding scale" approach articulated in the IVUM Framework (IVUMC 2019).

Table 4. Criteria for Good Indicators and Measures

Criterion	Explanation	Poor Measure	Better Measure
Significant	Important and directly tied to desired conditions and management goals. Important to both the public and land managers. Easy to understand and explain.	Ocean water temperature	Concentration of *E. coli* in lagoon water
Specific	To the extent possible, should be specific, not vague or general.	Use density at the park is low, moderate, or high	Number of people at one time within a specific area
Objective	Accurately and unambiguously characterizes the phenomenon of interest. Implications of the data for management are clear.	Inferring visitor learning from time spent reading signs	Number of questions answered correctly on a quiz
Reliable and repeatable	Different observers reach the same determination when observing the same phenomenon, and measures can be made consistently over time.	Visual count of the number of groups with glass containers at Ocean Beach	The number of times per hour bicycles are seen at a trail junction where they are not allowed
Directly related to visitor use	For the purposes of visitor use monitoring, measures should be elements directly impacted by human use and focused on adverse outcomes of an activity rather than the activity itself.	Number of bicyclists and pedestrians using a trail at the same time	Survey-based measure of perceived conflict among activity types
Signal-to-noise ratio is high	Changes in values are primarily due to changes in system attributes and not natural variability or other unmeasured factors. Not subject to significant influence from other causes, enabling the effect of recreation to be isolated.	Large tree mortality in a campground (causes may be difficult to determine)	Percent of visitors who keep dogs on leash where this is required
Sensitive and anticipatory	Should be sensitive to use over relatively short time periods and therefore may serve as an early warning (before conditions deteriorate substantially).	Decline in populations of mission blue butterfly	Amount of pet waste present on or immediately adjacent to trails
Manageable	Responsive to management action; relates to things managers can control (vs. outside influences).	Air quality at urban park units	Number of visitor entries into closed protected habitats
Efficient and effective	Operational – can be implemented on a regular basis and does not require impractical levels of effort.	Detection of highly infrequent events through on-site observation	Number of vehicles at one time parked in parking lots that are regularly staffed
Value-added	Provides useful new information not captured in other measures; may be usable for multiple purposes	On-line, user-generated maps of visitation generated through apps	Soundscape monitoring (useful for visitor experience and wildlife protection)

Using the criteria in Table 4, some potentially useful measures of indicators might ultimately not be chosen for various reasons, such as poor reliability, high expense, or operational complexity. For example, unsafe bicycling speed could be measured by a human observer using a stopwatch to count the time it takes for a bike to pass through a pre-identified

transect. This example is measurable and speaks to the indicator of *compliance with bicycling regulations.* However, it could be unreliable because of the precision needed to time bicyclists coupled with errors that can be made by human observers. Related to expense, some measures might not be applied in remote, low-use areas due to the high costs associated with travel and personnel time that would need to be dedicated to such an endeavor, especially if conditions of interest rarely occur. Large numbers of zeros in a dataset can require complex statistical techniques (Reynolds et al. 2016) and require exorbitantly large datasets to detect trends with confidence. Ideally, if data collection will be done by various people with varying levels of expertise, it is important to consider skill and training needs. All other things being equal, measures should be chosen that do not require high levels of skill or expertise (Reynolds et al. 2016).

> *Choice of measurement is critical, affecting the cost of the monitoring program, skills required of observers, the sampling designs one might employ, the analytical methods that are appropriate, and, ultimately, learning." (Reynolds et al. 2016, p. 13).*

Once candidate measures have been identified for each indicator, the group of measures as a whole should be evaluated with some additional criteria. Ideally, they should capture all of the resource conditions, compliance issues, and visitor experience elements that were identified when establishing goals and objectives. That is, they should be comprehensive. At the same time, paradoxically, it is recommended that the final list be parsimonious (Fancy et al. 2009) – that is, it should include only strictly necessary measures. The temptation to add additional measures can quickly make monitoring impractical or too daunting to implement (Kachergis et al. 2022).

To facilitate the practical logistics of data collection, managers should consider whether different measures can be bundled, either in time or space (Fancy et al. 2009). At GGNRA, for example, it would be expedient to conduct monitoring at Marin County sites on the same days, to minimize travel time. Additionally, integrating monitoring into daily field operations should be prioritized (Fancy & Bennetts 2012). For example, to monitor a proxy for crowding, managers might choose to use twice-daily parking lot counts, which can be done by on-site staff, rather than administering a visitor survey.

Write protocols. Once measures have been defined, including their units of observation and analysis, field protocols are needed. These are essentially step-by-step recipes that contain all the information a person would need to carry out monitoring properly. A protocol establishes the standard operating procedures for when, when, and how to collect data (Oakley et al. 2003; Vos et al. 2000).

> *"Protocol development is an expensive, time-consuming process involving a research component. To promote consistency and data compatibility and to reduce costs, existing protocols developed by other programs and agencies should be adopted or modified whenever monitoring objectives are similar" (Fancy et al. 2009, p. 169).*

Many potential ecological and experiential measures already exist and have been described in the literature, so the first step is to determine whether existing protocols are adequate for current purposes (Fancy et al. 2009). For example, there are various protocols for the assessment of trampling of vegetation (Hammitt et al. 2015) or the presence and condition of social trails (D'Antonio & Hall 2016). Approaches for conducting visitor surveys to use questionnaire-based measures of experience quality are well established (e.g., Vaske 2008). Even if existing protocols are adopted, however, each instance will require a protocol that tailors it for the specific site where it will be used. This will include, at the minimum, the specific definitions of terms, methods and units of measurements, equipment needs, locations of data collection and field data forms (Ferretti 2009).

Importantly, each protocol should identify any ancillary data that would be useful for providing context for the key measures. For example, it is common to include variables related to weather or special events, which can help with interpretation of outliers in the data and assessing how representative data might be of typical conditions (Reynolds et al. 2016). In monitoring aspects of recreational use, it is quite common to include a measure of the overall density of use during data collection, which can be used to standardize observations to facilitate meaningful comparisons across sites and time. For example, a protocol might call for an observer to record the number of times during a set period that visitors enter a closed area, such as the lagoon at Rodeo Beach. On a cool, low-use day, this number might be quite small, while on a warm, high-use day, it could be large. Obtaining a consistent visitor count (e.g., the number of people within a specified area on the beach or the number of vehicles parked at the site) paired with the target measure enables conversion of the raw counts into comparable ratios (number of entries/number of people present).

For almost any protocol, there exist multiple ways for different data collectors to interpret the same guidance. As Vos et al. (2000, p. 335) noted, "any difference in observer qualities ... will lead to biased estimates of trends and treatment impact." This can be especially problematic in long-term monitoring where different individuals collect the data at different points in time. Thus, and perhaps counter-intuitively, it is most critical to ensure that data quality is constant over time, rather than striving for quality to be as high as possible (Vos et al. 2000). That is, having some noise in the data (compromised quality) is preferable to having biases in the data, especially biases that change year to year.

Because of these challenges in establishing the reliability of observational measures, it is critical to field test protocols with independent observers applying them to the same context.

This enables numerical computation of inter-rater reliability and identification of causes for inconsistency across observers. This field testing should be used to revise protocols and potentially simplify measures (Vos et al. 2000). Field testing also enables determination of the appropriate duration for observations, as observations should be at least as long as the phenomenon being observed (Lindenmayer & Likens 2010). Observation sessions should also be crafted to match the physical capacities of observers. For example, at GGNRA it was determined that observers could reliably track incursions into a lagoon in 2-minute intervals, but errors began to occur with longer observation periods.

In addition to detailed protocols for each individual measure, an operational plan (or field guide) must be developed for the package of measures (Oakley et al. 2003). This should specify, for example, which sites and dates might be bundled for convenience (Fancy et al. 2009), or what to do if a site is closed due to weather or fire. It should include a daily checklist and cover sheet to document observer names, dates, times, and locations of fieldwork. Table 5 lists important elements that should be addressed in the operational plan, modified based on our own team's experience from Lindenmayer and Likens (2010) and Karl et al. (2017).

Table 5. Desired Properties of Final Monitoring Methods

Property	Description
Quantitative	Methods record measurements or direct observations of sites, visitors, or situations, with specified units of measure.
Repeatable and efficient	Methods are repeatable by multiple observers within an acceptable margin of error and can be collected at lower cost relative to other methods.
Low potential for non-sampling error	Methods can be applied consistently across a wide range of settings.
Objective	Methods minimize the opportunity for observer bias.
Established and validated	Methods that have been previously used, tested, and documented are preferred, all else being equal.
Implementable with minimal training	Methods are preferred that can be learned quickly by individuals who do not have extensive experience.
Can be used for multiple purposes	Methods that generate data usable for other measures offer more value. For instance counts of vehicles at one time provide overall information valuable for park management and can also be used to standardize many other measures and also.
Used in other monitoring programs	Methods that are already built into other monitoring efforts should be used where possible.

Adapted from: Karl et al. (2017) and Lindenmayer & Likens (2010)

Develop the data management and analysis plan. Whether included with the field protocols themselves or as separate documentation, there must be clear guidance about the

management, analysis and reporting of data (Fancy et al. 2009). This should clarify how data should be submitted and entered, how and when data quality will be checked, and how data analysis should proceed. One of the most common errors in monitoring is to wait too long to examine data. It is critical to evaluate data as they are generated, particularly at the beginning of a monitoring program, so that any errors or confusion can be addressed (Broman & Woo 2018). Ample time and resources should be budgeted for data management, including cleaning, documenting meta-data, and conducting analyses. In the NPS Vital Signs program, approximately 30% of resources are devoted to these steps (Fancy et al. 2009). Specific recommendations for data entry, storage, and management are presented in Chapter 4.

A Note on Establishing Management Triggers and Thresholds

Agency-wide monitoring programs call for the establishment of benchmarks or standards for each measure that managers use to determine when action must be taken to address problems (IVUMC 2019). In the IVUM Framework, these are called "thresholds." Establishing a threshold is an inherently subjective decision, informed in part by the degree of risk to or sensitivity of the resource or condition being monitored. As an example of a threshold, in some US Forest Service wilderness areas, management plans stipulate that visitors in remote zones should encounter 10 or fewer other groups per day, 80% of the time. This determination, though informed by professional expertise, is inherently subjective.

> *"The most difficult step is setting benchmarks, or indicator values that define desired conditions and defensible decision support" (Kachergis et al. 2022, p. 59)*

It is most useful when thresholds are written using probabilistic language, as with the encounter standard above. If written in absolute terms (e.g., visitors should never encounter more than 10 other groups), the threshold would be violated on a single busy weekend day. In reality, it does not seem necessary or desirable to shift management as a result of a single outlier data point.

Partly in response to the trickiness of setting hard-and-fast thresholds to initiate action, the IVUM Framework adds the notion of "triggers." Triggers are points less stringent than thresholds; they indicate a declining trend in a measure that is reliable and concerning enough for managers to initiate some action, prior to reaching the absolute threshold.

Establishing reasonable and actionable triggers and thresholds requires in-depth knowledge about the existing conditions within a system and their intrinsic variability (Stauffer et al. 2022). Therefore, it rarely makes sense for them to be established prior to the collection of some baseline data. For GGNRA, we recommend that triggers and thresholds be developed after the initial round of baseline monitoring is completed.

Figure 2. Aerial View of Rodeo Beach and Protected Lagoon
Source: National Park Service (2015)

Sampling

Overview

> *"Determining an adequate sample size to accurately estimate key attributes is not a trivial problem" (Reynolds et al. 2016, p. 16)*

Once indicators and measures have been selected, a set of decisions needs to be made around where, when, and how much data to collect. These are all issues captured under the umbrella of sampling (Stauffer et al. 2022).

First, managers must decide upon the "reporting units," that is, the temporal or spatial level at which results will be summarized (Stauffer et al. 2022). In the case of GGNRA, the logical reporting units are generally the individual park units, although in some cases, such as Crissy Field, the unit was subdivided into a small number of individual reporting units, given its spatial characteristics and types of use in different areas (e.g., West Bluff picnic area or East Beach). It is important to establish and clarify the reporting units in advance, so that plans can be made to ensure that adequate amounts of data are collected for each reporting unit.

To establish when and where to collect data within reporting units, a decision must be made whether to use a random sampling approach or some other, non-random approach (Stauffer et al. 2022). To be able to track changes over time with confidence, the best approach

is to use some form of random sampling, wherein each element in the population of interest has equal probability of being selected (for example, all visitors to Muir Beach during the high use season have an equal likelihood of being observed). To draw a random sample, one needs a "sample frame," that is, a list of the elements in the population (Stauffer et al. 2022). As an example, if one were to conduct a survey of all campers in a campground, the population would be all groups that camped in a season, and the sample frame would be the list of contact information for all campers who registered. This sample frame may be a complete list of everyone in the population (if all campers registered) or it may be incomplete (if certain types of campers failed to register, or if some did not supply contact information). To draw a random sample from the sample frame, one would simply assign a number listwise to every reservation and then use a random number generator to select the desired number of reservations.

In many recreation settings, establishing the sample frame is not so simple as in the campground example. This is because there is no pre-existing list of visitors, and it is impractical or ineffective to try to create one. Therefore, a different approach is needed when seeking to obtain a random sample of visitors. Typically, this is done by randomly sampling time periods during which visitors will be observed or contacted. Generally, one identifies the season(s) when data are needed, breaks the season into relevant sampling periods (e.g., 4-hour blocks during daylight hours) and then draws a random sample from this sample frame.

During development of a sampling approach, it is useful to consider whether any stratification of the sample frame is desirable, particularly if the values of a measure are likely to vary in patterned ways across space or time. For example, in many recreation settings, weekend use is much higher than weekday use. A simple random sample of 4-hour observation sessions distributed randomly across days of the week would mean approximately 5 of every 7 times chosen would be on a weekday. If this would generate a smaller than ideal number of weekend sessions, and if there is a desire to compare weekday to weekend data, it would be more appropriate to draw a stratified random sample (i.e., a separate random sample of weekday times and a separate random sample of weekend times). Stratification reduces the amount of variance in each sub-sample, which improves ability to detect change over time, and it also allows for disproportionate sampling in strata that might deserve more or less intensive monitoring (Stauffer et al. 2022). Samples can be stratified by different variables of interest, such as location or season. Such decisions should be made judiciously, however, because every additional stratum essentially doubles the time and resources needed for data collection.

Why is random sampling the gold standard? Random sampling (whether simple random sampling or stratified random sampling) enables the use of inferential statistical analyses to describe the magnitude of change over time and the confidence one can have in concluding that observed changes are real (Stauffer et al. 2022; Vos et al. 2000). Particularly where decisions based on monitoring will be significant and/or controversial, random sampling enables a high degree of confidence (IVUM 2019).

However, random sampling may entail significant costs. Often it is logistically challenging to implement, as data collectors must be available at the times and locations selected, which may not be possible if park staff are integrating monitoring with other duties. Also, randomly sampled sessions may not be well distributed across the population of potential sample times (Stauffer et al. 2022). This may put pressure on a program to collect fewer observations, but small samples can result in high variability in the data and lack of confidence in the conclusions (e.g., if a busy holiday weekend happens to be sampled as one of only a few weekends). Random sampling can also result in observation sessions that generate few observations, for example, if a randomly selected monitoring session is chosen happens to be an early morning on a winter weekday when no one is present.

Because of the costs associated with random sampling, it is common for recreation managers to use convenience or purposive sampling to generate monitoring data. Convenience sampling occurs when observers simply choose times to collect data, such as times that coincide with regular maintenance visits to a recreation site (Hall 2021). Purposive sampling is similar to convenience sampling, except that the decisions about where and when to collect data are guided by principles, such as collecting data at the most popular times and places. While strictly speaking, data collected through a convenience or purposive sample cannot be used for statistical purposes the same way a random sample can be used (Stauffer et al. 2022), the data are not necessarily of poor quality, and they can certainly be very useful in making management decisions, even if the decision is to implement a random sampling approach to obtain higher quality data. Stauffer et al. (2022) point out that purposive sampling of key areas may be appropriate for specific areas or activities, especially when resources are limited. Nevertheless, careful consideration needs to be given to a variety of factors when using convenience sampling. These include the number of observations obtained, how those observations are distributed across the times and locations of interest, whether other information is available to evaluate the representativeness of the data, and the variability within the data.

Careful consideration needs to be given to a variety of factors when using convenience sampling. These include the number of observations obtained, how those observations are distributed across the times and locations of interest, whether other information is available to evaluate the representativeness of the data, and the variability within the data.

This last point deserves a bit of elaboration. A common problem with convenience samples is that data collected from year to year may not be directly comparable. For example, in year one, data might have been collected during several weekend days, but in year two, data collection might be skewed toward weekdays. If this isn't taken into consideration, a manager might conclude that conditions had changed when, in actuality, they had not. Thus, it is critically important to examine the number and timing of observations before simply computing differences across time. Questions that should be asked include the following:

- Are samples in each year large enough to make confident conclusions? The answer to this question depends in part on the variability (distribution and standard deviation) of the data from each year. For instance, if 10 observations taken at a range of times in a single year generate very similar data, then one may have confidence that the data represent general conditions. On the other hand, if the data points are highly variable, one might wish to gather more data before making general conclusions.
- Were data collected at generally representative times? Taking into account the distribution of use levels across days of the week and times of day, data that proportionately represent different temporal strata are more likely to represent general conditions than data that are weighted toward certain times.
- Were there any other factors that might have influenced the nature of data collected? This could include factors such as weather, smoke from wildfires, or the timing of holidays. Often data from traffic counters or reservation systems (e.g., for campgrounds) can be used to assess the representativeness of convenience sample data.

As noted above, when collecting data over multiple years to understand trends or evaluate change due to management actions, it is critical to be able to accurately conclude that trends or changes are due to known drivers in the system, and not simply an artefact of differences due to sampling and/or measuring differently at different times. Thus, one important consideration in designing a sampling plan is whether to measure the same objects or locations over time as opposed to drawing a new sample each time (Vos et al. 2000). The first, known as "repeated measures" or "longitudinal monitoring," provides greater ability to detect changes over time, but makes use of only a portion of the geographical area (Reynolds et al. 2016). Selecting new locations or samples each time, known as a "cross-sectional" design, "maximizes coverage of the sample frame through time but potentially at the cost of reducing the ability to detect changes in the response of interest (because of the added noise of changing locations)" (p. 15). To detect changes, it is generally recommended to use repeated measures (Vos et al. 2000), and that is the approach built into GGNRA's monitoring program.

Amount of Data

A question that inevitably must be answered is how much data should be collected? Decisions need to be made regarding how many samples to collect at a single location, how many locations to sample, and when to collect data (Reynolds et al. 2016). There is no simple answer to this question, as it depends on the nature of the phenomenon being measured (its rate of occurrence and intrinsic variability) and the degree of confidence one wishes to have when drawing conclusions from the data (Bartlett et al. 2001). As explained by the Interagency Visitor Use Management Council (IVUMC 2019), managers should consider decisions about the

amount of data to collect along a sliding scale that accounts for several factors, such as the degree of risk to valued resources, the geographic extent of the issue, and the level of controversy of the issue being monitored. Deciding on a target sample size can be challenging, because often the variation in each measure is unknown until after an adequate amount of data has been collected. Experiences at other locations or professional judgment should be used to consider how variable data are likely to be, as well as how frequently events or conditions of interest occur. In general, obtaining valid and precise estimates of infrequent events is particularly costly. Likewise, obtaining valid and precise estimates of highly variable phenomena is costly. On the other hand, estimating frequent and/or rather uniform events requires much less effort.

When deciding on target sample sizes, careful consideration must be given to ways the data might ultimately be subdivided and analyzed. To be able to draw confident conclusions about any particular subgroup of interest (e.g., a particular site or a particular visitor type), it is necessary to obtain an adequately large sample for each subgroup or site. Thus, for example, if one wanted to make conclusions about each unit within a park that has three units, all other things being equal, three times as much data would need to be collected than if one wished only to draw conclusions about the park as a whole. However, data for the park as a whole likely will not generate enough data to draw conclusions for each park unit. A good example of this is the US Forest Service's National Visitor Use Monitoring Program (English et al. 2020). This program estimates annual visitation to each national forest, for each of four types of sites (day use, overnight use, wilderness access, and general forest access), based on a stratified random sample where the sample frame is a combination of sites and dates. As a result, each forest will obtain an estimate, for instance, of use of all overnight use locations, but will not be able to disaggregate that overnight use by individual campground.

Sometimes people believe that obtaining more data is always better than having less data, but this is not true. As a general rule, increasing the size of a sample does improve statistical power markedly when samples are small (e.g., increasing a sample from 10 to 20). However, when samples are large (e.g., 200), there is usually very little additional benefit from adding more data (Bartlett et al. 2001; Vaske 2008). Whether the initial monitoring intensity set forth for GGNRA (see chapter 2) is sufficient for monitoring purposes can be explored after the initial round of baseline data collection.

Practical vs. Statistical Significance

Finally, it is worth taking some time to discuss the notion of "significance," as it is often misunderstood. In monitoring, a common question is whether a condition has changed meaningfully over time. A statistical test generates an estimate of the probability of obtaining a difference as large or larger than an observed difference, assuming there has been *no* change over time. It is common to set a threshold for this probability, commonly referred to as alpha.

Typically, a value of 0.05 is used, and the *p*-value (i.e., probability value) from a statistical test is compared to alpha. The general idea can be illustrated with an example. Imagine that in year 1, observers counted the number of cars present within a parking lot during each of 20 randomly sampled sessions. These data generated a mean value of 24 cars present. Then in year 2, they repeated the 20 observations, and obtained a mean value of 29 cars present. A *t*-test comparing these means generates a *p*-value of 0.01. This would be interpreted to mean that the difference between the two years (five cars) would be highly unlikely to be observed by chance if, in fact, there was no change at all in mean visitation between the two years. Alternatively, if the *t*-test generated a *p*-value of 0.60, this would be interpreted to mean that the difference of 5 cars could very easily be due to chance differences associated with normal variation in use levels or randomly selecting some times that happened to be higher or lower in use than the norm.

Statistical significance does not indicate that meaningful change has happened or that action should be taken. Instead, the concept of practical (or managerial) significance gets at whether change is meaningful, regardless of its statistical significance. If we come back to the example of parking, the difference between 24 and 29 cars in a 100-vehicle lot is not important, even if it is statistically significant. However, if the parking lot capacity is only 30 vehicles, the observed increase in use may indeed be important to address. So, whenever a finding is observed to be statistically significant, a follow-up question must be asked whether then finding is of practical significance.

Statistical significance does not indicate that meaningful change has happened or that action should be taken.

The determinations of statistical and practical significance are intertwined with sample size. Because the sample size is one variable in the computation of a *p*-value, when samples are very large, even very small differences between years or observations can generate a statistically significant (small) *p*-value. Conversely, if sample sizes are very small, even real differences that are large between years or observations may not generate a statistically significant *p*-value. In such cases, if the data relate to an issue of high concern, the decision can be made to gather additional data to confirm whether the apparent changes shown by the small samples are real.

CHAPTER 2: GGNRA MONITORING PROGRAM DESIGN

Overview

Background

Chapter 1 provided a high level, general overview of monitoring. This chapter applies that guidance to the situation at GGNRA. The indicators and measures presented in this chapter are the foundation of a monitoring program to support the sustainability and long-term management of park recreational resources and visitor experiences, as well as to protect visitors, staff, and natural resources. The monitoring program may be implemented to document compliance with existing regulations and policies in GGNRA and to monitor visitor behaviors that could lead to unacceptable impacts and impairments to park resources and values. Data from this monitoring can be used by park management and law enforcement personnel to determine when, where, and how to prioritize responses to efficiently and effectively address noncompliance and to prevent undesirable impacts.

Following the guidance described in Chapter 1, we worked with park staff to identify broad desired conditions and associated goals, indicators, and specific measures (see Figure 3). In this chapter, we describe the purposes of this specific monitoring program, the key characteristics of each park unit, and the process used to select indicators, develop measures, and craft the final protocols. We also present recommendations for sampling and field data collection.

Identification of Desired Conditions and Issues

The primary purpose of this monitoring program is to track trends over time in managerially salient social and biophysical resource conditions across and within selected units in GGNRA. Managerial salience was based on several factors, including relevant national and local policies and regulations, the feasibility and reliability of data collection, and existing scholarship on best practices for monitoring biophysical resources and visitor experiences, as well as the professional judgement of NPS staff and the OSU team.

