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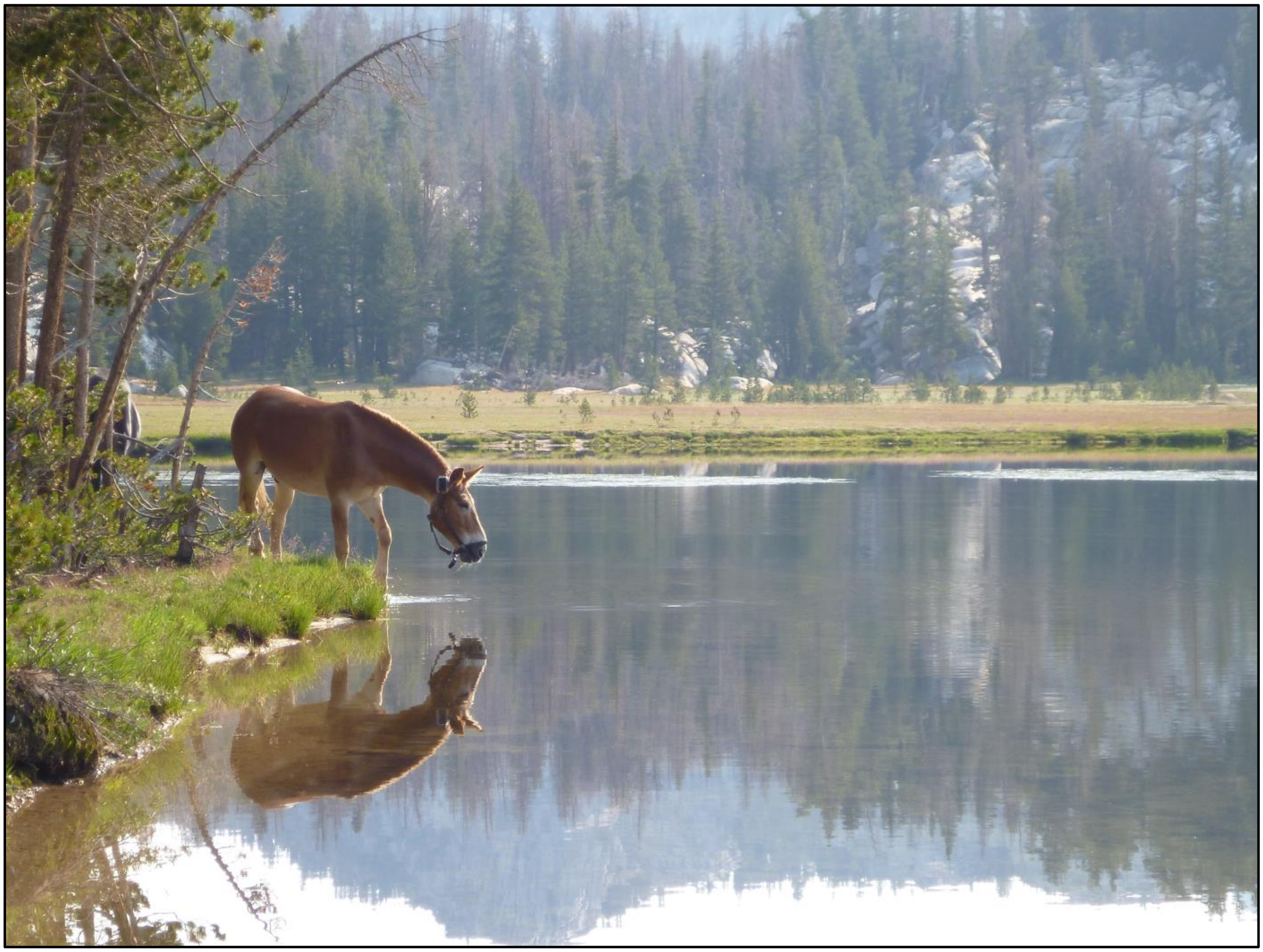
Natural Resource Stewardship and Science

Management Tools and Framework for Pack Stock Use and Meadow Monitoring in Yosemite Wilderness

Natural Resource Report NPS/YOSE/NRR—2018/1591



ON THE COVER
“D.C.” the ornery mule and reflection at Emeric Lake, Yosemite National Park.
Photograph by T. Kuhn.

Management Tools and Framework for Pack Stock Use and Meadow Monitoring in Yosemite Wilderness

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Abstract

The management and monitoring of pack stock use (saddle and pack stock horses and mules) has been the subject of litigation on public lands surrounding Yosemite National Park since 1995. Pack stock is used at Yosemite for commercial, administrative, concessioner, and private purposes, and has potential to impact wilderness character and the integrity of natural and cultural resources valued by society. Changes in the magnitude and patterns of use have occurred since Yosemite's 1989 wilderness management plan. In addition, an array of science-based studies regarding stock use in wilderness have been completed in recent years. As a result, a comprehensive approach to pack stock management can be synthesized from these efforts to inform park planning and augment the protection of wilderness and park resources. The aim is to benefit all parties, including stock users, other park visitors, and park managers.

The scope of this report is overnight wilderness pack stock use (i.e., horses and mules) from NPS trails and extending to camp site access routes, stock holding areas, and forage areas for grazing. This report does not address on-trail use, day use (such as supply trips for the High Sierra Camps), or use by llamas or other pack animals. This information is intended to support the development of the Yosemite National Park Wilderness Stewardship Plan by providing suggestions to enhance current pack stock management; it is not decisive in form or intent; rather, decisions for implementation based on information provided in this report are left to the discretion of park management through the record of decision for the Wilderness Stewardship Plan.

This report: 1) incorporates existing policies and guidance for stock use types in Yosemite; 2) summarizes past stock use patterns, and; 3) recommends management objectives, tools and a monitoring strategy to augment current guidance to achieve the mission of the park. A suite of best management practices are recommended to determine w*here* (site suitability), *when* (meadow opening dates), *how* (handling practices), and *how much* (site grazing capacity) use at a given site might occur, while avoiding, reducing, or mitigating the occurrence of unacceptable impacts.

This report reflects the current state of knowledge of pack stock use in the Yosemite Wilderness. Summaries of studies on other topics also are presented in this report as part of recommendations for determining site suitability for pack stock use, meadow opening dates, and grazing capacities. Each of these studies considered a different number of sites or meadows depending upon the park's knowledge of stock use at that time and the specific focus of each study. We recommend management tools for sites with high use levels but do not detail them for every stock-use site within the park explicitly. Additional monitoring of sites and meadows not yet evaluated could provide further information for more comprehensive management.

An adaptive three-tiered monitoring approach focusing on status indicators, diagnostic secondary investigations, and the effectiveness of management actions is then recommended to enhance the preservation of wilderness character and the integrity of natural and cultural resources. We anticipate that, with careful monitoring and adaptive management, pack stock use in the Yosemite Wilderness could continue in alignment with the mission of the National Park Service.

Acknowledgments

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Introduction

The 1916 Organic Act (39 Stat. F35) established the National Park Service (NPS) and directed its primary purpose to “conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Accordingly, Yosemite National Park’s 2020 Strategic Vision (USDI NPS 2012) expressed the importance of the conservation of natural ecosystems and preservation of cultural resources. Furthermore, the integrity of natural and cultural resources was identified as outstandingly remarkable values (ORV) in the final environmental impact statements for the Merced River Plan and the Tuolumne River Plan (USDI NPS 2014a, USDI NPS 2014b). The protection of natural resources complies with federal laws including the Clean Water Act (33 U.S.C. §1251), the Endangered Species Act (16 USC § 1531-1540), and the Wild and Scenic Rivers Act (16 U.S.C. §1271-1287), among other federal laws. The protection of cultural resources aligns with Section 106 of the National Historic Preservation Act (NHPA) of 1966 (16 USC §470f), and its implementing regulations (36 CFR 800). The Wilderness Act of 1964 (Public Law 88-577 16 U.S. C. 1131-1136) assigns the preservation of designated wilderness, its character and qualities, to each administering land agency. Effective land and resource management maintains wilderness character, supports functioning meadows, and protects archeological resources whereby ecological and physical processes, as well as our cultural heritage, are preserved over the long term.

The vast majority of saddle and pack stock use in Yosemite involves horses and mules (collectively referred to as *pack stock* or *stock*, hereafter) and this use pre-dates designation as a national park. Pack stock use was a critical component of the development and protection of the Yosemite landscape and its wilderness; this traditional use of Yosemite Wilderness continues to be used for commercial, administrative, and private packing and riding purposes. However, pack stock is an example of public land use that can impact meadow condition and function (Ostoja et al. 2014, Kuhn et al. 2015), including water quality, wildlife, wildlife habitat, and the integrity of cultural resources including those that are associated with the rich history of stock use at Yosemite.

Concerns in Yosemite regarding impacts of pack stock use on meadows date from as early as 1932 (Sumner 1935). Recently, the management and monitoring of pack stock use on public lands has been the subject of litigation at the Inyo and Sierra National Forests (USDC 2002, USCA 2004, USDC 2006, USDC 2007), and Sequoia and Kings Canyon National Parks (USDC 1995, USDC 2012). The extent of public interest was highlighted when the issue of pack stock in Wilderness was elevated to the U.S. 112th Congress, who passed the 2012 Sequoia and Kings Canyon Backcountry Access Act (PL 112-128). This Act affirmed NPS Management Polices (USDI NPS 2006) describing the use of saddle and pack stock that “may be employed when it is an appropriate use to support backcountry transport of people and materials and will not result in unacceptable impacts.”

Pack stock use has been reported to impact meadow soils, hydrology and plant communities (Rauzi and Hanson 1966, Van Haveren 1983, McClaran and Cole 1993, Moore et al. 2000, Cole et al. 2004), cultural resources (Gavette 2009), and scenic qualities of the landscape (Marion and Leung 2006). Impacts related to pack stock use of meadows are attributable primarily to the timing, frequency, and intensity of use (Debenedetti and Parsons 1983). Impacts to archeological sites are primarily related to the location of stock use areas, the intensity of use, and the type of cultural materials present. Examples of potential impacts from stock use at wilderness sites include: grazing, trampling, roll pits, trail use, social trailing, and manure, as well as fire ring construction, digging (e.g. latrines, wastewater pits), and the placement of hitching rails and corrals.

Hydro-ecological effects associated with these impacts can include: loss of or changed above-ground vegetation, reduced litter depth and cover, creation of bare soil, soil compaction, reduced soil porosity and infiltration, soil displacement, increased erosion, decreased stream bank stability, changes in soil pH and redoxomorphic conditions, and reduced abundance and diversity of soil biota (Ratliff 1985, McClaran and Cole 1993, Cole et al. 2004, Sørensen 2009, Ballenger et al. 2011, Holmquist et al. 2013b, Lee 2013, Holmquist et al. 2014, Ostoja et al. 2014, Kuhn et al. 2015). These impacts have potential to impair or exacerbate overall meadow condition and function (Edouard et al. 2009, Ostoja et al. 2014). The hydro-ecological importance of functioning montane, sub-alpine, and alpine meadows has been widely reported. Benefits of functioning meadows include: carbon sequestration and nitrogen fixation (Kayranli et al. 2010, Norton et al. 2011, Blankinship et al. 2014), flood water retention (Welsh et al. 1995, Smakhtin and Batchelor 2004), water filtering and storage (Junk et al. 1989, Loheide and Lundquist 2009), and high diversity of vegetation types that provide an array of above-ground habitat structure (Kauffman et al. 1997).

Several studies have attempted to discern a link between pack stock use and occurrence of pathogens in wilderness streams (Derlet and Carlson 2002, Derlet and Carlson 2006, Derlet et al. 2008). Indeed, these studies established that pack stock manure can potentially contain pathogens, although the extent to which these pathogens can be transported into rivers and streams remains unclear. Forrester et al. (in prep) found localized effects on water quality from pack stock use at two stream crossings (with mean annual number of crossings of 1,600 and 4,500) on small tributary streams during 2012 - 2014. These effects occurred during steady-flow conditions (non-storm), but were larger during storms. However, in grazed meadows, Forester et al. did not detect significant increases for any of the measured water quality indicators (consisting of *Escherichia coli*, nitrogen, phosphorus, carbon, and suspended sediment concentration) downstream of a grazing location during steady-flow conditions, and notably found a significant decrease in *E. coli* concentrations downstream from meadows. Attenuation may be attributable to in-channel processes (e.g., inactivation by ultra-violet radiation). An assessment of water quality on rivers in Yosemite by Clow et al. (2011) found low levels of *E. coli*. Ultimately, Clow et al. indicated that overall water quality in the Yosemite Wilderness is high.

The effects of stock use on meadow hydrology and vegetation can indirectly impact wildlife species, particularly among meadow-dwelling wildlife. While there are many wildlife species in Yosemite Wilderness (Appendix A), the Yosemite Toad (*Anaxyrus canorus*) and Sierra Nevada yellow-legged frog (*Rana sierra*) are the only federally listed species that have critical habitat and/or known populations which overlap spatially with stock use sites. Yosemite toads use shallow flooding in meadows for breeding, and Sierra Nevada yellow-legged frogs live in waterbodies, generally in meadows, which has raised concerns that pack stock use may negatively influence toad and frog population persistence. Matchett et al. (2015) leveraged available datasets to investigate patterns between Yosemite Toad occurrence and stock use, and did not detect a negative relationship between pack stock grazing and Yosemite toad in Yosemite. However, more research is needed to understand the validity of potential effects of meadow use by pack stock on the Yosemite toad. Mortality of adult Sierra Nevada yellow-legged frogs has been observed on USFS lands from trampling by cattle (Brown et al. 2014), and similarly mortality of Yosemite Toad tadpoles in Yosemite has been observed among trampling by pack stock animals (USDI NPS, Thompson and Grasso, unpublished data). But the frequency of such incidents and their potential effect on Yosemite toad and Sierra Nevada yellow-legged frog population dynamics are poorly understood (Brown et al. 2014, Brown et al. 2015). In addition to direct effects, the indirect effects of stock on amphibian populations may also be a concern: Brown et al. (2014) described that overgrazing by cattle may decrease vegetation cover, reduce food resources, and increase exposure to predators. But the differences between grazing of cattle and stock impacts are not well understood. Stream bank erosion resulting from either pack or livestock use may impact successful Sierra Nevada Yellow-legged frog reproduction because the species attaches their egg masses to undercut banks and/or to woody debris in these areas which also provide cover for frog larvae (USDA Forest Service 2004). Kuhn et al. (2015) found increased streambank stability at sites with lower levels of pack stock use in the previous year. Additionally, trampling associated with streambank erosion may increase sedimentation, and result in wider and shallower streams (Duff 1977, Kauffman et al. 1983, Bohn and Buckhouse 1985) which can lower meadow water tables and reduce the extent of permanent water bodies, such as shallow wetlands, needed by Sierra Nevada yellow-legged frogs for successful reproduction (Brown et al. 2014). As conservative measures park wildlife staff have recommended seasonal and year-round closures of grazing at specific stock camps (e.g., Upper Kerrick Canyon, which is located in known habitat for both the Yosemite toad and Sierra Nevada yellow-legged frog; USDI NPS 2016).

People have used wilderness areas for thousands of years, leaving behind archeological sites that contain artifacts and features throughout Yosemite. Stock use sometimes overlaps with sensitive archeological materials because many contemporary camp sites and travel routes are in locations that were also popular with prehistoric and historical occupants. Staying for extended periods on archeological sites, trampling of the ground surface by stock and recreational users, creation and use of fire rings, and any digging can impact artifacts (i.e., breakage or collection), alter surface and subsurface features, and increase runoff and erosion of sensitive materials. Gavette (2009) reported that effects to cultural resources from pack stock impacts can include: alterations to surface features; damage to site stratigraphy and horizontal and vertical context of artifacts; breakage, microchipping, and abrasion of flaked and ground stone artifacts; loss of data context and integrity via soil and artifact displacement; cultural constituents used in fire rings, and; damage to obsidian hydration data, protein and organic residues, and an inability to use radiocarbon dating. Given these concerns, park archeologists have worked to assess and relocate stock camps to both protect important nonrenewable cultural sites while accommodating the continuation of the historical tradition of stock use in Yosemite Wilderness.

Best management practices could be implemented to augment the preservation and protection of wilderness character, and the integrity of natural and cultural resources at Yosemite. The goal of this report is to inform development of Yosemite Wilderness Stewardship Plan synthesizing the state of knowledge of pack stock use in designated wilderness areas. This report provides tools to address fundamental questions related to pack stock use, including: w*here* and *when* (and *how* and *how much*) pack stock use might occur at a given site but be managed to prevent unacceptable impacts. Specifically, this report: 1) incorporates existing policies and guidance for stock use types in Yosemite; 2) summarizes past stock use patterns, and; 3) recommends management objectives, tools and a monitoring strategy to augment current guidance to achieve the mission of the park.

The scope of this project includes the four operational components of overnight wilderness stock use: the access route (generally informal, non-maintained user trails extending from the NPS trail system to the campsite and stock holding area), the campsite, the holding area, and the forage area. This report does not address on-trail use, day use (such as supply trips for the High Sierra Camps), or use by llamas. Decisions for implementation of tools provided herein are under the discretion of park management. Detailed information on some components described within this report is provided in separate technical reports referenced herein. These include: a determination of site suitability for use by pack stock (Kuhn et al. 2015), estimates of grazing capacity and residual biomass monitoring (Jones et al., 2018), tools to inform the determination of opening dates for early-season access to meadows by pack stock (Kuhn et al., in review), environmental and managerial factors associated with pack stock distribution in high-elevation meadows (Walden-Schriner et al., 2017), and overlap of cultural resources and pack stock use (Gavette 2009, Wills 2013, 2016).

Background Context for Stock Use at Yosemite

Three types of pack stock use occur in Yosemite Wilderness: administrative, commercial, and private recreational use. Administrative stock users are employed or contracted by the NPS and use stock to assist with park duties, including mounted wilderness patrol, trail construction and maintenance, backcountry utilities, search and rescue, fire management, and monitoring/research project support. The locations and magnitude of administrative stock use vary based on the needs of park management. Such use is typically accomplished as single-day trips but sometimes requires overnight stays with grazing or supplemental feed. Typically, the dominant form of administrative stock use occurs in association with trail crew camp set-up, supply, and demobilization. Recently, this has been limited to one or two backcountry locations per year, though these projects can span multiple years. Supply trips typically include a single "stock string" (i.e., one horse and five mules), whereas multiple strings may be required each season for camp set-up and for demobilization. Alternatively set-up and demobilization are sometimes accomplished via helicopter, to reduce the level of pack stock use and effects to wilderness character. Other typical administrative use is short-duration and low density, such as annual trail clearing which usually requires two or three head at a site for a single night. Administrative stock use planning is coordinated through annual meetings with interested park staff (i.e., typically staff from the Visitor and Resource Protection Division, and Resource Management and Science Division). To the extent feasible, administrative stock use adheres to Leave No Trace principles and other management guidance typical of commercial users.

Commercial pack stock outfitters provide three types of services. Full-service trips include guided riding, packing, and camp cooking services. Spot trips (also called spot and dunnage trips or spot pack trips) are defined as a trip where the client either hikes or is taken by horseback, which may include pack animal, to their campsite, but the wrangler(s) and stock do not stay with the client. The wrangler may or may not return on a predetermined date to pick up the client. A continuous hire trip occurs when the wrangler(s) and stock support a client by moving gear/equipment from point to point, but do not prepare/maintain the camp or offer any other client services. Like other businesses that operate within the park, commercial outfitters are required to have a NPS Commercial Use Authorization (CUA) permit; clients of commercial providers are also required to obtain wilderness permits. In recent years, the park has permitted approximately 10 different commercial pack stock outfitters annually to offer services within designated wilderness at Yosemite. Commercial outfitters must use formal trails and stock sites approved by the NPS. Commercial use patterns (in terms of typical camp sites and portions of NPS trail systems used) can be generalized based on points of origin (i.e., typically based on vicinity of trailheads to locations of the outfitter pack station facilities) without substantial overlap occurring among the outfitters and their use areas within the park. The type of each commercial trip (e.g., spot trip, overnight, or multiple night stay), locations, and the number of supporting stock animals are determined by the desires of the clientele (i.e., pack load and travel distance) and the business plans of individual outfitters. CUA permits and requirements specified in the Superintendent's Compendium (36 CFR §2.16) (NPS 2016) are issued annually and reviewed each year by park staff—including the Business Revenue Management, Resources Management and Science, and Visitor and Resource Protection Divisions—for guidance of commercial stock services. Compliance with Sections 106 and 110 of the NHPA for the annual CUA is through the Programmatic Agreement—*National Park Service at Yosemite, the California State Historic Preservation Officer, and the Advisory Council on Historic Preservation Regarding Planning, Design, Construction, Operations and Maintenance, Yosemite National Park, California* (NPS 1999).