NPS agency-wide and park-specific goals and policies are set forth in various documents. We thoroughly reviewed the 1979 GGNRA Pet Policy (NPS 1979), the 2006 Service-wide Management Policies (NPS 2006), the GGNRA General Management Plan (NPS 2014), and the Superintendent's Compendium (NPS 2017b), which lists the specific designations, closures, permit requirements, allowed activities, and other restrictions imposed under the authority of the Superintendent. These led to the following broad categories within which monitoring indicators could potentially be developed.

Prevention of degradation of natural resources by recreational use. Of primary concern at GGNRA are potential impacts to natural vegetation communities and habitat for sensitive wildlife species, such as the endangered mission blue butterfly and San Francisco garter snake.

Such degradation can occur when visitors leave established trails, creating informal social trails that can trample endangered species, fragment habitat and potentially introduce invasive species. In some areas, like sand dune plant communities, such degradation can occur rapidly, and restoration can be difficult to achieve.

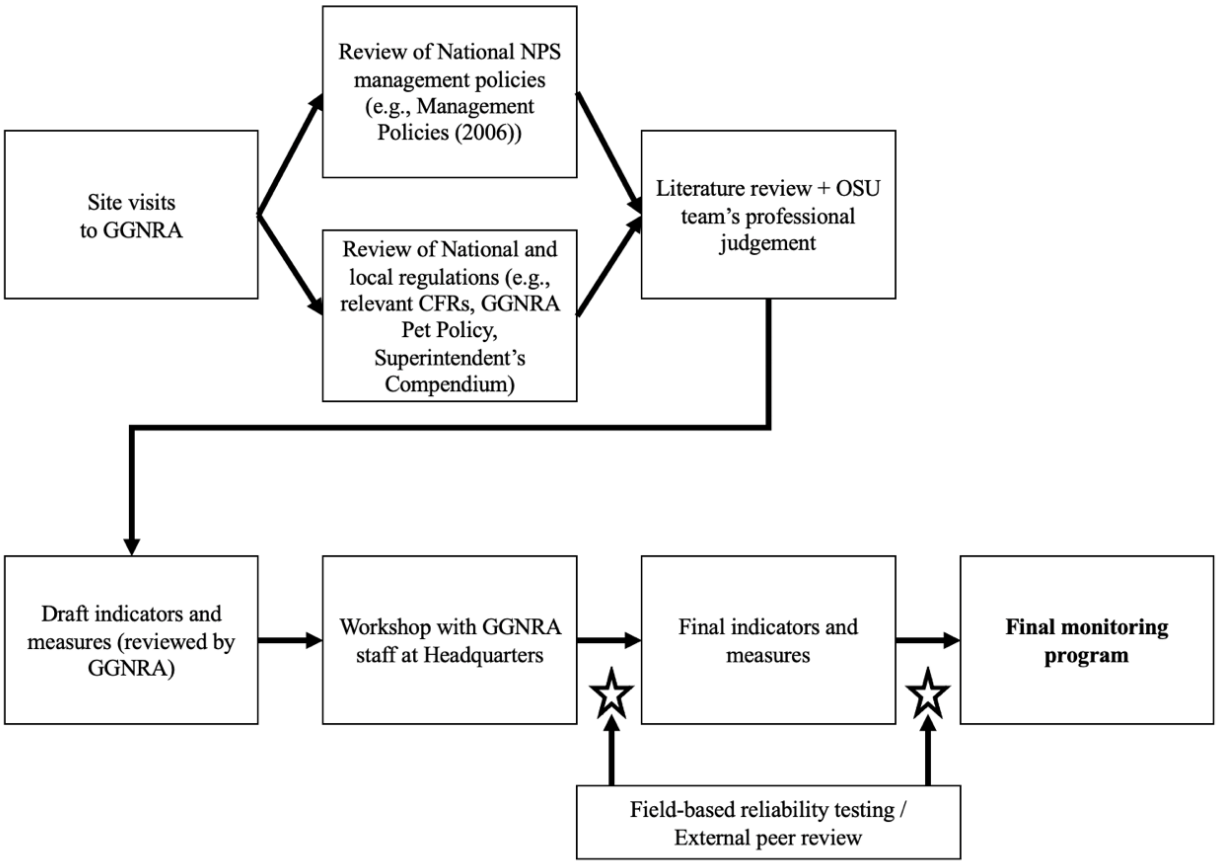


Figure 3. Process Used to Identify Indicators, Measures, and Data Collection Sites for the GGNRA Visitor Use Monitoring Program

In several units of GGNRA, extensive efforts have been made to reestablish native plant communities and habitats, and these were considered high priorities for monitoring. For instance, at Crissy Field, creation of an 18-acre tidal wetland area within a 100-acre restoration site was completed in 2000. Sixteen acres of restored dune habitat there now support western snowy plovers (https://www.nps.gov/goga/learn/nature/crissy-field.htm). At the mouth of Redwood Creek at Muir Beach, riparian and wetland habitat was restored in a nearly 50-acre site between 2013 and 2014 (https://www.nps.gov/goga/learn/nature/muir-beach.htm), and this system is supporting endangered Coho salmon and the California red-legged frog. Similar to Muir Beach, in 2013, GGNRA undertook restoration at Rodeo Beach to restore hydrological processes, remove invasive plants, and reestablish native plants. This site now supports the

endangered marsh sandwort as well as California red-legged frogs (https://www.nps.gov/articles/rodeo-wetland-restoration-supporting-threatened-and-endangered-species.htm). Mori Point, located on cliffs above the ocean south of Pacifica, has undergone extensive restoration efforts to develop freshwater ponds, remove non-native plants, and create sustainable trails (https://www.nps.gov/goga/learn/nature/restoration-projects.htm). In all of these areas, ensuring that recreational use (either by people or dogs) does not encroach on restored habitat or sensitive resources is a park priority.

While direct harassment and impacts to wildlife from recreation can be significant concerns in some parks, according to park specialists, at GGNRA this is less of a concern than recreational impacts to vegetation. Nevertheless, recreational trails in some upland areas intersect habitat for sensitive wildlife species, and there is potential for recreational use to disturb or displace wildlife. Such impacts have not been systematically documented at GGNRA, and this was deemed not to be a priority for monitoring at this time. On the other hand, a more significant wildlife issue is recreational impacts to various shorebirds, including overwintering western snowy plovers. Snowy plovers use open beach and dune habitats, and they can be displaced, stressed, or killed by recreational users or dogs (Lafferty et al. 2006, 2013; Ruhlen et al. 2003).

Safe environment for visitors or employees. At least two dimensions of safety were identified as potential issues at GGNRA. The first has to do with congestion and crowding in specific locations, such as parking areas. With dogs, people, and vehicles entering and exiting parking areas, sometimes from adjacent busy city streets, there is a potential for accidents and conflicts. Similarly, along the waterfront Promenade near Crissy Field, in places where bicycles, pedestrians, and dog walkers all converge, accidents might occur, for example if bicyclists exceed speed limits. The second safety issue has to do with aggressive dogs, which is a particular concern in locations where dogs must be under voice control but use of a leash is not required. The park has received reports of such conflicts with dogs. Another safety aspect of unleashed dogs has to do with the welfare of the animals; for instance, dog rescues are not infrequent at the cliffs at Fort Funston. Such rescues also place rescue personnel at risk.

Healthful environment for visitors and employees. While there appear to be few issues related to maintaining a healthy environment at GGNRA, dog excrement is a concern, especially in certain park units. The requirement that pet handlers remove their pets' waste appears to be well-followed in some locations, but less so in others. Pet waste has been shown to introduce pathogens to the soil and water (Dado et al. 2012; Proctor et al. 2014), although a recent review paper reported that studies on whether pests or diseases are actually transmitted to humans are rare, and therefore the risk is unknown (Rahim et al. 2018). In some locations, the number of dogs present each day is considerable, and we observed multiple instances of dogs defecating on sand or in vegetation during all of our field visits.

Maintenance of an atmosphere of peace and tranquility. With many units of GGNRA being surrounded by urban streets and businesses, opportunities for calm, quiet recreation could potentially be impacted. The Management Policies (NPS 2006) specifically call out the need to "monitor human activities that generate noise that adversely affects soundscapes" in and adjacent to parks (p. 56). While soundscapes are not commonly monitored, GGNRA has established a precedent for such monitoring in previous monitoring and management policies at Muir Woods (Manning et al. 2010). Due to the proximity of some units to busy city environments, soundscapes were considered for monitoring in this program.

Appropriate visitor use of a park. The Park Service's policies define "appropriate uses" as those that are "suitable, proper, or fitting for a particular park, or to a particular location within a park" (NPS 2006, p. 13). If a type of visitor use conflicts with the protection of park values (including visitor experiences) and resources, the park values and resources take precedence (NPS 2006). At GGNRA, with its wide variety of settings and facilities, a great range of visitor uses are welcome and appropriate. Inappropriate uses are those that are explicitly illegal by regulations or that directly interfere with the experiences of other visitors. Research at other locations has documented a variety of types of uses or conditions that can interfere with high-quality recreation experiences. For instance, crowding may create stress and sub-optimal experiences for visitors (Manning et al. 2017). Direct interpersonal conflicts, either based on personal values or behavioral norms for a particular site, have been documented in parks and protected areas, particularly among visitors who engage in different types of activities (Carothers et al. 2001; Vaske et al. 2007).

At GGNRA, with its high level of use and ease of access, there is the possibility that some activities could be deemed inappropriate uses. For example, crowding on beaches or congestion in parking areas may adversely impact visitor experiences. Additionally, it is well known that conflicts occur between pedestrians, equestrians, and bicyclists at other sites (e.g., Pickering & Rossi 2016), and these uses are permitted together in various units of GGNRA. Furthermore, while many visitors may enjoy interacting with dogs, many visitors may be adversely affected by unleashed dogs entering their personal space or acting aggressively. While not inherently problematic, situations where potentially conflicting uses co-occur could be monitored to evaluate the status of crowding or conflict.

Another consideration under "appropriate use" is the presence of educational facilities and activities at several GGNRA sites. For example, the Crissy Field Center offers a range of programming for youth and school groups and offers unique programming related to social and environmental justice, some of which takes place outdoors at Crissy Field. Nature Bridge uses facilities adjacent to Rodeo Beach (Fort Cronkhite) for environmental education programming for schools, individuals, families, and groups. These include both day and overnight programs, with participants exploring Rodeo Beach and Marin Headlands trails. Fort Funston houses an Environmental Science Center in the southeast corner of the property that offers field study

programs for elementary students from San Francisco. Finally, the Bay Area Discovery Museum is located in the middle of the Fort Baker unit of GGNRA. In all of these sites, there is the potential for recreational activities to interfere with educational programming, particularly at sites where dogs are permitted to be off-leash.

Compliance with regulations. Many of the regulations in effect at GGNRA are intended to protect and maintain desired natural resource conditions and visitor experiences, as discussed above. We single out several of these specific regulations here, because their precise wording has implications for the characteristics of measures that could be used to monitor them. The Superintendent's Compendium (NPS 2017b) lists the following regulations related to visitor use:

- Beach fires are permitted only at Muir Beach and Ocean Beach, and only in NPS designated fire pits.
- Glass bottles and containers are prohibited on all beach areas, at Crissy Field north of the Promenade, and at Upper Fort Mason Great Meadow.
- Alcoholic beverages are prohibited at Ocean Beach.
- Bicycle use is prohibited at Battery Yates Trail (Fort Baker); Crissy Field Lagoon Boardwalk; areas of Milagra Ridge (Milagra Ridge Trail, Milagra Creek Overlook, and Milagra Summit Trail); various locations at Mori Point; the Notch Trail at Sweeney Ridge; on Alta Vista Trail; and on the Ember Ridge Trail at Rancho Corral de Tierra.
- The speed limit for bicycles in developed areas is 15 mph (5 mph around blind curves) at Fort Mason, Crissy Field, and the Battery East Trail.
- All areas fenced or posted as closed are closed to public use.
- Various trails are designated as "stay on trail."
- In all areas, pet excrement must be removed and deposited in an appropriate refuse container.
- The use of horses is permitted on several trails, primarily in the Marin Headlands and San Mateo County units; otherwise, horse use is prohibited.
- Rodeo Lagoon, Tennessee Valley Pond, all freshwaters at Muir Beach (including the Lagoon), Lobos Creek (at Baker Beach), Crissy Marsh, the ponds at Mori Point, and Charthouse Mitigation Site Pond at Rancho Corral de Tierra are closed to swimming and bathing.

Site Visits and Specialist Consultation

In addition to the above policy review, the development of indicators was informed by field visits in December, 2017, and January, 2018. On these visits, NPS and Golden Gate National Parks Conservancy staff provided an orientation to the type, location, and amount of use within each of the 20 units included within the scope of this work, as well as the social and biophysical impacts of visitor use. During most of the site visits, our team met additional GGNRA staff members, such as law enforcement personnel or biologists, who answered questions and provided site-specific detailed information, such as the prevalence of illegal

behavior, visitor-caused impacts and user-related conflict. Additional park reports (e.g., related to visitation or existing monitoring efforts) and maps (e.g., delineating management zones) provided more in-depth information. Our discussions with staff focused on overall park management approaches to address potential problems, such as the actions of law enforcement, strategies for communicating with visitors, and infrastructural changes made to protect resources and habitat (such as fencing sensitive areas). We also discussed the desirability and feasibility of monitoring various aspects of visitor use and behavior, such as the total amount of use, behaviors that are out of compliance with park regulations, and behaviors that might damage natural or cultural resources in GGNRA. A synopsis of the key issues, by site, is presented below.

Marin County (Figure 4)

Stinson Beach. Stinson Beach is immediately adjacent to the community of Stinson Beach and is frequently used by park neighbors. It also abuts a County Park beach, where dogs are allowed on-leash. Because Stinson is designated as a swimming beach, dogs are not allowed on the beach; however, they are permitted on-leash in parking and picnic areas. Because of the different rules for different locations adjacent to one another, compliance with leash regulations and dog closures is a concern. There is also some concern about trampling and erosion in the native dune vegetation communities that separate parking and picnic areas from the beach proper.

Figure 4. Golden Gate National Recreation Area Park Units in Marin County
https://www.nps.gov/goga/planyourvisit/upload/GOGA_X3-web_sm3-2.pdf

Muir Beach. Muir Beach experiences very high levels of use during the summer, with much lower use in winter. Fires are permitted in three metal fire rings on the beach, but visitors move those to unsafe places where fires might escape. Visitors also build unauthorized firepits. A significant concern at this site is the protection of the lagoon, estuary, and riparian areas. As noted above, major habitat restoration efforts have been undertaken, including introduction of pond turtles, which bask on logs and are sensitive to disturbance. California red-legged frogs (an endangered species) and Coho salmon also use these areas. Visitors and dogs enter the lagoon area in the summer; dogs have been observed entering other estuary areas as well. Dogs must be on leash in the parking area and access trail, but not on the beach itself (although they must be under voice/sight control), so on the beach there is the potential for conflict with at-large dogs. Additionally, pet waste disposal, particularly along the access trail, is a concern. High use in the parking and access areas leads to the possibility of conflicts.

Figure 5. A Sunny September Day at Muir Beach
(photo: Troy Hall)

Tennessee Valley area. The Tennessee Valley area encompasses less-developed highland areas in Marin County. Dogs are not allowed on the Tennessee Valley Trail, but the Coastal Trail (where leashed dogs are allowed) bisects the Tennessee Valley Trail and shares the same corridor for ~100 yards. This regulatory situation could be confusing for visitors. Indeed, law enforcement personnel reported that dogs are sometimes present where they are prohibited. On trails closed to dogs, some people have service dogs (which is legal), and others have "emotional support" dogs (which are not allowed on federal lands). The illegal use of bicycles on trails was also somewhat of a concern here.

Oakwood Valley. This area provides habitat for the mission blue butterfly; however, the habitat patches are sufficiently distant from the trail that incursion by visitors and dogs is unlikely, except where people cross the hillside as part of unauthorized loop from the Alta Trail above. There is a well vegetated pond along the road west of the trail connecting the Oakwood Valley and Meadow Trails that potentially has California red-legged frogs. Dogs have been seen

to jump in the pond, and park staff may consider fencing this area if egg masses are present. During a site visit, we observed many social trails in the Oakwood Valley area (at least ten along the Meadow Trail). Oakwood Meadow Trail and Oakwood Valley Trail have similar names and form a loop trail, but they have different regulations (on Oakwood Meadow Trail, dogs must be on leash; on the Oakwood Valley Trail, dogs must be in voice/sight control). The differences in rules may be confusing for visitors. There have been complaints from the public about commercial dog walking at this site. Litter is also an issue, including bagged dog waste left on site.

Alta Trail. This area is heavily used by commercial dog walkers – park staff estimated that perhaps 80% of use on weekdays is commercial. However, its remote location and limited parking capacity mean that overall use is quite low. There was some concern about the use of social trails, but overall, this was not considered a significant problem.

Fort Baker. Use at Fort Baker is mainly from people staying at the on-site conference center/resort, which allows dogs, and residents from Sausalito. The other main user group consists of bicyclists, who often rent bikes in San Francisco and ride through Fort Baker to catch the ferry at Sausalito. NPS staff estimated that perhaps two-thirds of bike renters come across the Golden Gate Bridge. Bicyclists do not always stop at stop signs and, when the site is busy, cars become backed up waiting for bikes to pass at the entry to parking areas. The backside of Battery Yates has mission blue butterfly habitat and is fenced and closed to use.

Rodeo Beach. Rodeo Beach can be quite heavily used in the summer months; the parking area is large, and at peak times it can take 2.5 hours to drive to Highway 101 from the beach. Although the creek and lagoon are closed to use, people and dogs enter these waters when the weather is warm (Figure 6). Dogs must be on-leash in parking and picnic areas, though they often are not. Thus, there is a risk of visitor conflict or off-leash dogs being hit by vehicles in parking areas. Problematic interactions among dogs have been observed when the site gets crowded. The Headlands Institute is on-site and has camps for school-aged children (grade school through middle school) all year. Children are present all week, in 4-5 groups of 20 each. There is also a summer day camp.

Figure 6. People in the Lagoon at Rodeo Beach.
https://www.nps.gov/places/000/rodeo-beach.htm?utm_source=place&utm_medium=website&utm_campaign=experience_more&utm_content=large

Interruption of these programs by dogs is considered an "unacceptable impact" that should be monitored.

Bobcat Trail/Miwok/Rodeo Trail Junction. This relatively undeveloped headland area is primarily used for its access to trail networks. The Miwok side is zoned for voice/sight control of dogs, while the Bobcat Trail is closed to dogs to reduce conflicts with horse use and because the trail runs through core wildlife habitat. Thus, compliance with dog regulations and activity-specific conflict could potentially be monitored here.

Slacker Trail. Slacker Trail is open to dogs in voice/sight control from the trailhead to Slacker Ridge (0.4 mi). Beyond the saddle, host plants for mission blue butterfly grow adjacent to trail, so there is the potential for impacts to natural resources if visitors or dogs leave the trail. This was not deemed a substantial concern at this time.

San Francisco County (Figure 7)

Fort Mason. With its residential neighborhoods and businesses, Fort Mason has regulations requiring dogs to be on-leash throughout the area, though compliance is a concern, especially in the Great Meadow. NPS staff also reported that lawns are used for playing catch with off-leash dogs. Commercial dog walkers occasionally use a gated grass area across from NPS offices for training, which is not permitted. During our field visits, we regularly observed bicyclists traveling against car traffic through the parking area at the headquarters building, sometimes at high speeds. Thus, safety may also be an issue in the area when many people and bicycles are present.

Crissy Field. Crissy Field encompasses a long stretch of bayshore and has several discrete use areas. The NPS estimates that it receives about 10,000 visitors/day, about 13-24% of whom (depending on the season) are with dogs. At the west end of Crissy Field, the Promenade receives heavy bicycle use; speed may be a safety concern, and there is the potential for conflicts between cyclists, runners, pedestrians and dog walkers who all share the path. The West Bluff picnic area and the associated parking lot are managed as on-leash areas, and compliance is a concern. When the area becomes crowded, user conflict is a problem, according to law enforcement staff, with the primary issues being roaming dogs intruding on families with children. Torpedo Wharf is closed to dogs and bikes, but both are sometimes seen on the Wharf.

The Crissy Wildlife Protection Area (WPA) currently has approximately 4-10 western snowy plovers overwintering annually; they mostly stay east of the Coast Guard pier. There are a few other shorebirds here, particularly killdeer, which nest in the WPA. Dogs must be on leash during snowy plover breeding and nesting season. The existing fence prevents access to the western end of the WPA (especially when the gate is locked); the fence is well constructed and seems effective. Current monitoring involves snowy plover counts at the WPA 20-25 times

between August and March/April, and this monitoring protocol systematically captures instances of dogs or people crossing fence or entering the lagoon.

The Crissy Airfield is used for playing catch with dogs, which is permitted, as well as other field-based recreational activities. Not much picnicking occurs there, due to the uneven nature of the turf, so conflicts between dogs and picnickers are less than in other locations. However, environmental education programs from the NOAA building use the western section of the airfield and there are reports of them being disturbed by dogs.

Figure 7. Golden Gate National Recreation Area Park Units in San Francisco County

At Crissy East Beach, the tidal outlet is the most sensitive area from a natural resources perspective. Dogs and people are not allowed in the outlet, the lagoon, or marsh (Figure 8). People are allowed to park on the grass here, making grass technically part of the parking area (so dogs must be on-leash). The beach proper is very heavily used, often by families with children and picnickers. NPS staff reported hearing complaints from families about unmanaged dogs impacting them.

Figure 8. A Relatively Low-use Day at Crissy Field East Beach, with Users around the Marsh Outlet
Photo: Troy Hall

Baker Beach. Baker Beach provides a wide range of recreational opportunities, including picnicking, sightseeing, and beach activities, as well as access to the Coastal Trail. This is a heavily used site, with considerable pedestrian and bicycle access from surrounding communities. NPS staff estimate that approximately 6-10% of all users bring dogs, depending on the season and day of week. Additionally, the NPS reports that approximately 4% of all use here is by commercial dog walkers. Lobos Creek flows into the ocean at Baker Beach and is closed to public use, though this is not readily apparent to visitors, and non-compliance is high. The foredunes have European dunegrass, but since the 1990s restoration efforts have been undertaken to remove non-native grass and plant native species. The success of these efforts may be hindered by inappropriate recreational use; social trails and trampled vegetation show that considerable recreational use occurs in closed areas by people crossing the dunes between the parking areas and the beach. There are also sensitive plants in the dunes north and south of

the sand ladder, but it is not clear how much use these areas receive. Voice/sight control of dogs is permitted on the beach, but in the parking, trail, and picnic areas dogs must be leashed.

Ocean Beach. Ocean Beach has an extremely large and long parking area and is a prominent, easily accessible site, leading to very high levels of use in summer. A specific natural resource concern at this site is shorebirds, including the western snowy plover, which rests in shallows or protected areas in dry sand. NPS staff estimate that approximately 28-30 western snowy plovers overwinter at Ocean Beach. Sanderlings are the most prolific shorebirds (thousands can be found here), along with willits, marbled godwits, whimbrels, and a few other species. Recreation near the surf line is not problematic for plovers, but it is detrimental for other shorebirds, which flush when disturbed. Overall disturbance of shorebirds was deemed by park staff to be a more significant concern than conflicts among people. The area between Stairwell 1 and Stairwell 21 is designated voice/sight control for dogs. By contrast, the area south of Stairwell 21 to Sloat (approximately 2 miles) requires that dogs be on-leash during shorebird season. Off-leash dogs are allowed between Stairwell 21 to Sloat between May 15th and July 1 (when snowy plovers are no longer present). The distinction between the two zones is marked with a prominent sign on the beach; however, shorebird monitoring data suggest compliance with the leash requirement is very poor (80% of dogs are off-leash). Additionally, some surfers may leave dogs unattended while they are surfing, and there have been reports of off-leash dogs occasionally pestering joggers.

Fort Funston. Fort Funston is a complex, busy site. It offers perhaps the largest variety of recreational uses of any of GGNRA's units, including equestrian use and hang gliding, in addition to very heavy use by the general public with dogs and commercial dog walkers. NPS staff estimates this site receives ~0.5 million visitors per year; of these, approximately 60% have dogs. Half of the dog use is estimated to be associated with commercial dog walking. Dog rescues from the cliffs are a concern, with an average of 6-12 per year. There are also safety concerns around dogs being off-leash in the parking area. With the heavy use by dogs, removal of pet waste is a priority for monitoring.

The Environmental Education center at Fort Funston is used by San Francisco public schools. There is a weekly campout next to the center in a dune area that is separated from the main recreation spaces, but occasionally some off-leash dogs enter the area when children are present. Teachers report that when they orient children to the site, they feel the need to teach children to stand still around unleashed dogs.

Natural resource concerns at Fort Funston are present in specific areas. There has been vegetation restoration in various parts of the site, some of which has been quite successful. However, the system "horse trail" goes through a restoration area, and it is easy for visitors to leave the trail and cut through vegetation to reach other areas. Given the sandy nature of the soil and low vegetation, it is not clear to visitors which trail treads are authorized system trails

versus unauthorized social trails; the official trail does not look different on the ground from the web of social trails and other denuded areas.

San Mateo County (Figures 9 and 10)

Sweeney Ridge. Sweeney Ridge is situated amid other protected areas and therefore it contributes key wildlife habitat for many species within the larger landscape. For example, there are mission blue butterflies, San Francisco garter snakes and California red-legged frogs in this area, though in low abundance. The Mori Ridge Trail allows on-leash dogs, but dogs are not allowed on the Notch Trail. Being a remote area without facilities, the primary activities are trail-based, and use is much lower than at other sites.

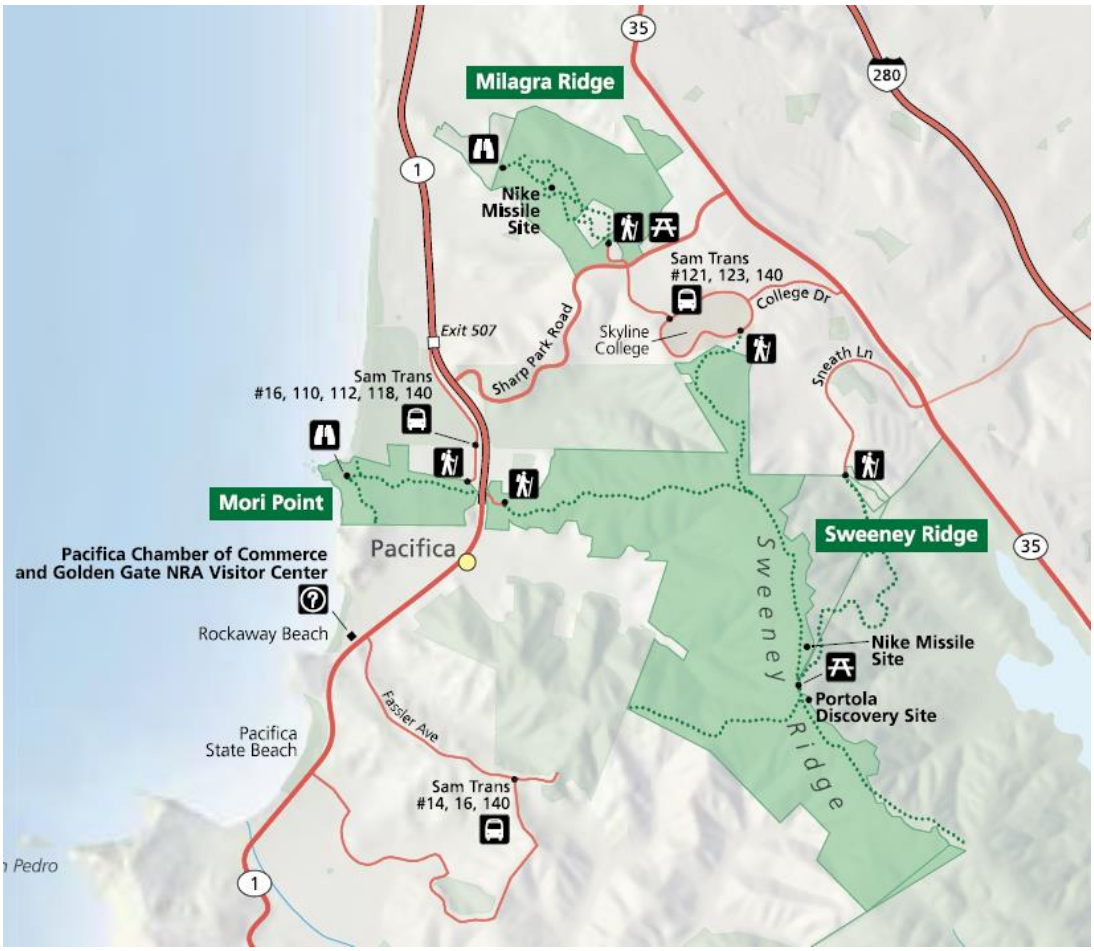


Figure 9. Northern Golden Gate National Recreation Area Park Units in San Mateo County
https://www.nps.gov/goga/planyourvisit/upload/GOGA_X3-web_sm3-2.pdf

Mori Point. Mori Point provides habitat for the endangered San Francisco garter snake, and California red-legged frogs use moist ditches along the paved path into the site from the parking lot, from which they migrate uphill. The frogs also breed abundantly in ponds at the site

and in riparian wetlands in an adjacent area of Sanchez Creek. As noted above, the trail and habitat enhancements made by the Parks Conservancy and NPS – including creation of three ponds, elevating trails, and moving trails behind natural scrub barriers to deter off-trail use -- have been quite successful.

Park Service staff estimate that approximately 500-600 people use Mori Point per day. On weekends, perhaps one-quarter to one-third of these visitors have dogs, and staff estimate that there can be as many as 100 dogs on any given day, depending on the season and day of week. Although there is clear signage in spots, containing use to system trails is an issue, as it can be difficult for visitors to know what is a visitor-created social trail versus a system trail in upland areas. Private property abuts portions of Mori Point, and there is concern about pet waste from adjacent homeowners.

Figure 10. Southern Golden Gate National Recreation Area Park Units in San Mateo County
https://www.nps.gov/goga/planyourvisit/upload/GOGA_X3-web_sm3-2.pdf

Rancho Corral de Tierra (Montara). Rancho Corral de Tierra is a large unit and has two distinct parcels. The northernmost of these, Montara, provides habitat for a listed endangered plant – Hickman's potentilla – which is found only at this site (along the Farralon Trail). There is not much concern at this time about recreational impacts to it, because the habitat patches are away from the trail, and people generally stay on the trail. Additionally, the plant appears to respond favorably to some disturbances. Along Le Conte Trail there is a short, narrow decked "bridge" over the creek, which may have California red-legged frog egg masses. Staff report that dogs regularly enter the water here, which can harm frog populations. Commercial dog walking is not authorized in San Mateo County, though there may be reason to monitor compliance, given reports of such use occurring.

Rancho Corral de Tierra (San Vicente Creek area). This parcel of property is quite large, though many portions are remote and lightly used. However, use concentrates on the Spine Trail and funnels through the Ember Ridge equestrian facility; here, there is overlapping use by cars, horses, bicyclists, pedestrians, and dogs, posing safety concerns.

There is a potential for confusion and non-compliance with leash requirements in this area, given the different status of trails in the area. Specifically, while leashed dogs are allowed on system trails, some previously existing trails were not included in the formal trail system when this parcel was added to GGNRA. Therefore, dogs are not allowed on them. This distinction is not evident to visitors, and use of non-system trails may merit monitoring at this site.

Conclusions from Site Visits and Specialist Consultation

The site visits revealed that most potential issues were highly localized, and some were relevant at only a few park units. The following conclusions were reached. First, documenting recreational impacts to heritage resources through this program was not a high priority. While there are many important archaeological and historic sites and artefacts throughout GGNRA, their protection is addressed through other park efforts. Second, while there are many important natural resource concerns throughout GGNRA, specialists believe that recreation per se poses relatively minor risks, with a few localized exceptions. These exceptions are areas that have undergone

Figure 11. Dogs in the Lagoon at Muir Beach
Photo: Troy Hall

restoration, contain sensitive habitat where recreation occurs, or are home to threatened or endangered wildlife species. This focused our attention on specific locations within several park units, most notably, the lagoons at Rodeo Beach and Muir Beach (Figure 11), given the common occurrence of intrusions into these closed areas.

Within the domain of natural resources, considerable discussion was devoted to shorebird protection, especially for western snowy plovers. It is well documented that dogs chase shorebirds on beaches, and some species of birds – including the western snowy plover – are sensitive to such disturbances. Ultimately, it was decided that the existing shorebird monitoring program at GGNRA is sufficient to monitor such impacts, and no additional protocol is needed. Under the existing program, monitoring occurs twice per week every other week during the shorebird season. Observers walk a systematic path along the beach and record sighting and location of any bird species seen, the number of people encountered, the number of dogs seen (on- and off-leash, separately), and any incidence of dogs chasing birds.

A third conclusion from site visits and specialist consultation was that the specific visitor behaviors and social conditions in need of monitoring at this time are fairly narrow and issue-specific. For instance, there was a desire to monitor interruption of field-based educational programming, especially by at-large dogs. Similarly, while safety is always an important consideration, specific concerns focused on behaviors that might be related to the need for rescue (e.g., dogs on cliffs). Regulatory compliance concerns in need of monitoring were restricted to certain issues, such as pet waste removal and leash requirements, and did not extend to other regulations such as use of established fire pits on beaches, group size limits, or the presence of alcohol where it is not allowed. Law enforcement personnel believe that existing approaches to handling these issues are adequate, or their relative infrequency does not call for routine monitoring.

Finally, one of the more salient issues to surface was the potential for crowding and/or conflict in specific locations. With parking areas being hubs of activity, there is a desire to monitor both overall use levels, particularly in certain parking lots, and compliance with leash requirements in them. Additionally, some areas of concentrated use, such as parts of the Promenade, were identified as potential sites for monitoring crowding and conflict between activity types.

Literature Review

Having identified the broad issues of concern and their specific manifestations in GGNRA, we turned to the literature to explore two topics: 1) what is known about the relationship between visitor use and impacts to the identified values, resources, and experiences; and 2) existing monitoring protocols or approaches that can provide reliable, valid information for selected indicators. Given our experience in visitor use monitoring and recreation ecology, we have expertise in applying established protocols for monitoring the type

and amount of visitor use and recreational impacts to vegetation; therefore, a review around those topics was not needed. However, several proposed aspects of the GGNRA monitoring program were new, and we focused on finding literature related to those. For example, we were unaware of any preexisting protocols for monitoring dog interactions in recreational contexts, so we focused on literature regarding the ability to reliably and validly assess such interactions, either among multiple dogs or between dogs and strangers. As another example, new technology and tools for remote image capture were coming online, and we wanted to explore the potential to use artificial intelligence for image recognition, in the event that some monitoring data might be collected by automated camera systems.

The first literature review (Engebretson & Hall 2018) used a comprehensive search of scientific databases (e.g., Web of Science) and Google Scholar with search combinations of "recreation," "monitoring," "dogs," and "impacts" to identify peer-reviewed papers on these topics. For the 47 papers with clear relevance to our work, we created entries in an annotated bibliography capturing the salient elements related to potential indicators and measures, as well as field methods. This review was submitted to GGNRA in February, 2018, and went through an external peer review process. The final document incorporated and addressed reviewer feedback.

Our review confirmed that monitoring protocols for recreation in general are well established, but there are no existing protocols for monitoring dogs and their interactions with visitors. Moreover, objective determinations about the nature of dog behaviors (e.g., "aggressive behavior") and human responses are unreliable; human observers cannot accurately or consistently identify aggression. Because of this, ethological researchers caution against describing behaviors using functional terms such as "initiated play" or "exhibited fear" and recommend instead that the behaviors themselves should be documented in objective terms (e.g., "wagged tail" or "held out hands palms up"). Therefore, if observational approaches are to be used, they should focus on describing behavior without making inferences about an animal's or person's motivation, intention, or other psychological state. Ultimately, our review recommended that any measures associated with interference with visitors' experiences should be based on engaging with the visitors themselves, such as through questionnaires, because people's overt behaviors do not reliably signal their internal mental states.

Our review uncovered relatively few studies documenting compliance with dog regulations. However, the research to date shows that leash compliance can be extremely low. Additionally, whether owners pick up dog waste varies considerably across locations, and is related to the presence of infrastructure (notably whether bags and receptacles are provided) and the level of use or remoteness of the site.

The second literature review (Applied Trails Research 2018) presented findings and conclusions from a selection of 34 papers related to the use of still and video cameras to

quantify visitor use, behaviors, and activities in recreation areas. We wanted to explore the potential to use these remote technologies given the large expanse of GGNRA and limited staff and resources available to conduct in-person field observations. A specific question was how well cameras can be used to document human and pet use and behavior, particularly on trails. For instance, how well do they capture group size, or whether dogs are on- or off-leash? Additionally, it was important to understand the state of the art for automated image processing, since camera trap methods can generate thousands of images, which would be impractical or impossible for humans to process.

This review generated several conclusions. First, video and still cameras can be utilized to create robust datasets allowing for systematic review and quantification of visitor use levels, types and behaviors, particularly when use is confined to a trail corridor. However, the limited research shows that sometimes there are differences in the counts and classification of users between field observers and processed images. The technologies that support these efforts are advancing rapidly and draw heavily from the hunting, self-driving vehicle security, and recreational support industries. Hardware and software costs vary, while improvements in sensors and support hardware (resolution, sensitivity, accuracy, battery life) are increasing the utility of the devices and the quality of their outputs.

To be effective in monitoring at GGNRA, several concerns and shortcomings of image capture techniques would need to be addressed. A significant concern is protecting the privacy of visitors to public lands; several studies spoke to the need to blur images of people or activities. Even if this is done, however, the public may object to the presence of cameras documenting their behaviors. Additionally, there are security concerns, including theft and vandalism. Some studies report differences in the ability of cameras to perform in a variety of locations and environmental situations (e.g., varying temperatures or humidity, or images obscured by precipitation, fog, or clouds).

At the time of our review, studies suggested that analysis of images could be supported and semi-automated by software. However, the amount of time spent reviewing video and time-lapse photography can often be greater than the real-time duration of video recorded. Researchers who are manually analyzing images often utilize work-study students and software to lessen this burden. This can be a considerable cost in time and money, and the NPS should weigh the benefits of image capture against challenges with its sustainability (available resources, timeliness of processing) before deciding to use it for long-term monitoring. We should note, though, that hardware and software in this area are rapidly evolving; for example, artificial intelligence technologies are now being used for sophisticated image recognition. However, at this time such approaches would still require considerable expertise (or cost for consultants).

Proposed Monitoring Program

Selection of Final Indicators

Based on the literature review, field visits, and park specialist input, we drafted a detailed and comprehensive matrix of potential indicators and measures in May of 2018, matching these to specific park units (Engebretson et al. 2018). This was intended to include all possible indicators and measures, with the recognition that most would be dropped after further consideration and prioritization. The matrix and documentation included our professional assessment of the extent to which each measure meets the criteria for quality as discussed in Chapter 1 (e.g., is objective, reliable, sensitive, efficient, and significant). The detailed discussion of indicators and measures (Engebretson et al. 2018) provides the rationale for the assessment of each potential measure, while Table 6 provides an overview of the full list of indicators and potential measures.

Table 6. List of Indicators and All Measures Considered for Inclusion in the Monitoring Program

Condition	Indicator	Potential Measures
Desired condition of park natural resources	Compliance with prohibition of use of trails or other areas	# visitors entering closed area # dogs entering closed area # bicyclists entering closed area # motorized vehicles entering closed area
	Compliance with fenced or posted sensitive resource or habitat restoration closures	# off-leash dogs in areas # visitors in areas # visitors with dogs in areas # bicyclists in areas
	Harassment of wildlife	# visitors approaching wildlife # dogs approaching wildlife # protracted bird flushing events caused by humans # protracted bird flushing events caused by off-leash dogs # protracted bird flushing events caused by humans with dogs
	Digging vegetation	# dogs digging in vegetation # visitors digging in vegetation
	Compliance with trail regulations	# visitors using informal trails # bicyclists using informal trails # pedestrians off-trail # bicyclists off-trail # dogs off-trail # visitors with dogs off-trail
Maintenance of an atmosphere of peace and tranquility	Soundscape	% ambient sound vs single-source high frequency noise

Table 6. List of Indicators and All Measures Considered for Inclusion in the Monitoring Program (continued)

Visitor interference with appropriate visitor use of the park	Uninvited entry into personal space	% of potential incursions that enter visitors' personal space
	Visitors' reported and observed reaction to dogs entering their personal space	% of visitors who have positive, neutral, and negative reactions to dogs entering their personal space (survey)
	Compliance with commercial dog walking regulations	# of commercial dog walkers observed in restricted areas % of commercial dog walkers who have >6 dogs per handler # dog walkers with >3 dogs who do not have a commercial permit displayed
	Interference with organized group educational activities	# dogs entering the space of a school or educational group
Safe and healthful environment for visitors or employees	Compliance with on-leash regulations	% dog walkers in compliance with on-leash regulations at beach sites % dog walkers in compliance with on-leash regulations at trail sites % dog walkers in compliance with on-leash regulations in parking lots
	Compliance with managed dog(s) regulation	% of dog walkers in compliance with voice and sight control regulations # "at large" dogs
	Conflict	# observed dog-dog conflicts # observed dog-person conflicts # observed person-person conflicts
	Compliance with bicycling regulations	% of bicyclists who exceed speed limits
	Compliance with dog waste disposal requirement	% of observed excrement events in which handler picked up waste # littered excrement baggies within 2 m of the trail
Visitor interference with appropriate visitor use of the park	Uninvited entry into personal space	% of potential incursions that enter visitors' personal space
	Visitors' reported and observed reaction to dogs entering their personal space	% of visitors who have positive, neutral, and negative reactions to dogs entering their personal space (survey)
	Compliance with commercial dog walking regulations	# of commercial dog walkers observed in restricted areas % of commercial dog walkers who have >6 dogs per handler # dog walkers with >3 dogs who do not have a commercial permit displayed
	Interference with organized group educational activities	# dogs entering the space of a school or educational group

Of particular note, measures that involve human sentiment (e.g., enjoyment or conflict) generally have no effective way to be measured with observation and instead require the use of surveys and scale measures (Keeney & Gregory 2005). Because of this, we developed a set of questions that could be used in a survey to monitor visitor experiences and learning. This may not be a high priority at this time, as a recent field survey at GGNRA (Solop 2019) revealed that few visitors in 2018 (i.e., 4% of those surveyed at Crissy Field) reported any problems during their visit. Among those who did report problems, bicycle speed and dogs being off-leash were two of the top three issues.

Another general decision that limited the scope of the monitoring program was the recognition that existing management practices are adequate to address some problems that arise, making monitoring unnecessary. At several sites, NPS managers can and do simply take action, for example, fencing sensitive areas. Extensive monitoring is often not needed for this; routine visits by recreation staff can reveal if a problem needs to be addressed. Nevertheless, there are places with fencing (e.g., Crissy WPA) where monitoring of compliance is warranted, and locations that cannot be fenced (such as lagoons) should be monitored.

Selection of Final Measures

At an in-person meeting at park headquarters in June of 2018, the OSU team and park staff discussed each of the potential measures, including their likely reliability, their effectiveness in detecting issues of significant concern, and their feasibility to implement. This resulted in the decision to select a limited number of key measures and to monitor at only a subset of sites. Several potential measures were dismissed as too unreliable, potentially objectionable to the public, or too data-intensive to be practical. Table 7 gives the definition of the final measures and the sites proposed for monitoring them.

As noted above, based on the literature review and the challenges we experienced in creating viable observational protocols for measures related to visitor experience (namely conflicts between dogs, conflicts between dogs and visitors, and conflicts between activity types), we agreed that survey-based measures would be most valid and reliable. Surveys can obtain a random sample with efficiency at busy sites like GGNRA, and they are the most accurate way to judge subjective reactions to events. Therefore, in 2018 we developed a written questionnaire that could be distributed to visitors. We completed the required forms for approval of this questionnaire and submitted it to the Information Collections Review Coordinator in the NPS Social Science Program. Unfortunately, it appears that the submission was never reviewed by the Office of Management and Budget and the effort stalled. Nevertheless, we continue to recommend that – if GGNRA staff choose to proceed with a visitor use monitoring program – they consider inclusion of survey-based measures for selected indicators. If park staff choose to monitor human sentiments, the survey questions we developed are on file at Park Headquarters.

We also recommended that the most efficient and effective way to monitor interference with organized group educational activities would be by asking each organization to maintain a standard log of any such incidents. We did not develop a formal data sheet for this, however.

Table 7. Final Measures Selected and Sites Where Applicable

Indicator	Final Measure	Sites
Compliance with on-leash regulations	The percent of groups who have dogs that are in compliance with regulations to have dogs on a leash no longer than 6 feet ("leash compliance")	Stinson Beach Muir Beach Baker Beach Crissy East Beach & West Bluff
Safe and healthful environment for visitors and employees	The number of instances of dog excrement counted along specified transects per specified duration of time ("excrement counts")	Muir Beach Fort Funston
Compliance with fenced or posted sensitive resource or habitat restoration closures	The number (and percent) of dogs and people entering lagoon areas within a 2-minute observation period ("sensitive habitat entries")	Muir Beach Rodeo Beach
Compliance with commercial dog walking regulations	For groups with one or more dogs, the mean number of presumed commercial dog walking parties (>3 dogs/person) seen per hour; the proportion of presumed commercial dog walkers that have >6 dogs per handler ("dogs per group")	Alta Trail Fort Funston Crissy East Beach

Ancillary Data for Standardization and Context

Many of the selected measures involve simple counts (e.g., the number of people entering the lagoon at Muir Beach per hour) or percentages (e.g., the percent of groups with dogs off-leash). To be able to confidently assess trends over time, count data often require the measurement of additional variables for the purposes of standardization. For example, observing four people entering the lagoon during an 8-hour monitoring session when 80 total people were observed is a different rate of non-compliance than observing four people entering a lagoon during a 2-hour monitoring session when 10 people were present. Therefore, it is important to document overall visitation to a site in association with the focal monitoring variables. This can be done in a variety of ways, such as having an observer count vehicles in a parking lot or using an automatic counter to count individuals along a trail. In general, we recommend reporting count data as a percentage of instances (e.g., the percent of observed bicyclists who were exceeding the speed limit) and standardizing by time (e.g., the number of entries into the lagoon per hour). To enable such standardization, we developed two measures

that, while not linked to any of the indicators per se, provide important context for the indicator-specific measures:

- Visitor density. The number of people at one time and number of dogs at one time within established zones or passing a point along a path.
- Parking lot counts. The number of vehicles present at one time in parking lots.

While data on overall site visitation is important for standardizing data, other types of ancillary data can also be important for helping understand patterns of behavior and determining whether apparent trends are likely to be genuine trends or merely artefacts of varying properties of the samples over time. For example, temperature and time of year likely influence whether people enter the lagoons at Muir Beach and Rodeo Beach. Similarly, if field data collection occurs when the creeks are not flowing, there would be no opportunity for visitors to enter into the lagoons, and records would lead to a conclusion of no non-compliance. Therefore, the field protocol and data sheet for each of the measures include additional data fields to capture such contextual information.

Development of Field Protocols

Following the meeting and workshop in June 2018, in-depth work began to develop written protocols and test the reliability of measures. Field visits to each of the selected sites and attempts to capture data led to substantial changes in how data would be collected for three measures:

1. We had initially considered using trail cameras to collect observational data to measure factors such as non-compliance with bicycle regulations or leash compliance. However, the decision was made not to pursue that approach at this time. First, based on input from facility maintenance staff, it was determined that the likelihood of vandalism of cameras was too high to be able to rely on this technology for data collection. Second, there were serious concerns about whether cameras could be used effectively while ensuring visitors' privacy. Third, where use is high and/or dispersed in an area, cameras may not be able to capture the behaviors of interest. Fourth, as indicated by the literature review, software to automate image analysis was not adequate for the purposes (at the time of our review), and the park does not have staff resources for image analysis. Fifth, where multiple types of data can be collected by an observer (but not a camera) it may be more efficient to use human observers. Therefore, all protocols we developed use human observers on-site.
2. Various approaches for observing negative visitor or dog behaviors were considered and piloted over a period of nearly a year. However, monitoring these behaviors through observation was determined to be infeasible due to the many hours of

observation required to detect a single incident of behaviors that could be definitively classified as negative (e.g., a dog bite or verbal altercation). Therefore, visitor reports of such types of extreme incidents via a survey were determined to be the best method for monitoring them. Additionally, an approach to monitor whether dogs or people entered other visitors' personal space (to be used as a measure for the indicator of inappropriate use) was developed and repeatedly tested and refined. However, it was ultimately determined to be unreliable, because observers could not consistently or accurately assess the proximity of people and dogs, especially in busy settings. Instead, a questionnaire was developed to ask visitors directly about their experiences (see above).