Concessioner pack stock use is lumped with the commercial type given that it fulfills obligations under the park concession contract to facilitate public recreation in wilderness. Stock use in wilderness is covered by the contract rather than a specific CUA permit. Given that day ride services have been excluded through the Merced River Plan (MRP) and the Tuolumne River Plan (TRP) (USDI NPS 2014a, USDI NPS 2014b), the vast majority of concessioner stock use is used for resupply of the High Sierra Camps, with a minor portion fulfilling special trip hires by park visitors (NPS, unpublished data). In the case of special trips, valid wilderness permits are required for all clients and guides.

Private users are typically small, non-commercial groups that use pack stock for recreational purposes within Yosemite Wilderness. There are fewer restrictions on private stock use compared to commercial use. Private stock users are required to possess a valid wilderness permit and can use camp sites within ¼ mile of NPS trails, including backpacker sites. Patterns of use are sporadic and based on user preferences. Currently, and in the recent past, private use has primarily comprised small groups (i.e., typically fewer than 6 head of stock). In the distant past, however, as exhibited by past Sierra Club rendezvous trips, private use was, at times, substantial in terms of number of head and duration of stay. Private stock use is tracked after the fact, via database entry and synthesis of wilderness permits issued for that year.

Three terms are used throughout this document to depict the spatial scale of interest for stock use within a given location, including: *meadow, forage area, and site*. Meadow refers to the meadow ecosystem (i.e., area dominated by herbaceous and graminoid species often with wetland-type soils, hydrology, physical and ecological processes). Forage area refers to the area typically grazed by pack stock, including meadow, but often also including uplands and forested areas. Site refers to the collective pack stock use area as a whole at a given location, including the access route, campsite, holding area, and grazing area (noting that more than one of these features can exist at a given site).

Policies and Guidance Specific to Stock Use

Overall guidance for all pack stock use types in wilderness and within National Parks is provided by the Federal Code of Regulations (36 CFR 2.16) and NPS Management Policies (NPS *Management Policies 2006*, Chapter 4 and Section 8.6.8). Yosemite-specific guidance is provided by the park Superintendent's Compendium (36 CFR §2.16) (NPS 2015b:21-22), Final Environmental Impact Statements for the MRP and the TRP (USDI NPS 2014a, USDI NPS 2014b), and CUA permits (for commercial use types only).

Guidance stipulated by the Compendium addresses an array of factors including: locations and origins of permitted use, group size, trail and off-trail use, reporting obligations, and fundamental stock handling practices for grazing, stock holding, camping, and watering. The MRP and TRP address stock use at specific sites including the Lyell Canyon of the Tuolumne and Merced Lake. In addition, these management plans eliminated concessioner day trips from both the Tuolumne and Yosemite Valley stables. Provisions provided in CUA permits address multiple topics in detail for commercial stock use only. Outreach to private stock users is provided by the park website (https://www.nps.gov/yose/planyourvisit/stock-lnt.htm), NPS Wilderness Centers, contacts by patrolling NPS rangers, through adjacent U.S. Forest Service offices who also issue permits for within-park trips, and through direct contacts and meetings with organizations such as Back Country Horseman of America.

Reported Pack Stock Use

In this report Stock Use Nights (SUN) is used to express the number of overnight stays by a single head of stock at a given site. For instance, 12 SUN reported for a site conveys that a site had been utilized by 12 animals for one night. Whereas, the term Grazing Nights articulates that grazing of meadow forage occurred by a given number of animals, as opposed to being fed supplemental feed (e.g., alfalfa or hay cubes) which occurs at some sites and often by private users. Also note, where feasible, concessioner use is reported separately from other use types, as predominantly this use does not include grazing.

All pack stock users in the park, including administrative, report their level of use by location to the Yosemite Wilderness Office (Visitor and Resource Protection Division). Commercial outfitters and the concessioner also provide a summary of their annual use to the Yosemite Business Revenue Management Division for fiscal tracking. Detailed reporting by stock users has improved over time. Generally, the park did not collect data on administrative stock use until 2006, whereby only trail crew resupply was recorded; in 2011, the park began collecting data on use by sawyers, ranger patrols, and other smaller uses. Cooperation by the park concessioner to track and provide detailed information on their stock use has varied over time, but notably improved since 2011. Also, since 2011 stock use reporting has included the number of Grazing Nights and/or fed supplemental feed. Currently included on the pack stock use reporting card are requirements to also indicate the stock type, dates of use by location, and the total number of stock grazed and fed (Appendix B). The accuracy and completeness of reporting, and forage strategies, associated with past use limits the ability to determine reliable stock use trends over time. Nonetheless, accurate reporting by all user types, from 2012 and beyond, will enable the park to determine and track trends in stock use, which is fundamental to allocating monitoring resources as well as research studies that investigate conditions in relation to use.

Stock Use by Type

Noting the caveats described above regarding the accuracy of use reporting, total reported SUN among all types within Yosemite Wilderness was 28,841 SUN between 2004 and 2016. Acree et al. (2011) suggested that commercial and administrative use levels were roughly equal (i.e., 50% and 45%), while private use accounted for roughly 5%, between 2004 and 2009. Since 2012 however, improvements in use reporting indicate that the total amount of reported SUN was 12,638, with an average of 632 SUN per year through 2016. During this five year period, commercial and concessioner use were roughly equivalent, accounting for 42% (5,336 SUN) and 40% (5,066 SUN) of the total reported SUN, while administrative and private use accounted for 12% and 6% (1,536 and 700 SUN) (Figure 1). Locations of permitted private stock use were generally non-specific. Reported concessioner use occurred primarily at the High Sierra Camps but has only been recorded since 2012.

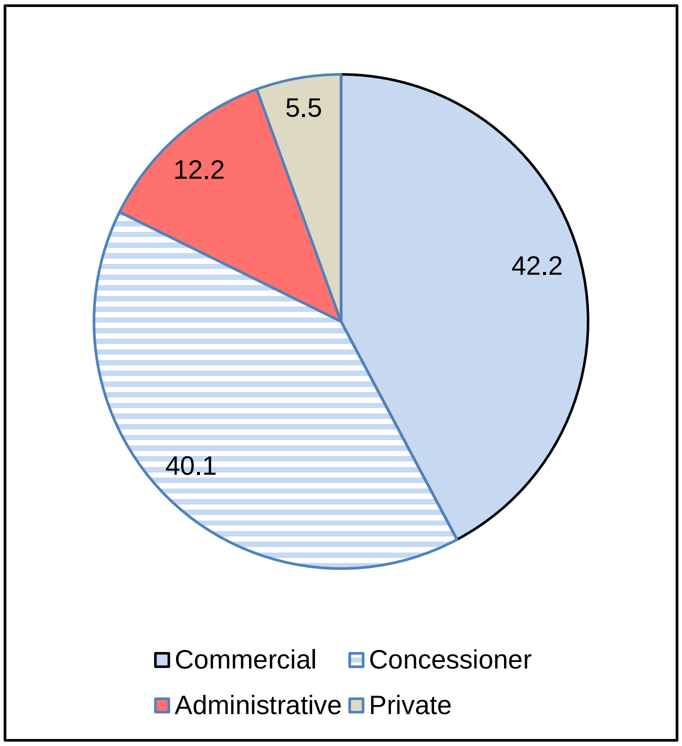

Figure 1. Reported stock use nights: Pie chart of proportion of total reported stock use by type, 2012 and 2016.

Patterns of stock use have changed over time, in terms of both locations and magnitude (Figure 2; use levels). Since 2004, administrative use peaked in 2009 at 840 SUN but declined to 326 SUN in 2014. Commercial use has generally declined over time (M. Fincher, Yosemite Wilderness Specialist, pers. comm., 2016); commercial use was up to an order of magnitude greater at some locations in the 1990s than reported since 2004. From 2004 to 2016, commercial stock use (excluding concessioner use) has declined from its maximum of 2,242 SUN in 2004 to a low of 555 in 2011, it notably recovered to 1,734 in 2015 but declined again in 2016 to 1,050 SUN. Since 2012, concessioner use increased from 249 reported stock use nights in that year to 1,504 SUN in 2014. Reported private use ranged from a high of 300 SUN in 2007 to a low of 55 in 2016.

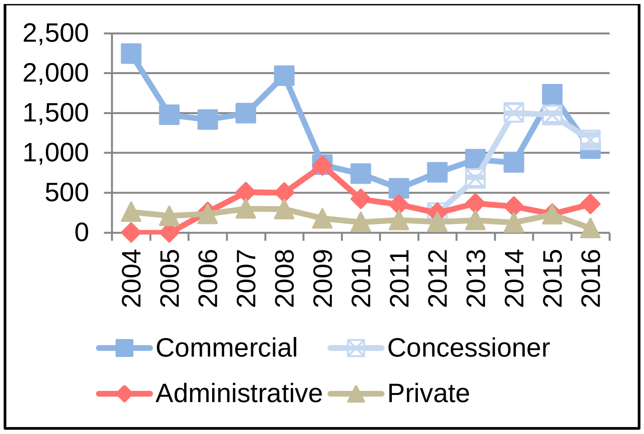

Figure 2. Reported stock use nights: Line graph of changing magnitudes of stock use between 2004 and 2016. Note, pack stock day use not included.

Notably, not all SUN include grazing (Table 1). Though not specified, concessioner use at the High Sierra Camps typically includes supplemental feed at corrals associated with each camp, and although generally not reported forage strategies employed by private users are often limited to supplemental feed (Unknown = 100%). Administrative use predominantly occurs as day use without a need for grazing, but, for administrative trips requiring overnight stays, 57% of reported SUN includes grazing of forage areas, while roughly 19% of reported SUN includes supplemental feed. Commercial use exhibits the highest level of grazing; 66% of reported SUN for commercial trips includes grazing, while 7% includes supplemental feed. Roughly 52% of SUN reported for administrative and commercial types did not specify forage type. In general, however, if grazing is available most operators will choose to graze over providing supplemental feed as this requires extra stock, logistics and costs.

Table 1. Forage by use type based on reported stock use nights between 2012 and 2016. Grazing Nights indicates that pack animals were allowed to free-graze at the forage area, Supplemental Feed indicates that operators provided feed for the animals and no grazing occurred, and Unknown means the forage type was not reported.

	Forage Type		
Use Type	**Unknown**	**Grazed**	**Supplemental Feed**
Administrative	370 (24.2%)	872 (56.9%)	290 (18.9%)
Private	700 (100%)	NR	NR
Commercial	1,410 (27.3%)	3,133 (65.7%)	364 (7.0%)
Concession	1,934 (76.5%)	0 (0%)	593 (23.5%)
Total	**4,414**	**4,266**	**1,247**

Stock Use by Site

Between 2004 and 2009 park management solicited commercial operators to identify sites that were traditionally used (Gavette 2009). Prior to this effort no single source of reliable data for commercial site locations had been assembled. These efforts included synthesis of information from several sources, including paper maps submitted by commercial stock operators (NPS, Karels, unpublished data); sites identified by Yosemite Wilderness staff including Wilderness Manager Laurel Boyers and Specialist Mark Fincher, and other park staff; review of CUA logs (formerly Incidental Business Permit); and spatial data from wilderness ranger and wilderness restoration staff site visits.

Initially 304 sites were suggested (Figure 3), but many of these were not verified locations or appeared to be duplicate listings from multiple data sources (Gavette 2009). Results of Gavette's investigation were compiled into a Geographic Information System (GIS) database. Subsequently this number was reduced to 101 sites (Figure 4) by 2012, through continued field effort by park staff to verify locations and meetings among commercial operators, wilderness managers and park staff (Gavette 2009, Curtis 2012).

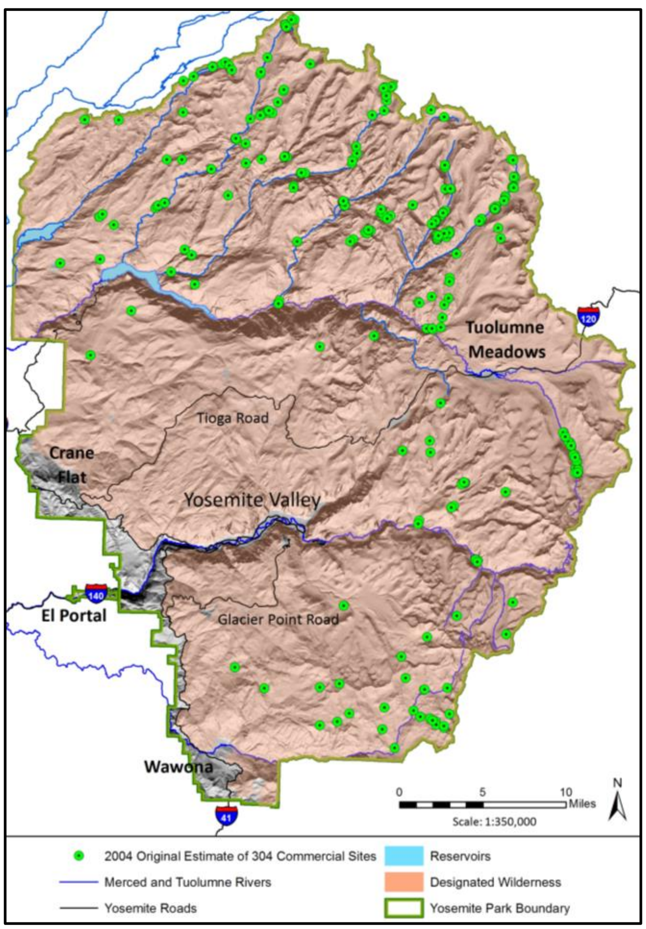

Figure 3. Map of Yosemite wilderness areas and original 304 approximate commercial site locations based on unverified data from 2004.

Figure 4. Map of Yosemite wilderness areas and 101 operator specified priority commercial stock camp sites as of 2012.

Of the approximately 3,000 meadows within Yosemite Wilderness (Viers et al. 2013), only 200 are within the ¼ mile limit prescribed by regulations and policies (Figure 5). These regulations are specific to "riding" stock, whereas some free-range grazing is known to occur at nearby meadows beyond the ¼ mile limit. Nonetheless, only a total of 65 meadows have recorded grazing since 2004, according to submitted commercial use authorization post-trip reports. Prior to 2004 use commercial use reportedly occurred at the other sites (Gavette 2009), but has not been quantified or categorized among grazing or other feeding strategies.

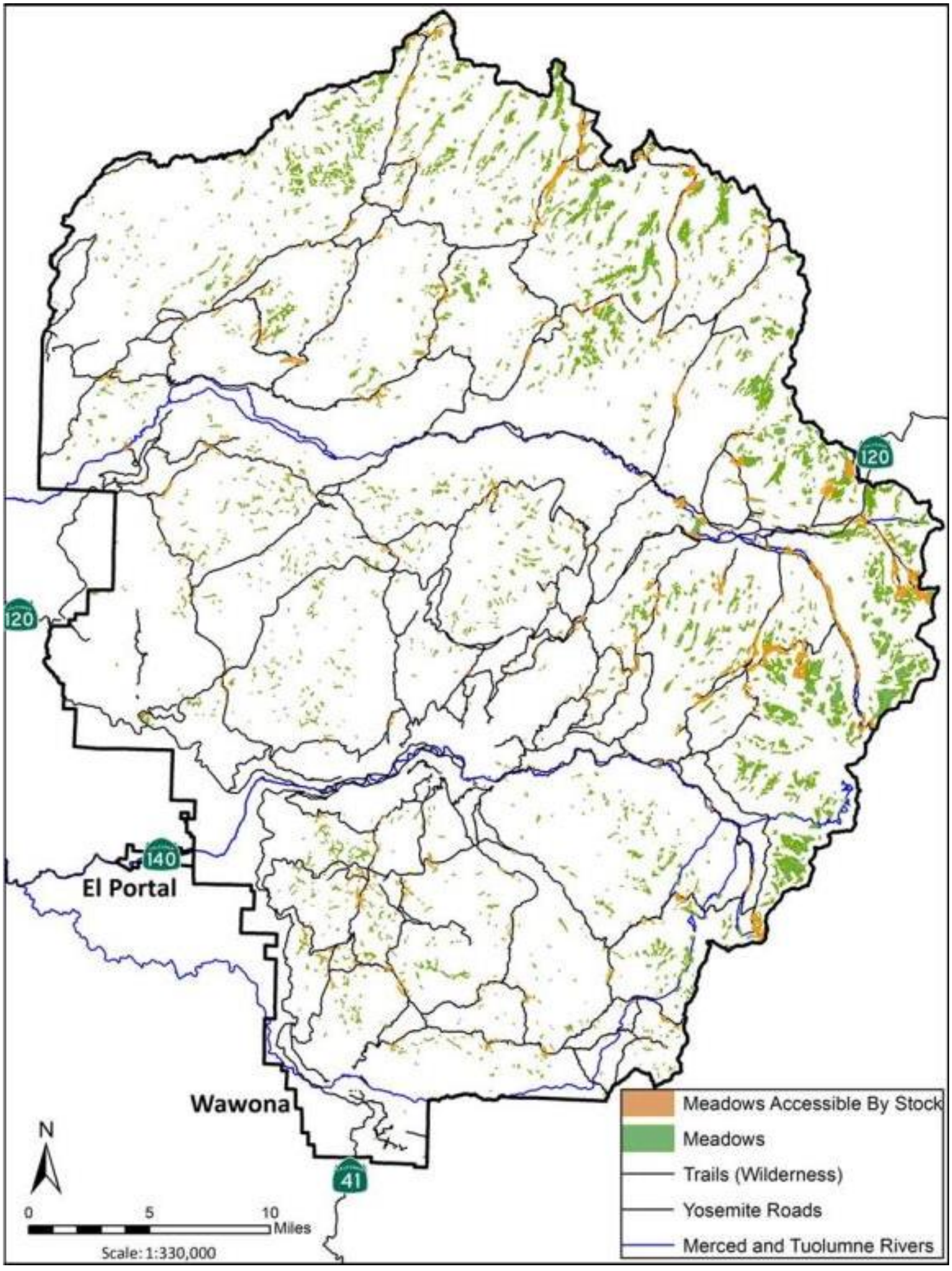

Figure 5. Map of meadows in Yosemite Wilderness (meadows within four miles of trailheads and paved roads have been omitted), and those accessible to pack stock based on current regulations.

Between 2004 and 2016, concessioner use at the Merced Lake HSC accounts for the highest single year maximum (846 SUN) (Figure 6), but these overnight stays use supplemental feed in the corral at that facility. Highest annual average SUN occurred within Lyell Canyon (among 3 individual sites), which received roughly 286.2 SUN per year with the feeding strategy heavily skewed towards grazing. Supplemental feed at the administrative corral has also occurred at the Merced Lake Ranger Station site, as prescribed by the MRP. The best approximation of grazing (Figure 7) can be gleaned from reported Grazing Nights since 2012 and assuming "unknown" as grazing for commercial and administrative types only. Stratifying the data in this manner, between 2012 and 2016, shows that six locations incurred roughly half (51%) of the total grazing in Yosemite Wilderness, including: Lyell Canyon, Benson Lake, Virginia Canyon, Smedberg Lake, Matterhorn Canyon, and Pate Valley. Three of these locations (Lyell, Matterhorn, and Benson) are on the Pacific Crest National System Trail, while Virginia Canyon has been a primary access point for an active CUA stock outfitter. Also note that some of these locations comprise a number of individual sites, but reported use has not always been to that level of detail. Use at these sites is dominated by commercial use, but each has also incurred administrative use. Since 2012, the greatest single year maximum reported and annual average Grazing Nights occurred at Lyell Canyon (299 Grazing Nights in 2015, 175 annual average Grazing Nights). Also notable is that 564 SUN were reported for this area in 2007; though not reported explicitly, it is likely that the majority of these were Grazing Nights. Lyell Canyon comprised up to five stock sites but was reduced in 2014 to three sites—Rock Camp, Peninsula Camp, and an overflow camp (USDI NPS 2014b) for commercial outfitters.

Use and grazing levels at any site may vary due to commercial or private user preferences, or according to the locations and needs of administrative projects (Figure 8). Such variability results in a high inter-annual variation among years and highlights a need for managers to look at specific reported SUN and Grazing Nights, as well as trends over time.

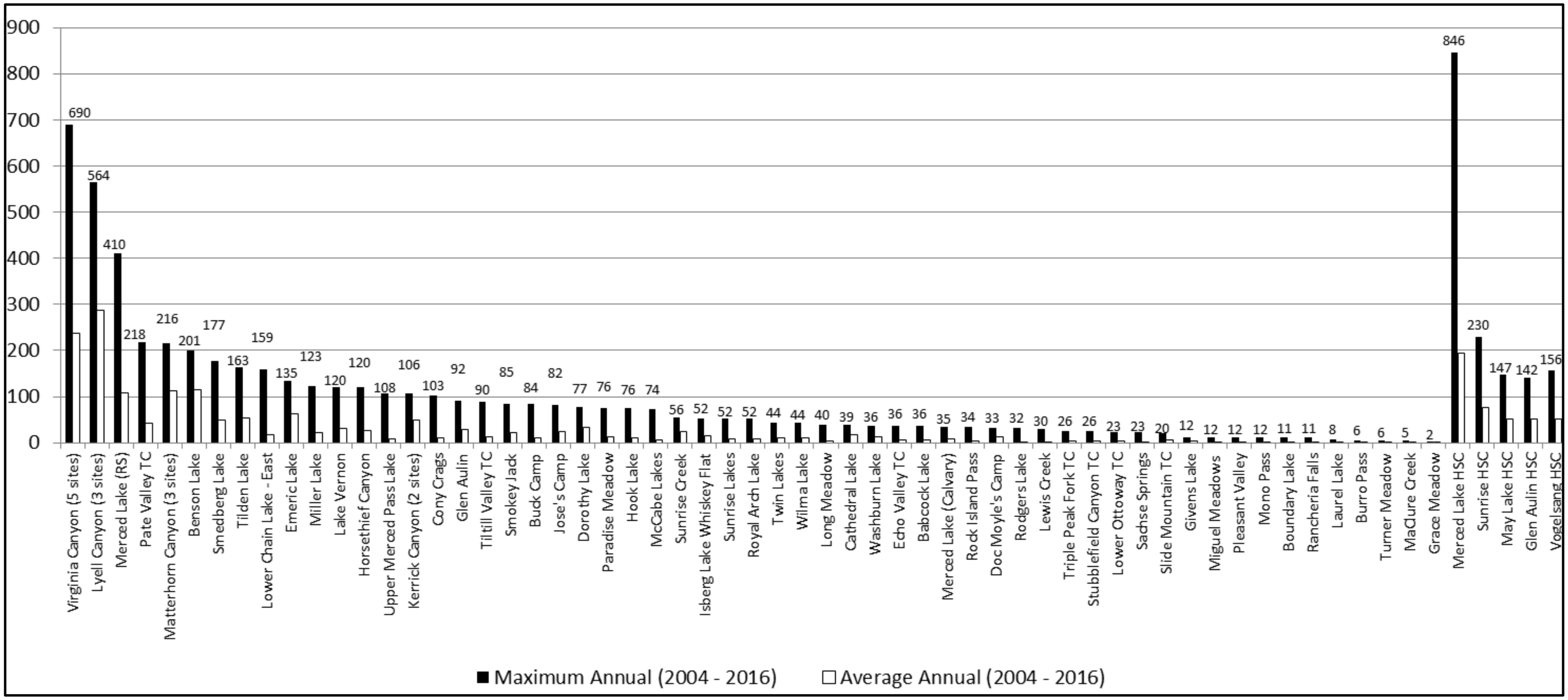

Figure 6. Bar chart of maximum annual (labeled) and average annual Stock Use Nights reported between 2004 and 2016, for 69 sites (57 commercial use sites, 7 administrative trail crew camps "TC", and 5 High Sierra Camps "HSC"). Reporting for some locations was non-specific; for those locations all reported data is grouped by general location. Camp names and Camp ID#s are provided in Appendix C.

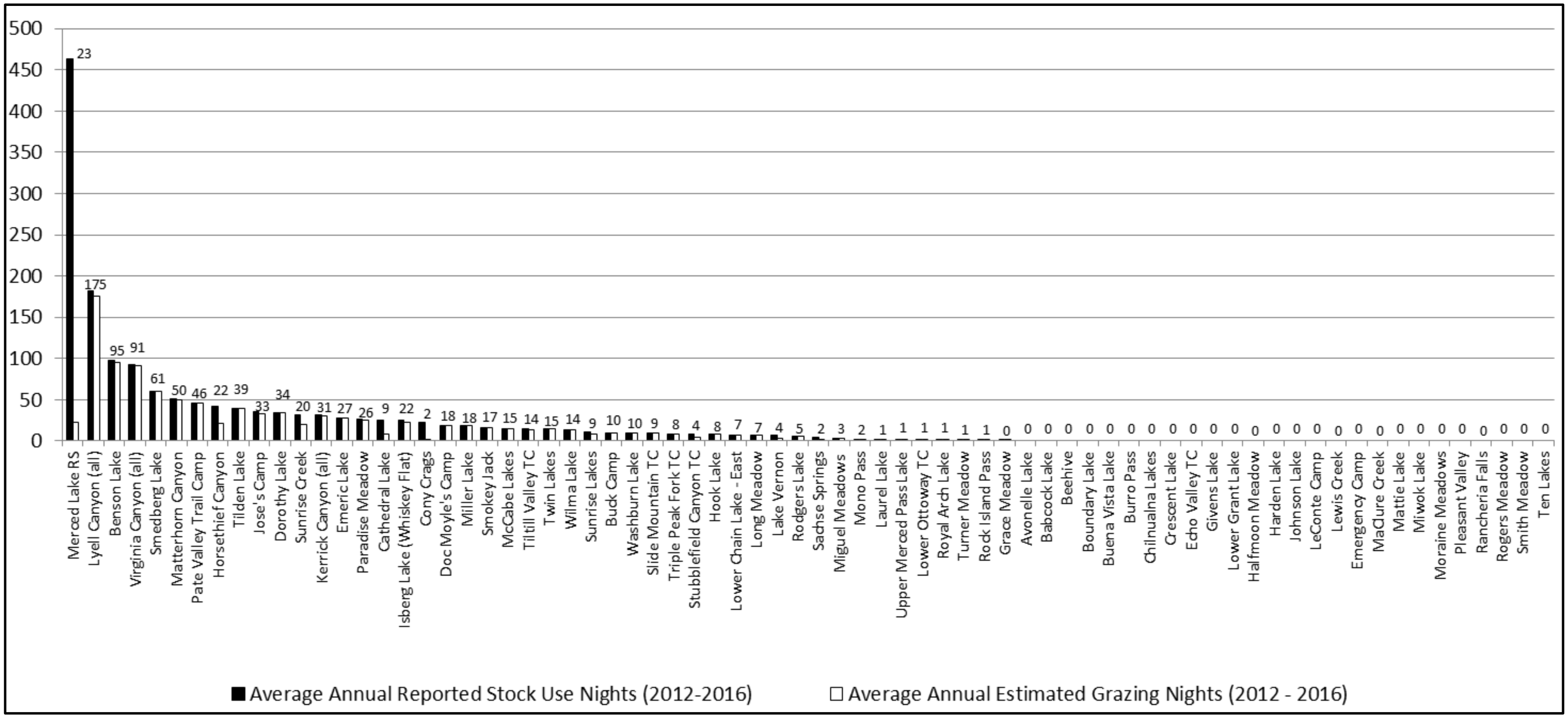

Figure 7. Bar chart of average annual Stock Use Nights and average annual Grazing Nights (labeled) reported between 2012 and 2016 at 98 locations. Estimated Grazing Nights represents reported grazing nights for all use types plus SUN reported as “unknown” forage type for administrative and commercial use types.

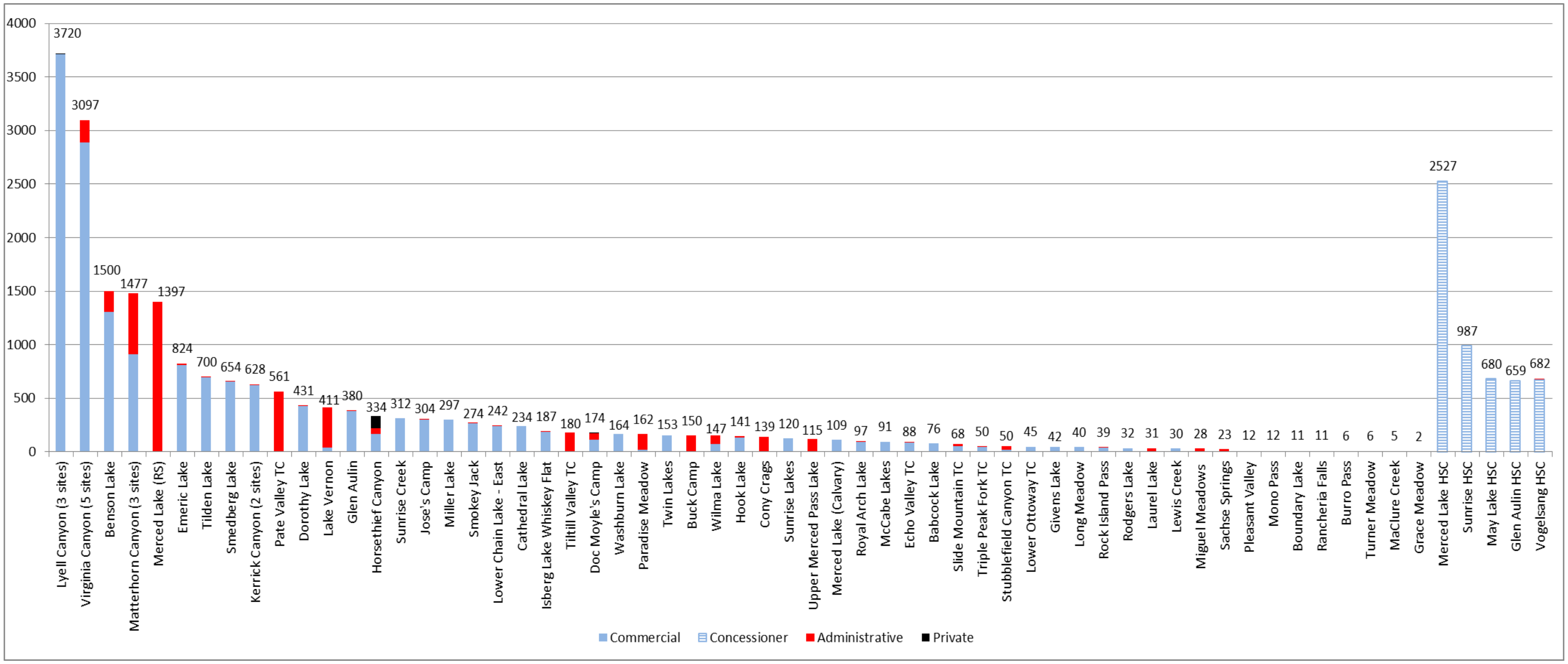

Figure 8. Bar chart of cumulative stock use nights (labeled) partitioned by reported use type between 2004 and 2016.

Goal and Objectives for Pack Stock Management

The goal for pack stock management and the stewardship of Yosemite Wilderness is to allow use where it is commensurate with the long term preservation of wilderness character and the integrity of natural and cultural resources—the processes that shape them, their functionality and history—and the quality of current and future visitor experiences. This goal aligns with the mission of the National Park Service. The premise of this report is that effective and adaptive management can allow pack stock access to wilderness while minimizing impacts from stock use. The fundamental approach suggested in this report aligns with assertions by Cole et al. (2004) who suggested where stock use is low, meadows are large, or grazing impacts are widely dispersed, passive management of pack stock use may be adequate, while areas that receive repeated or high levels of stock use may require more oversight from management. Monitoring can be used as a tool to assure the protection and preservation of park resources at sites with use and disturbance. Monitoring can be strategized such that sites that receive high levels of reported use and those with sensitive resources are prioritized and monitored at higher frequency than those sites with low levels of use. Incorporation of monitoring at reference sites with no pack stock use could enable differentiation between use-related changes and natural and/or climate related hydro-ecological fluctuations in these ecosystems over time.

We propose that, through the application of park-wide and site-specific best management practices (i.e., BMPs, including meadow opening dates, grazing capacities, and stock handling practices), stock use could occur in wilderness while allowing for the preservation of wilderness character and protecting the integrity of its natural and cultural resources. Accordingly, this report recommends an array of best management and stock handling practices to achieve the following objectives:

- Prevent changes from stock use to springs, seeps, wetlands, stream banks and channels (and other hydrologic features) that could impair water quality, streambank stability, and hydrologic processes.
- Manage the timing, intensity, and pattern of stock use and grazing to maintain plant species cover, vegetation productivity (i.e., biomass), and species habitats by minimizing habitat fragmentation from informal trails and bare soil in meadow and wetland ecosystems.
- Prevent adverse effects to soils and associated sod that may lead to accelerated erosion (e.g., soil compaction, increased bare soil surface).
- Avoid or minimize disturbances to the integrity of cultural resources, listed species, designated Critical Habitat for listed species, and sensitive ecosystems.
- Minimize the effects of pack stock on trails and camp sites.

The effectiveness of management prescriptions to protect park resources from use-related impacts requires validation through long term monitoring. Monitoring is a critical part of implementing adaptive management (Stem et al. 2004), and monitoring objectives are guided by the management objective and reflected in the sampling design.

This report suggests the implementation of a three-part monitoring strategy (status indicator monitoring, diagnostic secondary investigations, and effectiveness/validation monitoring) to provide relevant information about the effects of pack stock use on meadows, streams and riparian areas, cultural resources, and wilderness values within the park. The first tier of this monitoring strategy, status monitoring, incorporates the use of selected indicator metrics through application of cost- and time-efficient protocols that can be applied to a wide range of stock sites throughout the park. Status indicator monitoring evaluates baseline conditions of sites and uses prescribed trigger points to ensure management objectives are achieved. Trigger points are quantitative monitoring thresholds that act as check points to activate more scrutinous and comprehensive evaluation of site conditions, whereby adaptive management could be applied to arrest downward trends if those evaluations suggest a causal relationship among site use and declining conditions. The second tier of this strategy is an in-depth diagnostic secondary investigation implemented at specific sites when first-tier monitoring suggests declining conditions or that management objectives are not being achieved (i.e., breached trigger point). This second tier investigates the applicability of the park-wide management and monitoring objectives to the specific context of the site(s) of interest, if declined indicator values are indicative of declined resource conditions, and evaluates potential causations to the extent feasible as to whether pack stock use is likely responsible or contributing to declined conditions. Lastly, third-tier monitoring is effectiveness/validation monitoring, which is applied once management actions have been implemented, to determine if such actions are appropriate, and in terms of their spatial and temporal extent, to manifest recovery toward the desired status conditions.

Management and Monitoring Framework for Pack Stock Use in Wilderness (Overview)

Our suggested management and monitoring framework for pack stock use in Yosemite Wilderness is based on stock use reporting and baseline assessments to determine site suitability for use (where), management prescriptions including best management and stock handling practices (when, how, and how much), and indicator monitoring to provide feedback on site suitability and management effectiveness (Figure 9). Site suitability for use by pack stock was comprised of assessments of meadow condition and vulnerability to disturbance (Kuhn et al. 2015), site evaluations to identify specific resource concerns, and assessments of climate change sensitivity (as they become available).

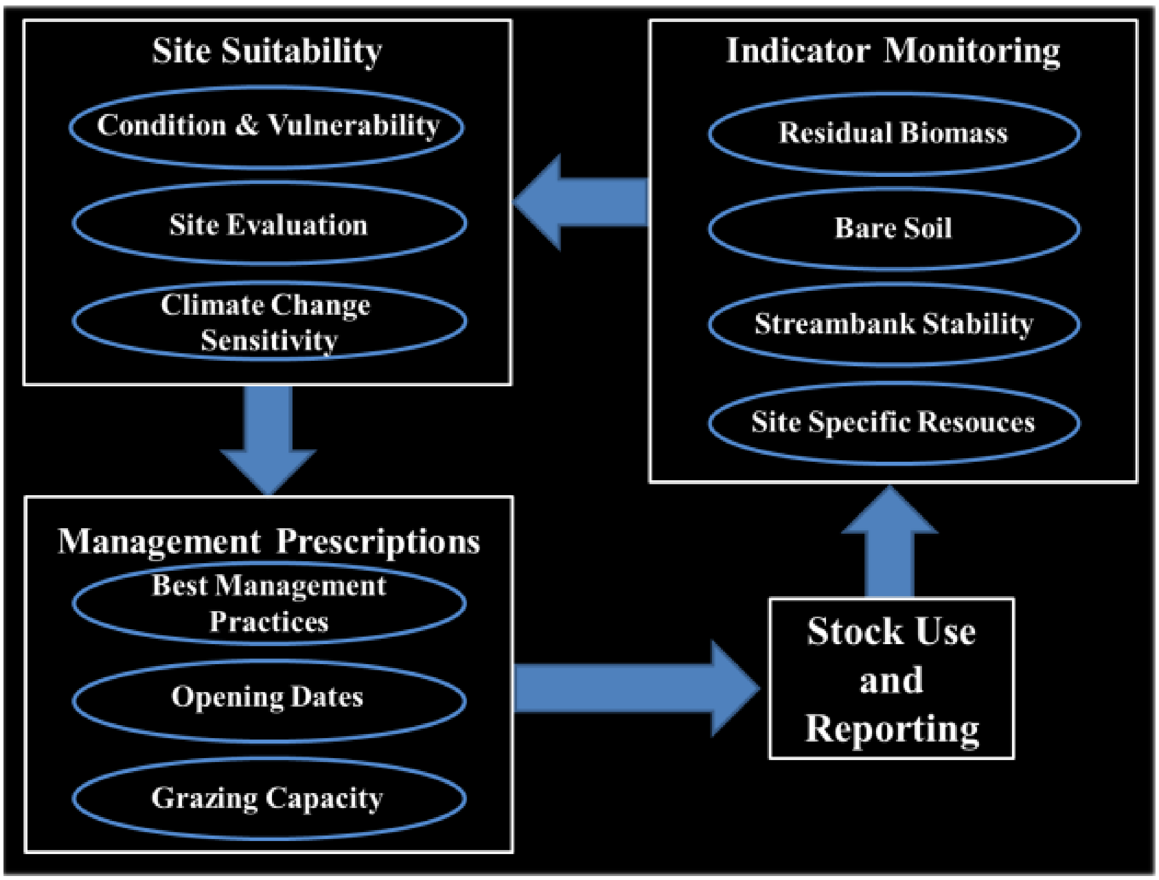

Figure 9. Flowchart of draft management and monitoring framework for stock use in Wilderness.

NPS Resource Management and Science staff then recommends a combination of park-wide and site-specific prescriptions for best management practices (including opening dates and grazing capacities, as well as stock handling practices) designed to protect wilderness character and the integrity of biological and cultural resources. Stock use reporting is also used to prioritize monitoring to higher use sites and sites with specific resource protection concerns. The monitoring program uses indicators of wilderness character and water quality to evaluate the effectiveness of prescriptions and to provide feedback for adaptive management responses that facilitate improved trends over time.

Baseline Assessments—Pack Stock Site Suitability

Pack stock sites in Yosemite Wilderness have a wide range of physical, ecological, and cultural characteristics, and are located across a wide range of elevation and biogeographical zones. Features of sites include large or small (or even non-existent) meadows, encompassed by forests and granitic rock slabs or cliffs. Meadows at sites can have areas that are wet or dry and some have surface water features such as wetlands, fens, and stream channels, while others are dominated by sheet flow and groundwater sources. How weather and climate interacts with the ecological and physical factors, and variation in use types and levels over time, increases the complexity factored into management decisions.

Meadow Suitability

Kuhn et al. (2014) synthesized survey data from 53 high elevation wilderness meadows in Yosemite to present an assessment of ecological condition and vulnerability to disturbance, as a basis of suitability for stock use. For this, they relativized five metrics to calculate meadow ecological condition scores (bare ground cover, total vegetation cover, late seral species cover, early seral species cover, and litter depth), and seven metrics for vulnerability to disturbance scores (elevation, slope, streambank area, lakeshore area, pond area, dry meadow area, and wet meadow area). By contrasting scores for ecological condition and vulnerability to disturbance, they suggested the relative suitability for use of a given meadow against the others.

These authors suggested that additional information could be incorporated to better refine a determination of suitability for pack stock use, including park objectives such as special status or rare species, sensitive habitats, archeological sites, potential user conflicts, or site resilience. They also mentioned the possibility to use plant functional ratings (Eviner and Chapin 2003) instead of seral state, if those ratings could be developed for the suite of plant species typical of Yosemite meadows.

From the comparison of ecological condition scores with vulnerability to physical disturbance scores, 40 meadows were rated as having moderate suitability for use. Six meadows had a low suitability rating: Doc Moyle's-West, Merced Lake-Shore, Red Peak-North, Washburn Lake, Smedberg Lake and Twin Lakes. Seven meadows received a high suitability rating: Doc Moyle's-East (Camp ID# 130), Merced Lake-West (1163w), Benson Lake (37 and 95), Cold Canyon-Smokey Jack (3207s), Paradise (136 and 137), Upper Lyell-South (32), and Upper Slide (N/A). Site Suitability ratings are summarized in table format in Appendix C.

Stock Utilization Patterns in Meadows

Stock users in Yosemite Wilderness employ a variety of methods for holding, feeding and grazing their stock. The approaches used vary by site, animal behavior, and user type (McClaran, 1989; Ostoja et al., 2014). Users tend to travel during the day to the desired destination and then utilize a highline to hold stock until dusk. Stock are then typically released for free-range grazing for portions or the entire night. Reportedly, because stock do not become familiar with the location during the day, they graze closer to camp and are easier to round up for use the next day.