3. We had initially developed a measure to observe pet waste removal that entailed observing dogs and their handlers. However, during testing of this measure, observed defecation events were so infrequent that it became apparent that considerable time would be required to collect an adequately large dataset. Moreover, during busy times it was not always feasible to track which handler was with which dog, or whether the dog handler picked up their pet's waste. Therefore, we developed a different measure and protocol to indirectly monitor pet waste removal based on the presence of pet waste in specific monitoring areas.

To finalize the measures and field manual (Hall et al. 2022), we made the decision to select key observation points or zones within selected units, rather than randomly sampling from among all possible observation locations or traveling haphazardly through a site. Clearly delineating observational spaces helps ensure the comparability of data over time and significantly increases the efficiency of field data collection (Reynolds et al. 2016). After field reconnaissance of patterns of visitor movement through each park unit, the observation location(s) were selected based on the following criteria:

- Locations where use concentrates, or where problematic behaviors would be most likely to occur (e.g., dog waste pickup in locations near where dogs exit vehicles).
- Locations that could serve as representative instances of conditions within an entire site (e.g., counting the number of dogs per handler as groups cross the pedestrian bridge at Muir Beach).
- Ease of unobtrusive observation by field staff.
- Appropriate size of a delineated area for the observer to be able to see all events within it.

Reliability of the Final Measures

Having selected the measures, the next step was to establish if the protocols were reliable. Hall and Sidder (2021) reported details of the reliability assessment, so only key

findings are summarized here. Reliability in this case means that independent observers can read the instructions, observe the same situation, and reach the same determination about the status of each measure. Field assessment of reliability enables protocols to be finalized, or if needed, improved to increase reliability. Common problems that can lead to unreliable data include having observational areas be too large, so that different observers might see things in different parts of the zone; having vague instructions or definitions, so that different observers interpret and record the same event in different ways; making tasks so complex that the observer becomes mentally fatigued and unable to accurately and completely record data; and requiring frequent glancing back and forth from a datasheet to the site, so that instances of an event are missed by one or both observers.

Detailed protocols were created for each of the field measures, which (1) delineated observational zones using low-elevation aerial photos; (2) stipulated travel paths through sites where observations are made during a "roam" versus from a stationary location; (3) provided decision rules for counting (e.g., what to do if it was not possible to determine which individuals were traveling with which groups); (4) specified the duration of each observation session and the minimum time interval required between observations of the same measure; and (5) included paper field data collection forms, with each field clearly defined. The reliability testing process we used was as follows:

1. Initially, we set a goal of 50 paired observations for each measure. We established field testing schedules that we anticipated would generate these data in June, 2019. Two observers were used during the June 2019 session. One of these had not been part of protocol development previously, so she was able to serve as a "typical" field technician. This field testing involved >80 hours of paired observations, requiring ~200 person-hours of field time, including travel.
2. The June 2019 testing revealed some significant problems with the initial sensitive habitat measure and various issues with some other measures. Additionally, we realized that some events were so infrequent that it was impractical to try to collect data using our proposed approaches. Because some protocols subsequently had to be changed, we were unable to collect sufficient data during the June 2019 visit to establish adequate interrater reliability (IRR) for most measures. However, the initial field testing allowed us to refine observation locations and methods. We were unable to test protocols at Crissy Field and Stinson Beach, but all other sites were accessible.
3. Following protocol refinement, five observers, working in pairs to test measures, were used during a testing session in September of 2019. An intern at GGNRA also participated as a sixth observer on one day of data collection. During this field visit, we tested each measure at most of the sites where they will ultimately be used. However, we could not conduct observations at Alta, Crissy Field, or Stinson Beach. Also, given logistics of field travel and varying use levels at sites, in some cases, we used substitute

sites where use was adequately high (i.e., would generate enough data in the short time available) and the site was considered to be similar to the actual monitoring locations. For instance, we tested measures of leash compliance at Ocean Beach – which is not a selected site for the monitoring program – as well as at the edge of the parking lot at Baker Beach, where it will be used.

4. In September the refined protocols worked well for most measures, but the protocols for two measures were still not generating reliable data:
    a. The original excrement pick-up measure proved not to be feasible. As noted above, it required a great deal of time to observe these infrequent events, and pairs of observers did not always see the same dog at the moment it was defecating. Therefore, the protocol was changed to count instances of excrement present on site, rather than dogs in the process of defecating. Some data were collected to test reliability with that new protocol during the September field visit.
    b. The sensitive habitat protocol was not working well at Muir Beach, because observers could not accurately document entries into the large lagoon area. This led to a complete revision and new measure focused on observing zones and using shorter observation periods. A small dataset was obtained using the new protocol, which suggested that it would be feasible and reliable.
5. Following analysis of the combined June and September (2019) data, we identified targets for completing collection of remaining IRR data. Interns at GGNRA collected these data from late September to early December, 2020. At that time, we had sufficient data for each of the final measures.

When computing reliability, one metric commonly adopted is Krippendorff's alpha. This coefficient provides a measure of how likely agreement between observers is to occur simply by chance. Krippendorff provides conservative recommendations for interpreting alpha values (Hallgren 2012; Krippendorff 2004). Values less than 0.67 suggest the results should be "discounted," meaning the measure does not have sufficient reliability for definite conclusions. For coefficients less than 0.67, the results should not be assumed to be any better than would result from chance. Values between 0.67 and 0.80 suggest "tentative conclusions" can be made from the data; in other words, the data are considered somewhat reliable. Finally, alpha values above 0.80 suggest "definite conclusions" can be made from the data; in other words, the data are considered reliable.

All but one of the measures we tested achieved alpha coefficient values of greater than 0.80, indicating the data are reliable and definite conclusions can be made when they are put into practice at GGNRA as part of an overall monitoring program. The only measure with slightly lower reliability (α= 0.78) was the number of people per group, which is included in the dog

walking protocol; this was slightly less reliable because, at busy sites like the entry trail to Muir Beach, it can be difficult to determine which individuals are with which groups. Nevertheless, the reliability for this measure was at the high end of the range for "tentative conclusions." The following measures and their specific sub-measures achieved reliability $\alpha>0.80$ (details are provided in Hall and Sidder (2021)) and are recommended for use in future monitoring:

- Dogs per Group Protocol (measure: for groups with one or more dogs, the mean number of presumed commercial dog walking parties (>3 dogs/person) seen per hour; the proportion of presumed commercial dog walkers that have more than six dogs per handler). Data fields:
    - Number of dogs per group
    - Number of people per group
- Leash Compliance Protocol (measure: the percent of groups who have dogs that are in compliance with regulations to have dogs on a leash no longer than 6 feet). Data fields:
    - Number of groups without dogs
    - Number of groups with at least one dog off-leash
    - Number of groups with all dogs on-leash
- Sensitive Habitat Entry Protocol (measure: the number (and percent) of dogs and people entering lagoon areas within a 2-minute observation period). Data fields:
    - Number of people entering the lagoon during the observation period
    - Number of dogs entering the lagoon during the observation period
    - Number of people within 5 feet of lagoon shore at the end of the observation period
    - Number of dogs within 5 feet of lagoon shore at the end of the observation period
    - Number of people 5-25 feet of the lagoon shore at the end of the observation period
    - Number of dogs 5-25 feet of the lagoon shore at the end of the observation period
- Excrement Count Protocol (measure: the number of instances of dog excrement counted along specified transects per specified duration of time). Data fields:
    - Duration of time (hours) between cleaning the transect and counting instances of excrement
    - Number of unbagged excrement piles along specified linear transect
    - Number of bags of excrement present along a specified linear transect
- Visitor Density Protocol (ancillary data). Data fields:
    - People at one time
    - Dogs at one time
- Parking Lot Count Protocol (ancillary data). Data fields:
    - Vehicles at one time

Recommendations for Implementing the Monitoring Program at GGNRA

Sampling Decisions

In discussions with GGNRA staff, key decisions were made that informed the recommended approach to data collection. First, it was decided to restrict sampling to the high use season, specifically summer months. Arguably, this is the time when certain types of problems would be more likely to occur. For instance, bathing in the lagoon at Rodeo Beach or problems with crowding and conflict are more likely in the high-use summer months.

Second, it was decided to use random sampling to schedule dates of data collection rather than convenience sampling. This will help ensure a higher level of confidence and credibility in conclusions about trends over time. However, random sampling does entail considerable advance planning and additional staff and resources beyond what is required for convenience sampling. If park staff decide to implement this monitoring program, they will need to randomly choose sampling dates in advance of the monitoring season.

Third, it was decided to establish sampling schedules in such a way that allows conclusions about trends over time to be made for individual park units (six units were selected for initial monitoring, though units could be added or subtracted in the future as park staff deem necessary). The rationale for this takes into account that certain management concerns might be addressed differently in different park units, for example by signage, additional staff presence, fencing, or other actions. Therefore, it was important to obtain information about each site independently, rather than sampling in a way that aggregates data across sites.

Fourth, there was a desire to understand conditions on weekdays versus weekends and holidays, because some types of behaviors of interest (e.g., leash compliance) could potentially differ by time of week. This stipulation requires sampling from each of the two temporal strata.

Ultimately, considering the tradeoffs between the cost of obtaining large samples and the desire for validity and precision in estimates, we recommend that the park randomly sample one weekday and one weekend (or holiday) per week throughout the 12-week high-use season (June, July, and August), which would result in 24 observations per measure per site. Drawing sample dates randomly from each week ensures that the data points will be spread throughout the use season, which is not guaranteed with simple random samples, particularly when sample sizes are small, as in this case. This approach to sampling follows the “sliding scale” recommendations of the Interagency Visitor Use Monitoring Council (IVUMC 2019), insofar as data from the monitoring program can be used to identify whether there appear to be patterns or trends that might warrant more intensive monitoring in subsequent years. The specific sampling dates should be randomly selected from all available dates between the start of Memorial Day Weekend and the end of the Labor Day holiday. For each week, four dates should be selected, with one weekday and one weekend day (or holiday) being the primary

date and the other two serving as “backup” dates in the event that data collection cannot occur on the originally sampled primary dates.

Given the number of park units to be sampled and target sample sizes, this monitoring program will entail a substantial effort. Therefore, for the purposes of implementation, the sites have been bundled into groups to facilitate logistics and transportation. Specifically, Muir Beach and Rodeo Beach will be sampled on the same dates; Stinson Beach and Alta will be sampled on the same dates; and Fort Funston and Baker Beach will be sampled on the same dates. Given the proximity of Crissy Field to Park Headquarters, it is treated independently with its own sample of dates, which may or may not occur on the same dates as other sites.

The NPS will need to decide at what yearly interval to conduct repeat monitoring. It is unlikely that data will need to be collected annually. However, it seems prudent to collect data at least once every five years. The decision could be made to collect data for all sites in each year, or to stagger data collection such that some portion of the sites are monitored each year. Either will generate usable data.

Because the sample size for each measure at each site is rather small, it is recommended that the NPS inspect the data promptly and evaluate whether any issues of managerial concern arise in the findings. For example, if there appears to be a significant problem with people swimming in lagoons, there might be a need for additional data to validate the degree to which this is a problem (which might also need to involve wildlife biologists). If warranted, additional data fields could be added during subsequent monitoring, such as information about visitor group characteristics.

Limitations of the GGNRA Protocols

As described earlier, the purpose of the *Golden Gate National Recreation Area Visitor-Use Monitoring Program* is to document trends in the state of selected social and biophysical conditions over time. With that said, there several things that the protocol cannot accomplish. Specifically, as it is currently designed, the protocol cannot provide information about specific types of users. For instance, the protocol is not designed in a way that would yield data to help managers determine whether any particular age group tends to be out of compliance with regulations or if local visitors differ from non-local visitors. If managers desire such information, field protocols and sampling would need to change. Further, this program is not designed to yield broad and general characterizations of the GGNRA as a whole, as it only includes specific locations within specific units of the Park. Thus, the results of monitoring (e.g., the percent of groups complying with regulations or the rate of entry into a closed area) are not generalizable across the GGNRA or to units that are not included in the monitoring protocol, such as Muir Woods. However, the protocols could easily be adapted for use at any GGNRA unit. Finally, the relatively small number of observations for each measure at each site may enable only limited

conclusions, and it may be desirable to consider intensifying monitoring over time if initial data suggest there may be concerns.

Change Management

To be valid for monitoring trends over time, a monitoring protocol must be implemented in the same way each time. This means that field staff must be properly and consistently trained, to avoid the common problem of different crews interpreting the meaning of different variables in different ways. For example, if decision rules are not clearly articulated, observers in different years might use different rules for considering an action to be an entry into closed habitat. Such problems are quite difficult to identify after the fact, and they can invalidate the results obtained. *Therefore, we strongly recommend that the NPS not alter the existing measures and protocols*. There are three acceptable types of changes.

First, there is no problem with subdividing an existing measure into more refined measures, so long as future data can be reaggregated into a form comparable to earlier years' data. For example, the current measure of people per group could be subdivided into the number of adults and the number of children per group. These values could be added together to generate the number of people per group, making the data fully comparable over time. As another example, where current protocols specify the duration of an observation session as 10 minutes, this could be done in subsequent years as two 5-minute sessions. Again, because the data can be aggregated in a way fully comparable to the original data, this is acceptable.

Second, it is acceptable to add additional fields to existing measures or to create entirely new measures to supplement the existing measures. For instance, it might be desirable to add a field to the leash compliance data sheet to document whether park staff are present or not. Or the agency might choose to develop a new measure related to vegetation loss from trampling. Such additions do not compromise the ability to track changes over time in the original measures as long as data for those original measures continues to be collected.

Third, and related to adding additional data, it is permissible (sometimes desirable) to increase sampling intensity and obtain more data points than the minimum required, so long as the same approach to sampling (stratified random sampling of weekdays and weekend days) is retained. However, if data are collected outside the 12-week monitoring period, only the observations collected at comparable times should be used to determine trends.

CHAPTER 3: FIELD METHODS AND DATA COLLECTION

Overview

This chapter provides guidance for collecting data for the selected measures at GGNRA. It begins with a discussion of field preparations and training. It then describes each of the individual protocols for measures, which are elaborated in full detail in the *GGNRA Visitor Use Monitoring Field Guide* (Hall et al. 2022). It concludes with a discussion of adaptive monitoring and recommendations for change management, as well as considerations and guidance for planning and carrying out fieldwork.

Field Season Preparations

Each year, time should be set aside for planning the data collection effort, analysis, and reporting. This includes pre-field tasks, training, field time for gathering monitoring data, and steps taken after the completing of data collection (Table 8).

Table 8. Considerations for Field Monitoring and Data Management

Pre-data collection	Ensure the availability and functionality of field equipment and reliable access to field sites.
	Assemble field data forms and/or electronic data collection devices and interfaces.
	Select sample dates and times (with backup dates).
On-site	Clearly identify and demarcate observation locations (on-site, or with aerial photos), so that different field personnel can consistently find locations and know their boundaries.
	Specify the duration, frequency, and interval for replication for each measure at each site within and across sampling dates.
	Spell out counting rules for all observational measures (e.g., define what is meant by “group”).
	Provide guidance about how to pause and recommence data collection if unexpected events occur on site during data collection.
Post-data collection	Develop a plan and platform for long-term curation of datasets, including meta-data (see Chapter 4).
	Articulate all data cleaning steps required, including handling of missing data.
	Describe statistical analysis procedures, including software.
	Create a process for regular, efficient reporting of results.

Well in advance of the field data collection season (ideally in the winter), the the monitoring program lead should confirm which measures are to be monitored at which sites and should create a **calendar** of dates for monitoring. As noted in Chapter 2, at GGNRA, the decision was made to sample on one weekend day (or holiday) and one weekday, each week, at each site for the 12 weeks of the high use season. If the full set of sites will be monitored, this will likely require at least two technicians, and potentially more on weekends. Random sampling of dates can sometimes lead to the same date being selected for multiple sites. If staff are available to cover multiple locations, that is not a problem. However, in such cases, it is permissible to substitute a different randomly sampled date for sites, to accommodate staffing constraints.

Ideally, full-time technicians should be hired to conduct all monitoring, to enhance consistency and validity of the data. It is well documented that having different observers collect data is one of the major sources of error monitoring programs. Technicians should have good attention to detail, have flexibility in their working situations (including the ability to to work on weekends), and have strong interpersonal skills to interact with park visitors. Volunteers can often be used successfully in monitoring – particularly for simple measures – but care should be taken that they have the time and commitment to carry through on assigned work.

Two to three days should be planned for **training field technicians**. A key purpose of training is to establish quality assurance practices that prevent errors in the data (McCord et al. 2022). Quality assurance includes having clear program design and measurement rules, as well as calibrating observations for consistency.

Training should include an overview of the monitoring program, its purposes, and how data will be used, to increase commitment and buy-in from technicians. It should also include an introduction to best practices for monitoring (material discussed in Chapter 1 of this report). During training, roles and responsibilities of each involved staff member should be clearly explained.

The majority of the training should take place on-site, with technicians practicing collecting data (McCord et al. 2022). Ideally, this should be done at times when use levels are moderate to high, because those represent the most challenging conditions for collecting valid and reliable data. The technicians should be trained in one measure at a time. This should begin with them individually reading the field protocol and then attempting to implement it. Doing this before any discussion of the protocol is the best way to surface any confusion or inconsistency in the instructions. A group discussion should then explore all questions and problems until everyone understands the process, decision rules, and data recording requirements. Training should address the following elements that can involve subjectivity:

- Standardized pace for walking during roving counts
- The field of vision or scanning path when conducting stationary counts

- Rules for counting individuals seen more than one time per observation session
- The importance of making written comments for unique circumstances and how to document them
- Rules for handling missing data

It is important to stress that consistent application of rules across different observers is more important than having the most precise or accurate measure of a phenomenon. This is because the primary goal is to detect trends over time, and inconsistency among observers can impair the ability to isolate true changes. If actual changes are small, or if there is a fair amount of natural intra-annual variability in a measure, even small differences across observers can mask an actual trend. Moreover, if the error between observers is in the range of variation of expected values, the error may never be detectable (McCord et al. 2022). For some types of monitoring, such as national protocols for grassland monitoring, field technicians are required to calibrate at least once monthly and any time they enter into a new ecosystem (McCord et al. 2022). At GGNRA, the protocol with the most potential for problems with reliability is the sensitive habitat measure, and we recommend re-calibrating two or three times during each field season.

Following the discussion, technicians should be split into pairs to practice observing the same situation at the same time, to evaluate the inter-rater reliability of their data (McCord et al. 2022). They should conduct at least 20 such paired observations for each measure. Iterative training rounds may be necessary to establish a desired level of reliability (>85% agreement).

Inter-rater reliability can be established by field visits to one or two sites. For GGNRA, we recommend training at Fort Funston, Crissy East Beach, and Muir Beach, to capture the range of measures and different use levels and user types. While it is not necessary to collect reliability data at all sites, each site should still be visited and the group should practice the protocols at every observation location within every site.

Apart from the protocols themselves, several other topics should be covered during training. Standard National Park Service practices regarding safety should be discussed. Field technicians should also be trained in appropriate visitor contact and how to handle questions they may receive from visitors. While many of the observations included in the protocols can be collected unobtrusively, there is the chance that visitors may become curious about the presence of an individual with a notebook or tablet or someone they see at a site multiple times throughout the season. Training in visitor contact can usefully employ role play, where individuals practice responding to questions or challenges such as, “what are you doing here?” or “is the Park Service going to use the data to restrict access?” We recommend that GGNRA develop a postcard-sized informational handout with contact information for the monitoring program lead or other responsible official that technicians can distribute to interested visitors. Finally, we recommend that conversations about attire should be had with technicians; we

recommend that they collect data in plain clothes (i.e., not uniforms), because the presence of uniformed staff can itself potentially bias the data, for instance if compliance is higher when uniformed staff are present.

Background and Context for Measures Selected

The following section provides an overview of the measures developed for each indicator. The specific field procedures are detailed in Hall et al. (2022). The discussion below provides explanation and context that does not need to be included in a field manual, but that is important for understanding each of the protocols.

Dogs Per Group

The *dogs per group* protocol uses observation to determine the extent of compliance with regulations regarding the number of dogs permitted per handler in GGNRA. This protocol collects data on the number of people and dogs in groups that visit with at least one dog. (Groups without dogs are not included.) This protocol also includes fields to record information about whether handlers appear to be commercial dog walkers; however, at present those data are not considered reliable enough to serve as formal measures for compliance with commercial dog walking regulations. Commercial dog walkers are required to display their permit, but at the time of the development of the protocol, we were unable to develop a systematic and unobtrusive way to document permit display. Many commercial dog walkers are easily identified by insignia or information on their transportation or clothing, but we could not assume that all commercial dog walkers could be confidently identified by such indirect methods. If the GGNRA were to institute new policies regarding the display of permits that would lead to more reliable data collection, for example a requirement that commercial dog walkers wear unique vests, an additional measure for commercial dog walking could be considered in the future.

There are two component variables used for this protocol: the number of people in the group (where a group is defined as one or more people traveling together) and the number of dogs associated with each group. Documentation occurs in one of two ways, depending on the configuration of the site and the nature of its use: the observer counts either (1) the number of groups (and the number of dogs associated with each group) that are present within a specified zone or (2) the number of groups (and the number of dogs associated with each group) that cross an invisible threshold into an area (such as from a parking lot into a picnic area).

The field locations for this protocol were selected to maximize the ability of an observer to accurately and reliably count people and dogs, and to determine which people and dogs are together as a group. Some sites with complex use patterns, or where visitors can enter from multiple points, have more than one observation location (or zone), while others have only one. The duration of observation sessions varies from 10 minutes to one hour, depending on the

typical use level of the site. Also, the number of repeat observations per day is specified for each site in the field manual. Our field visits revealed that some individual commercial dog walkers tend to exhibit patterns in the way they use GGNRA sites, for instance using the same site at the same time each day. Therefore, to avoid systematically biasing the data toward any particular individuals, care must be taken to rotate the times of day that observations are made within any given park unit, as well as to allow sufficient time to elapse between observations on the same day so that observers are not documenting the same individuals multiple times.

Dog Excrement Count

The *dog excrement* protocol uses observation to indirectly document compliance with regulations about dog excrement removal (36 CFR § 2.15 (a)(5)). According to the Superintendent's Compendium (NPS 2017b, p. 26), "pet excrement shall be removed immediately from the park or deposited in a refuse container by the person(s) controlling the pet(s)."

The protocol calls for technicians to count instances of dog excrement along one or more transects at selected monitoring sites. A single instance consists of a pile of excrement or individual pieces of feces identified as being from the same dog. The field protocols call for recording whether feces are bagged or unbagged.

The transects are lines along which the observer walks, scanning from side to side. They were selected to represent focal areas within each park unit. For instance, one transect is located adjacent to the primary large parking lot at Fort Funston, where many dogs enter the site for the first time from a parking lot. Transects are also present along the access trail from the Muir Beach parking lot to the beach itself. The transects are different lengths, and each receives different levels of use by groups with dogs, so it is not appropriate to compare the counts across sites. This protocol will be applied at only a few units of GGNRA, as our field testing along ocean beaches revealed very little pet waste, and it was deemed not to be a good use of time to monitor at them at this time. However, the park could revisit that decision over time.

Because the time that elapses between observations is likely to be correlated with the amount of waste present, this protocol requires technicians to clean each transect upon arrival at a site in the morning by removing all pet waste present. The counts are later conducted as the last activity of the day, and the elapsed time between cleaning the transect and collecting data is recorded, so that counts can be standardized by elapsed time. Technicians will pick up the dog excrement as they count to ensure the transect is "clean" after each data collection session. On the same days as excrement counts are made, data will also be collected using the *visitor density* protocol to facilitate interpretation of excrement count data.

A limitation of this protocol is that it does not document the actual pick-up or disposal of pet waste. Although guardians are required to properly dispose of waste by taking it to a

provided receptacle or off-site, the protocol only counts waste that was either not picked up by guardians or that was bagged and left on site. Thus, it is not possible to determine the percentage of dog handlers who comply with disposal regulations. Data to determine percent compliance would require observing dogs and their handlers at the time a dog defecates, which pilot testing revealed would be time consuming and difficult for technicians to do reliably.