Tying stock to a highline (a rope strung between two trees) keeps the stock restrained and prohibits them from roaming away from camp. If stock are restrained all night, they are usually given supplemental feed at some point to mitigate their lack of grazing opportunity. This method has the advantage of keeping stock out of meadows that are closed to grazing and keeps stock from roaming far from camp.

Free-range grazing allows stock to optimize their forage patch selection, and has the benefit to reduce the number of stock needed to carry feed and limits the chances of weed infestations from imported feed (Wells and Lauenroth 2007). The movement of grazing stock can be restricted by hobbling, use of pickets, or through use of a portable electric fence. Another technique is hand grazing. Animals are led out to graze and controlled by their handler with the animal's lead rope and halter. This technique keeps control of where the stock graze, but is labor intensive and therefore typically only employed for a short duration of time (i.e., one to two hours).

During the summer of 2014, Yosemite National Park staff collaborated with North Carolina State University to conduct a pilot research project to test the accuracy and feasibility of global position system (GPS) equipment to track the movement of administrative pack stock in 17 meadows in Yosemite Wilderness. From these efforts, the team found that the location where stock were released for free-range grazing influenced the subsequent distribution of use throughout the forage area. On average, stock travelled 182 meters from the point of release, spending 48% of time within the mapped meadows boundaries (Walden-Schreiner et al. 2015), and 52% of time within upland or forested habitats. In addition, Walden-Schreiner et al. (2017) results found that when a portable electric fence was used to contain movement of the lead horse, this simultaneously limited the movement of all other animals within the herd to within the vicinity of the lead horse. Note that it remains unknown if activity patterns differ for commercial or concession stock, released overnight, or how those use patterns may change during the course of the night; these are topics of current studies by the USGS Yosemite Field Station.

Stock Site Evaluation

The goal of the Stock Site Evaluation (SSE) component was to conduct field evaluations of traditional stock site locations and their operational components—access routes, camp sites, holding areas, and forage areas—to determine if use at existing sites was compatible with the preservation of wilderness character and protection of natural and cultural resource integrity. The evaluation group comprised an interdisciplinary team of NPS Resources Management and Science natural and cultural resource subject matter experts, Wilderness specialists, and NPS stock wranglers. The compatibility of newly proposed future sites (i.e., those sites proposed by CUA permitees or for administrative needs) could be assessed similarly through a determination of site suitability and field evaluations.

Through evaluation of available spatial data (i.e., to identify sensitive resources and species occurrences within vicinity of the stock site) and subsequent field evaluations of the sites, the SSE interdisciplinary team developed a suite of recommended park-wide and site-specific BMPs. Best management practices are guidelines for park managers that provide strategies for reducing the impacts of pack stock to wilderness character and the integrity of natural and cultural resources. These practices are applicable to all stock use types and sites in park wilderness. Subsequently, the

SSE team evaluated the context of each stock site and recommended mitigation actions to adhere to the prescribed BMPs. Common characteristics that are ideal for access routes, holding areas, camp sites, and forage areas are listed in Table 2.

Table 2. Preferred characteristics of the operational components of pack stock use.

Operational Components	Preferred Characteristics
Access Route	Minimum feasible length that avoids sensitive resources (fens/wetlands, listed species habitat, cultural resources, stream banks)
	Flat or low gradient
	Hardened surfaces with controlled drainage through effective buffers (Mayer et al. 2005, Tate et al. 2006)
	If necessary, channel crossings should be at selected locations with natural or NPS constructed armoring to minimize impacts to streambanks and channel substrate
Holding Area	Sufficient size to accommodate expected use levels
	Flat, in-sloped (i.e., closed basin), or low gradient
	Armored surface, or substantial litter depth
	Non-vegetated
	Bounded by trees and rocks
	Alignment should be perpendicular to adjacent slope
	Located away from surface water features and trail(s)
Camp Site	Existing fire ring
	Located away from surface water features and trail(s), as well as sensitive resources such as archeological sites.
	Located away from NPS trails.
	Includes natural barriers such as rocks, or down logs, that inhibit site expansion.
Forage Area	Large size with areas of preferred forage that are devoid of sensitive resources such as fens/wetlands and springs, listed species or their habitat, and cultural resources.
	Minimal to no invasive weeds
	Access to stock water location is naturally armored

These recommendations guide the mitigation of observed or potential impacts from stock use on wilderness character, and natural and cultural resources, and range from no recommended changes, to suggested minor or major alterations. Examples of minor alterations may include recommended actions such as reconfiguring access route, holding area, or camp locations to reduce overlap with sensitive resources and thereby passively improve resource integrity at existing use levels. Other minor alterations include the incorporation of meadow opening dates for use by stock, and grazing capacities, to manage when and how much grazing occurs at a given forage area, as well as recommended Stock Handling Practices (Appendix D), based on Leave No Trace Principles, to be implemented by stock users for enhanced stewardship of park resources and wilderness. Major alterations may include recommended actions such as delaying grazing opening dates, reducing allowable grazing levels, or, in rare cases, suggest that a site is not appropriate for grazing (i.e., requiring supplemental feed at holding areas, or restricting to drop-site only) to improve site conditions or maintain the integrity of sensitive resources. Where potential resource impacts could not feasibly be mitigated, SSE team findings include recommended restrictions such as limited or no grazing, or in rare cases the omission of stock use from a site. In cases of recommendations for the exclusion of stock use, practical alternative sites for stock use were identified at nearby locations if available. Implementation of these recommendations is at the discretion of park management. Findings are presented as sites maps (Appendix E) and recorded in a geodatabase.

Development of BMPs for cultural resources required identifying what archeological sites are present, where stock use occurs, and how stock use can disturb cultural constituents. Identification of archeological sites and their overlap with stock sites has occurred as part of various studies, with the most prominent research occurring in 2006-2016 (Gavette 2009, Curtis 2012, Wills 2013 and 2016). Potential disturbances to archeological sites were also identified and vary based on the type and intensity of use (see Gavette 2009, Wills 2013).

Previous unpublished surveys (USDI NPS, Thompson and Grasso, unpublished data) and the SSE surveys collectively detected the presence of Yosemite toads at 14 meadows with potential use by pack stock, and a total of 78 sites are located within critical habitat for the Yosemite toad or Sierra Nevada Yellow-legged frog. A conservative approach to avoid, minimize and mitigate the overlap of stock use with detected species occurrences and within areas of designated critical habitat, a combination of reconfiguration of the operational components and stock handling practices such as use of portable electric fences, hand-grazing, use of strategic release points, or in rare cases the exclusion of grazing, are recommended at sites. As information on the potential for pack stock use to impact species occurrences and their habitat (i.e., such as the Sierra Nevada yellow-legged frog, Pacific fisher, red fox, and bighorn sheep, and the great gray owl) becomes available from monitoring efforts and research studies, best management practices may be refined or added.

Recommended park-wide best management practices for avoidance, minimization, or mitigation of potential impacts at stock use sites are presented in Table 3. Recommended site specific BMPs are described on maps in Appendix E and are coded according to topic in Appendix C. Each BMP is a common management practice and/or based on research recommendations; otherwise, the BMP represents a conservative approach to protect wilderness character and the integrity of natural and cultural resources. BMPs may need to be adapted based on results and findings from effectiveness/validation monitoring (see the *Monitoring Strategy and Thresholds for Adaptive Management Actions* section), as well as through feedback from NPS law enforcement, stock operators and wranglers, and American Indian tribes. These BMPs could be incorporated into the CUA, Superintendent's Compendium, and/or as guidance provided by the Wilderness Stewardship Plan. In addition, supplemental public outreach materials that provide information on meadow opening dates for stock use, grazing capacities, and stock handling practices have been developed.

Table 3. Recommended park-wide best management practices for stock use in Yosemite National Park, and corresponding stewardship purpose.

Best Management Practice (BMP)	Stewardship Purpose
Encourage stock wranglers and users to act as stewards of Yosemite Wilderness, particularly at areas that are rarely visited and areas with historically significant connection to stock such as the High Sierra Camps, Doc Moyle's, and NPS Ranger cabins. Encourage stewardship of species habitats, sensitive ecosystems (such as fens, wetlands, and riparian areas), historic properties, and places of religious and cultural significance to American Indian groups traditionally associated with Yosemite through outreach, education, and interpretive materials.	To enhance interpretation, education, and collaboration to optimize wilderness experience of visitors.
Prescribe opening dates for stock access to meadows and limit use until soils have sufficient strength to resist physical compaction and shearing. Restrict the timing of use, especially grazing, until plant phenology has reached the target stage and during critical life-cycle stages for listed species such as the Yosemite toad or Sierra Nevada yellow-legged frog.	To minimize soil disturbance, formation of bare soil, erosion, and impacts to plant fecundity, meadow productivity, species and their habitats. To preserve ecosystem diversity and rare biological attributes of meadows and alpine ecosystems, as well as wilderness aesthetics.
Avoid overgrazing where grazing is permitted by estimating annual productivity and prescribing grazing capacities.	To avoid impacts from overgrazing and maintain meadow plant productivity and invertebrate communities. Wilderness aesthetics.
Minimize, limit, or avoid stock use in rare hydrogeomorphic meadow types, such as fens and wetland complexes, and in sensitive alpine habitats (i.e., above 9,600 feet).	To preserve ecosystem diversity and rare biological attributes of meadows and alpine ecosystems.
Minimize or avoid stock use and monitor potential effects, near feeding, breeding, or sheltering habitats (i.e., wetlands, pond areas, streambanks) for special status species including the Yosemite toad, Sierra Nevada yellow-legged frog, Pacific fisher, red fox, and bighorn sheep, and bird species such as the great gray owl.	To preserve ecosystem diversity and rare biological attributes of meadows.
Minimize or avoid use, especially grazing, in locations where noxious and invasive plant species are present. Restrict supplemental feed to highly-processed or fermented certified weed-free sources only (e.g., pellets, rolled grains, and bagged, fermented feed). Monitor known occurrences for spread.	To reduce the likelihood of spread of non-desirable species, and impacts to the physical, biological, and aesthetic characteristics of meadows from changing plant communities.
Conduct archeological surveys, testing at stock sites per compliance with, and recommendations from, Sections 106 and 110 of the NHPA (1966, as amended) and its implementing regulations (36 CRF 800). Surveys and testing could be prioritized based on the compliance needs, level of stock use, the intensity and extent of potential disturbances, the sensitivity and the data potential of the cultural materials at the site.	To ensure a combination of proactive and compliance-based management for cultural resources.
Locate and configure access routes, camp sites, and holding areas of stock sites through a collaborative process informed by an interdisciplinary team from Visitor and Resource Protection (wilderness staff, and mounted patrol rangers) and Resources Management and Science Division staff.	To enhance interpretation, education, and collaboration to optimize wilderness experience of visitors.

Table 3 (continued). Recommended park-wide best management practices for stock use in Yosemite National Park, and corresponding stewardship purpose.

Best Management Practice (BMP)	Stewardship Purpose
Plan administrative stock use through annual collaborative meetings among: NPS and concessioner stock wranglers and corral managers; Visitor and Resource Protection, Resources Management and Science, and Business Revenue Management Division staff, and; other interested NPS staff. Discussion should include topics such as current and out-year planned projects and needs, meadow opening dates, grazing capacities, monitoring results for site conditions and trends.	Cross-division planning to optimize planned stock use for administrative purposes.
Minimize and limit concessioner stock use to the amount necessary to operate and maintain concession-operated wilderness facilities, including the High Sierra Camps. Enforce stock handling practices (no grazing should be permitted for High Sierra Camp supply trips, unless authorized through NPS approval).	NPS and contractor planning to optimize planned stock use for concessioner/administrative purposes.
Strategically locate access routes, camp sites, and holding areas, in locations with: • Flat topography or slope gradients less than 2% • >100 Feet from surface water feature • Previously disturbed areas • Use of sturdy/robust trees for anchoring high lines • Limit the length and width of access routes • Away from cultural resources and historic properties, meadows, and listed species habitat. Drainage for these operational components should be filtered through well-vegetated buffers.	To avoid and minimize impacts to soil, vegetation, water quality, cultural resources, listed species and their habitats, and wilderness aesthetics. Sierra Nevada Yellow-legged frogs are highly sensitive to changes in water chemistry. Limit mortality of amphibians by avoiding aquatic habitats.
Limit the number of stream channel crossings/fords required to access sites by strategically locating access routes. Stream crossings on unstable or eroding substrate required for site access that cannot be relocated to more resistant streambanks, should be monitored commensurate with use levels. If monitoring indicates substantial effects to channel or riparian conditions or water quality, measures to reduce site use levels or armoring the crossing should be considered.	To minimize potential impacts to water quality, aquatic habitat, and riparian and streambank resources. Sierra Nevada Yellow-legged frogs are highly sensitive to changes in water chemistry. Limit mortality of amphibians by avoiding aquatic habitats.
To the extent feasible, restore user-created bare and compacted soil areas, trampled vegetation, and radiating social-trails associated with stock sites.	To preserve wilderness character and integrity of natural and cultural resources.
Encourage the use of leave -no -trace principles and best stock handling practices (Appendix D).	To preserve wilderness character and integrity of natural and cultural resources.
Require the removal of manure piles from the camp site area and require the raking and spreading of manure piles along access routes and in holding and grazing areas	To minimize potential impacts to water quality, and limit effects of stock use on wilderness character.
Conduct impact and trend monitoring at sites that have overlap of the operational components of stock use and known listed species, sensitive habitat types, and archeological resources, as well as status indicator monitoring for wilderness character and the biological and cultural integrity of resources.	To inform adaptive management for the preservation of ecosystem diversity and rare biological attributes of meadows.

Table 3 (continued). Recommended park-wide best management practices for stock use in Yosemite National Park, and corresponding stewardship purpose.

Best Management Practice (BMP)	Stewardship Purpose
Conduct surveys where the presence and abundance of special status species is unknown, assess impacts to species at occupied sites, and make adaptive management recommendations.	To inform adaptive management for the preservation of ecosystem diversity and rare biological attributes of meadows.
Implement land and resource management guidance in state and federal species recovery plans for the California red-legged frog, Sierra Nevada bighorn sheep, and the Lahontan cutthroat trout. Adhere to existing strategic plans and conservation strategies for the Sierra Nevada red fox, Yosemite toad, great gray owl, Sierra Nevada yellow-legged frog, and the Townsend's big-eared bat.	Compliance with state and federal recovery plans, and to preserve ecosystem diversity and rare biological attributes of meadows.

Camp locations included in this component focused on traditional stock sites being used by commercial or private groups. The focus on commercial and private sites is due to the fact that the majority of the traditional stock site locations had not been evaluated prior to this project, and the majority of administrative stock use occurs either at these locations, at other locations previously evaluated and approved, or are proposed and evaluated by the team prior to use each year. Previous work in 2006-2012 identified 101 stock sites in Yosemite that were prioritized for use by commercial operators (i.e., "operator specified priority sites"). Of these sites, 62 had verified locations (GPS identified UTM coordinates; Gavette 2009, Curtis 2012). Supplemental field work to other projects prior to 2013 identified an additional 29 sites with evidence of use by commercial or private groups. This suite of 130 sites was targeted for field evaluation by the SSE team; sites with high levels of reported use, known sensitive resources, or logistically important sites were prioritized.

Logistically important sites are those that have higher value to commercial and private groups travelling with stock. These sites may consequently receive higher use than other areas. Characteristics of high logistical value are: those sites that are closest to a high pass used for park entry from outside of park boundaries, first forage area beyond day-trip distance from trailhead, lack of other nearby forage areas open to grazing, and strategic location for administrative activities.

Following evaluations, the SSE team recommended approval for 99 stock-use sites (Figure 10). Evaluation findings supported the removal of 31 sites because they were duplicative to another camp identified in the area, field surveys found no stock site at this location, or the site did not conform to park policies or other regulations (i.e., the camp is more than 1/4-mile from a trail and is not included as one of the six designated cross-country stock camps, or conflict with guidance in the 1989 Wilderness Management Plan, the TRP, or the Raker Act), or were deemed suitable only for administrative use.

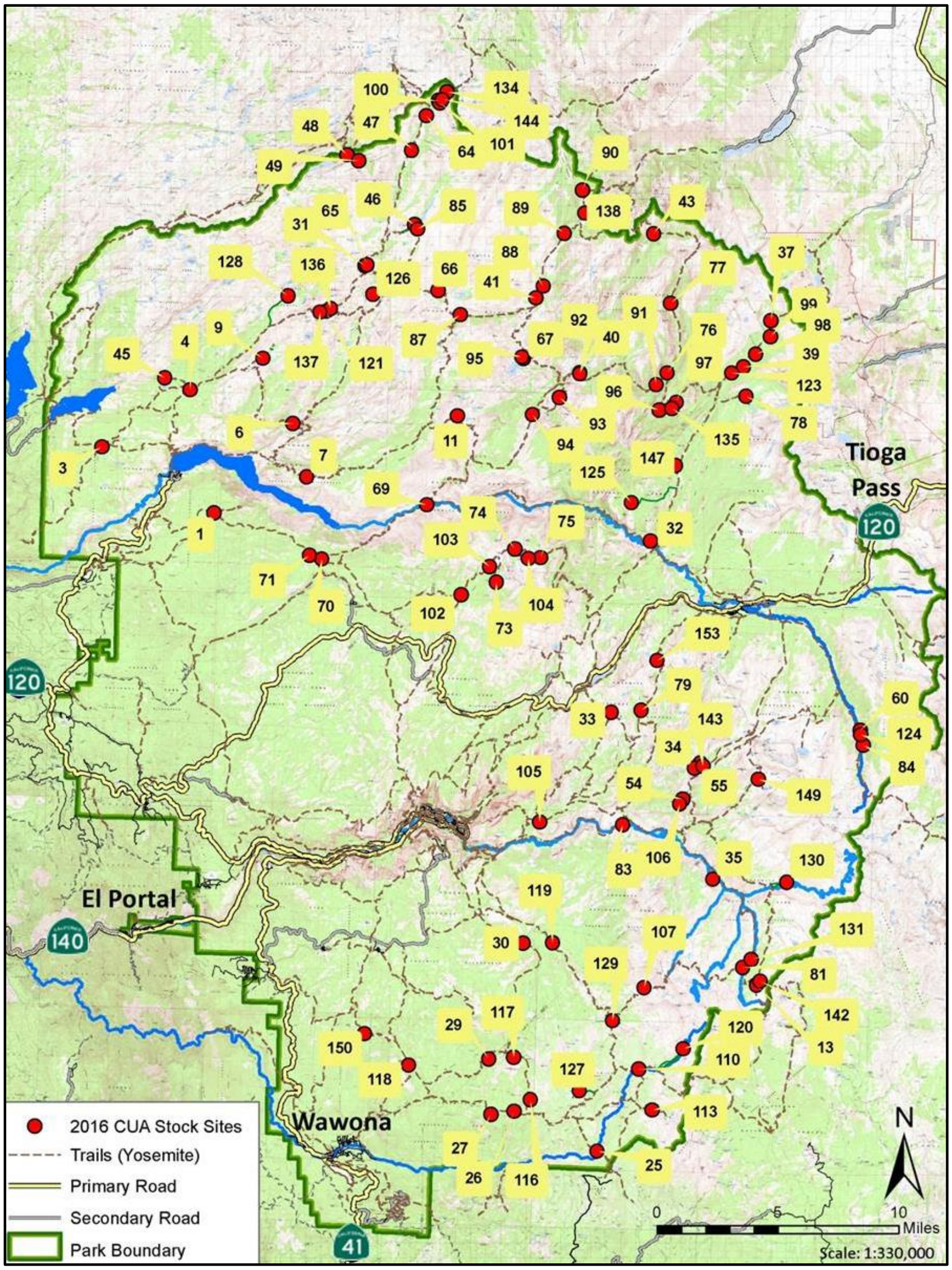

Figure 10. Map of 99 commercial sites (93 sites within ¼ mile of an NPS system trail, and six cross-country sites) permitted for use in 2016 Commercial Use Authorization. Labels represent camp ID numbers.

High Elevation Use

Rundel and Millar (2016) classified alpine ecosystems in the Yosemite region as above 3,200 m (10,500 ft) elevation, and Pauchard et al. (2009) and described them as rare and fragile. In this region, they are dominated by a Mediterranean climate regime with short dry summers and long cold winters, and are subjected to a suite of stressors including: extreme winter temperatures, short growing season, low nutrient availability, high winds, low partial pressures of carbon dioxide, high

UV irradiance, and limited water availability (Chapin and Körner 1996, Körner 2007). Rundel and Millar described that roughly 95% of the total precipitation is delivered as snow, with the remainder sourced from occasional summer orographic thunderstorms. Much of the snow is input from a very small number of storms and separated by long, dry intervals. This pattern produces extreme inter-annual variability in precipitation and water availability. Notably, this precipitation regime differs significantly from most of the continental alpine habitats of the world where summer precipitation often predominates.