Leash Compliance

The *leash compliance* protocol uses observation to determine the extent of visitors' compliance with regulations requiring dogs to be leashed where such regulations are in effect. The inclusion of this indicator is motivated by regulations articulated in the *Superintendent's Compendium* (NPS 2017b), the GGNRA Pet Policy (NPS 1979), and 36 CFR § 2.15(a)(2). This measure relies on a stationary or roving observer to document instances of dogs on- and off-leash. The observations consist of counting the number of parties that have dogs that are in compliance and out of compliance with the regulation.

Although the GGNRA regulations specify that leashes shall be no longer than six feet in length, for the purposes of this protocol a dog attached to a leash of any length that is held by a person is considered to be "on-leash." Any rope, chain, cord, or strap that attaches to a collar or harness is considered a leash. Dogs that have a leash not actively being held by their guardian (i.e., dogs that are running free with a leash attached) are considered off-leash.

Two approaches were developed to document leash compliance, given the different ways people use picnic areas versus other areas. In locations where visitors are traveling (e.g., walking to the beach or hiking along a trail), the approach relies on observing groups crossing an invisible threshold into a predefined space. In these situations, multiple observations sessions are scheduled for each monitoring day, and each will last 10 minutes. During that time, all groups that enter the area with one or more dogs will be documented.

At picnic areas, individual groups may stay at a table (or on the grass) for an extended time. Therefore, using 10-minute continuous observations sessions is inefficient. Instead, the approach is to conduct instantaneous counts by systematically scanning the area and documenting all groups with dogs that are using (not traveling through) the picnic area. At intervals, the technician will "map" each group occupying a picnic table or set up with blankets or chairs (or other indications of staying put). This can be done from a stationary point or by walking through the site. Because groups may be present for an extended time, during each pass through the zone, the technician will record which groups are newly arrived since the prior observation and which were present previously (and therefore already recorded).

Sensitive Habitat

The *sensitive habitat* protocol uses observation to determine the extent of compliance with park-mandated closures of ecologically sensitive areas. The inclusion of this indicator is

motivated by regulations articulated in site-specific guidance found in the *Superintendent's Compendium* (NPS 2017b) and general rules codified in 36 CFR § 1.5(a). Although there are various types of sensitive habitat at GGNRA, the final protocol focuses solely on entries into the lagoons at Muir Beach and Rodeo Beach.

Development of a feasible, reliable measure proved difficult. We initially considered trying to track the duration of all incursions into the lagoons, but this was impractical at busy times. We also initially considered using 10-minute observation sessions but found that it was often impossible to keep track of people and dogs for that long of a period or to count the number of times a dog went in and out of the water. The final protocol simply counts the number of people and dogs entering the water during a 2-minute observation session. Entry is defined as any portion of a person or dog breaking the surface of the water, for any period of time. The protocol indicates that each person or dog entering the water should be tallied only once during each 2-minute observation session, even if they enter the water multiple times. This decision simplified the observation process and greatly enhanced the reliability of the measure.

The counts of entries into the water are accompanied by instantaneous counts of nearby people and dogs present at the end of the observation period. To enhance reliability of these counts, the protocol specifies two zones: within 5' of the lagoon's shore and 5-25' from the lagoon shore (these distances are short enough that observers could reliably identify them). These data will be used during analysis to standardize the number of lagoon entries counted (i.e., the number of people/dogs entering the water divided by the total number of people/dogs present within the zone). The protocol calls for the observer to conduct three observation sessions (entries + people/dogs present) per day, separated by 10 minutes. Given the short interval between observations, the same dogs and people may be counted in subsequent 2-minute sessions. Because this violates the independence of observations required for statistical analysis, data will need to be averaged across sessions that occur consecutively to generate a single data point for the location.

A limitation of this protocol is that each dog or person observed entering the lagoon during the 2-minute session is counted only once. Thus, multiple entries into the water by a single person or dog would be documented as a single entry. Additionally, any entry is considered equivalent to any other entry, regardless of the behavior of the dog or person. It is also important to acknowledge that, during busy times, it can be difficult to track individuals; however, the segmentation of the lagoon shore and the short observation interval help ameliorate this problem.

Another limitation of the protocol is that, being based on observation, it cannot document whether visitors know they are entering a closed area. Information about whether violations are intentional or unintentional can be important for park managers. Specifically,

such knowledge would help staff better understand the efficacy of the park's communication and education efforts.

This protocol could be adapted for monitoring entries into other types of sensitive habitat at GGNRA, probably with greater ease than was the case for the lagoons. For example, in many areas with sensitive vegetation (e.g., upland trail corridors), it would be relatively easy to observe whether people or dogs leave the trail corridor. However, the levels of use in places where this might be a concern could be rather low, which would require many or long observation sessions to gather an adequately large sample. Park staff could also reconsider the use of trail cameras in locations of high priority.

Parking Lot Counts

To facilitate interpretation of the data collected in some of the other protocols, it is useful to collect a consistent type of information about visitation. *Counts of parked vehicles* can be made quickly and accurately, and they give a good sense of visitation at sites that are primarily accessed by vehicle. Additionally, though this is not described in detail in this monitoring manual, visitor use data can be used to standardize observations across monitoring days having different use levels. This can be helpful in understanding trends over time. For instance, the amount of pet waste present at Fort Funston is likely to be in part a function of the overall use of the site. By converting the counts of excrement into a value such as the number of instances per 10 vehicles present, noise associated with varying use levels is removed, and any actual trends over time are more likely to become apparent.

This protocol involves simple counts of all parked vehicles present in parking lots. The protocol specifies a travel path for the observer to walk through parking lots and count all vehicles parked in established parking spots or in informal spaces. Bicycles are not counted. As presently written, the protocol provides a single overall value for each observation session, but it could easily be modified to count different types of vehicles (e.g., busses, camper vans, or passenger vehicles). As presented, the protocol does not stipulate the timing or number of counts that should be completed per day at each site, but a reasonable practice would be to conduct one count upon arrival at a site and another at the time of departure and average the two.

Visitor Density

Similar to the motivation for the parking lot counts, the *visitor density* protocol collects ancillary data that can be used to standardize data from other measures and facilitate interpretation of trends over time. The protocol calls for counts of the number of visitors (both people and dogs) at one time within specified areas. It sets out three approaches, depending on the nature of the site and its use. In the first (roving counts), technicians walk a predetermined path as quickly as possible while counting all dogs and people present. The second approach,

zone counts, involves a stationary observer standing in a predetermined location and scanning a defined area as quickly as possible. The third approach, visitor flow, involves standing at a predetermined location and counting the number of dogs and people that cross an imaginary line on the path within a 2-minute period.

Data Collection

Daily Schedule

As noted in Chapter 2, the sites are bundled, so that in most cases (except Crissy Field), a full day will be needed for monitoring. When leaving the office each day, technicians should have:

- The cover sheet for documenting the day's work
- The field manual (protocols)
- An ample number of data sheets and clipboards
- A waterproof field notebook for extra notes
- A charger or extra batteries for electronic devices, if they will be used
- Pencils and erasers (pencils are preferred over ink)
- Drinking water
- Food
- First aid kit
- Personal medical supplies (Epipen, inhaler, etc.)
- Emergency contact numbers for supervisors or law enforcement
- Official identification
- Sunscreen, hat, sunglasses
- Appropriate warm or cold weather attire

Data collection should take place in a prescribed sequence within the sited bundled for a given field day. Table 9 presents these recommended sequences. For each cluster, technicians should alter which site is visited in the morning and afternoon, to achieve a balance of observation times. (The only exception is that on days when Fort Funston is sampled, it must be visited first so that technicians can clean the transects of pet waste.) Crissy Field is not shown in Table 9 because it is not bundled with another site and the sequence in which the different measures are made should simply vary each day. When arriving at a site, technicians should review the field manual for specific instructions at a site. They should then proceed to collect data as outlined in Table 9.

Before leaving each site, it is critical that all datasheets be reviewed for accuracy and completeness. Visitor use monitoring differs from other types of monitoring, in that it is not possible to return to a site and retake measurements if errors were made. During ecological

monitoring, if an error is detected in a measure such as vegetation cover within a plot, it may be possible to remeasure the plot. It is not possible to return to the same time and space to remeasure visitor density or leash compliance, so if data are missing or invalid, replacement sampling may need to be scheduled, depending on the severity of the errors.

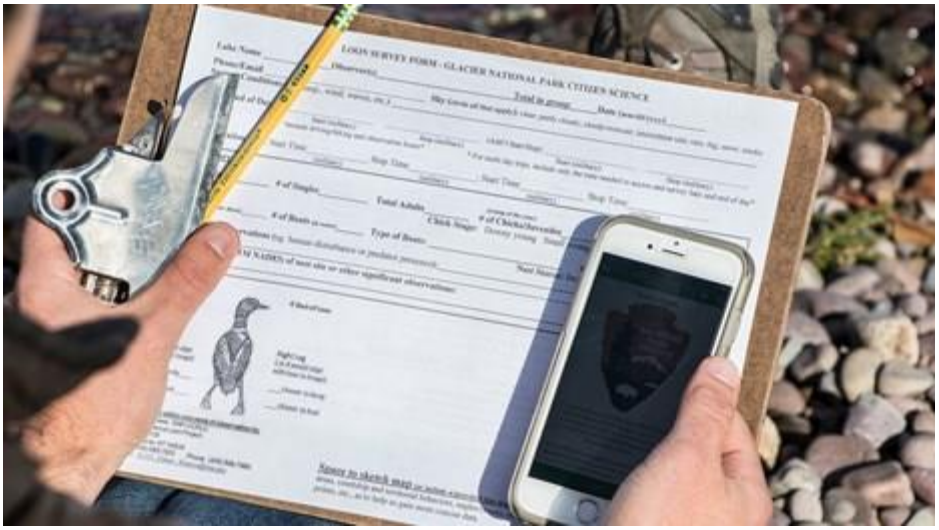
Field forms should be returned to the office as soon as practicable and stored in a central location. The program lead should review forms as they are submitted to identify any problems with illegible or missing data.

Table 9. Sequence of Data Collection for Sites Bundled for Monitoring

	Muir Beach & Rodeo Beach	Alta & Stinson Beach	Fort Funston & Baker Beach
Morning	Rodeo Beach • Vehicle count • Sensitive habitat • Vehicle count	Alta • Vehicle count • Leash compliance	Fort Funston • Clean transects • Vehicle count • Dogs per group
Afternoon	Muir Beach • Clean transects • Vehicle count • Sensitive habitat • Leash compliance • Excrement count • Vehicle count	Stinson Beach • Vehicle count • Leash compliance	Baker Beach • Vehicle count • Leash compliance Fort Funston: • Vehicle count • Dogs per group • Excrement count

A Note on the Use of Paper Forms Versus Electronic Devices for Data Collection

Field monitoring programs are increasingly turning to electronic and cloud-based interfaces such as ArcGIS Survey 123 (Figure 12). Using such devices improves the efficiency of data collection by removing a separate step of data entry, ensures higher quality data than is obtained using handwritten forms (by avoiding legibility problems, allowing automatic checks for valid entries, and enforcing required fields to be completed), and enhances data accessibility (Kachergis et al. 2022; McCord et al. 2022). Electronic data capture has the additional advantage of recording precise GPS coordinates automatically. Nevertheless, use of electronic data capture requires more knowledge of interface design and more effort for field technician training than using paper forms. It also relies on battery power and can be subject to problems if internet connectivity is unavailable. Therefore, it is always recommended that paper backup forms and instructions be taken in the field, even if the plan is for electronic data capture (McCord et al. 2022).



https://www.nps.gov/articles/survey123.htm

Figure 12. Using ArcGIS Survey 123 for Wildlife Monitoring

Adaptive Monitoring and the Change Management Process

The management, resource, and recreational environment are continually changing in parks, making it necessary to consider whether a monitoring program needs clarifications or updates (Kachergis et al. 2022; McCord & Pilliod 2022). There are several questions to be considered and decisions to be made when reviewing a monitoring program over time.

First, a logical question is whether more (or less) data should be collected in subsequent monitoring years. If initial monitoring suggests reasons for concern (e.g., problematic conditions or downward trends) or lack of clarity about the state of conditions due to high levels of variability in the values for a measure, it may be desirable to intensify efforts to generate additional data for those specific measures (Stauffer et al. 2022). This can be particularly important when potential future management actions taken on the basis of monitoring will be controversial (IVUMC 2019).

Gathering additional data for existing measures may also be desirable if management actions have been taken that could affect the type and amount of recreation, compliance with regulations, or the impacts from recreation. This might include the construction of new trails or facilities, implementation of new regulations or fees, or new programming or communication regarding the park. Similarly, additional data may be required if there have been changes due to natural processes (e.g., wildfire or flooding) or popularization of sites via social media.

On the other hand, it is possible that some measures may become obsolete over time, leading to a decision to drop them from a monitoring program. Or, if routine monitoring at relatively short return intervals is showing little change over time, it might be reasonable to move a measure to a longer return interval for monitoring (Lindenmayer & Likens 2009). The pros and cons of these decisions should be carefully debated and well documented.

Apart from potentially altering sampling schedules, other types of changes should be considered when reviewing the monitoring program for updating. For instance, new techniques may become available that generate better or less costly data (e.g., drones), and the rapid pace of change in technology and data entry interfaces means that workflows for data collection may need to be updated regularly (Kachergis et al. 2022). While the decision to adopt a new method to measure an indicator should only be made after careful considerations of the comparability of data over time, in some cases it may be reasonable or necessary to shift approaches (Lindenmayer & Likens 2009; McCord et al. 2022). Another reason that protocols might be updated or changed would be to accommodate or capitalize on changes in other program areas; for example, if the wildlife program begins a detailed program of monitoring endangered species, staff may be able to build monitoring of recreation incursion into sensitive habitat into their protocols.

When first rolled out, a monitoring program is based on the most accurate current understanding of use levels and patterns at monitoring sites. However, initial implementation can reveal that some assumptions were erroneous, or that certain aspects of implementation are difficult to carry out (McCord & Pilliod 2022). For instance, technicians might find that – in busy park locations – visitors engage them in conversation to the extent that they are unable to carry out their monitoring duties. Or it may be discovered that randomly sampling dates for on-site monitoring generates many days with extremely low visitation, leading to a determination that resources are not wisely being spent to sample at those times. Such problems may lead to small adjustments, or in rare cases, to significant alterations of the program and protocols. If so, the justification for the decision should be fully articulated in writing, and implications for the comparability of data over time (i.e., the ability to detect trends) must be known and acceptable (Vos et al. 2000).

A final reason to update a monitoring program is that management priorities or questions may change. It is always worth asking whether the existing monitoring objectives, indicators, and measures are still relevant to management priorities and reflect any evolution in scientific understanding that may have occurred since the program's inception (McCord & Pilliod 2022).

CHAPTER 4: DATA ENTRY AND ANALYSIS

Overview

Careful attention must be paid to managing monitoring data – from the point of collection through reporting – so that the data remain accessible and useful over time (McCord & Pilliod 2022; McCord et al. 2022; Michener 2015). This chapter discusses best practices for data entry, quality control of datasets, and suggestions for data analysis. It draws heavily on Sidder and D'Antonio (2020), Browman and Woo (2018), and McCord et al. (2022).

> *"Proper data management before, during, and after a study is one of the most critical, and often overlooked, parts of data quality."*
> *(McCord et al. 2022, p. 21)*

The monitoring program lead should have responsibility for coordinating all data management elements and developing a data management plan (McCord et al. 2021). This individual will plan and oversee data collection, as described in Chapter 3. Additionally, because they will be responsible for data entry, they should have experience working with spreadsheets. If the program lead has analysis skills, they would also be responsible for the analysis step, though sometimes this is done by other individuals.

The data management plan should include all phases of quality assurance and quality control (see Figure 13). Quality assurance involves steps taken before and during data collection, while quality control refers to procedures taken after data have been collected to identify errors and, ideally, fix them. Among other things, this includes examination of data for outliers, considering whether obtained values are plausible, and identifying missing or erroneous entries (McCord et al. 2022). Below, we first discuss the data entry process, including quality control and documentation. The following section discusses analysis and reporting.

Protocols for Data Entry into Microsoft Excel

Data Entry Set-Up

The monitoring program manager should create an Excel workbook for each protocol into which data will be entered. Microsoft Excel was selected as the most suitable platform for GGNRA, given its ease of use and availability on government computers (Michener 2015). A consistent file naming convention should be used, containing the year of data collection and clearly conveying the theme of each file (Borer et al. 2009).

Several best practices should be followed in structuring each database (Table 10). Consistency is crucial, whether naming variables, entering site names, or formatting dates and times. It is also important to use a consistent indicator for missing values (we recommend using "999"); cells should not be left blank, because it is not possible to determine whether a cell is empty because data are missing due to an oversight during data entry. It is also recommended

to avoid using spaces in any names or values; rather, use an underscore (e.g., “no_dogs” instead of “no dogs”). Excel and other analysis programs are sensitive to case, so consistent rules should be followed for using capital and lowercase letters (e.g., Excel would read “MB” as different from “mb”). Also, characters should be restricted to ASCII only (for example, letters with accents, such as “é” or “á” are non-ASCII and should not be used).

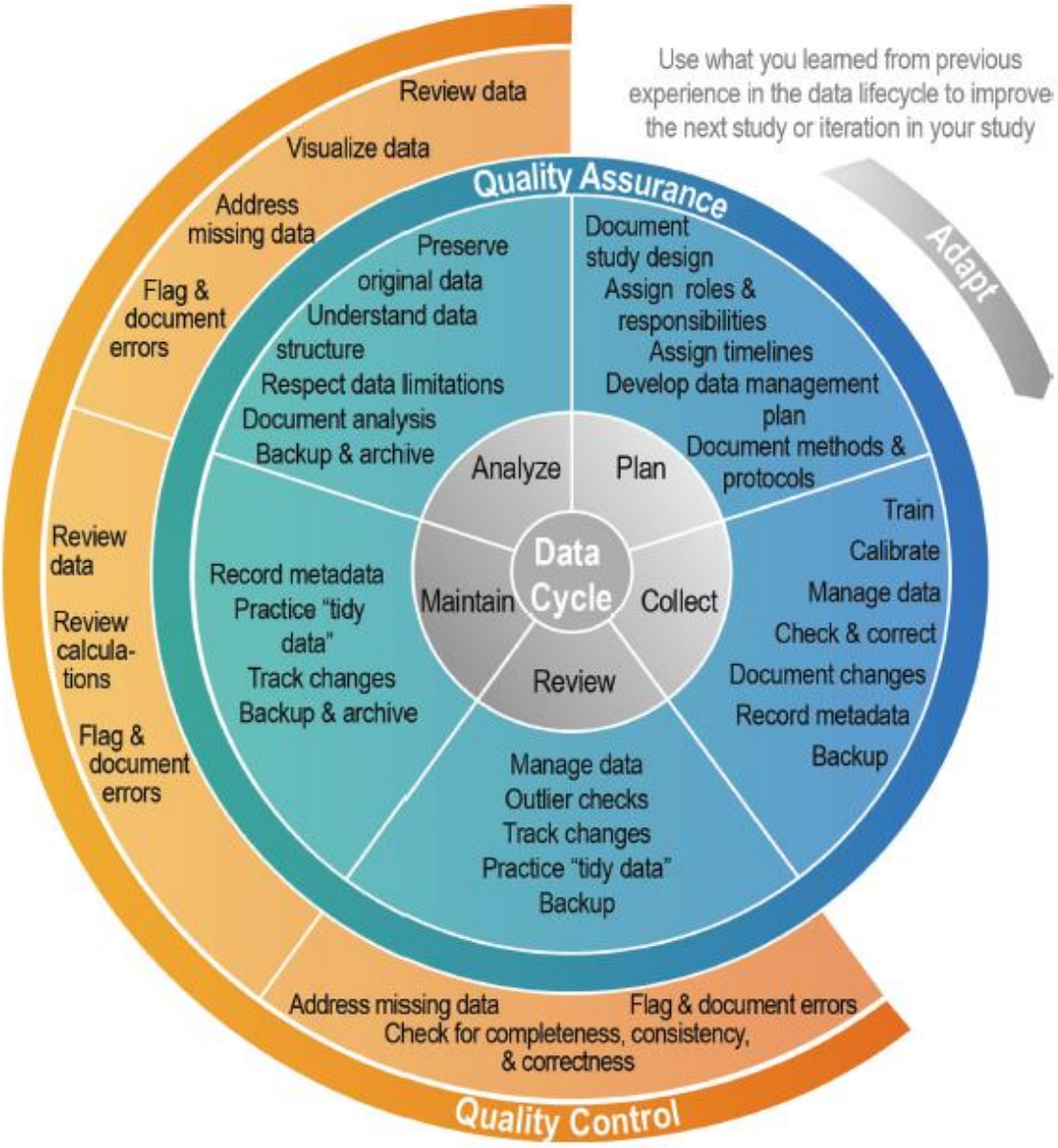


Figure 13. The Quality Assurance and Quality Control Framework from McCord et al. (2021)

Table 10. Guidelines for the Design of Spreadsheets

Be consistent: in codes for values of measures; variable names; identifiers (e.g., observer names or initials); file naming convention; format for dates and times; values for missing data (vs. zero values)
Choose good names for things: do not use spaces; avoid special characters (use ASCII characters); keep names short, but meaningful; follow agency conventions for naming file versions
Do not have empty cells, and put only one measure value in each cell. Each cell should contain only one type of information (e.g., text, numeral, date, Boolean operator, or comment). Dates should be entered following ISO standards: YYYY-MM-DD
Carefully consider spreadsheet layout to facilitate data entry and analysis
Do not use font, color, or highlighting to indicate data values
Use data validation (i.e., range of values) to avoid errors

Note: Adapted from Borer et al. (2009) and Broman & Woo (2018).

The first worksheet in each workbook should be labeled "Metadata" and should contain information relevant to data entry technicians as well as analysts. This should be sufficiently detailed to enable a future analyst, who was not involved with data collection or entry, to understand the data, how they were collected, and how they were entered. At a minimum, it should include the following elements (Borer et al. 2009; McCord et al. 2022; Michener 2015):

- The name and full citation (including version) for the protocols used, including permanent file location.
- Standard nomenclature for park units and observation sites within them (e.g., "CFWB" = Crissy Field, West Bluff Picnic Area).
- The structure of each worksheet in the workbook, for example the raw data, working data, and any sheets created for analysis.
- Field naming conventions for each element entered into the database (i.e., each variable name; i.e., the "data dictionary")
- Lists of valid values for each measure, as well as the required format for field types (e.g., text, date, integers)
- Units for each type of measure
- Value used for missing data
- The spatial projection used (if applicable)
- The relationship of this file to other monitoring files

Figure 14 illustrates how the names of fields from the data sheets should be listed, along with their short-hand variable names, acceptable data types, and lists of acceptable values.

	A	B	C	D	E	F
1	**Field name**	**Variable**	**Data type**	**Values**		
2	Unit	**unit**	text (abbreviation)	A = Alta		
3				BB= Baker Beach		
4				CFE = Crissy East Beach		
5				CFWB = Crissy West Bluff		
6				FF= Fort Funston		
7				MB = Muir Beach		
8				RB = Rodeo Beach		
9	Monitoring location	**location**	text			
10	Name	**name**	text (initials)	Upper case		
11	Date	**date**	date (MM/DD/YYYY)			
12	Sky cover	**sky**	text	S = sunny		
13				P = partly cloudy		
14				O = overcast		
15	Precipitation	**precip**	Whole number	1=present		
16				2 = absent		
17	Temperature	**temp**	Whole number	4 = 40-49		
18				5 = 50-59		
19				6 = 60-69		
20				7 = 70-79		
21				8 = 80-89		
22				9 = 90+		
23	Start time	**start**	Time			
24	End time	**end**	Time			
25	Groups without dogs	**no_dogs**	Whole number			
26	Groups with all dogs leashed	**all_on**	Whole number			
27	Groups with 1+ unleashed dog(s)	**any_off**	Whole number			
28	Comments	**comments**	text			

Figure 14. Screen Capture Showing Field Names, Associated Variable Names, Acceptable Data Types, and Lists of Allowed Values for the Leash Compliance Dataset

The next worksheet in the workbook should be used for entering the raw data from field data sheets. This tab should be labeled with the measure name (or abbreviation) and include "raw data" to indicate that it contains the unedited, raw data. A standard practice for data sheets is to use columns for variables and rows for observations. The first row in each column should contain the names of each variable from the field data sheets. Ideally, these should be ordered as they appear on the data form, to facilitate data entry. The "comment" feature in Excel can be used in the column header cell for each variable to document the acceptable list of values.