High elevation soils are often thin and poorly developed compared to lower elevations (Ratliff 1985). Vegetation biomass productivity generally decreases with elevation (Ratliff 1985, Rundel and Millar 2016), thus vegetation cover (i.e., higher amounts of bare soil), and the contribution of vegetation to soil organic matter content can be limited at elevations. Higher elevation ecosystems generally tend to be species poor (McCain and Grytnes 2010), but support a high-level of endemic floral (Körner 2003), fauna (Jennings 1996, Erman 1996, Rundell and Millar 2016), and invertebrate (Holmquist et al. 2011) species. Like their lower elevation counterparts, wetland and meadow habitats of higher elevations are notably more species-rich than the surrounding uplands (Körner 2003). It is generally assumed that species invasions of alpine habitats are limited by three factors—the paucity of non-native species that are pre-adapted to the harsh abiotic conditions of mountains, low non-native propagule pressure, and low human disturbances—however, changing climates may facilitate conditions that are more prone to species invasion (Pauchard et al. 2009). Moreover, Chapin and Körner (1996) described that the loss or gain of species in alpine areas may have substantial effects on ecosystem processes because of their relative simplicity (i.e., low functional and niche overlap).

Alpine ecosystems in Yosemite have historically been subjected to grazing by large native herbivores including mule deer (*Odocoileus hemionus* ssp. *californicus*) and Sierra Nevada bighorn sheep (*Ovis canadensis sierrae*), as well as many small and mid-sized grazers, such as yellow-bellied marmots (Marmota flaviventris) and American pikas (*Ochotona princeps*). In addition, domestic sheep occurred in some alpine areas of Yosemite. Snyder (2003) noted evidence of sheep above 9,800 feet in Matterhorn Canyon and also at Mono Pass, though most of domestic grazing was likely concentrated in meadows of sub-alpine and montane elevations. Beyond potential effects to vegetation communities from extensive grazing, the introduction and spread of domestic sheep into the Sierra landscape coincided with reductions in bighorn sheep populations (Buechner 1960), which may have also altered Sierran meadow ecology at high elevations (see also USDI FWS 2007).

Current studies report mixed effects of grazing on ecosystem function, productivity, and biodiversity at high elevations, ranging from positive, to negative or neutral effects. Grazing is generally a concern at high elevations because of low resilience by alpine plant species to herbivory (Körner 2003) and because grazing is concentrated during the short snow-free season. As with lower elevation meadows, dry types are more resistant but less resilient to grazing while wet types are less resistant to grazing induced changes (i.e., higher soil moisture is generally less resistant to compaction and sod/root cutting) but can recover more rapidly if the grazing pressure is removed. Walker et al. (2004) described resistance as the capacity of systems to absorb disturbance, resilience as the ability of a system to reorganize from disturbance to retain the same functions, structures, identities, and feedbacks.

Barros et al. (2014) evaluated the effects of short term (one season) exclusion of grazing pack stock in a high elevation meadow in Aconcagua Provincial Park of Argentina. They found that vegetation in exclosures was more than twice as tall, had 30% more above-ground biomass, a greater cover of grasses and litter, than plots with grazing. Experimental studies of grazing (primarily sheep) exclusion in meadows on the Tibetan Plateau indicate that light-intensity grazing can facilitate more carbon uptake than complete exclusion due to enhanced micro-site characteristics including stimulation of new leaf growth, increased soil temperature, and fecal deposition (Yan and Lu 2015, Zhang et al. 2015). However, McSherry and Ritchie (2013) found that grazer effects on soil organic carbon are highly context-specific and imply that grazers in different regions might be managed differently to help mitigate greenhouse gas emissions. Norton et al. (2013) described that the primary concern regarding grazing interactions with soil organic carbon is the potential for site drying to be accelerated from trampling and its secondary effects of increased erosion and precipitation runoff.

Millar (2011) found negative effects of grazing on the distribution of pika hayfields used for feeding and apparent negative effects on the nutritional value of hayfields compared to areas not subject to grazing. At a study in Sequoia and Kings Canyon National Parks, Klinger et al. (2015) found little evidence supporting negative effects of pack stock grazing upon meadows used by Sierra Nevada bighorn sheep. Similar to findings by Roche et al. (2012) regarding potential livestock effects, Matchett et al. (2015) did not detect negative effects of pack stock grazing on the Yosemite toad (*Anaxyrus canorus*) in Yosemite, though more research is needed at lower elevations where populations of this species exhibit higher fluctuations.

Climate Change Sensitivity

Climate change has been noted as the most prevalent widespread stressor currently confronting the integrity of the National Park ecosystems and its mission to preserve resources unimpaired for future generations (USDI NPS 2010). Specific effects of climate change are forecast to include increased temperatures, rising snowlines and decreased snowpack particularly between 1300 and 2700 m (Knowles and Cayan 2004), shifts towards more frequent and intense rain events (Knowles et al. 2006), earlier peak stream flow and lower base flows especially in the central Sierra Nevada (Stewart et al. 2005, Null et al. 2010, Andrews 2012, Cristea et al. 2014), and drier late-summer soil conditions (Dettinger et al. 2004, Arnold et al. 2014).

The sensitivity of Yosemite stock sites, and associated biological and cultural resources, to changing climates has not been comprehensively assessed, though threats are omnipresent with some effects currently evident. Ultimately, acute and broad-scale changes across the Yosemite landscape may cause some stock sites to become more or less suitable for use. Changes in the location, intensity, or duration of stock use in some areas may have direct and indirect consequences on park resources depending upon their inherent resistance to, or resilience from, impacts associated with climate change.

Meadow Sensitivity

Regarding meadow sensitivity to climate change, key points include:

- Sierra Nevada meadows are snow-melt dependent groundwater driven ecosystems (Loheide and Gorelick 2007). Evident changes in temperature, timing of snowmelt and peak stream flow, and snow water equivalent (below 8,500 feet) have been linked to earlier drying of meadow soil and the onset of plant senescence (Westerling et al. 2006, Arnold et al. 2014)
- Factors affecting the accumulation of snow, such as elevation and aspect, may influence the sensitivity of a given meadow.
- Conversion of meadows to conifer forests has been linked to higher ambient air temperature and micro-site conditions (distance to available seed source, available soil moisture, and inter-plant competition) (Millar et al. 2004). Benefits of meadow ecosystems decline as they convert to conifer forests, such as water filtration, flood retention, and diverse and abundant wildlife habitat (Sahin and Hall 1996, Haugo and Halpern 2007, Emmons et al. 2013).
- Annual net primary productivity varies by hydrologic type (Moore et al. 2013), where productivity in xeric types was negatively related to snow water equivalent and thawing degree days; mesic types are negatively related to snow water equivalent, and large within year variation of annual aboveground net primary productivity in the hydric meadow limited detection of correlation.
- Fens exhibit vulnerability to drying under increased temperatures (Drexler et al. 2013).
- Loarie et al. (2008) predicted that 66% of the native flora of California will experience greater than 80% reduction in range size by 2100, and that the loss of plant species and lower overall diversity will likely be greatest in mountainous landforms. Species-specific effects were reported for varying temperature regime changes (such as constant increases, step-wise, and pulse heat waves) including biomass, cover, plant height, richness and diversity, whereby pulse heat waves exhibited substantial effects on graminoids, which dominate Yosemite meadows (Alatalo et al. 2016).
- From re-surveys of the Grinnell transects through Yosemite (Grinnell and Storer 1924), Moritz et al. (2008) generally found that low elevation wildlife species exhibited range expansion, while high elevation species exhibited range contraction. For example, meadow-dependent wildlife species, such as the Yosemite toad (*Anaxyrus canorus*) and the Sierra Nevada yellow-legged frog (*Rana sierrae*), may be particularly sensitive to changes in hydrology, vegetation composition, and changes in available prey and food resources. Under high emissions climate change projections Stewart et al. (2015) predicted loss of the American pika (*Ochotona princeps*) at Yosemite, Morelli et al. (2012) predicted substantial loss of habitat for the Belding's ground squirrel (*Urocitellus beldingi*), and Siegel et al. (2014) ranked the white-tailed Ptarmigan (*Lagopus leucura*) as extremely vulnerable. Ultimately, many questions still remain about the effects of climate change on species ranges, phenology, and invasive species.

Archeological Sensitivity

Archeological sites are present throughout the park and in all elevations, but there are no current field studies or existing research that has focused on the connection between climate change, cultural resources, and pack stock management. Despite this lack of data, there are some predicted impacts of climate change (Rockman et al. 2016) that may lead to changes in stock use areas that overlap with archeological sites and other cultural resources. For instance, changes in temperature and precipitation regimes that result in longer and more severe drought conditions within the park may lead to an increase in dead trees and larger and more intense fires, especially at lower elevations. There is also anticipation that some high elevation areas may become more suitable for stock use and some areas may be available for stock use at different times of the year. Strategies should be developed by cultural resources staff to respond to anticipated changes. Potential impacts of climate change on archeological sites and other cultural resources include:

- Changes in stock use patterns may increase use of some sites and decrease use at others that overlap with archeological sites.
- Increased fire severity and more fires at higher elevations may expose artifacts at sites used by stock groups, increasing the potential for artifact movement and illegal collection.
- Some areas used by American Indian groups for traditional practices, such as gathering certain plants and animals, may become unsuitable for use and might require additional protection, including stock use restrictions.
- Some historic structures (e.g., cabins, hitching rails, and corrals) have potential to be damaged and need to be documented and/or protected.
- Monitoring plans and archeological research may need to be adapted to changing conditions.
- Shifts in drainage patterns may increase erosion in some areas, which can be worsened by stock use.

Management Tools

Details of the following management tools are provided in other publications for opening dates (Kuhn et al., in review), grazing capacity estimates (Jones et al., 2018), and results from cultural resource studies (Gavette 2009, Wills 2016). Results from these efforts are summarized in Appendix C along with listing of recommended site-specific BMPs on public outreach maps in Appendix E. Note that each of these studies considered a different number of sites or meadows depending upon the park's knowledge of stock use at that time and the study's specific focus. Typically these studies included at least all those wilderness locations with reported high use levels. Unfortunately some confusion for readers stems from the fact that sites and meadows are not necessarily distributed as one-to-one relationships, but rather some sites may be associated with multiple meadows, or a given meadow may be accessible from more than one site. Though past use reporting has not always been specific to a camp or a meadow, the current stock use itinerary and reporting card (Appendix B) requires specific use-location identifiers like camp identification number or name.

Opening Dates

Meadows are particularly vulnerable to potential impacts from early-season stock use when soils are saturated and vegetation is still developing (Cole 1987). The most obvious signs of trampling damage are hoof punches into the meadow surface and the formation of compacted informal trails from repeated use. Excessive trampling can be the result of pack stock use at inappropriate locations or times. Trampling by livestock and by pack stock has been reported to impact soils, hydrology and plant communities (Rauzi and Hanson 1966, Van Haveren 1983, McClaran and Cole 1993, Cole et al. 2004) and to cause direct mortality to sensitive amphibians like the Yosemite toad and Sierra Nevada yellow-legged frog (USDI NPS, Thompson and Grasso, unpublished data). Such impacts may have pronounced effects resulting in substantial damage to meadow function (Cole et al. 2004). Effectively managing opening dates for meadow use by stock can mitigate potential impacts and preserve and protect meadow function (DeBenedetti & Parsons 1983).

During 2012 and 2013, a team of investigators and Yosemite staff carried out vegetation and physical science studies in Yosemite meadows to determine the seasonal timing of soil resistance sufficient to support a horse with rider or mule with load (i.e., 500 kilo pascals) without succumbing to compression and compaction (Kuhn et al., in review). For this, they used a dynamic cone penetrometer to collect weekly measurements (over a six week period from June 13 – July 18, 2012, and over an eight week period June 10 – August 5, 2013) of soil resistance in the four very common vegetation types of Yosemite meadows. The vegetation types from driest to wettest included: *Ptilagrostis kingii* (Sierra ricegrass; PTIKIN), *Calamagrostis breweri* (Brewer's reedgrass; CALBRE), *Deschampsia cespitosa* (tufted hairgrass; DESCES), and *Carex vesicaria* (bladder sedge; CARVES).

Results of this soil resistance study confirmed that meadow soils with higher moisture levels are more susceptible to compaction from hoof action by pack stock and that differences in soil resistance are detectable among each of the four vegetation types. Furthermore, this study detected relative uniformity between study years for when the soils achieved sufficient resistance to potential physical impacts from pack stock. Even during the two exceedingly dry study years, resistance in the wet vegetation type, *Carex vesicaria*, was insufficient to withstand simulated compression forces roughly equal to that of walking pack stock without compaction through the end of July and early August. Conversely, during both study years, resistance in the dry and moist vegetation types (dry: *Ptiligrostis kingii and Calamagrostis breweri*; moist: *Deschampsia caespitosa*) exceeded this threshold by mid-June and mid-July, respectively.

Kuhn et al. (in review) also assessed soil moisture conditions at peak vegetation greenness for 104 Yosemite meadows from analyses of a 26 year (1986 – 2011) dataset for Normalized Difference Vegetation Index (NDVI) and Normalized Difference Water Index (NDWI). Based on soil moisture conditions at peak vegetation greenness, study meadows were separated into Early, Mid, and Late opening date classes by relativizing each meadow against the others.

The authors then suggested that for dry years, where the water year was roughly equivalent to 50% of average, meadows within the Early class could be assigned an opening date around mid-June, while meadows in the Mid class could be assigned opening dates around mid-July, and meadows in the Late class if deemed suitable for grazing could be prescribed opening dates in early-August or later. For average or above-average water years, the timing of meadow openings to pack stock would be delayed beyond those dates suggested for dry water years. Study findings at Sequoia and Kings Canyon National Parks (USDI NPS 1986) and Blankinship et al. (2014), as well as implementation by USFS (2004), found that opening dates for water years between 50% and 150% of average could be delayed two to four weeks later than those for a dry water year, and opening dates for water years with >150% of average moisture could be prescribed roughly two to four weeks later than those for a 50% to 150% of average water year. At sites with known populations of the Yosemite toad and Sierra Nevada yellow-legged frog, early season grazing could be further restricted to protect these species and their habitat. Currently, 14 locations with stock use have also been identified as occupied by the Yosemite toad (USDI NPS, Thompson and Grasso, unpublished data; see Appendix C), and a total of 78 locations are within designated critical habitat for these two amphibian species. Such additional protection measures might include temporary exclusion of stock from specific habitats within a forage area, or in some rare cases temporary exclusion from an entire forage area. For instance the Sierra and Inyo National Forests prohibit any pack stock entry or grazing within 100 yards of any permanent water source within occupied toad habitat during the breeding cycle (see Injunctive Relief order No. C-00-01237). The timing of such exclusions could be set according to the timing of snow melt; literature suggests opening dates that are roughly 8 weeks from snow melt at a given site would provide sufficient time for completion of breeding and rearing cycles for Yosemite toads (Kagarise Sherman 1980, Kagarise Sherman and Morton 1993). Due to the highly aquatic nature of all life stages of Sierra Nevada yellow-legged frog and their tendency to remain close to their required habitat (deep lakes) throughout the year, population trend and/or habitat monitoring to inform adaptive management may be more effective than temporal closures.

Kuhn et al. (in review) disclosed assumptions and limitations regarding their approach, and emphasized the importance of monitoring to refine the suggested meadow opening dates based on observed conditions over time. Importantly, these authors acknowledged that their approach assumed homogeneity of moisture and greenness conditions within a meadow based on its dominant characteristics. Rather, despite a specific classification assigned for a given meadow, areas of wet and moist vegetation types may be vulnerable to physical impacts from pack stock use on the suggested dates. Follow-up monitoring, such as implementation of the Soil Resistance and Plant Phenology Rapid Assessment to evaluate the level of physical impacts and plant growth stage, could be used to refine the suggested dates over time.

Grazing Capacity Estimates

Grazing capacity estimates are an important tool for managing pack stock in Yosemite meadows because they form the basis for determining the maximum annual allowable stock use nights for each meadow. Grazing capacity estimates provide a useful starting point for setting a stocking rate (i.e., actual number of animals, on a specified acreage, for a specified period of time) and are best used as a general guide (Bush 2006).

Estimates of grazing capacity may be derived from past management history or calculations of forage area productivity and availability, which are variable based on the timing of use (Huntsinger et al. 2007) and as a function of elevation, meadow hydrology, vegetation type, and condition class (Ratliff 1987). They also vary annually in response to spring snow water content and seasonal temperatures (Moore et al. 2013). A six-year study in Yosemite showed the coefficient of variation of productivity in Yosemite meadows was between 17-34%, indicating substantial inter-annual variation in productivity (Moore et al. 2013).

Based on meadow elevation, size, type, and species composition, Jones et al. (2018) applied a model to estimate grazing capacities for 46 meadows at 5%, 25% and 35% utilization levels. These meadows were selected as those with the highest reported use levels that had available vegetation composition data (see Kuhn et al. 2015). As follow-up monitoring, Jones et al. (2018) proposed the comparative yield method (also used by Sequoia-Kings Canyon National Parks) to monitor residual biomass and determine actual utilization for a given meadow as a basis for adjusting stocking rates.

Over time, as residual biomass data for grazed and ungrazed locations are collected, analysis of productivity (at scales such as the meadow, hydrologic type, or by vegetation community) in relation to remotely-sensed data (e.g., precipitation, Normalized Difference Vegetation Index, temperature, elevation) may provide a cost-effective alternative to field-intensive estimations and allow annual park-wide estimates of productivity and related grazing capacities and stocking rates.

Calculating Grazing Capacity

Ratliff (1987) tied forage productivity estimates directly to condition class where meadows in “good” condition produce 65% of forage produced in meadows in “excellent” condition; meadows in “fair” condition produced 44% of “excellent”; and those in “poor” condition only produced 25% of those in “excellent” condition. These condition classes were based on those outlined in Crane (1950), who noted that most meadows in “excellent” condition were in irrigated pasture, while the greatest proportion of natural meadows were in “good” condition. Based on measurements made by Ratliff (1987) and the assumption that most meadows in Yosemite produce forage equivalent to that expected from meadows in “good” condition, Jones et al. (2018) used a suite of equations to estimate the productivity (pounds per acre) of dry, moist, and wet meadows (for example, see below). These authors subsequently applied an estimated stock consumption rate of 32.5 pounds per night (based on estimates by Bush 2006) to determine recommended grazing capacities, in number of stock use nights, for each meadow at the three target utilization levels.

<u>Example calculation of grazing capacity for a hypothetical site, from Jones et al. (2018).</u>
Hypothetical "Meadow X" has 2 acres of mesic vegetation, and 3 acres of dry (xeric) vegetation. It is at 8,700 feet in elevation and within the upper montane/subalpine zone, in an area of low logistical value; thus, the recommended allowable utilization rate is 25%. The estimated grazing capacity would therefore be calculated as:

Moist area: Productivity = 4,725 - 0.325 * Elevation
Productivity (per acre) = 4,725-0.325*8,700 = 1,897.5 lbs/acre
1,897.5 lbs/acre * 2 acres = **3,795 lbs**

Dry area: Productivity = 2,275 - 0.175 * Elevation
Productivity (per acre) = 2,275 - 0.175 * 8,700=752.5
752.5 lbs/acre * 3 acres = **2,257.5 lbs**

Total estimated productivity = 3,795 + 2,257.5 = 6,052.5 lbs

$$Grazing\ Capacity = \frac{(6052.5)\ \boldsymbol{X}\ 25\%}{(\sim 32.5\frac{lbs}{day}for\ horses)} = \mathbf{46.6}\ (\boldsymbol{or} \sim \mathbf{47})\ \boldsymbol{animal\ nights}$$

Thus, the estimated grazing capacity for Meadow X is approximately 47 stock use nights at a 25% utilization rate.

Monitoring Strategy and Thresholds for Adaptive Management Actions

The complexities and uncertainties of managing stock use across a highly variable and dynamic landscape argues against the rigid imposition of strictly applied park-wide meadow management standards. Such complexities and uncertainties prompt the application of goal based adaptive management that optimizes management actions to the needs of resource protection and preservation (Rists et al., 2013). Meeting these goals is dependent upon the flexibility of the management approach over time and its responsiveness to changing conditions. In fact, even the monitoring approach needs to be adaptable to changing conditions and management targets over time.

To track success of management actions, systematic indicator monitoring could be used to measure change relative to management objectives, initial conditions, and adaptive management efforts. Periodic review of monitoring results in light of the assumptions, timelines, needs and objectives would determine whether to continue or to change approaches employed by management. To monitor pack stock use over time and impacts within park wilderness areas, a three-part monitoring strategy could be applied (Figure 11), including status indicator monitoring, diagnostic secondary investigations, and effectiveness/validation monitoring. The crux of adaptive management is to monitor both areas under management and control areas (locations in which management is not applied but which are as similar as possible to the areas under management). Generally, it is desirable to employ a quasi-experimental monitoring design to facilitate comparison among multiple management and control plots (replication) and incorporates randomized location of plots and assignment of treatments to maximize the extrapolation of findings.

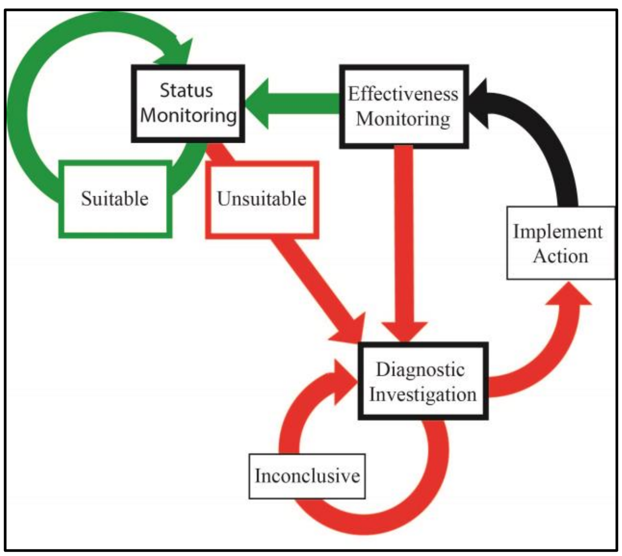

Figure 11. Flowchart illustration of the three part monitoring strategy to inform the adaptive management of stock use in Yosemite Wilderness.

Monitoring Implementation Steps for Adaptive Management

The purpose of the monitoring strategy is to inform the adaptive management of pack stock use in Yosemite Wilderness using periodic condition assessments to track suitability of sites for use.

1) Suitable: Use is permitted at sites deemed suitable, and Status indicator monitoring (residual biomass, bare soil, streambank stability, and site-specific resource evaluations) are used to periodically validate site conditions.

2) Unsuitable: Sites may be deemed unsuitable for use based on initial stock site evaluations, or via results of Status indicator monitoring. In these cases, site use may be limited or even excluded, and diagnostic investigations would be used to evaluate potential causal factors that limit suitability for use.

    a) Diagnostic investigation: Results and findings from diagnostic investigations may be:
        i) Inconclusive: In these cases, additional investigation is needed to inform and develop management actions.
        ii) Conclusive: Management actions could be developed from results and findings and implemented to improve declined site conditions.
            (1) Effectiveness/Validation Monitoring: Targeted monitoring is implemented to determine if prescribed actions achieve management objectives.
                (a) If prescribed actions successfully achieve management objectives, the site could then be determined suitable for use at previous or newly prescribed levels and
                (b) Status indicator monitoring would resume.

If implemented actions are deemed unsuccessful to achieve management objectives, diagnostic investigations could be renewed and adapted based on any newly available information. Status indicator monitoring is time-efficient and inexpensive, and protocols can be applied annually on a rotating basis to a large number of sites park-wide. These results are tied to quantitative threshold trigger points that are suggestive of declining conditions and potential impacts to wilderness character or park resources. This approach is commensurate with ongoing monitoring for the Merced and Tuolumne River plans and expands the scope of two of those rigorously field-tested protocols—bare soil and streambank stability monitoring. For stock use, applicable indicators could also include residual biomass monitoring to validate prescribed grazing capacities and track utilization in relation to use levels. In addition to monitoring these three park-wide indicators, site-specific resources would be evaluated at each location, including cultural resources and rare or endangered species or sensitive community types including fen/wetland ecosystems. Some site-specific resources may have their own monitoring and management requirements.

If trigger points are breached at sites, diagnostic secondary investigations could be implemented. These assessments are multi-faceted with three primary purposes: 1) to determine if park-wide thresholds are appropriate given the specific ecological potential of a given site (including revisiting assumptions and information gaps); 2) whether the observed indicator values are indicative of actual impacts to wilderness character, resource integrity, or meadow function, and; 3) to discern, to the extent feasible, if use-related disturbance or impacts are a wholly or partially attributable cause to declining status of the site, and/or if impacts could be alleviated through changes in visitor (i.e., backpacker, or pack stock) management. Diagnostic secondary investigations are inherently site-specific, designed to address the conditions of interest, and may occur over multiple year time-scales. For example, these might include repeat and more focused measurements of the indicators or a suite of supplemental metrics to more comprehensively understand site conditions, or alternatively the assessments might focus on use-related disturbances and their connection to ecosystem function such as user or stock created informal trails, roll pits, trampling, or streambank alteration. Additionally, the interplay of visitor-use and ecosystem function could mandate research studies that investigate their interconnectedness, as well as ecosystem fluctuation and change over time to complex factors such as climate change. In consultation with an interdisciplinary team including Resources Management and Science subject matter experts and wilderness staff, the outcome of diagnostic secondary investigations would be a list of suggested management actions to initiate improvement of status conditions of the site towards alignment with management objectives. The most highly used sites and those where impacts could critically affect natural or cultural resources could be prioritized for action.

In general, an important component of monitoring in complex and dynamic systems is the on-going process of developing a response dataset that is adequate for testing the effectiveness of management actions. Thus, the described trigger points can be viewed as working hypotheses that can be verified and refined through the collection and analysis of site- and time-specific monitoring data over time. As NPS staff implements and evaluates the monitoring protocols described, data gaps and inherent assumptions become clearer, and evidence may accumulate that, at certain sites and in certain situations, these triggers do not achieve the desired goals and need to be revised to be more appropriate and specific to a given site. Similarly, analysis of monitoring data could also reveal that in some instances management actions are not achieving desired outcomes. Results of these analyses would then be used to refine specific management actions, as well as monitoring protocols (Reever-Morghan et al. 2006). In this manner, an adaptive management process can be a powerful tool for creating data-based feedback that improves management outcomes and long-term ecosystem conditions, and moreover, prevents the need to revisit the same issue in the future. Examples of management actions might include user education campaigns through permitting, enforced stock handling practices and leave no trace principles, controlled distribution of stock away from affected areas, active restoration of affected areas (e.g., rehabilitate informal trails), installation of signs to inform users on site, altering management prescriptions for opening dates and/or grazing capacities, or reducing permitted stock use nights.

As adaptive management actions are implemented to mitigate use-related impacts and improve site status, effectiveness/validation monitoring would be applied to determine if actions are effective (appropriately scaled, and timed) in initiating recovery toward the desired status conditions. Similar to the diagnostic secondary investigations, the effectiveness/validation monitoring would be designed specifically to assess effectiveness of implemented actions, focusing on metrics that are expected to change; thus, for each case, monitoring study designs and protocols would be developed accordingly, and are therefore not presented within this report. Results from effectiveness monitoring are subsequently used as feedback to gage the success of management actions. As necessary, supplemental assessments and on-going status monitoring would be done to guide further management actions.

Collectively, results of monitoring efforts—relative to changes in use, environmental context or any critical events--are reviewed periodically by managers, Resources Management and Science subject matter experts, and wilderness staff to guide changes in timing, frequency, and duration of use allowed at pack stock sites. The effectiveness of actions taken can be used to institute changes in monitoring itself. Monitoring the implementation of adaptive management avoids a one-size-fits-all approach that can over regulate in some places and under regulate in others, and is the best approach to ensure the maximal sustainable use of pack stock in park wilderness. Accomplishing management objectives on a limited number of high priority sites will increase understanding and information about the most effective BMPs, how timing of management limits can impact results and how the targeted resources are impacted by factors beyond the influence of management, such as climate. In this manner, a robust management model could be applied across the park.

Status Indicator Monitoring

Recommended monitoring indicators include: meadow bare soil, streambank stability, residual biomass, and site-specific resource metrics. Each recommended indicator measures different aspects of pack stock site conditions that may be affected by users and stock access at sites or free-range behavior such as trampling, rolling, informal trail use, stream crossings and bank disturbance, and grazing. Site-specific resource monitoring addresses the occurrence of cultural sites, listed species and their habitat, and sensitive community types such as fens and wetlands. Information obtained through Visitor Use Impacts Monitoring Program status indicator monitoring can be used to evaluate the distribution of pack stock effects on meadow resources and track effectiveness of applied management actions. Descriptions of each indicator monitoring protocol provided below include a justification for the metric, an overview of the basic methodology, and discussion of suggested trigger points.

Bare Soil Monitoring

<u>Justification</u>

Bare ground has been shown to be a sensitive indicator of pack stock use in Yosemite, generally increasing with increasing stock use levels in a given meadow (Cole et al 2004, Kuhn et al. 2015, Ratcliff et al. 2014). Analyses performed by David Weixelman (USFS, D. Weixelman, unpublished data) link bare soil values to meadow ecological condition classes for grazed National Forest lands of the Sierra Nevada. Weixelman's results show that levels of bare soil differ by elevation and hydrologic regime, and within each combination he assigned a range of values that correspond to *high*, *moderate*, and *low*, ecological condition classes (Table 4). Significant differences in bare soil values between meadow hydrologic types have also been observed in Yosemite (Ratcliff et al. 2014).

Table 4. Bare soil values for condition classes developed by (USFS, unpublished data). These values provide initial standards by which condition of meadows in Yosemite are evaluated (USDI NPS 2014b).

Elevation	Meadow type	Ecological Condition Class		
		High	Moderate	Low (Trigger Point)
Montane (4,000 to 8,000 feet)	Hydric meadow	0-4%	5-9%	>9%
	Mesic meadow	0-6%	7-13%	>13%
	Xeric meadow	0-8%	9-13%	>13%
Subalpine (8,000 to 9,500)	Hydric meadow	0-4%	5-8%	>8%
	Mesic meadow	0-6%	7-13%	>13%
	Xeric meadow	TBD[1]	TBD	TBD

[1] TBD (to be decided) reflects a data gap.

Basic Methodology

A detailed methodology for bare soil monitoring was published by Ratcliff et al. (2014). In brief, this methodology consists of delineating meadows by hydrologic type in the field, and evaluating six or more randomly-located 25-meter step-point transects within each hydrologic type. This evaluation provides a cumulative 150 sampling points or more per meadow hydrologic type. Ground cover at each step-point is sampled to determine whether it is bare soil or not (i.e., vegetation cover, litter, rock, anchor wood, etc.). From these data, a percent bare soil estimate with confidence intervals is calculated and can then be compared to the trigger point values for the appropriate hydrologic type and elevation (Table 4).

Trigger Point

Suggested trigger point values for the bare soil indicator are based on those provided by (USFS, unpublished data) which correspond to different 'Ecological Condition Classes'. The trigger point is the value that corresponds with the *Low* condition class for a given meadow hydrologic type and elevation (Table 4). For hydric vegetation types, this is 9% bare soil in montane meadows and 8% bare soil in sub-alpine meadows. For mesic vegetation types, the trigger point is 13% bare soil in both montane and sub-alpine meadows. For xeric vegetation types, the trigger point is 13% bare soil in montane meadows, but the trigger point for sub-alpine meadows still needs to be evaluated. As with the MRP and TRP, additional trigger points for bare soil could be incorporated.

Streambank Stability Monitoring

Justification

Streambanks are the steep-sloped areas between the scour line and bankfull elevation of channels (Burton et al. 2011). These areas are highly susceptible to scour during high flow events. Stability of streambanks is related to the amount of vegetative cover, the presence or absence of erosional features on the bank, and whether the location is depositional or erosional habitat (Burton et al. 2011). Studies suggest that livestock can reduce streambank stability through trampling, hoof-shearing, hoof-sliding, and grazing riparian vegetation (Allen-Diaz et al. 1999, Burton et al. 2011), and Kuhn et al. (2015) found increased stability at sites with lower levels of pack stock use in the previous year, as well as for banks with greater vegetation biomass, and lower frequency of dry (facultative upland) vegetation types.

Degradation of riparian zones and stream channels diminishes their capacity to provide critical functions, including chemical and nutrient cycling, water purification, flood attenuation, maintenance of stream flows and temperatures, groundwater recharge, and habitats for fish and wildlife (Kauffman et al. 1997). Loss of streambank stability can lead to increased bank erosion, and subsequent channel adjustments such as widening and/or incision (Simon 1989), which can lead to broad-scale changes in depth to water table and meadow vegetation composition (Loheide and Gorelick 2007). Adverse consequences of channel instability or disequilibrium have been associated with land productivity change, land loss, aquatic habitat deterioration, changes in both short- and long-term channel evolution, and loss of physical and biological function (Rosgen 2001).

Basic Methodology

Streambank stability monitoring applied at Yosemite is based on the Multiple Indicator Monitoring (MIM) framework developed by Burton et al. (2011), and the trigger point aligns with recommendations by Frazier et al. 2005) who used a highly similar approach to evaluate stability. Within a monitoring reach, streambank stability is evaluated at a minimum of 80 plots (i.e., 40 on each side of the creek), and the reach's overall stability percentage rating is derived from the number of locations deemed "stable" divided by the total number of plots (Burton et al. 2011). The stability rating for a given plot is based on a combination of factors including vegetation cover, the presence or absence of erosional features, and whether the location is depositional or erosional habitat (Frazier et al. 2005, Burton et al. 2011). In addition to being time-efficient, this assessment approach has been shown to be consistent and repeatable; Archer et al. (2004) assessed observer variability, and found that, on average, observers reached the same bank stability rating approximately 83% of the time.

Trigger Point

Although streambank stability is affected by stock grazing, every channel has a different inherent geomorphology, and processes affecting streambank stability vary by site (Allen-Diaz et al. 1999). Therefore, it is difficult to determine a park-wide threshold for streambank stability; rather, site-specific standards may be applicable at some locations. The Tuolumne and Merced Wild and Scenic River Comprehensive Management plans defined surpassing the trigger point as observed values at a channel reach having an upper 95% confidence interval falling below 75% stability (USDI NPS 2014a, USDI NPS 2014b). This trigger point was prompted by data from Frazier et al. (2005) for reference and non-reference channels, and is supported by results from monitoring conducted in Yosemite on 46 reaches between 2010 and 2016 (NPS, unpublished data), whereby sites with higher levels of use anecdotally appear to have lower bank stability (i.e., less than 75%). As more data are gathered within the park, stream- or segment-specific guidelines and trigger points could be developed and refined. These should consider the effects of watershed/landscape position, geology and geomorphology, and climate on the background stability for any given stream or segment (Allen-Diaz et al. 1999), as well as visitor and stock use levels.

Residual Biomass Monitoring

Justification

Residual biomass is the amount of above-ground herbaceous biomass left after the grazing season, which plays a critical role in meadow function by protecting the soil surface, contributing soil organic matter, trapping soil moisture and providing above-ground habitat structure. Cole et al. (2004) found that, along with bare ground, biomass was the most sensitive indicator of pack stock use and that herbaceous productivity in Yosemite meadows was significantly negatively related to percent utilization. Control plots used for residual biomass monitoring could inform calculated estimates of meadow productivity, while grazed plots are used in calculations to determine the amount of herbaceous biomass consumed by stock. As such, it is an important metric to gage the level of meadow productivity that has been extracted by pack stock use and to monitor that level over time as a component of meadow resource conditions (e.g., organic matter contribution to soil). Residual biomass is ideal as a primary indicator because it is time-efficient, does not require specialized knowledge, is reproducible, and can point to management issues resulting from improper stocking rate, stock distribution, or timing of use.

Basic Methodology

The residual biomass monitoring approach proposed for Yosemite wilderness areas is presented by Jones et al. (2018). This approach is adapted from the comparative yield method for estimating above-ground biomass in herbaceous systems (Haydock and Shaw 1975), and has also been used by Sequoia and Kings Canyon to monitor pack stock effects (USDI NPS 2014c). Residual biomass is sampled annually after the majority of stock use for the season has occurred, and after plant growth in the meadow has peaked (i.e., typically mid- to late-September). Monitoring can occur any time after peak production; if production has not yet reached its peak, results must be interpreted with caution.

Initial biomass measurements are related to a rank score of 1-5, by clipping all above-ground herbaceous vegetation to 1 cm and collecting leaves (only) from woody species, within selected 30 cm x 30 cm quadrats representative of each rank ranging from the lowest productivity of the meadow (i.e., rank score = 1) to the highest productivity of the meadow (i.e., rank score = 5). At least one and optimally 2 quadrats representing each rank are clipped, collected, dried and weighed.

Rank measurements are then recorded from randomly placed transects within two locations of a meadow: 1) a “core” location that shows the heaviest pack stock grazing pressure in a meadow, and; 2) a “reference” location that shows no evidence of grazing over the past year. Where possible, reference and core areas should be located in the same meadow on similar hydrologic types and land forms. If necessary, reference locations can be sited in nearby meadows with similar conditions. Care must be taken to avoid placing sampling locations near camps, stock holding areas, or areas that could bias results.

Parallel sampling transects (up to 100 m long) are established within each of the core and reference locations, and residual biomass is visually estimated by rank and recorded for 150-200 quadrats. Subsequently, a calibration curve is fitted to these data using simple linear regression of the dry weights for the ranking scale in each the core and reference locations. Residual biomass and meadow productivity are then calculated (see below).

List of equations used to calculate residual biomass at a given meadow:

Equation 1: $b = \frac{\sum(x_c - \bar{x}_c)(y - \bar{y})}{\sum(x_c - \bar{x}_c)^2}$

Equation 2: $a = \bar{y} - b\bar{x}_c$

Equation 3: $\hat{Y} = a + b\bar{x}_o$

Where:

$\boldsymbol{x_c} = biomass\ rank\ for\ calibration$
$\boldsymbol{x_o} = biomass\ rank\ for\ occular\ estimates$
$\boldsymbol{y} = clipped\ vegetation\ biomass$
$\boldsymbol{\hat{Y}} = predicted\ biomass\ for\ the\ site$

Trigger Point

The suggested trigger point for residual biomass is breached when its measurements at the selected core location falls below the targeted utilization level for the given meadow. Managers should note, however, that grazing is non-uniform and results in more intensely grazed patches within meadows, and that the residual biomass monitoring method subjectively targets the most heavily-grazed portions of a meadow. Therefore, applying the trigger point would facilitate an early warning that utilization may be reaching the allowable use level at the meadow scale, and alert park staff to conduct status monitoring. Nonetheless, the effects of high-intensity grazing at the patch scale can have notably negative impacts on vegetation structure and invertebrate assemblages (Holmquist et al. 2014), which may conflict with management objectives for a given site. Applicable management actions stemming from observed excessive grazing utilization in one year may include reduced allowable utilization the following season, such that site recovery occurs.

Site-specific Resource Evaluation

Site-specific resources including archeological sites and natural resources such as sensitive, rare, endemic, or listed species or their habitats, were identified during SSE preparation work and surveys. Wildlife resources were evaluated at stock sites using biological inventory databases that contain almost 30 years of monitoring data and include sensitive amphibian species occupancy data for 1,345 meadows in Yosemite (USDI NPS, Thompson and Grasso, unpublished data). Depending on the type of resource and conditions, these resources often require targeted management to protect and preserve their integrity, or specific regulations. For instance, at sites where pack stock have potential to impact these resources, mitigation measures such as site reconfiguration (e.g., altered access route, or relocated holding areas) or stock handling practices such as use of portable electric fences, hand-grazing, or strategic release points that minimize or eliminate the overlap of use with the resources may be effective (Walden-Schriener et al. 2017). Similarly, the occurrence of these resources often requires targeted monitoring.

A core element of the stock site evaluation program was development of resource-specific questionnaires to determine stock site suitability. These questionnaires were designed so that professional-level NPS employees including Resources Management and Science staff, Wilderness personnel and stock wranglers could assess camp suitability using a consistent methodology.

Findings from the Stock Site Evaluation surveys and other previous work identified 31 sites where pack stock overlapped with cultural resources of concern. As part of this study, recommendations were developed to avoid or mitigate stock use impacts at 22 of those sites. For example, Castle Camp in Virginia Canyon has been evaluated under Section 106 of the NHPA and was determined by NPS and the State Historic Preservation Officer as eligible for the National Register of Historic Places (NRHP) (Lee and Montague 2013). This determination included multiple management recommendations to protect the site but allow continued stock use. These included use of designated access routes, loading/unloading and holding areas, retention of the existing fire ring (with prohibition of new fire ring construction), educational efforts for operators and their clients, and annual monitoring. Compliance for the remaining nine sites with known cultural resources of concern has yet to be completed, but these sites have been prioritized for consultation with the State Historic Preservation Officer based on evaluation of seven assessment categories (Appendix G), and detailed site-specific summaries are provided by Wills (2016). An additional consideration is that many of these sites have yet to be addressed through consultation with American Indian tribes and groups, some of whom may prioritize protection of some sites and locations higher than others regardless of their noted archeological value.

The presence of Yosemite toads has been detected at 14 meadows with potential use by pack stock, and a total of 78 sites with potential use by stock are located within critical habitat for the Yosemite toad or Sierra Nevada Yellow-legged frog. NPS staff will conduct surveys where the presence and abundance of special status species is unknown, and assess impacts to species at known occupied sites. As information on the potential for pack stock use to impact species occurrences and their habitat is gained, adaptive management recommendations would be made.