For each field data sheet, the information contained in the header of the field form will be associated with multiple observations. This is illustrated in Figures 15 and 16, which show the data sheet for leash compliance (at thresholds) and the associated Excel worksheet. The

header fields are the same for every observation recorded below it. In a relational database, different tables would be created for the header data and for the observations, with the tables linked via indexing variables. However, based on the assumption that use of relational databases (like Microsoft Access) is beyond the capacity of many staff, for the purposes of data management at GGNRA, in each Excel worksheet, the header information (columns A to G) is copied and pasted for all of the observations to which it is associated (Figure 16).

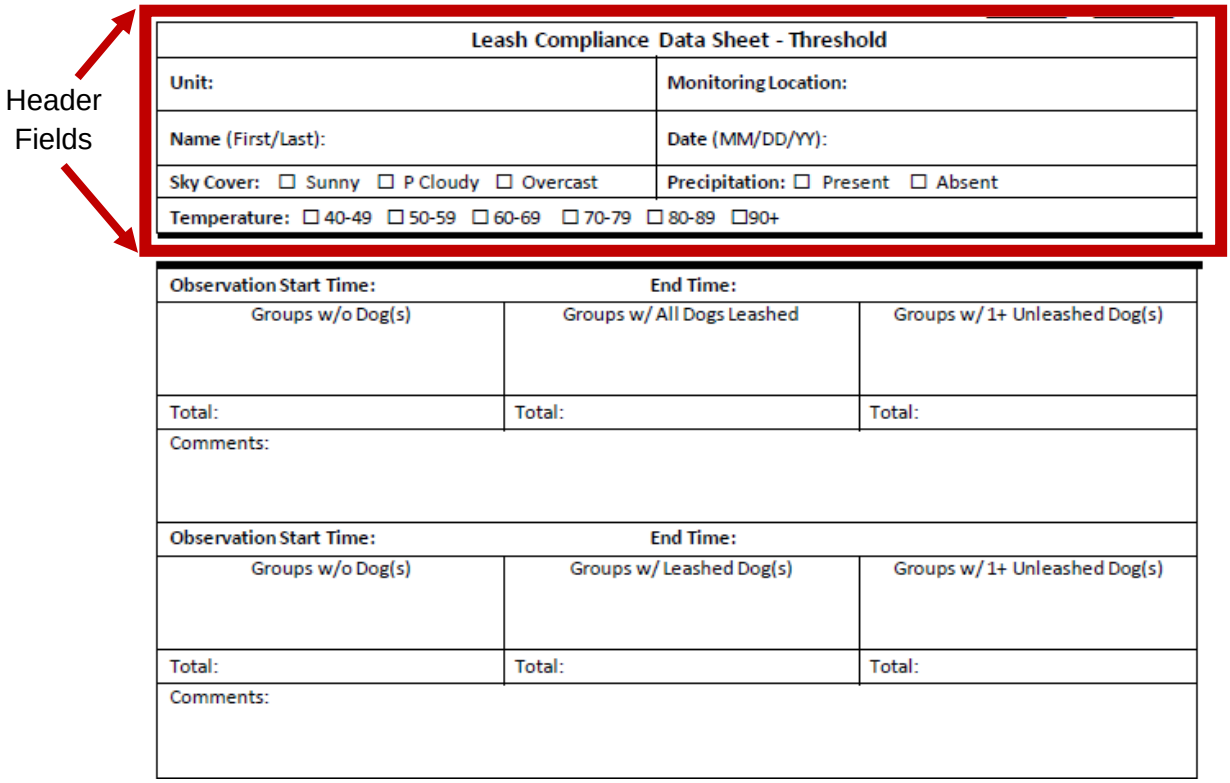


Figure 15. Field Form for Recording Data on Leash Compliance at Thresholds

	A	B	C	D	E	F	G	H	I	J	K	L
1	unit	location	name	date	sky	precip	temp	start	end	no_dogs	any_off	all_on
2	MB	Bridge	TH	6/18/2019	O	1	7	10:28	10:38	3	1	0
3	MB	Bridge	TH	6/18/2019	O	1	7	10:40	10:50	4	0	1
4	MB	Bridge	TH	6/18/2019	O	1	7	11:00	11:10	8	0	0
5	MB	Bridge	TH	6/18/2019	O	1	7	11:15	11:25	5	0	0
6	MB	Bridge	TH	7/5/2019	P	2	8	12:15	12:25	13	0	3
7	MB	Bridge	TH	7/5/2019	P	2	8	12:27	12:37	7	0	2
8	MB	Bridge	TH	7/5/2019	P	2	8	12:45	12:55	16	0	1
9	BB	Parking	SS	8/23/2019	S	2	7	14:33	14:43	3	0	3
10	BB	Parking	SS	8/23/2019	S	2	7	14:50	15:00	5	2	6
11	BB	Parking	SS	8/23/2019	S	2	7	15:30	15:40	7	1	3

Figure 16. Screen Capture of Raw Data Worksheet Corresponding to Field Data Form for Leash Compliance, with Header Fields Outlined

A few useful tips can facilitate data entry and reduce the chances of errors in the data. First, the top row should be "frozen" so that as more data are entered, the header fields (variable names) remain visible at all times. This is done under the "View" menu in the "Freeze Panes" feature (Figure 17).

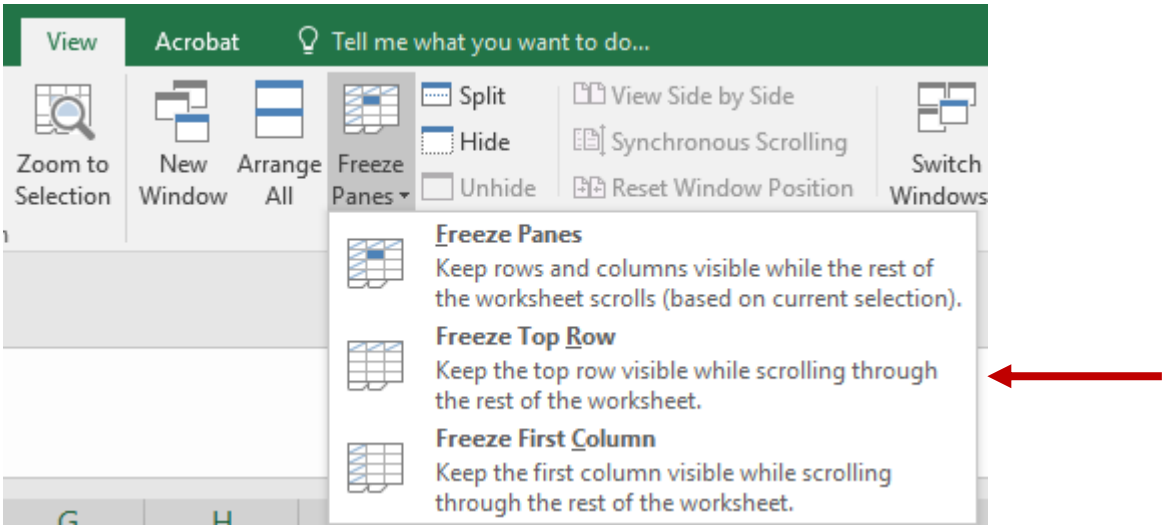


Figure 17. Screen Capture Illustrating the "Freeze Panes" Feature to Freeze the Top Row in a Spreadsheet

Another useful tip is to use the "Data Validation" feature in the "Data" menu. This allows the data manager to specify acceptable types of data and/or values for each field. The types can be constrained to whole numbers, decimals, dates, and lists. To specify the "whole number" or "decimal" data type, simply highlight the column for that variable, click on "Data Validation" and select the appropriate type under "allow" (Figure 18). A powerful feature within data validation is the ability to create a list of acceptable values. This feature requires listing all acceptable values somewhere in the workbook, and then specifying the location of those values in the "source" field of the data validation window. If it is decided to use this feature, it is best to create a separate spreadsheet with the acceptable values for all fields whose values are constrained, and title this sheet "Data Validation Values" (see Figure 19). When this feature is used, the data entry column for the respective variable automatically creates a drop-down menu (Figure 20) – the values can be pulled from this menu or entered manually. If an invalid entry is made, Excel will return an error message.

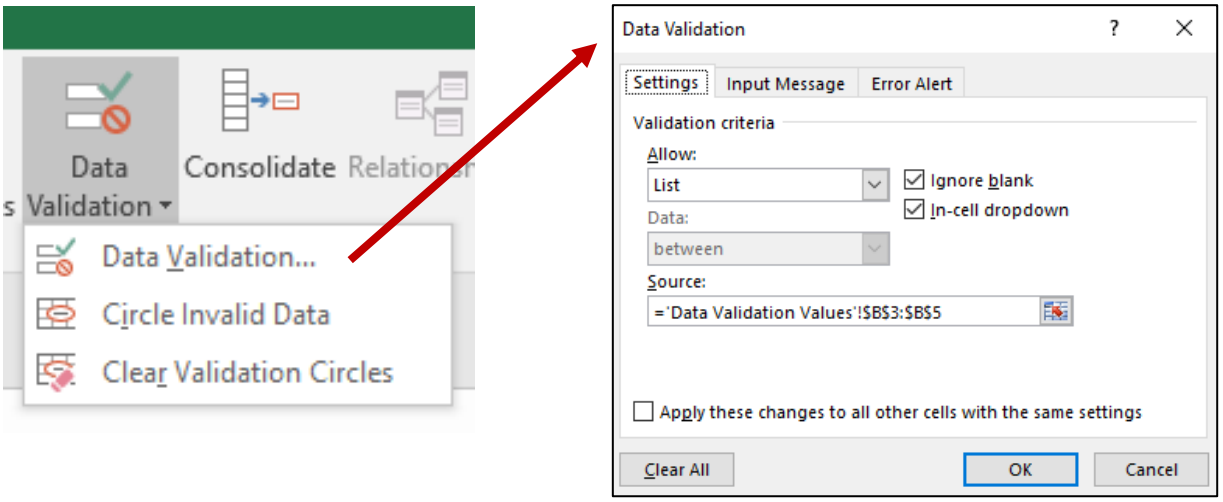


Figure 18. Screen Captures Showing the Use of the "Data Validation" Feature Excel to Create Drop-down Menus and Perform Data Validation

	A	B	C	D
1	**unit**	**sky**	**precip**	**temp**
2				
3	A	S	1	4
4	BB	P	2	5
5	CFE	O		6
6	CFWB			7
7	FF			8
8	MB			9
9	RB			

Figure 19. Screen Capture of the "Data Validation Values" Sheet in the Workbook, Showing the Acceptable Values that Can Be Entered for Certain Variables

	D	E	F
	date	**sky**	**precip**
	6/18/2019	O	1
	6/18/	S	1
	6/18/	P	1
	6/18/2019	O	1

Figure 20. Screen Capture Showing Drop-down Menu on the Raw Data Worksheet When Data Validation is Active

Once the database has been created, data entry technicians should be given the responsibility for data entry. This task should be limited to one or two individuals for

consistency and completeness. If multiple technicians are used, it is best to have each be responsible for one or two of the protocols, rather than distributing all the measures across different individuals. Data entry should be scheduled as a routine duty, ideally at least once per week. The field data sheets should be sorted by protocol, ensuring that all sheets from the same observation session are kept together. Prior to any data entry session, the program manager should confirm that the data are on hand for each of the sites and dates scheduled in the master calendar. The following section provides step-by-step instructions for entering data.

Data Entry Steps

1. Open the Excel workbook with the name that corresponds to the data to be entered. Each data entry workbook will have two sheets, one labeled "Metadata" and one with a descriptive label for the data type (e.g., "Excrement Count Raw Data"). The "Metadata" sheet provides the directions and code book for how to enter the data, and the second sheet is where the data will be entered.

2. Carefully review the definitions on the Metadata sheet for how datasheet values should be entered into each field (i.e., column) in the database. Data should be entered following the exact definitions provided. For more information regarding the datasheet fields, refer to the field manual of protocols that correspond with the datasheet (Hall et al. 2022).

3. Begin entering data into the second sheet (the "raw data" sheet). This sheet has two parts: 1) the header information and 2) the recorded observations (see Figures 15 and 16). The header information is only recorded once on a field data form; however, it is entered for each recorded observation on the Excel datasheet. This may seem repetitive, but it ensures that each observation has the appropriate contextual information associated with it in the database in the event that data are separated or sorted during analysis.
    a. Begin by entering the field form's header information. The columns for this information are the first columns (left-most) in the database.
    b. After the header information has been entered for the first observation in Row 2 in the datasheet, enter the first observation in the columns to the right of the header fields. For each consecutive observation, copy the pre-entered header information and paste it into the next row. Repeat this step until all observations on the data sheet have been entered.
    c. Each time a new data sheet is entered, its header information must be entered, along with all associated observations.

d. After entry of a paper datasheet is complete, initial the sheet in the top right corner, write the date of entry on the paper form, and label it with a capital E in a circle to indicate "entered." Entered datasheets with flagged cells or questions should be separated out from the other entered datasheets and delivered to the project lead for review.
e. For each measure, all data sheets from each unit and location should be entered into the same worksheet (see example in Figure 16, which shows observations from both Muir Beach and Baker Beach).

4. While entering data, flag any problems encountered using the "Comment" feature in Excel to indicate to the project lead that further review is needed. For example, if the handwriting is difficult to decipher, take your best guess at what it says but flag the cell with a note for the project lead to review. To use the comment feature in Excel, right click the cell and select "Insert Comment" (or "New Comment," depending on the version of Excel you have). A small red triangle will appear in the top right corner of the cell and a text box will open for typed comments. Hovering over the triangle displays the contents of the comment. To help quickly find cells with comments during later stages, you can also use the "Cell Styles" feature on the Home tab; selecting "Neutral" style will highlight the cell in orange.

5. When entering data, fields that are blank (i.e., missing information) should be entered using a distinctive code that cannot be confused with a valid value. *Missing data should not be entered as 0 (zero).* The value of 0 should be used only if a 0 (zero) value is written on the datasheet. For users of SPSS, this is commonly set to "999." However, this value can be problematic if analysis will be done in R or Excel, in which case "NA" could be used instead of "999."

Quality Control Procedures for Entered Data

Prior to beginning analysis, the data must be checked for quality. This ensures that entered data are relatively free from errors. Analysis should only be performed on data that have been reviewed following the below-described procedures.

1. Once data entry is complete, paper datasheets and Excel files should be returned to the project lead. The project lead should check any flagged cells as an initial step. These issues should be resolved by the project lead before moving onto Step 2. This may require making an informed decision or following up with data collection technicians (if available) to resolve the question. If an issue cannot be resolved, the cell should be highlighted (for example, by using the "Bad" style under "Cell Styles," which highlights

the cell in red), and the comment should be updated to indicate the inability to resolve the problem.

2. To verify accuracy of data entry, a subset of the completed Excel spreadsheets and entered paper datasheets should be given to another individual who did not enter the data. Depending on timeline and funds, this may be a volunteer, the project lead, or another project team member. The review data should be a random subset of approximately 10% of the data from each protocol.
    a. The second person should review all entered data to make sure that all fields were accurately entered. This should include review for the following errors: incorrect date format, incorrect time format, incorrect site name entered, incorrect value entered, repeated entry of the same observation or data sheet, header information missing or incomplete, and observations not entered. Once this is done, the reviewer should physically mark the sheets with their initials and a check mark.
    b. The data checker should flag issues they discover either in Excel (using the "Comment" feature) and/or on the paper data sheets themselves depending on the nature of the error.

3. If error rates in step 2 are low (<5%), the data checking is complete. However, if error rates are greater than 5%, it may be necessary to validate all data. In making this decision, attention should be given to the trade-off between achieving fine-grained accuracy and making efficient use of resources available. For example, small errors that are well within the natural range of variability in a measure may not be worth scrutinizing, especially for ancillary variables.

4. The double-checked Excel spreadsheets and paper datasheets (with issues flagged) from Steps 2 and 3 should be returned to project lead for final resolution of any flagged cells and entry of any data that were overlooked during data entry (overlooked data identified in Step 2 should be entered by the project lead or data technicians for consistency).

5. To finalize the data workbooks prior to analysis, the "Metadata" sheet of each Excel workbook should be updated with the name(s) and affiliation of data entry technicians, the date of data entry completion, name(s) and affiliation of QA/QC technicians, and the date of QA/QC completion.

6. The entire raw data worksheet should be copied into a new worksheet, labeled "working data." In this sheet, *but not in the raw data sheet*, any remaining problems (highlighted during earlier steps) should be replaced with the value for missing data (999). Then, the program lead should make at least one backup copy of the entire workbook, being sure to include the word "backup" in the file name. Ideally, one copy should be stored on a local computer and one uploaded to secure cloud storage. At this point, the dataset is complete and the data are ready for analysis.

Analysis and Reporting

Reviews of monitoring across different resource programs shows that a common problem is the failure to analyze data or use it in decision making. Data are collected, entered into databases, but then not analyzed or used (Kachergis et al. 2022). Often, this is because resource managers are unsure how to analyze the data or interpret them (McCord et al. 2022). To this end, it can be helpful to have standardized reporting templates, and such a template is included as Appendix B.

Various analyses can be conducted in Excel, through the use of pivot tables and various functions. As a general rule, raw data should never be overwritten with calculated or new values (such as when raw values are assigned categories). Instead, new columns should be added to store calculated variables. Additionally, it can be tempting to sort the data in an Excel worksheet. This is strongly discouraged. Instead, we recommend using the "filter" feature in Excel to enable exploration of subsets of data more easily (Figure 21). To enable filtering, highlight all columns in the worksheet, and then click on the "Sort & Filter" feature on the main ribbon.

Computation of New Variables in Excel

GGNRA staff indicated that the monitoring program lead will use SPSS for data analysis, which is much more efficient than conducting analysis in Excel, which is most suitable for data entry. We recommend Field (2015) as an excellent, user-friendly reference for using SPSS. Assuming SPSS will be the software used, prior to importing the data to SPSS, a few additional steps need to be taken within the Excel workbooks.

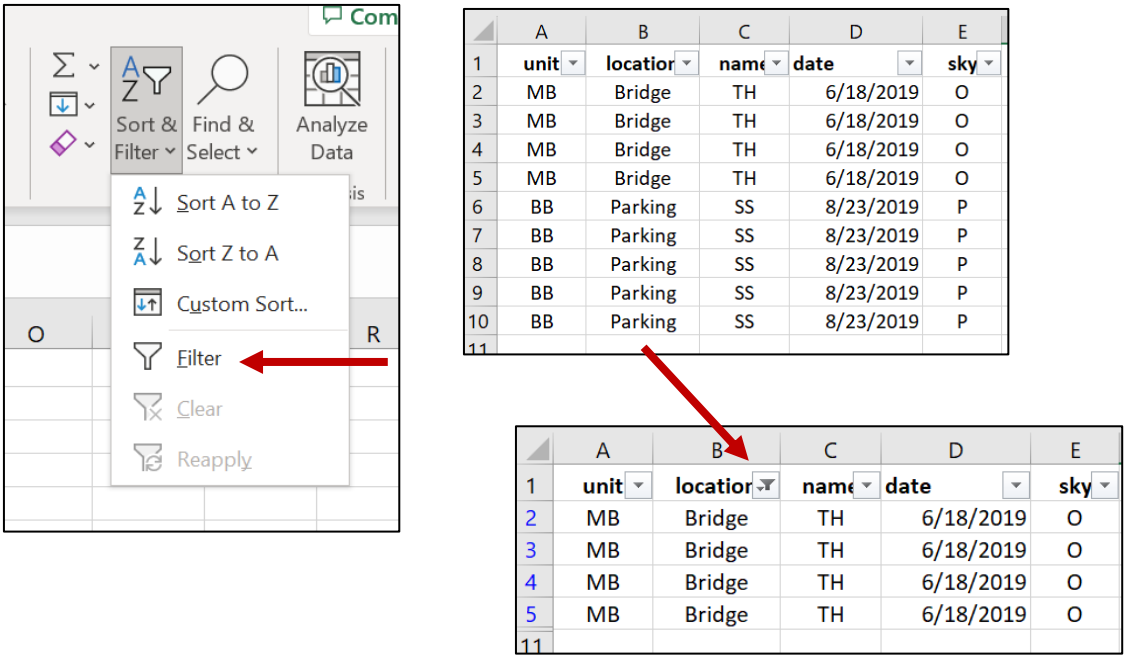


Figure 21. Screen Captures Showing (a) the "Filter" Feature in the Home Tab; (b) A Spreadsheet in which All Variables Are Filtered; and (c) The Icon Indicating that the "Location" Variable Is Being Filtered.

First, create a new column next to the date field in each of the active data worksheets. Use the "WEEKDAY" function to assign a numeric value to each date. The default values are 1 = Sunday to 7 = Saturday. Manually identify any holiday dates and code those as "8" in the weekday field. You can then manually create a new binary variable in Excel for weekdays vs. weekend/holidays, or you can do this in SPSS by recoding the data into a new variable. Similarly, use the "HOUR" function in a new column to transform the HH:MM data in the "start" variable to a value of 0-23. This will facilitate binning observations by hour, if that is desired.

Second, for measures where elapsed time will be used in computing a variable, create a new column for the duration of observation, and insert a function to subtract the start time from the end time. For example, for the excrement count protocol, for each transect on a given day, subtract the "time transect was cleaned" from the "transect walk start time." This new variable will be needed for standardizing some measures.

For protocols where repeat observations are made on a single day, the observations need to be combined into overall daily values. For instance, if multiple sessions of leash compliance are made in a park unit on the same day, they should be combined into three daily totals: the total number of groups without dogs, the total number of groups with all dogs leashed, and the total number of groups with any unleashed dogs.

Steps for Creating SPSS Files for Each Protocol

Once new variables have been created as described above, The Excel data should be imported into SPSS and various steps should be taken to prepare the data for analysis, as listed below:

1. For each measure, import the working data sheet into SPSS and create a .sav file following a standard naming convention. In the "Variable View," check that the names of each field (variable) have imported properly in the "Name" field.

2. In "Variable View," you have the option of assigning longer, more descriptive labels for each variable in the "Label" Field (see Figure 22). Although this is not required, it can be helpful for clarifying interpretation of output at later stages of analysis.

3. The "Values" field will initially show "none" for each variable; you will have to manually enter values for categorical variables, following the naming conventions in the Excel Metadata sheet. Simply click on the appropriate cell and the dialogue box will open to enter value labels (see Figure 23).

4. Assign missing values in the "Missing" column.

Name	Type	Width	Decimals	Label	Values	Missing
Unit	String	3	0	Park Unit	{A, Alta}...	999
Location	String	6	0	Location	{WF, Water Foun...	999
Name	String	3	0	Initials	None	999
Date	Date	10	0	Date	None	None
Sky	String	1	0	Sky cover	{O, Overcast}...	999
Precip	Numeric	3	0	Precipitation	{1, Present}...	999
Temp	Numeric	3	0	Temperature	{4, 40-49}...	999
Session_No	Numeric	4	0	Session Number	None	999
Grp_No	Numeric	3	0	Group Number	None	999
Num_People	Numeric	3	0	Number of People	None	999
Num_Dogs	Numeric	3	0	Number of Dogs	None	999
CDWEvidence	Numeric	3	0	CDW Evidence	{1, Yes}...	999
OtherComments	String	8	0	Other Comments	None	None

Figure 22. Screen Capture Showing the Variable View in SPSS after Labels, Values, and Missing Values Have Been Entered

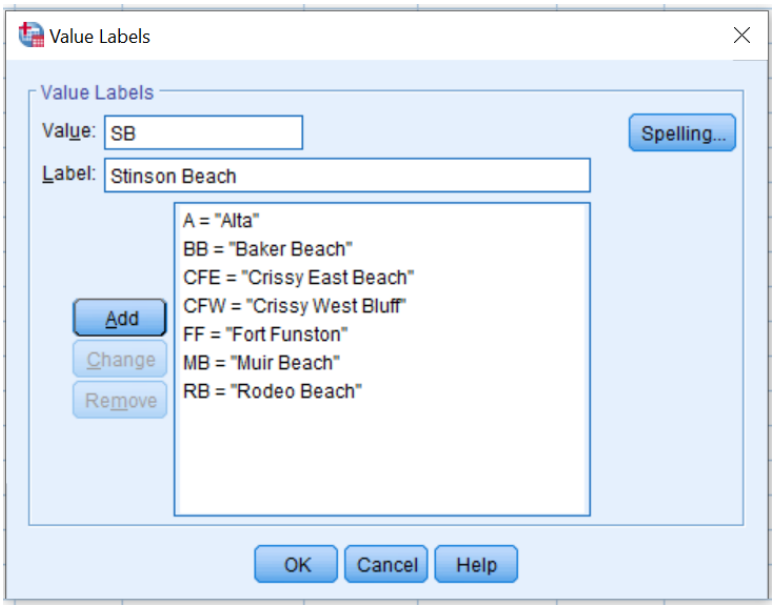


Figure 23. Screen Capture Showing the Dialogue Window for Entering Value Labels in the Variable View

Overview of Analysis

The basic report (see Appendix B) involves presenting means (averages), standard deviations, and/or maximum values for various measures. These are all easily computed with the "Analyze" and "Graphs" features in SPSS (refer to Field 2015). Because reporting will be done on subsets of the data for each measure (e.g., comparing weekday data to weekend/holiday data; or reporting individual means for each observation location), it will be necessary to analyze the data in groups. In SPSS, this can be done by using the "Split File" feature in the primary data menu; within the "Split File" dialogue box, one would select "Organize Output by Groups" and choose the appropriate grouping variable (e.g., "Park Unit" or "Time of Week"; see Figure 24).

It is also possible to select a subset of observations using the "Select Cases" feature within the main Data menu, which can be most useful when examining data for specific cases, rather than comparing among groups. For example, one could select only the cases with various attributes, such as all afternoon times at a given park unit (Figure 25). When using this feature, cases that are not selected are indicated with a black slash in the primary data view (Figure 26). It is important to remember to reset (select all cases) when done; all subsequent analyses will be performed on the selected cases until the feature is deactivated.

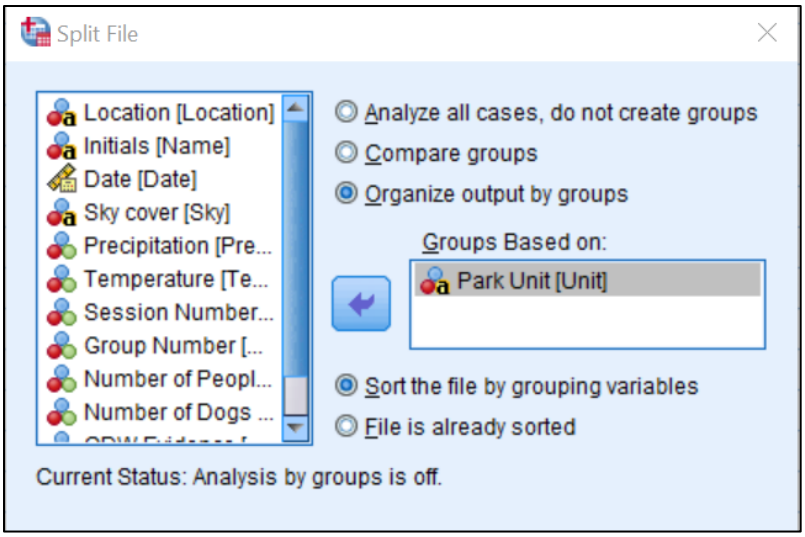


Figure 24. Screen Capture Showing the "Split File" Feature within the Data Menu

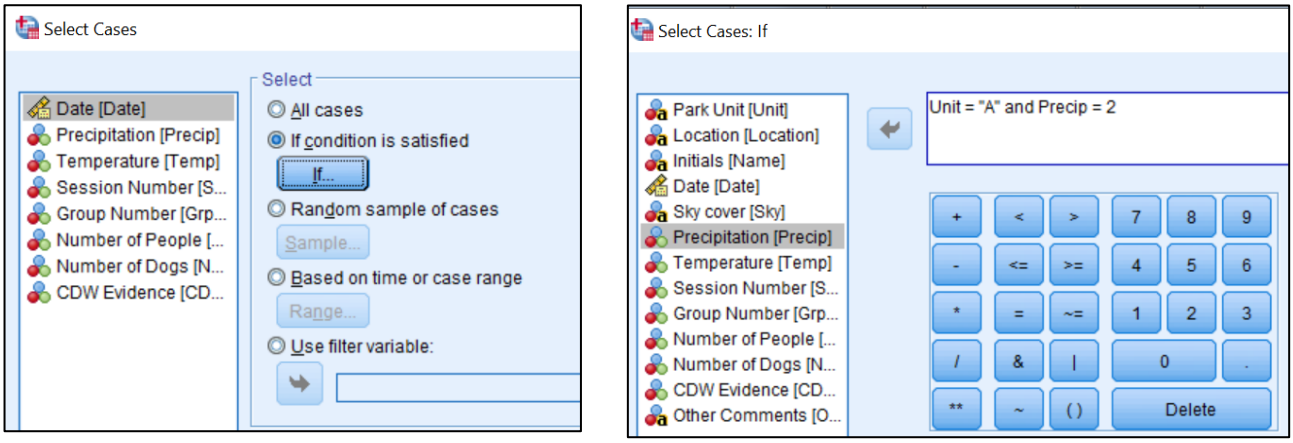


Figure 25. Screen Capture Showing the "Select Cases" Feature within the Data Menu

	Unit	Location	Name	Date
1	FF	DogRun	RG	18-Jun-19
2	FF	DogRun	RG	18-Jun-19
3	FF	DogRun	RG	18-Jun-19
4	FF	DogRun	RG	18-Jun-19
5	FF	DogRun	RG	18-Jun-19
6	FF	DogRun	RG	18-Jun-19
7	FF	DogRun	RG	18-Jun-19
8	FF	DogRun	RG	18-Jun-19

Figure 26. Screen Capture of the "Data View" Identifying Cases Not Selected with a Black Slash

Initial analyses should explore the distributional properties of each raw or computed variable. A particularly useful approach is to plot the data using box plots (also known as box-and-whisker plots) and histograms. These enable one to easily determine if there are outlier values and whether the data are relatively normally distributed. Histograms quickly illustrate the number of zero values in each variable, which can be important when exploring trends over time and indicating whether it might be inappropriate to use statistics that are most appropriate for normally distributed data (such as the mean and standard deviation).

As noted below, each measure may require the creation of new variables for the purposes of reporting and interpreting patterns and trends. This is done within the "Transform" menu. One operation is to combine values within a variable to a smaller set of categories (this is called recoding). It is important always to choose "Recode into Different Variables" (not "Recode into the Same Variables"), so that the initial values are preserved in the event of an error. Another approach to creating new variables is using logical operators to compute new variables as a function of more than one existing variable; this is done through the "Compute Variable" option. Figure 27 illustrates the use of this feature to compute the number of dogs per person, by diving the number of dogs by the number of people. When using this approach, the analyst assigns a name for the new variable, and by default, it will appear as the last variable in the dataset in the Variable View.

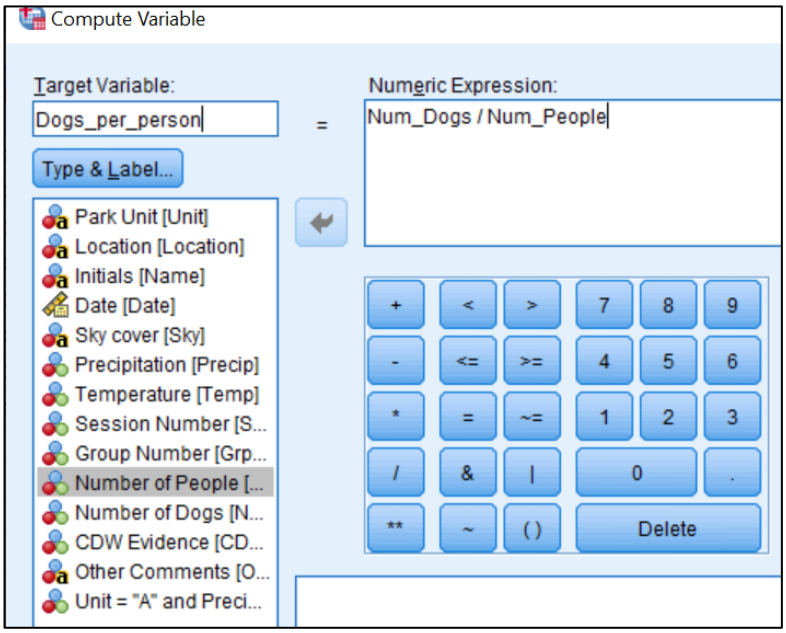


Figure 27. Screen Capture of the "Compute Variable" Feature within the Transform Menu

Analysis Tips for Each Measure

The following are some general analysis tips that will be useful for reporting the findings from each measure. The report template assumes that, for each measure, the data will always be reported separately for each monitoring location. In most cases, the data are also analyzed separately for weekdays and for weekend days/holidays. For each measure, any unusual values revealed by the histograms or box plots should be discussed in the report narrative.

Vehicle Counts. For the vehicle count protocol, it may be useful to compute two new variables:

- Time of day (hour of observation recoded into morning, midday, afternoon)
- Total number of vehicles ("# Reg Vehicles" + "# Gov Vehicles")

The report calls for presenting the mean, standard deviation, and maximum number of vehicles at one time. We recommend including information about the capacity of each parking area in the report; if that is done, the maximum vehicles values can be useful in assessing the level of demand relative to capacity. In addition to the recommended analyses, it could be useful to report the mean number of vehicles present by time of day, either by hour or binned into morning, midday, and afternoon times. It could also be useful to explore whether days with poor weather (colder temperatures and/or precipitation) had notably lower visitation than days with good weather.

People and Dogs at One Time. For the people at one time (PAOT) and dogs at one time (DAOT) protocol, it may be useful to compute two new variables:

- Time of day (hour of observation recoded into morning, midday, afternoon)
- The number of dogs per person present (= "# Dogs" / "# People"). This standardizes the number of dogs present by the total number of people observed in the area (both those visiting with and without dogs). Although these values are not very meaningful on their own, they will be needed in the future for interpreting trends over time.

The report calls for reporting the mean, standard deviation, and maximum number of people and dogs present at one time. Because the observation zones are different sizes and counts are done in different ways, it is not appropriate to compare values across park units or even observation zones within a single unit; comparisons should only be made over time within each observation zone.

In addition to the recommended analyses, it could be useful to report the mean number of people and dogs present by time of day, either by hour or binned into morning, midday, and afternoon times. It could also be useful to explore whether days with poor weather (colder temperatures and/or precipitation) had notably lower visitation than days with good weather.

We also recommend that the analyst use scatterplots to examine the relationship between PAOT/DAOT and the counts of vehicles done on the same days. In advance of baseline

data collection, it is not possible to know how strong these relationships may be, but they do prove to be strong; this could be useful in streamlining future monitoring (for example, by only monitoring vehicle counts in alternate years).

Dogs per Group. For the dogs per group protocol, one new variable needs to be created:

- Number of dogs per person in each group (= "# Dogs" / "# People")

The report template calls for reporting the percentage of all groups seen that had any dogs, as well as the percentage of groups seen that had more than six dogs per handler. These values can be obtained from simple frequency distributions or histograms of the variables. The dataset also has a field for documenting whether groups displayed clear evidence of being commercial dog walkers. At this time, it is not clear how valid or comprehensive those data will be, but if the program manager believes there is sufficient data, those findings could be reported as simple percentages.

When interpreting the findings for this measure, it will be useful to discuss any field comments about the type and location of commercial dog walking. For instance, if the field technicians recorded the same handlers on multiple days, this would be important to note. Additionally, if there are any comments about being unable to accurately count dogs and handlers (for instance, at busy times at Fort Funston), this should also be noted.

Leash Compliance. For the leash compliance protocol, two new variables will need to be computed:

- Total number of groups observed (= "Groups without Dogs" + "Groups with All Dogs Leashed" + "Groups with ≥1 Dogs Unleashed").
- Total number of groups visiting with dogs (= "Groups with All Dogs Leashed" + "Groups with ≥1 Dogs Unleashed").

The report calls for presenting the percentage of groups in compliance and out of compliance with leash regulations. Although not part of compliance per se, it may be useful contextual information to present the percentage of groups observed that had any dogs. This protocol has two versions – one for picnic areas and one for thresholds. When computing the percentages of groups in compliance at picnic areas, it is important to select only new groups, to avoid double counting groups that were counted on a previous round. This can be done using the "Select Cases" feature and choosing "New Group = 1".

Excrement Count. For the excrement count protocol, the two new variables should be computed:

- Total number of instances of bagged and unbagged waste divided by the time elapsed between cleaning the transect and conducting the count. ("Not Bagged" / "Elapsed Time" and "Bagged" / "Elapsed Time"). Standardizing the counts by

the duration of time elapsed since cleaning the transect allows comparison of values across time for each transect.

The report calls for the mean (and standard deviation) of counts by transect. (Transects should each be analyzed separately). If counts are infrequent (that is, if there are many zero values), it may also be desirable to present data as frequencies or histograms. The dataset has fields for documenting whether waste bag dispensers are present and stocked. If there is variation between observations in whether the dispensers are stocked, it could be valuable to explore counts on days when the dispensers are stocked versus when they are not stocked.

Sensitive Habitat Closure. The protocol for counting entries into sensitive habitat requires computation of several new variables:

- Total number of people within 25' of shore (= "# People within 5'" + "# People 5-25'")
- Total number of dogs within 25' of shore (= "# Dogs within 5'" + "# Dogs 5-25'")
- Number of entries by people and dogs standardized by use (= "# People Entries" / "Total number of people within 25' of shore" and "# Dog Entries" / "Total number of dogs within 25' of shore"). Although these percentage values are not very meaningful on their own, they will be needed in the future for interpreting trends over time, because they remove noise created by variations in overall use level at different times.

The report calls for the computation of the mean (and standard deviation) of the standardized percentages of people (dogs) entering the water. It may be useful to explore variations in these values associated with different weather conditions, such as temperature and precipitation. Additionally, any comments entered by technicians regarding whether the lagoons are dry should be addressed in the report narrative.

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APPENDICES

Appendix A.1: Suggested Visitor Survey Questions for General Survey

General Visitor Survey (Non-paired survey)

*The following questions are all directly from or are amended variations of survey questions and items from the Pool of Known Questions or from existing research on relevant topics. For all questions in this document, we note the Pool of Known Questions signifier in bold prior to the question and whether the question or its items are verbatim from the Pool or adaptations (e.g., **Adapted from GEND1**). When questions are from existing research (vs. the Pool), we cite the study.*

Socio-demographic questions (to permit profiling visitors)

Adapted from GEND 1
What is your gender? *Please select one.*
☐ Male
☐ Female
☐ Transgender
☐ Other
☐ Prefer not to say

Adapted from AGE2 [age categories <18 years were deleted]
What is your age?

☐ 18-24 years old
☐ 25-34 years old
☐ 35-44 years old
☐ 45-54 years old
☐ 55-64 years old
☐ 65-74 years old
☐ 75 years or older

Adapted from EDUC1
What is the highest level of formal education you have completed? (Please select **only one response.**)

☐ Less than high school
☐ Some high school, no diploma
☐ High school graduate or equivalent (e.g., GED)
☐ Vocational/trade school training
☐ Some college, no diploma
☐ Two-year college degree (e.g., Associate's degree)
☐ Four-year college degree
☐ Master's degree
☐ Ph.D., E.Ed., J.D., M.D., or equivalent

Adapted from GROUP2

Please select the choice(s) below that best describes the people in your group today. (*Please select all that apply to members of your group*.)

☐ Traveling alone
☐ Preschoolers (less than 5 years old)
☐ Children (5-12 years old)
☐ Teenagers (12-19 years old)
☐ Adults (20-64 years old)
☐ Anyone over 65 years old

Adapted from RACE/ETH2 and RACE/ETH1

Which of these categories best indicates your race? Answer only for yourself. (*Please select **all that apply.)***

☐ American Indian or Alaska Native
☐ Asian
☐ Black or African American
☐ Native Hawaiian or other Pacific Islander
☐ White

Are you Hispanic or Latino?

☐ YES
☐ NO

Directly from RES10

What is the ZIP Code of your primary residence? If not a US **resident**, please mark "Not a US resident."

_____ _____ _____ _____ _____

___ Not a US resident.

Adapted from DEST9

On this visit, about how many hours have you been at [UNIT]? (Please list partial hours as 1/4, 1/2, or 3/4.): _____

Directly from VISHIS7

Have you visited [UNIT]?

☐ YES
☐ NO

If **YES**, approximately how many times have you visited [UNIT] during the past 12 months?

☐ 1-5 times
☐ 6-10 times
☐ 11-20 times
☐ 21-50 times
☐ More than 50 times

Adapted from KNOW7

Who do you think manages this site? (*Check all that apply*).

☐ Bureau of Land Management
☐ California Department of Fish and Wildlife
☐ San Francisco Recreation and Parks OR Marin County Parks [unit specific]
☐ National Park Service
☐ U.S. Forest Service
☐ U.S. Department of Fish and Wildlife
☐ Don't know

Adapted from ITIN11

As you were planning your trip, which activities did you expect to include on your visit to [UNIT] today? (*Please select all that apply.*)

☐ Day hike
☐ Picnicking
☐ Dog walking
☐ Photography
☐ Wildlife/bird viewing
☐ Beachcombing
☐ Swimming
☐ Group play (e.g., frisbee, volleyball, etc.)
☐ To "hang out"
☐ Horseback riding
☐ Bicycling
☐ Jogging
☐ Surfing
☐ Leisurely walking/strolling
☐ National Park Service Ranger programs
☐ Other: _____

Adapted from PREF5, but all items directly or adapted from Recreational Experience Preference scales (Driver, 1983; Manfredo, Driver, & Tarrant, 1996)

Below is a list of possible experiences you may want (prefer) to have while visiting [UNIT]. For each item, pleases *indicate how important the experience is* to you on this visit.

Experience	Not at all important	Slightly important	Moderately important	Very important	Extremely important
To view the scenery	1	2	3	4	5
To get exercise	1	2	3	4	5
To be with friends	1	2	3	4	5
To get the family together for awhile	1	2	3	4	5
To relax	1	2	3	4	5
To enjoy the smells and sounds of nature	1	2	3	4	5
To do something with your family	1	2	3	4	5
To think about your personal values	1	2	3	4	5
To keep physically fit	1	2	3	4	5

To get away from the usual demands of life	1	2	3	4	5
To look at the pretty view	1	2	3	4	5
To observe the other people	1	2	3	4	5
To think about who you are	1	2	3	4	5
To be in a natural setting	1	2	3	4	5
To meet new people	1	2	3	4	5

Adapted from ITIN18

Please indicate whether (and if so, how often) you have ever done each of the following in Golden Gate National Recreation Area (See map below for all recreation area locations). For those you have done, please also mark how often you have done it.

	Ever done? (circle NO or YES)		**If YES, how often**				
	NO	**YES**	**Rarely**	**Occasionally**	**Often**	**Usually**	**Always**
Avoid specific locations where safety is a concern	**NO**	**YES →**	1	2	3	4	5
Visit on weekdays to avoid weekend crowds	**NO**	**YES →**	1	2	3	4	5
Avoid locations where drugs and alcohol area a problem	**NO**	**YES →**	1	2	3	4	5
Go to specific trails [for Coastal Trl.)/beaches (for Stinson, Muir, East Crissy) to get away from crowds	**NO**	**YES →**	1	2	3	4	5
Go to areas where you are less likely to see people with dogs	**NO**	**YES →**	1	2	3	4	5
Avoid locations where dogs are allowed, but must be kept on leash	**NO**	**YES →**	1	2	3	4	5
Avoid locations where it is legal for dogs to be off-leash	**NO**	**YES →**	1	2	3	4	5
Avoid locations that do not allow dogs	**NO**	**YES →**	1	2	3	4	5

[MAP OF GGNRA]

Adapted from EVALSERV29, EVALSERV4, Jorgenson and Bomberger Brown (2014), and Rutter (2016)
Please tell us how you feel about the following at [UNIT].

- First, **rate how important** each item is to you when visiting the [UNIT] (left columns).
- Then, **rate how satisfied** you are with this site for each item (right columns)**.**

IMPORTANCE						**SATISFACTION**				
Not at all important	Somewhat important	Moderately important	Very important	Extremely important		Very unsatisfied	Somewhat unsatisfied	Neither	Somewhat satisfied	Very Satisfied
					Park Information					
1	2	3	4	5	Printed information (e.g., maps and brochures) about this park	1	2	3	4	5
1	2	3	4	5	Signs with general rules/regulations for this park site	1	2	3	4	5
1	2	3	4	5	Informational kiosks/displays about this park site and its resources	1	2	3	4	5
1	2	3	4	5	The directional signage on the trail [for Coastal Trl.]	1	2	3	4	5
					Facilities					
1	2	3	4	5	Developed picnic areas	1	2	3	4	5
1	2	3	4	5	Restroom facilities	1	2	3	4	5
1	2	3	4	5	Garbage and Recycling cans	1	2	3	4	5
1	2	3	4	5	Visitor centers	1	2	3	4	5
1	2	3	4	5	Availability of benches	1	2	3	4	5
1	2	3	4	5	Bike racks	1	2	3	4	5
1	2	3	4	5	Transit connection to site	1	2	3	4	5
					Recreational Opportunities					
1	2	3	4	5	Opportunities to observe wildlife	1	2	3	4	5
1	2	3	4	5	**Off-leash** dogwalking access to [beach/trail]	1	2	3	4	5
	2	3	4	5	A beach experience without dogs	1	2	3	4	5
1	2	3	4	5	**On-leash** dogwalking access to [beach/trail]	1	2	3	4	5
1	2	3	4	5	Bicycling opportunities on separated paths	1	2	3	4	5
	2	3	4	5	Coastal trails(hiking opptys without dogs)	1	2	3	4	5
	2	3	4	5	Coastal trails(multi- use with dogs & bikes)	1	2	3	4	5
					Natural environment management					

1	2	3	4	5	Protecting habitat for endangered shorebirds	1	2	3	4	5
1	2	3	4	5	Restoring native vegetation on sand dunes to control erosion	1	2	3	4	5
1	2	3	4	5	Protecting habitat for endangered butterflies	1	2	3	4	5
1	2	3	4	5	Protecting habitat for endangered reptiles	1	2	3	4	5
					Other					
1	2	3	4	5	General personal safety	1	2	3	4	5
1	2	3	4	5	Amount of law enforcement presence	1	2	3	4	5
1	2	3	4	5	Educational interactions with a ranger	1	2	3	4	5

What, if any, other facilities, services, and/or recreational opportunities are lacking at [UNIT]?:

_____

_____

Adapted from PERSAFE4

Have you or your personal group encountered any safety issues during this visit to the GGNRA?

☐ NO

☐ YES

If **YES**, what and where was the problem?

_____

_____

Adapted from KNOW15

The following question will help us understand how familiar people are with rules and regulations at [UNIT]. Please indicate if you think each of the following statements is TRUE or FALSE, or if you don't know.

	True	False	Don't Know
Visitors are prohibited from entering areas that are fenced-off with rope	☐	☐	☐
Dogs are required to be on leash at this site	☐	☐	☐
Dogs are required to be within voice and sight control of their guardians at this site	☐	☐	☐
No dogs are allowed at this site	☐	☐	☐
Bicycling is only allowed on designated pathways at this site	☐	☐	☐
There are certain areas of the [UNIT] where it is okay to leave pet excrement on the ground without picking it up	☐	☐	☐
It is legal to chase birds at this site	☐	☐	☐
Commercial dog walkers must abide by all the same dog walking rules as other users at this site	☐	☐	☐

It is legal to dig up plants at this site	☐	☐	☐
Horseback riding is prohibited at this site	☐	☐	☐

Adapted from CROWD20

Please indicate whether you encountered each of the following today and, if you did, the extent to which it affected your overall experience.