Application to Management

Baseline (i.e., initial), impact (i.e., point in time), and trend (i.e., long term) monitoring could be conducted to track the status of bare soil, streambank stability, and residual biomass as use occurs over time and used to inform adaptive management of stock use in Yosemite Wilderness. Such monitoring could be prioritized at those sites that receive notably high levels of use, have numerous or complex sensitive resource concerns, and reference sites, as needed, for comparison with natural conditions. If results of indicator monitoring suggest declined conditions (i.e., breached trigger points), diagnostic secondary investigations could be implemented to further discern site conditions and potential causal factors.

Diagnostic Secondary Investigations

If results of one or more of the status indicator monitoring protocols breaches the trigger point for a given site, diagnostic secondary investigations could be conducted to further investigate the findings of indicator monitoring and meadow conditions at that site. Diagnostic secondary investigations could also be applied if findings from site-specific resource monitoring merit it. The objectives of this process are two-fold: 1) Determine if the observed indicator findings indicate actual impacted conditions to wilderness character or the integrity of biological or cultural resources, or if park-wide indicator standards are applicable to the site of interest or whether that site has unique hydro-ecological capacity or context that warrant specific thresholds, and 2) Investigate whether the actual impacted conditions are wholly or partially attributable to visitor use (including use by pack stock) or other factors, such as climate and weather conditions or episodic events.

Notably however, although investigations into potential sources of decline are an imperative step to more comprehensively understand resource and wilderness conditions, often even with in-depth investigations, it can be difficult to objectively determine specific causal mechanisms (e.g., if pack stock are responsible for degraded conditions). Rather, it is more likely that signals of causal mechanisms may be ambiguous, and often provide insufficient evidence that neither implicates nor exonerates use by pack stock. Therefore, the diagnostic secondary investigation is a process to synthesize numerous indicators and further assess resource conditions to infer whether changes in visitor use and pack stock management could be used as a tool to improve observed conditions and facilitate discussion among resource scientists, park management and stakeholders.

Because the diagnostic secondary investigation is site-specific and may be triggered by one or multiple monitoring indicators (i.e., bare soil, streambank stability, and/or residual biomass) or site-specific resource monitoring, the approach is purposefully broad in scope and would be tailored to the specific circumstances and the needs of park management. This approach may address topics such as:

- Spatial overlap of indicator data—vicinity of informal trails to areas of concentrated bare soil or low streambank stability,
- Data collection and synthesis of visitor use disturbance—camp site conditions, radiating trails, as well as roll pits, trampled areas, manure, and grazed areas,
- Evaluation of available remotely sensed data—such as normalized difference data for vegetation, and site wetness,
- Meadow hydrogeomorphic classification (Weixelman et al. 2011),
- Presence of meadow erosion features—headcuts, rills, gullies, expansive alluvial deposits,
- Channel and floodplain geometry—width:depth, entrenchment ratios, sinuosity,
- Visitor use data—number of permits issued for backpackers, and stock use levels, in current and preceding years, as well as historically,
- Climate data—wet vs. dry cycles, climate change vulnerability (Viers et al. 2013).
- Timing of storms relative to use by backpackers and stock users.

Possible recommendations from diagnostic secondary investigations may include suggestions such as: no changes required as would be the case for causal mechanisms not related to management or site use (e.g., impacts are attributable to hydro-ecological or climatic fluctuations); move pack stock holding areas; establish targeted release points, or utilize portable electric fences to distribute site disturbance away from sensitive or impacted areas; temporarily lower grazing capacity; or temporarily eliminate visitor use by either pack stock, backpackers, or both. Prescribed management actions may be immediately applicable within the given season or, in the case of residual biomass, the following season.

Research Needs

There are fundamental assumptions and limitations to the proposed management and monitoring of stock use across Yosemite Wilderness. Some of the key assumptions include: if prescribed trigger points for status indicator monitoring are not breached, current stock use patterns—in terms of magnitude (use level), disturbance/extraction (grazing and relative timing of use)—are generally acceptable, and the current locations are amenable to continued use. However, given continuously dynamic conditions derived from factors such as climate change and disturbances like wildfire, annual monitoring would help to protect wilderness character and preserve the integrity of biological and cultural resources over time.

There are several areas where further research could inform pack stock management in Yosemite Wilderness. Probably the most important area is the development of park-specific guidelines for primary assessment trigger points. The trigger points suggested in this document are based on peer-reviewed literature, general technical reports and bulletins, and other available research (sometimes performed outside of Yosemite). The unique physical, biological, and management conditions within Yosemite may warrant investigation of park-specific ranges for key indicators and trigger points that are used to indicate decline of ecological function. Additional research topics could include the following.

- The stock site evaluation program has not considered all stock camps in the wilderness of Yosemite. Evaluation of impacts to biological and cultural resources as well as to wilderness character could be conducted at sites yet to be evaluated.
- Evaluation of bare soil values correlated with meadow condition and varying intensities of pack stock use in hydric, mesic, and xeric meadow types at different elevations, and under variable climatic regimes.
- Assessment of natural variation in streambank stability ratings for creeks in different watersheds, of different sizes, and with different substrates, under different management scenarios.
- Development of meadow-specific forage production estimates and park-wide regression model estimates linking forage production to remotely sensed data (e.g., NDVI, NDWI), elevation, soil type, vegetation, or hydrologic type. As well as understanding factors that drive productivity, such that use levels for given sites can be forecasted and used for planning purposes, and a process developed for estimating forage outside of meadows (i.e., forest understory).
- Evaluation of the resilience of biological and cultural resources to short-term, but sometime frequent, disturbance from pack stock use, and the occurrence of steady and transitional ecological states (i.e., state and transition models).
- Assess the vulnerability of meadows in Yosemite to climate change.

- Evaluation and compliance for nine archeological sites that overlap with stock use has yet to be completed under Section 106 of the NHPA. Findings from any future determination of eligibility could consider implementing a monitoring protocol similar to the one developed for Castle Camp.
- Coordination with American Indian tribal groups has not been addressed for many stock sites, and minimal subsurface or NRHP evaluation data in the study area.

Conclusion

Pack stock have a long history of providing recreational opportunities to the public and serving key administrative roles in Yosemite. Although some types of use have waned over the past decade, stock use still presents potential impacts to wilderness character and the integrity of biological and cultural resources. Thus, measures to manage and monitor use and its associated effects upon park resources are imperative.

This report provides a synthesis of management tools as well as a cost- and time-efficient monitoring strategy that can be implemented as a framework to provide relevant information for a continuous adaptive approach addressing varying use levels and dynamic ecosystems. This report reflects the current state of knowledge of pack stock use in Yosemite Wilderness. Additional monitoring of sites and meadows not yet evaluated may be important for comprehensive management. Results from the status indicator monitoring can be used to evaluate the effects of past management decisions and to provide guidance for management alternatives, and refine indicator thresholds. By including the monitoring protocols within an adaptive management framework, not only can the effectiveness of management decisions and actions be evaluated, but the usefulness and efficiency of monitoring strategies can be assessed and the strategies adjusted where necessary.

The provided approach closely aligns with the NPS mission, Yosemite's 2020 Strategic Vision, and addresses important aspects of other Federal legislation including The Wilderness Act of 1964 (Public Law 88-577 16 U.S. C. 1131-1136), the Clean Water Act (33 U.S.C. §1251), the Federal Endangered Species Act (16 USC § 1531-1540), and Section 106 of the National Historic Preservation Act of 1966 (16 USC §470f), as amended, and its implementing regulations (36 CFR 800).

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Personal Communications

M. Fincher. Pers. comm. 2016. Yosemite Wilderness Specialist, Visitor Use and Protection Division, Yosemite National Park

Appendix A – Sensitive Wildlife Species with Potential Overlap in Stock Use Sites

Table A-1. Special status wildlife species within Yosemite (January 2015) by taxonomic group. Species listed under the Federal Endangered Species Act (endangered or threatened: FE or FT) and California State Endangered Species Act (CE or CT), and California Fish and Wildlife candidate Species of Special Concern (CSC) are included in the table.

Taxonomic Group	Species	Federal	State
Invertebrates	Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)	FT	–
Fish	Hardhead (*Mylopharodon conocephalus*)	–	CSC
Amphibians	Yosemite toad (*Anaxyrus canorus*)	FT	CSC
	Foothill yellow-legged frog (*Rana boylii*)*	–	CSC
	Sierra Nevada yellow-legged frog (*Rana sierrae*)	FE	CT
	California red-legged frog (*Rana draytonii*)	FT	CSC
Reptiles	Western pond turtle (*Emys marmorata*)	–	CSC
Birds	Harlequin duck (*Histrionicus histrionicus*)	–	CSC
	Northern goshawk (*Accipiter gentilis*)	–	CSC
	Northern harrier (*Circus cyaneus*)	–	CSC
	Golden eagle (*Aquila chrysaetos*)	–	CFP
	Bald eagle (*Haliaeetus leucocephalus*)	–	CE,CFP
	Peregrine falcon (*Falco peregrinus*)	–	CFP
	Long-eared owl (*Asio otus*)	–	CSC
	Great gray owl (*Strix nebulosa*)	–	CE
	California spotted owl (*Strix occidentalis occidentalis*)	–	CSC
	Vaux's swift (*Chaetura vauxi*)	–	CSC
	Black swift (*Cyseloides niger*)	–	CSC
	Olive-sided flycatcher (*Contopus cooperi*)	–	CSC
	Willow flycatcher (*Empidonax trailii*)	–	CE
	Yellow warbler (*Dendroica petechia*)	–	CSC
Mammals	Mount Lyell shrew (*Sorex lyelli*)	–	CSC
	Pallid bat (*Antrozous pallidus*)	–	CSC
	Townsend's big-eared bat (*Corynorhinus townsendii*)	–	CCT
	Spotted bat (*Euderma maculatum*)	–	CSC
	Western red bat (*Lasiurus blossevillii*)	–	CSC
	Western mastiff bat (*Eumops perotis*)	–	CSC
	Sierra Nevada snowshoe hare (*Lepus americanus tahoensis*)	–	CSC
	Western white-tailed jackrabbit (*Lepus townsendii townsendii)*	–	CSC
	Sierra Nevada mountain beaver (*Aplodontia rufa californica*)	–	CSC

Table A-1 (continued). Special status wildlife species within Yosemite (January 2015) by taxonomic group. Species listed under the Federal Endangered Species Act (endangered or threatened: FE or FT) and California State Endangered Species Act (CE or CT), and California Fish and Wildlife candidate Species of Special Concern (CSC) are included in the table.

Taxonomic Group	Species	Federal	State
Mammals (continued)	Sierra Nevada red fox (*Vulpes vulpes necator*)	FC	–
	California wolverine (*Gulo gulo*)	FC	–
	Fisher (*Pekania pennanti*)	FPT	CCT
	American badger (*Taxidea taxus*)	–	CSC
	Sierra Nevada bighorn sheep (*Ovis canadensis sierrae*)	FE	CE,CFP

Appendix B – Pack Stock Use Reporting

Table B-1. The table-form filled-out by end-users describing the timing, duration and location of pack stock use are requested from all pack stock users. Reporting includes the location of each overnight campsite, the number of people and stock present, the type of animals, the corresponding dates, and the number of stock fed versus grazed. Stock use reporting forms are provided to commercial pack stations administrative packers, and the park concessioner.

YOSEMITE NATIONAL PARK

NPS STOCK USE ITINERARY AND REPORTING CARD

Name of person filling out card and contact number: ______________________________ / _( )________________

Company:____

Reporting (please circle one): **Itinerary** **Monthly Report**

Stock Type: Horses/mules

Date* (2016)	(D)ay or (O)ver-night	Purpose F=Full Service S= Spot Pack C=Continuous Hire N=NPS hire	Starting Location** (Trailhead)	Ending Location** (Destination)	Camp ID# or Name	# Packers / # Of Clients	Total # Of Stock	# of Stock Grazed	# Stock Fed Supplement Feed
						/			
						/			
						/			
						/			
						/			
						/			

Please list specific locations ****Note:** Dates should account for each day stock are in park. **For stopover locations, list same name for Starting Location and Ending Location

Appendix C – Camp Location, Synthesized Study Results, and Findings from the Stock Site Evaluation Project

Table C-1a. *Merced Watershed*: Synthesized results for pack stock studies in Yosemite Wilderness described and referenced within this report including meadow suitability for use, meadow opening dates (“MOD Class” for an average water year), grazing capacity (by three utilization rates), and stock site evaluation. Identifiers are by Camp and Meadow Name, Camp ID# and Mdw ID#, UTM coordinates (NAD 1983, Zone 11N) for preferred fire ring, if known. Reported stock use level is for 2004 to 2016.

Camp Name (Meadow Name)	Camp ID (Mdw ID)	Preferred Fire Ring		Stock Use Mean (Max) 2004-2016	Mdw Suit. for Use	MOD Class[A]	Grazing Capacity			Stock Site Evaluation	
		UTME	UTMN				5%	25%	35%	Visit Status[B]	BMPs by Resource[C]
Babcock Lake-North	54 (1754)	289012	4181756	5.8 (36)	Mod	Early/Mid	18	89	124	Partial	Wildlife
Babcock Lake-South (East)	106 (1735)	288829	4181410	5.8 (36)	Mod	Mid	Not included	Not included	Not included	Partial	Arch, Wildlife
Babcock Lake-South (West)	106 (1738)	288829	4181410	5.8 (36)	Mod	Late	Not included	Not included	Not included	Not Visited	Not included
Cathedral Lake	153 ()	287308	4190987	18 (39)	Not included	Not included	Not included	Not included	Not included	Partial	Wildlife
Doc Moyle's (East)	130 (1487)	295947	4176235	13.4 (33)	High	Mid	22	109	152	Full	Arch, Wildlife
Doc Moyle's (West)	130 (1489)	295947	4176235	13.4 (33)	Low	Mid	10	48	67	Full	Arch
Echo Valley Trail Camp Admin. Site	83 (none)	285029	4180048	6.8 (36)	Not included	Not included	Not included	Not included	Not included	Partial	Arch, Wildlife
Emeric Lake-North	34 (1888)	290195	4184159	63.4 (135)	Mod	Early/Late	23	114	159	Full	Arch, Wildlife

[A] Findings by Kuhn et al. (in review) and suggested revisions by NPS staff based on professional judgement.

[B] ”Partial” indicates that one or more of the interdisciplinary team member was absent from the site visit.

[C] Site-specific BMPs by resource include: cultural (“Arch”); water-quality and soil (“PHYS”); terrestrial or aquatic (“Wildllife), and; botanical “VER”.

Table C-1a (continued). *Merced Watershed*: Synthesized results for pack stock studies in Yosemite Wilderness described and referenced within this report including meadow suitability for use, meadow opening dates ("MOD Class" for an average water year), grazing capacity (by three utilization rates), and stock site evaluation. Identifiers are by Camp and Meadow Name, Camp ID# and Mdw ID#, UTM coordinates (NAD 1983, Zone 11N) for preferred fire ring, if known. Reported stock use level is for 2004 to 2016.

Camp Name (Meadow Name)	Camp ID (Mdw ID)	Preferred Fire Ring		Stock Use Mean (Max) 2004-2016	Mdw Suit. for Use	MOD Class[A]	Grazing Capacity			Stock Site Evaluation	
		UTME	UTMN				5%	25%	35%	Visit Status[B]	BMPs by Resource[C]
Emeric Lake-West	55 (1888)	289811	4183818	63.4 (135)	Not included	Not included	Not included	Not included	Not included	Full	Arch, Wildlife
Emeric Lake-Northeast	143 (1888)	290360	4183957	63.4 (135)	Not included	Not included	Not included	Not included	Not included	Full	Arch, Wildlife
Empire Meadows	150 (748)	267844	4166141	Not included	Not included	Late	Not included	Not included	Not included	Not Visited	Not included
Illilouette Creek-East	119 (none)	280351	4172203	Not included	No meadow	No meadow	No meadow	No meadow	No meadow	Not Visited	Not included
Illilouette Creek-West	30 (none)	278398	4172169	Not included	No meadow	No meadow	No meadow	No meadow	No meadow	Not Visited	Not included
Isberg Pass Lake-East	142 (1039)	294168	4169621	14.4 (52)	Not included	Early	Not included	Not included	Not included	Full	Arch, Wildlife
Isberg Pass Lake-West	13 (1001 and 1001n)	293935	4169374	14.4 (52)	Not included	Early	Not included	Not included	Not included	Full	Arch, Wildlife
Lewis Creek (North & South)	149 (1842)	294052	4183079	2.3 (30)	Not included	Mid	Not included	Not included	Not included	Partial	Arch, Wildlife
Lewis Creek (North & South)	-1824	()	()	2.3 (30)	Not included	Early	Not included	Not included	Not included	Partial	Arch
Lower Grant Lake	73 ()	276606	4196197	Not included	Not included	Not included	Not included	Not included	Not included	Not Visited	Not included

[A] Findings by Kuhn et al. (in review) and suggested revisions by NPS staff based on professional judgement.

[B] "Partial" indicates that one or more of the interdisciplinary team member was absent from the site visit.

[C] Site-specific BMPs by resource include: cultural ("Arch"); water-quality and soil ("PHYS"); terrestrial or aquatic ("Wildllife), and; botanical "VER".

Table C-1a (continued). *Merced Watershed*: Synthesized results for pack stock studies in Yosemite Wilderness described and referenced within this report including meadow suitability for use, meadow opening dates ("MOD Class" for an average water year), grazing capacity (by three utilization rates), and stock site evaluation. Identifiers are by Camp and Meadow Name, Camp ID# and Mdw ID#, UTM coordinates (NAD 1983, Zone 11N) for preferred fire ring, if known. Reported stock use level is for 2004 to 2016.

Camp Name (Meadow Name)	Camp ID (Mdw ID)	Preferred Fire Ring		Stock Use Mean (Max) 2004-2016	Mdw Suit. for Use	MOD Class[A]	Grazing Capacity			Stock Site Evaluation	
		UTME	UTMN				5%	25%	35%	Visit Status[B]	BMPs by Resource[C]
Lower Ottoway Trail Camp Admin. Site	107 (none)	286450	4169210	3.5 (23)	No meadow	No meadow	No meadow	No meadow	No meadow	Full	Arch, Wildlife
Merced Lake (Calvary)	n/a (none)	n/a	n/a	8.4 (35)	No meadow	No meadow	No meadow	No meadow	No meadow	Not Visited	Not included
Merced Lake East (Ranger Station)	145 (1163e)	288939	4179463	107.5 (410)	Mod	Mid	5	25	35	Full	Arch, Wildlife
Merced Lake Shore	-1665	(n/a)	(n/a)	Not included	Low	Late	19	93	131	Full	Arch, Wildlife
Merced Lake West	(1163w)	(n/a)	(n/a)	Not included	High	Late	7	35	49	Full	Arch, VER
Sunrise Creek Trail Camp; Camp Many Bears Admin. Site	105 (none)	279482	4180223	24.0 (56)	No meadow	No meadow	No meadow	No meadow	No meadow	Partial	Arch
Sunrise Lakes	33 (2083)	284282	4187532	9.2 (52)	Mod	Mid	Not included	Not included	Not included	Partial	Arch
Triple Peak Fork (North)	131 (none)	293586	4171075	Not included	No meadow	No meadow	No meadow	No meadow	No meadow	Full	Arch, Wildlife
Triple Peak Fork (South)	81 (1164)	293011	4170542	Not included	Mod	Early	6	32	45	Full	Arch, Wildlife

[A] Findings by Kuhn et al. (in review) and suggested revisions by NPS staff based on professional judgement.

[B] "Partial" indicates that one or more of the interdisciplinary team member was absent from the site visit.

[C] Site-specific BMPs by resource include: cultural ("Arch"); water-quality and soil ("PHYS"); terrestrial or aquatic ("Wildllife), and; botanical "VER".

Table C-1a (continued). *Merced Watershed*: Synthesized results for pack stock studies in Yosemite Wilderness described and referenced within this report including meadow suitability for use, meadow opening dates ("MOD Class" for an average water year), grazing capacity (by three utilization rates), and stock site evaluation. Identifiers are by Camp and Meadow Name, Camp ID# and Mdw ID#, UTM coordinates (NAD 1983, Zone 11N) for preferred fire ring, if known. Reported stock use level is for 2004 to 2016.

Camp Name (Meadow Name)	Camp ID (Mdw ID)	Preferred Fire Ring		Stock Use Mean (Max) 2004-2016	Mdw Suit. for Use	MOD Class[A]	Grazing Capacity			Stock Site Evaluation	
		UTME	UTMN				5%	25%	35%	Visit Status[B]	BMPs by Resource[C]
Triple Peak Fork Trail Camp Admin. Site	(none)	()	()	3.8 (56)	No meadow	No meadow	No meadow	No meadow	No meadow	Full	Not included
Turner Lake	133 (942)	293026	4168429	Not included	Mod	Mid	8	39	55	Full	Arch, VER, WIldlife
Washburn Lake	35 (1507)	291019	4176420	12.6 (36)	Low	Mid	6	30	42	Full	Arch, PHYS
Yosemite Creek	102 (none)	274260	4195362	Not included	No meadow	No meadow	No meadow	No meadow	No meadow	Not Visited	Not included

[A] Findings by Kuhn et al. (in review) and suggested revisions by NPS staff based on professional judgement.