	Did you encounter? (circle NO or YES)		If YES, what affect did it have on your overall experience?				
			Added greatly	**Added somewhat**	**Had no effect**	**Detracted somewhat**	**Detracted greatly**
Large groups on social outings	**NO**	**YES →**	1	2	3	4	5
Bicyclists Speeding	**NO**	**YES →**	1	2	3	4	5
Visitors Littering	**NO**	**YES →**	1	2	3	4	5
On-leash dog(s)	**NO**	**YES →**	1	2	3	4	5
Controlled off-leash dog(s)	**NO**	**YES →**	1	2	3	4	5
Uncontrolled off-leash dog(s)	**NO**	**YES →**	1	2	3	4	5
Any dog(s) behaving friendly	**NO**	**YES →**	1	2	3	4	5
Any dog(s) behaving aggressively	**NO**	**YES →**	1	2	3	4	5
Dog(s) approaching you uninvited	**NO**	**YES →**	1	2	3	4	5
Conflicts between visitors	**NO**	**YES →**	1	2	3	4	5
Visitors building fire pits on beaches [Muir, Crissy, and Stinson]	**NO**	**YES →**	1	2	3	4	5
A lack of privacy	**NO**	**YES →**	1	2	3	4	5
Drug and/or alcohol use	**NO**	**YES →**	1	2	3	4	5
Picnickers	**NO**	**YES →**	1	2	3	4	5
Loud, noisy visitors	**NO**	**YES →**	1	2	3	4	5
Horseback riders [unit specific]	**NO**	**YES →**	1	2	3	4	5
Visitors entering habitat closures	**NO**	**YES →**	1	2	3	4	5
A lack of personal space for activities	**NO**	**YES →**	1	2	3	4	5
Dog guardians not picking up dog waste	**NO**	**YES →**	1	2	3	4	5
Dogs chasing birds or wildlife	**NO**	**YES →**	1	2	3	4	5

Adapted from OPMGMT14 Vaske and Donnelly (2007)

Among other National Park Service units in the country, Golden Gate National Recreation Area is the only one that provides legal opportunities for off-leash dog walking so long as dogs are within voice and sight control of their guardian(s). Given this unique policy, we are interested in visitors' insights about dogs in the park.

In general, how much of a problem is the following behavior at [UNIT]? (*Circle one number for each item*)

For dogs off leash. . .	Not a problem at all	Slight problem	Neutral	Moderate problem	Extreme problem
Dogs off trail (only Coastal Trail/Promenade)	1	2	3	4	5
Dog guardians repeatedly calling loudly (i.e., more than 3 times in quick succession at their dogs to control their dog's behavior)	1	2	3	4	5
Dogs "play" chasing other dogs	1	2	3	4	5
Dogs causing birds to flush or wildlife to flee suddenly	1	2	3	4	5
Dogs approaching visitors uninvited	1	2	3	4	5
Dogs physically contacting a visitor from another group	1	2	3	4	5
Owners not picking up their dog's waste	1	2	3	4	5
Dogs barking repeatedly	1	2	3	4	5

Adapted from Vaske and Donnelly (2007)

Do you currently own a dog?

☐ NO – I have never owned a dog.

☐ NO – But I used to own a dog.

☐ YES

If YES, how many dogs do you currently own?: _____

If YES, about how frequently do you visit any GGNRA locations (this site or others) with your dog? (*Check one response.*)

- ☐ Less than once a week
- ☐ Approximately one time a week
- ☐ 2-3 times per week
- ☐ 4-6 times a week
- ☐ Daily

Adapted from Vaske and Donnelly (2007) and Bekoff and Meaney (1997)
During this visit today, how many of **your own dogs** did you have with you?: _____ dogs.

Did anyone else in your group have a dog?

☐ YES
☐ NO
☐ Don't know

Adapted from Vaske and Donnelly (2007) Bekoff and Meaney (1997)
Were the dogs that you had with you: (*Check all that apply*)
☐ Leashed all of the time?
☐ Leashed part of the time?
☐ Leashed none of the time?

Directly from OPMGMT19
If you could ask the National Park Service to change some things about the way they manage [UNIT], what would you ask them to do?

_____

_____

Directly from OPMGMT10
Is there anything else you would like to tell us about your visit to [UNIT]?

_____

_____

References

Bekoff, M., & Meaney, C. A. (1997). Interactions among dogs, people, and the environment in Boulder, Colorado: A case study. *Anthrozoös*, *10*(1), 23-31.

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Vaske, J., & Donnelly, M. (2007). *Visitor tolerances and standards for off leash dogs at Boulder Open Space and Mountain Parks* (HDNRU Report No. 75). Boulder, CO: City of Boulder Open Space and Mountain Parks.

Appendix A.2: Suggested Visitor Survey Questions for Paired Observation + Survey

Paired Observation and Survey (paired survey)

*The following questions are all directly from or are amended variations of survey questions and items from the Pool of Known Questions or from existing research on relevant topics. For all questions in this document, we note the Pool of Known Questions signifier in bold prior to the question and whether the question or its items are verbatim from the Pool or adaptations (e.g., **Adapted from GEND1**). When questions are from existing research (vs. the Pool), we cite the study. Note, this survey will be conducted with visitors whom we observed interacting with a dog or dogs prior to administering it.*

Socio-demographic questions (to permit profiling visitors)

Adapted from GEND 1
What is your gender? *Please select one.*

- ☐ Male
- ☐ Female
- ☐ Transgender
- ☐ Other
- ☐ Prefer not to say

Adapted from AGE2 [age categories <18 years were deleted]
What is your age?

- ☐ 18-24 years old
- ☐ 25-34 years old
- ☐ 35-44 years old
- ☐ 45-54 years old
- ☐ 55-64 years old
- ☐ 65-74 years old
- ☐ 75 years or older

Adapted from EDUC1
What is the highest level of formal education you have completed? (Please select **only one response.**)

- ☐ Less than high school
- ☐ Some high school, no diploma
- ☐ High school graduate or equivalent (e.g., GED)
- ☐ Vocational/trade school training
- ☐ Some college, no diploma
- ☐ Two-year college degree (e.g., Associate's degree)
- ☐ Four-year college degree
- ☐ Master's degree
- ☐ Ph.D., E.Ed., J.D., M.D., or equivalent

Adapted from RACE/ETH2 and RACE/ETH1

Which of these categories best indicates your race? Answer only for yourself. Please select **one or more.**

☐ American Indian or Alaska Native
☐ Asian
☐ Black or African American
☐ Native Hawaiian or other Pacific Islander
☐ White

Are you Hispanic or Latino?

☐ YES
☐ NO

Adapted from GROUP2

Please select the choice(s) below that best describes your traveling party. (*Select all that apply to members of your traveling party*.)

☐ Traveling alone
☐ Preschoolers (less than 5 years old)
☐ Children (5-12 years old)
☐ Teen agers (12-19 years old)
☐ Adults (20-64 years old)
☐ Anyone over 65 years old

Adapted from DEST9

On this visit, about how many hours have you been at [UNIT]? (Please list partial hours as 1/4, 1/2, or 3/4.): _____

Directly from RES10

What is the ZIP Code of your primary residence? If not a US **resident**, please mark "Not a US resident."

_____ _____ _____ _____ _____
___ Not a US resident.

Adapted from ITIN11

As you were planning your trip, which activities did you expect to include on your visit to [UNIT] today? (*Please select all that apply.*)

☐ Day hike
☐ Picnicking
☐ Dog walking
☐ Photography
☐ Wildlife/bird viewing
☐ Beachcombing
☐ Swimming
☐ Group play (e.g., frisbee, volleyball, etc.)
☐ To "hang out"
☐ Horseback riding
☐ Bicycling
☐ Jogging
☐ Surfing
☐ Leisurely walking/strolling
☐ National Park Service Ranger programs
☐ Other: _____

Adapted from Vaske and Donnelly (2007)

Do you currently own a dog?

☐ NO – I have never owned a dog.

☐ NO – But I used to own a dog.

☐ YES

If YES, how many dogs do you currently own?: _____

If YES, about how frequently do you visit any GGNRA locations (this site or others) with your dog? (*Check one response*.)

- ☐ Less than once a week
- ☐ Approximately one time a week
- ☐ 2-3 times per week
- ☐ 4-6 times a week
- ☐ Daily

Adapted from ENVIRONED7 and Bekoff and Meaney (1997)

Please indicate how comfortable you generally feel around dogs.

Very uncomfortable	Uncomfortable	Neutral	Comfortable	Very comfortable
☐	☐	☐	☐	☐

Adapted from OPMGMT13 and Bekoff and Meaney (1997)

Please indicate the extent to which you would support or oppose each of the following possible regulations related to managing the behavior of dog owners at [UNIT].

	Strongly support	Support	Neither support or oppose	Oppose	Strongly oppose
All dogs should be required to be within voice and sight control (i.e., dogs are within earshot and eyesight of the owner and respond immediately to commands to return to owner when called) at [UNIT]	1	2	3	4	5
The only dogs that should be allowed to be off leash (i.e., within voice and sight control) at [UNIT] are those who have passed standardized obedience testing	1	2	3	4	5
All dogs should be required be on a leash at [UNIT]	1	2	3	4	5
No dogs should be allowed at [UNIT]	1	2	3	4	5

Adapted from Gazzano et al. (2013)

For the dog(s) that just approached you (i.e., came within 5 feet of you), what feeling(s) did you have when interacting with the dog(s)? (*Select all that apply*).

☐ Happiness
☐ Tenderness
☐ Liking
☐ Indifference
☐ Fear
☐ Disgust
☐ Other (*Please specify*: _____

Adapted from SOUND19 and Vaske and Donnelly (2007)

Please indicate whether you each of the following occurred with the dog(s) that just approached you (i.e., came within 5 feet of you), and if it did, the extent to which it affected your overall experience.

	Did this occur? (circle NO, DON'T KNOW, or YES)			**If YES, what affect did it have on your overall experience?**				
				Very annoying	**Slightly annoying**	**No effect**	**Slightly pleasing**	**Very pleasing**
You felt a desire to interact with the dog(s)	**NO**	**DON'T KNOW**	**YES →**	1	2	3	4	5
Dog(s) approached you or your group uninvited	**NO**	**DON'T KNOW**	**YES →**	1	2	3	4	5
Dog(s) approached you or your group after you invited it	**NO**	**DON'T KNOW**	**YES →**	1	2	3	4	5
Dog(s) barked at you or a member of your party	**NO**	**DON'T KNOW**	**YES →**	1	2	3	4	5
Dog(s) growled at you or a member of your party	**NO**	**DON'T KNOW**	**YES →**	1	2	3	4	5
Dog(s) bit you or a member of your party	**NO**	**DON'T KNOW**	**YES →**	1	2	3	4	5
Dog(s) exhibited friendly behavior	**NO**	**DON'T KNOW**	**YES →**	1	2	3	4	5
Dog(s) exhibited aggressive behavior	**NO**	**DON'T KNOW**	**YES →**	1	2	3	4	5
Dog(s) tried to play with a dog in your party	**NO**	**DON'T KNOW**	**YES →**	1	2	3	4	5

Adapted from SOUND13

Overall, how pleased, annoyed, fearful, and/or happy were you during your interaction with the dog(s)? (*Please select one box for "PLEASED," "ANNOYED," "FEARFUL," and "HAPPY"*)

PLEASED			
Extremely Pleased	**Moderately Pleased**	**Slightly Pleased**	**Not at all Pleased**
☐	☐	☐	☐
ANNOYED			
Extremely Annoyed	**Moderately Annoyed**	**Slightly Annoyed**	**Not at all Annoyed**
☐	☐	☐	☐
FEARFUL			
Extremely Fearful	**Moderately Fearful**	**Slightly Fearful**	**Not at all Fearful**
☐	☐	☐	☐
HAPPY			
Extremely Happy	**Moderately Happy**	**Slightly Happy**	**Not at all Happy**
☐	☐	☐	☐

Please briefly describe what made you react/feel the way you did:

_____

_____

_____

Adapted from KNOW7

Who do you think manages this area? (*Check all that apply*).

- ☐ Bureau of Land Management
- ☐ California Department of Fish and Wildlife
- ☐ San Francisco Recreation and Parks
- ☐ National Park Service
- ☐ U.S. Forest Service
- ☐ U.S. Department of Fish and Wildlife
- ☐ Don't know

Directly from OPMGMT10

Is there anything else you would like to tell us about your visit to [UNIT]?

_____

_____

References

Bekoff, M., & Meaney, C. A. (1997). Interactions among dogs, people, and the environment in Boulder, Colorado: A case study. *Anthrozoös*, *10*(1), 23-31.

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Gazzano, A., Zilocchi, M., Massoni, E., & Mariti, C. (2013). Dogs' features strongly affect people's feelings and behavior toward them. *Journal of Veterinary Behavior: Clinical Applications and Research*, *8*(4), 213-220.

Vaske, J., & Donnelly, M. (2007). *Visitor tolerances and standards for off leash dogs at Boulder Open Space and Mountain Parks* (HDNRU Report No. 75). Boulder, CO: City of Boulder Open Space and Mountain Parks.

Template Report for GGNRA Visitor Use Monitoring

Data Collection Year XXX

Date: XX/XX/XXX

Written by:

Name

Optional: Include a photo of one of the monitoring locations on the cover page

(Be sure to give proper photo credit)

Note: *The italicized text describes the minimum content that should be included in each section of the report. Basic data tables have been formatted for the report and should be populated with appropriate data.*

Table of Contents

Project Introduction

Provide a few paragraphs explaining the purpose of the current monitoring effort, including any connections to past monitoring efforts. This section could also include justification for the timing, level of effort, and locations of the monitoring effort. Any specific challenges that occurred during the monitoring effort should also be included here to provide context for the remaining sections. These might include unusual weather conditions, economic factors that affect use, or variations in park management during the season. This section should also describe any closures or changes in facilities, particularly any that might have occurred since the previous monitoring was done. Typically, this section is two to three pages in length.

Data Collection Methods & Analysis

Briefly describe the data collection methods used in the monitoring effort. The version of the data collection protocols should be reported. Ideally, the field protocols themselves should be included as an Appendix so that if individuals unfamiliar with the monitoring effort read the report, they can easily review the field data collection steps and instructions.

If the monitoring protocols or sampling approaches used in this report differ from those used in past reports, those changes should be made clear. The implications of any such changes for the ability to confidently draw conclusions about trends over time should be explicitly discussed.

This section should also briefly describe the data analysis approach used in the report. For most measures, basic descriptive statistics are reported (e.g., means, standard deviations, and frequencies). If additional analyses are performed, they should be clearly described here. This section can likely be covered in a single page, unless significant changes are made to data collection protocols, or new analysis approaches are included.

Data Collection Effort

This section should describe when, where, and how much data was collected, who collected the data (i.e., interns, volunteers, etc.), and any challenges associated with data collection. It should describe sampling and refer to the data collection calendars, which should be included as an Appendix. (For ease of review, the calendar for each measure may be presented separately, with the locations and dates of field data collection clearly displayed.) While the GGNRA program is based on randomly sampled dates for data collection, if any dates were substituted, or if convenience sampling was used, that should be made clear. If convenience sampling was used, great caution should be exhibited in making any conclusions about trends over time in the final sections of the report.

The overall data collection effort should be summarized in a table (see below). The accompanying narrative should discuss – based on professional judgment or other data, such as from traffic counters – the degree to which the collected data are representative of the high use season as a whole. This section may require two to three pages.

Table X: Summary of Data Collection Effort, By Measure and Location

	Number of Days of Data Collection[1]								
	Dogs/Group			Leash Compliance			Excrement Count		
Park Unit	**Total**	**WD**	**WE/H**	**Total**	**WD**	**WE/H**	**Total**	**WD**	**WE/H**
Alta									
Crissy - East									
Crissy - WB									
Ft. Funston									
Muir Beach									
Rodeo Beach									
Stinson Beach									

[1] This is the number of days on which data were collected, not the number of individual monitoring sessions completed. In many cases multiple sessions are collected on the same day, and during analysis those sessions are averaged to generate a daily value for the measure.
WD = Weekday; WE = Weekend or holiday

	Number of Days of Data Collection[1] Sensitive Habitat Entry		
Park Unit	**Total**	**WD**	**WE/H**
Muir Beach			
Rodeo Beach			

Vehicle Counts

This section should summarize daily vehicle counts, by park unit (see Table). The values include the number of observations (n), the mean (average), standard deviation (SD), and maximum observed count, separated by weekdays and weekend days/holidays. The data in the table should be summarized in the report narrative, including a discussion of the variability in the counts, and the relationship of the counts to capacity of available parking. Provide context for the counts by using the descriptive data about weather conditions included in the data sheets for each monitoring session (cloud cover, precipitation, and temperature).

If traffic counter data are available for any of the park units where vehicle counts were made, it would be valuable to include a scatter plot to inspect the relationship between the daily traffic counts and the instantaneous vehicle counts for the same dates. This can help establish the strength of the relationship between the two data sources, which could potentially be useful for longer-term monitoring. Additionally, comparing the mean counts made by observers to the overall mean weekday and weekend traffic volume can help establish the representativeness of the observational data.

Table X: Number of Vehicles Present at One Time, by Location

	Weekdays				Weekend Days/Holidays			
Park Unit	**N**	**Mean**	**SD**	**Maximum**	**N**	**Mean**	**SD**	**Maximum**
Alta								
Crissy -- East								
Crissy - WB								
Ft. Funston								
Muir Beach								
Rodeo Beach								
Stinson Beach								

People at One Time and Dogs at One Time

The field protocols call for instantaneous counts of people at one time (PAOT) and dogs at one time (DAOT) at Crissy Field and Fort Funston; the primary use of these data is to provide context and for standardizing other measures. The counts are made in specific portions of each park unit, using either a rove (counting people while walking through an area), a zone count (made from a stationary observation point), or a count of visitor flow past a specific location on a trail.

This section should summarize the PAOT and DAOT counts, by park observation location (see Tables). It is inappropriate to compare use among individual sites, given the different nature of the counts and size of the observation zones. Additionally, it is inappropriate to combine data from locations within a single unit. The values include the number of observations (n), the mean (average), standard deviation (SD), and maximum observed count, separated by weekdays and weekend days/holidays. The data in the table should be summarized in the report narrative, including a discussion of the variability in the counts. Provide context for the counts by using the descriptive data about weather conditions included in the data sheets for each monitoring session (cloud cover, precipitation, and temperature).

It may be useful to include a scatterplot showing the relationship between PAOT/DAOT and the number of vehicles present in the parking lot, which is collected on the same dates.

Table X: People Present at One Time, by Observation Zone

	Weekdays				Weekend Days/Holidays			
Park Unit	**N**	**Mean**	**SD**	**Maximum**	**N**	**Mean**	**SD**	**Maximum**
Crissy East Rove								
Crissy East Flow								
Crissy - WB								
Ft. Funston Zone								
Ft. Funston Rove								

Table X: Dogs Present at One Time, by Observation Zone

	Weekdays				Weekend Days/Holidays			
Park Unit	**N**	**Mean**	**SD**	**Maximum**	**N**	**Mean**	**SD**	**Maximum**
Crissy East Rove								
Crissy East Flow								
Crissy - WB								
Ft. Funston Zone								
Ft. Funston Rove								

Dogs per Group

The dogs per group measure is used to track compliance with regulations about dog walking. Table X shows the number of groups (both groups with dogs and groups without dogs) observed during all monitoring sessions at each park unit (N), along with the percentage of groups that had one or more dogs. The righthand column in the table shows the percentage of all observed groups that had more than six dogs per person in the group; these groups are out of compliance with park regulations. (It may also be desirable to display this value as a percentage of only those groups visiting with dogs.)

While this table aggregates all observations across all monitoring days, it may be desirable to explore daily variation in this measure to better track change over time. To do this, a table would be added that presents the mean and standard deviation of the percentage of groups with dogs and with >6 dogs per handler, by location.

Additionally, the field data form for this measure includes a field to document whether evidence of a party being a commercial dog walker was observed. Those data could be summarized in an additional table, by location.

Table X. Percent of Groups Visiting with Dogs and Percent of Groups with >6 Dogs Per Handler

Park Unit	N	% of Groups with Any Dogs	% of Groups with >6 Dogs/Handler
Alta			
Crissy - East			
Crissy - WB			
Ft. Funston			
Muir Beach			
Rodeo Beach			
Stinson Beach			

Leash Compliance

This measure tracks compliance with leash regulations at only those units where such regulations are in effect. Data are collected in two ways: 1) observing groups crossing an imaginary line into a park unit and 2) observing groups within picnic areas.

Table X shows the number of groups visiting with dogs (groups without dogs are not included) observed during all monitoring sessions at each park unit (N), along with the percentage of groups that had all dogs leashed (in compliance with regulations) and one or more dogs unleashed (out of compliance).

Table X. Percent of Groups Visiting with Dogs and Percent of Groups with >6 Dogs Per Handler

Park Unit	N	% of Groups in Compliance	% of Groups out of Compliance
Crissy – East Beach Picnic Area			
Crissy – West Bluff Picnic Area			
Muir Beach Bridge			
Stinson Beach Picnic Area			

Excrement Counts

Compliance with regulations regarding pick-up and disposal of pet waste is monitored indirectly by counting piles of excrement along transects. The amount of excrement present accumulates over time, unless it is collected and removed by park staff. Therefore, this measure standardizes the excrement counts by the amount of time (hours) that elapses between when the transect is cleaned of waste and when the subsequent count is made. This measure has been developed only for Crissy Field East Beach, Fort Funston and Muir Beach at this time.

Table X shows the number of observation sessions for each transect (N), along with the mean (and standard deviation) number of instances of bagged and unbagged excrement counted per hour. The field data form records whether there was a poop bag dispenser on site – and whether it was stocked – for each day of data collection. These data should be summarized in the text to provide context.

Table X. Mean (SD) Number of Instances of Pet Excrement by Hour, by Observation Location

	Bagged			Unbagged		
Park Unit	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
Crissy Field East Beach						
Fort Funston – Transect 1						
Fort Funston – Transect 2						
Fort Funston – Transect 3						
Fort Funston – Transect 4						
Muir Beach – Transect 1						
Muir Beach – Transect 2						

Sensitive Habitat Entries

Data for entries into the lagoons at Muir Beach (3 observation zones) and Rodeo Beach (1 observation zone) are captured in multiple 2-minute observation sessions. The data for all sessions within a single day are combined, though results are presented for each zone separately; thus, the sample size (N) in Table X represents the number of days of observations. Because entries into the water are a function of the number of people and dogs present, Table X represents the counts of entries as a percentage of all people or dogs present within 25 feet of the water's edge at the time the counts were made.

The narrative should provide context for the counts by using the descriptive data about weather conditions included in the data sheets for each monitoring session (cloud cover, precipitation, and temperature).

Table X. Mean (SD) Number of Instances of Pet Excrement by Hour, by Observation Location

Park Unit	N	People			Dogs		
		Mean # Present[1]	Mean % Entering	SD % Entering	Mean # Present[1]	Mean % Entering	SD % Entering
Muir Beach – Zone 1							
Muir Beach – Zone 2							
Muir Beach – Zone 3							
Rodeo Beach							

[1]The mean number of people (dogs) present within 25' of the shoreline upon completion of the 2-minute observation session.

Key Findings

This section should summarize and interpret the findings for each of the measures. Some topics that may be of interest include the following:

- *Professional judgment about the adequacy of the data, both amount of data and how well the field data collection dates appear to represent overall high-use season conditions within GGNRA.*
- *Differences or similarities in type and amount of use between weekends and weekdays.*
- *Identification of any issues that appear to be problematic, such as times or locations of entry into sensitive habitat.*
- *If GGNRA establishes triggers or thresholds for measures, this section should discuss how close measured values are to those thresholds, being sure to address the variability in the data.*

If previous monitoring has been done, this section should be used to examine trends for each measure over time.

Future Monitoring

This section should provide recommendations for future monitoring. It may suggest an appropriate time interval until the next monitoring should occur. It should indicate whether additional data are needed for any measure for the purposes of making management suggestions. It should indicate whether the monitoring efforts should be expanded to other park units or more/different locations within the currently monitored units.

Acknowledgements

This section is optional, but it is a standard practice to recognize those who contributed to the report, including field technicians or staff who conducted analyses.

References

If any additional sources are cited in the report, provide their full reference information here.

Appendices

Appendices are optional, but it can be very helpful to have all important documents related to this report contained in the same place for ease of references and to ensure the integrity of the overall program. This could include the field manual for data collection, the calendars of monitoring dates, any additional analyses (large tables or figures additional to those described in the body of the report, or other sources of data (e.g., visitation data from traffic counters). The appendices should be merged into a single pdf with the monitoring report, so that files do not become dissociated over time.