[B] "Partial" indicates that one or more of the interdisciplinary team member was absent from the site visit.

[C] Site-specific BMPs by resource include: cultural ("Arch"); water-quality and soil ("PHYS"); terrestrial or aquatic ("Wildllife), and; botanical "VER".

Table C-1b. *South Fork of Merced Watershed*: Synthesized results for pack stock studies in Yosemite Wilderness described and referenced within this report including meadow suitability for use, meadow opening dates ("MOD Class" for an average water year), grazing capacity (by three utilization rates), and stock site evaluation. Identifiers are by Camp and Meadow Name, Camp ID# and Mdw ID#, UTM coordinates (NAD 1983, Zone 11N) for preferred fire ring, if known. Reported stock use level is for 2004 to 2016.

Camp Name (Meadow Name)	Camp ID (Mdw ID)	Preferred Fire Ring		Stock Use Mean (Max) 2004-2016	Mdw Suit. for Use	MOD Class[A]	Grazing Capacity			Stock Site Evaluation	
		UTME	UTMN				5%	25%	35%	Visit Status[B]	BMPs by Resource[C]
Buena Vista Lake-East	28 (none)	277982	4164625	Not included	No meadow	No meadow	No meadow	No meadow	No meadow	Full	Arch, Wildlife
Buena Vista Lake-West	117 (none)	277751	4164581	Not included	No meadow	No meadow	No meadow	No meadow	No meadow	Full	Arch, Wildlife
Buck Camp Admin. Site	141 (331)	280072	4160055	11.5 (84)	Not included	Late/Mid	Not included	Not included	Not included	Full	Arch
Chain Lake, Middle-Northwest	16 (none)	287331	4160968	Not included	No meadow	No meadow	No meadow	No meadow	No meadow	Full	Arch, VER, PHYS
Chain Lake, Middle -South	19 (none)	287364	4160652	Not included	No meadow	No meadow	No meadow	No meadow	No meadow	Full	Arch, VER, PHYS
Chain Lake, Upper - Southwest	18 and 112 (none)	288112 / 287264	4160385 / 4160744	Not included	No meadow	No meadow	No meadow	No meadow	No meadow	Full	Arch, VER, PHYS
Chain Lake, Upper -West	21 (none)	288147	4160527	Not included	No meadow	No meadow	No meadow	No meadow	No meadow	Full	Arch, VER, PHYS
Chilnualna Lakes	29 (none)	276097	4164459	Not included	No meadow	No meadow	No meadow	No meadow	No meadow	Full	Arch, Wildlife
Crescent Lake (Northeast)	27 (363)	276257	4160770	Not included	Not included	Early	Not included	Not included	Not included	Not Visited	Wildlife
Givens Lake	127 (484)	282147	4162328	3.2 (12)	Not included	Late	Not included	Not included	Not included	Full	Arch

[A] Findings by Kuhn et al. (in review) and suggested revisions by NPS staff based on professional judgement.

[B] "Partial" indicates that one or more of the interdisciplinary team member was absent from the site visit.

[C] Site-specific BMPs by resource include: cultural ("Arch"); water-quality and soil ("PHYS"); terrestrial or aquatic ("Wildllife), and; botanical "VER".

Table C-1b (continued). *South Fork of Merced Watershed*: Synthesized results for pack stock studies in Yosemite Wilderness described and referenced within this report including meadow suitability for use, meadow opening dates ("MOD Class" for an average water year), grazing capacity (by three utilization rates), and stock site evaluation. Identifiers are by Camp and Meadow Name, Camp ID# and Mdw ID#, UTM coordinates (NAD 1983, Zone 11N) for preferred fire ring, if known. Reported stock use level is for 2004 to 2016.

Camp Name (Meadow Name)	Camp ID (Mdw ID)	Preferred Fire Ring		Stock Use Mean (Max) 2004-2016	Mdw Suit. for Use	MOD Class[A]	Grazing Capacity			Stock Site Evaluation	
		UTME	UTMN				5%	25%	35%	Visit Status[B]	BMPs by Resource[C]
Gravelly Ford Trail Camp	25 (none)	283324	4158325	Not included	No meadow	No meadow	No meadow	No meadow	No meadow	Full	Arch
Horsethief Canyon (Middle)	120 (737m)	289034	4165132	25.7 (120)	Not included	Late	Not included	Not included	Not included	Full	Arch
Horsethief Canyon (Upper)	(737u)	289253	4165676	Not included	Not included	Mid	Not included	Not included	Not included	Full	None
Johnson Lake	26 (372)	277793	4160961	Not included	Not included	Late	Not included	Not included	Not included	Not Visited	Wildlife
Lower Chain Lake-East (West)	17 and 113 (383)	286784 286973	4161180 4161060	18.6 (159)	Not included	Mid	Not included	Not included	Not included	Full	Arch, Wildlife
Merced Pass Lake-Lower	108 (866)	283911	4167371	Not included	Not included	Early/Mid	Not included	Not included	Not included	Full	Arch, Wildlife
Merced Pass Lake-Upper	129 (841)	284363	4166994	8.8 (108)	Not included	Late	Not included	Not included	Not included	Full	Arch
Moraine Meadows	110 (571)	286096	4163799	Not included	Not included	Late	Not included	Not included	Not included	Full	Arch
Royal Arch Lake	116 (608)	278884	4161814	7.5 (52)	Not included	Late	Not included	Not included	Not included	Full	Arch, VER, Wildlife
Turner Meadow	118 (638)	270736	4164084	0.5 (6)	Not included	Late	Not included	Not included	Not included	Partial	Arch, Wildlife

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[B] "Partial" indicates that one or more of the interdisciplinary team member was absent from the site visit.

[C] Site-specific BMPs by resource include: cultural ("Arch"); water-quality and soil ("PHYS"); terrestrial or aquatic ("Wildllife), and; botanical "VER".

Table C-1c. *Tuolumne*: Synthesized results for pack stock studies in Yosemite Wilderness described and referenced within this report including meadow suitability for use, meadow opening dates ("MOD Class" for an average water year), grazing capacity (by three utilization rates), and stock site evaluation. Identifiers are by Camp and Meadow Name, Camp ID# and Mdw ID#, UTM coordinates (NAD 1983, Zone 11N) for preferred fire ring, if known. Reported stock use level is for 2004 to 2016.

Camp Name (Meadow Name)	Camp ID (Mdw ID)	Preferred Fire Ring		Stock Use Mean (Max) 2004-2016	Mdw Suit. for Use	MOD ClassA	Grazing Capacity			Stock Site Evaluation	
		UTME	UTMN				5%	25%	35%	Visit Status[B]	BMPs by Resource[C]
Avonelle Lake	126 (none)	268396	4215380	Not included	No meadow	No meadow	No meadow	No meadow	No meadow	Not Visited	Wildlife
Beehive	4 (3449)	256205	4208985	Not included	Not included	Late/Mid	Not included	Not included	Not included	Full	Arch
Benson (Northeast)	67 (3570)	278422	4211075	115.4 (201)	High	Early/Mid	1	7	10	Full	Arch
Benson Lake Trail Camp Admin. Site (Northwest)	95 (3561)	278325	4211181	115.4 (201)	High	Early/Mid	9	43	60	Full	Arch, VER
Boundary Lake	n/a ()	n/a	n/a	0.8 (11)	Not included	Not included	Not included	Not included	Not included	Not Visited	Not ID'd in 2009 Operator Specified
Burro Pass	n/a (4025)	n/a	n/a	0.5 (6)	Not included	Early/Late	Not included	Not included	Not included	Not Visited	Not ID'd in 2009 Operator Specified
Cold Caynon (North and Elbow Hill)	147 (3207n)	288539	4203962	Not included	Mod	Early	42	209	293	Partial	Arch, VER
Cold Caynon (Smokey Jack)	113 (3207s)	288533	4203966	21.1 (85)	High	Early	67	333	467	Partial	Arch, VER, Wildlife

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[B] "Partial" indicates that one or more of the interdisciplinary team member was absent from the site visit.

[C] Site-specific BMPs by resource include: cultural ("Arch"); water-quality and soil ("PHYS"); terrestrial or aquatic ("Wildllife), and; botanical "VER".

Table C-1c (continued). *Tuolumne*: Synthesized results for pack stock studies in Yosemite Wilderness described and referenced within this report including meadow suitability for use, meadow opening dates ("MOD Class" for an average water year), grazing capacity (by three utilization rates), and stock site evaluation. Identifiers are by Camp and Meadow Name, Camp ID# and Mdw ID#, UTM coordinates (NAD 1983, Zone 11N) for preferred fire ring, if known. Reported stock use level is for 2004 to 2016.

Camp Name (Meadow Name)	Camp ID (Mdw ID)	Preferred Fire Ring		Stock Use Mean (Max) 2004-2016	Mdw Suit. for Use	MOD ClassA	Grazing Capacity			Stock Site Evaluation	
		UTME	UTMN				5%	25%	35%	Visit Status[B]	BMPs by Resource[C]
Cold Caynon (South)	-3093	Not Found	Not Found	Not included	Not included	Early	Not included	Not included	Not included	Partial	Arch, VER
Cony Crags Admin. Site	n/a (n/a)	n/a	n/a	10.7 (103)	Not included	Not included	Not included	Not included	Not included	Not Visited	Not included
Dorothy Lake Trail Camp Admin. Site	64 (4588)	271953	4227235	33.2 (77)	Mod	Mid	Not included	Not included	Not included	Not Visited	WIldlife
Dorothy Lake (Northeast-a)	134 (4730)	273317	4228846	Not included	Not included	Late	Not included	Not included	Not included	Full	Arch, VER, WIldlife
Dorothy Lake (Northeast-b)	-4737	Not Found	Not Found	Not included	Not included	Mid	Not included	Not included	Not included	–	–
Dorothy Lake (Northwest)	100 (4694)	272754	4228263	Not included	Mod	Mid	17	85	120	Full	Arch, VER, WIldlife
Dorothy Lake-Peninsula Camp (West)	144 (4702)	273011	4228297	Not included	Not included	Mid	Not included	Not included	Not included	Full	Arch, VER, Wildlife
Glen Aulin (East)	32 (2899)	286867	4198934	29.2 (92)	Not included	Early	Not included	Not included	Not included	Partial	Arch, Wildlife
Glen Aulin (West)	-2900	Not Found	Not Found	29.2 (92)	Not included	Mid	Not included	Not included	Not included	Partial	Arch, Wildlife
Grace Meadow	47 (4472)	270966	4224946	0.2 (2)	Mod	Early/Late	44	220	309	Full	Arch, PHYS, VER, Wildlife

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[C] Site-specific BMPs by resource include: cultural ("Arch"); water-quality and soil ("PHYS"); terrestrial or aquatic ("Wildllife), and; botanical "VER".

Table C-1c (continued). *Tuolumne*: Synthesized results for pack stock studies in Yosemite Wilderness described and referenced within this report including meadow suitability for use, meadow opening dates ("MOD Class" for an average water year), grazing capacity (by three utilization rates), and stock site evaluation. Identifiers are by Camp and Meadow Name, Camp ID# and Mdw ID#, UTM coordinates (NAD 1983, Zone 11N) for preferred fire ring, if known. Reported stock use level is for 2004 to 2016.

Camp Name (Meadow Name)	Camp ID (Mdw ID)	Preferred Fire Ring		Stock Use Mean (Max) 2004-2016	Mdw Suit. for Use	MOD ClassA	Grazing Capacity			Stock Site Evaluation	
		UTME	UTMN				5%	25%	35%	Visit Status[B]	BMPs by Resource[C]
Halfmoon Meadow	103 (2787)	276154	4197235	Not included	Not included	Late	Not included	Not included	Not included	Partial	Arch
Harden Lake-East and West	70 and 71 ()	264977 / 264183	4197725 / 4197998	Not included	Mod	Not included	Not included	Not included	Not included	Not Visited	Not included
Hook Lake-North	97 (3414)	288599	4208154	10.8 (76)	Mod	Mid/Late	10	50	70	Full	Arch, VER, Wildlife
Hook Lake-South	135 (3355)	288294	4207758	10.8 (76)	Mod	Early	16	79	110	Full	Arch, VER, Wildlife
Jose's Camp	88 (3915)	279740	4215888	23.4 (82)	Mod	Late	Not included	Not included	Not included	Full	Arch, PHYS, Wildlife
Kerrick Canyon - Middle	87 and 89 (4136)	274240 281120	4213994 4219469	48.3 (106)	Not included	Early/Mid	Not included	Not included	Not included	Partial	Arch, Wildlife
Kerrick - North of Upper	-4391	Not Found	Not Found	48.3 (106)	Not included	Mid	Not included	Not included	Not included	Full	Arch, VER, PHYS, Wildlife
Kerrick - Upper North	90 (4324)	282346	4222292	48.3 (106)	Mod	Mid	63	315	441	Full	Arch, VER, PHYS, Wildlife
Kerrick - Upper South	138 (4324)	282514	4220757	Not included	Not included	Mid	152	758	1062	Full	Arch, VER, PHYS, Wildlife

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[C] Site-specific BMPs by resource include: cultural ("Arch"); water-quality and soil ("PHYS"); terrestrial or aquatic ("Wildllife), and; botanical "VER".

Table C-1c (continued). *Tuolumne*: Synthesized results for pack stock studies in Yosemite Wilderness described and referenced within this report including meadow suitability for use, meadow opening dates ("MOD Class" for an average water year), grazing capacity (by three utilization rates), and stock site evaluation. Identifiers are by Camp and Meadow Name, Camp ID# and Mdw ID#, UTM coordinates (NAD 1983, Zone 11N) for preferred fire ring, if known. Reported stock use level is for 2004 to 2016.

Camp Name (Meadow Name)	Camp ID (Mdw ID)	Preferred Fire Ring		Stock Use Mean (Max) 2004-2016	Mdw Suit. for Use	MOD ClassA	Grazing Capacity			Stock Site Evaluation	
		UTME	UTMN				5%	25%	35%	Visit Status[B]	BMPs by Resource[C]
Lake Vernon (East)	9 (3552)	261086	4211105	31.6 (120)	Not included	Late	Not included	Not included	Not included	Full	Arch, VER
Lake Vernon Cabin Admin. Site (Southeast)	140 (3555)	261555	4211716	Not included	Not included	Late/Mid	30	152	213	Full	Arch, VER, Wildlife
Laurel Lake (North)	45 (3511)	254542	4209813	2.4 (8)	Not included	Late	Not included	Not included	Not included	Partial	Arch
Lower Kerrick (South)	41 (3875)	279228	4215118	Not included	Mod	Early	33	167	233	Full	Arch, PHYS, VER, Wildlife
Long Meadow (North & South)	79 (2147)	286229	4187690	3.1 (40)	Mod	Mid	43	214	299	Partial	Arch, Wildlife
Long Meadow (North & South)	-2103	()	()	3.1 (40)	Mod	Early	29	144	201	Partial	Arch, Wildlife
MaClure Creek	n/a ()	n/a	n/a	0.4 (5)	Not included	Not included	Not included	Not included	Not included	Not Visited	Not ID'd in 2009 Operator Specified
Matterhorn Canyon-Junction Camp (North)	76 (3499)	287996	4210104	113.6 (216)	Mod	Late	Not included	Not included	Not included	Full	Arch

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[C] Site-specific BMPs by resource include: cultural ("Arch"); water-quality and soil ("PHYS"); terrestrial or aquatic ("Wildllife), and; botanical "VER".

Table C-1c (continued). *Tuolumne*: Synthesized results for pack stock studies in Yosemite Wilderness described and referenced within this report including meadow suitability for use, meadow opening dates ("MOD Class" for an average water year), grazing capacity (by three utilization rates), and stock site evaluation. Identifiers are by Camp and Meadow Name, Camp ID# and Mdw ID#, UTM coordinates (NAD 1983, Zone 11N) for preferred fire ring, if known. Reported stock use level is for 2004 to 2016.

Camp Name (Meadow Name)	Camp ID (Mdw ID)	Preferred Fire Ring		Stock Use Mean (Max) 2004-2016	Mdw Suit. for Use	MOD ClassA	Grazing Capacity			Stock Site Evaluation	
		UTME	UTMN				5%	25%	35%	Visit Status[B]	BMPs by Resource[C]
Matterhorn Canyon-North (Upper)	77 (3835)	288199	4214521	113.6 (216)	Mod	Late	Not included	Not included	Not included	Full	Arch
Mattie Lake	125 (3026)	285618	4201478	Not included	Not included	Late	Not included	Not included	Not included	Not Visited	Not included
McCabe Creek (North)	78 (3457)	293235	4208590	7.0 (74)	Not included	Early/Mid	62	310	434	Partial	Arch, Wildlife
Miguel Cabin	3 (3223)	250340	4205193	2.2 (12)	Not included	Late/Mid	Not included	Not included	Not included	Partial	Arch
Miller Lake (North)	96 (3400)	287453	4207657	22.8 (123)	Mod	Early	10	50	69	Full	Arch, VER, Wildlife
Miller Lake (South)	-3342	()	()	22.8 (123)	Mod	Early	5	25	35	Full	Arch, VER, Wildlife
Miller Lake (Southeast)	-3332	()	()	22.8 (123)	Not included	Early	Not included	Not included	Not included	Full	Arch, VER
Miwok Lake	128 ()	262752	4215267	Not included	Not included	Not included	Not included	Not included	Not included	Not Visited	Wildlife
Paradise Meadow-North Admin. Site	136 (3768)	265577	4214417	12.5 (76)	High	Mid	21	106	149	Full	Arch, VER, Wildlife
Paradise Meadow-West Admin. Site	137 (3768)	264888	4214176	12.5 (76)	High	Mid	21	106	149	Full	Arch, VER, Wildlife

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[B] "Partial" indicates that one or more of the interdisciplinary team member was absent from the site visit.

[C] Site-specific BMPs by resource include: cultural ("Arch"); water-quality and soil ("PHYS"); terrestrial or aquatic ("Wildllife), and; botanical "VER".

Table C-1c (continued). *Tuolumne*: Synthesized results for pack stock studies in Yosemite Wilderness described and referenced within this report including meadow suitability for use, meadow opening dates (“MOD Class” for an average water year), grazing capacity (by three utilization rates), and stock site evaluation. Identifiers are by Camp and Meadow Name, Camp ID# and Mdw ID#, UTM coordinates (NAD 1983, Zone 11N) for preferred fire ring, if known. Reported stock use level is for 2004 to 2016.

Camp Name (Meadow Name)	Camp ID (Mdw ID)	Preferred Fire Ring		Stock Use Mean (Max) 2004-2016	Mdw Suit. for Use	MOD Class[A]	Grazing Capacity			Stock Site Evaluation	
		UTME	UTMN				5%	25%	35%	Visit Status[B]	BMPs by Resource[C]
Paradise Meadow-South	121 (3751)	265282	4214211	12.5 (76)	High	Late/Mid	11	55	76	Full	Arch, VER, Wildlife
Pate Valley (North)	69 (3061)	271988	4201327	43.2 (218)	Not included	Late/Mid	6	29	41	Partial	Arch, VER
Pate Valley (South)	69 (3051)	–	–	–	Not included	Late/Mid	Not included	Not included	Not included	–	–
Pate Valley Trail Camp Admin. Site	(none)	271988	4201327	–	No meadow	No meadow	No meadow	No meadow	No meadow	–	–
Pleasant Valley	11 (3323)	274006	4207254	0.9 (12)	Not included	Late	Not included	Not included	Not included	Partial	Arch
New City Camp (Rancheria Falls)	5 (none)	261326	4204387	0.8 (11)	No meadow	No meadow	No meadow	No meadow	No meadow	Partial	Raker Act restriction.
LeConte Camp (Rancheria Falls)	7 (none)	263995	4203205	0.8 (11)	No meadow	No meadow	No meadow	No meadow	No meadow	Not Visited	Not included
Rock Island Pass Trail Camp	152 (N/A)	282491	4219057	3.0 (34)	closed	closed	closed	closed	closed	Partial	Arch. Closed to grazing because of elevation. Wildlife

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[C] Site-specific BMPs by resource include: cultural (“Arch”); water-quality and soil (“PHYS”); terrestrial or aquatic (“Wildllife), and; botanical “VER”.

Table C-1c (continued). *Tuolumne*: Synthesized results for pack stock studies in Yosemite Wilderness described and referenced within this report including meadow suitability for use, meadow opening dates ("MOD Class" for an average water year), grazing capacity (by three utilization rates), and stock site evaluation. Identifiers are by Camp and Meadow Name, Camp ID# and Mdw ID#, UTM coordinates (NAD 1983, Zone 11N) for preferred fire ring, if known. Reported stock use level is for 2004 to 2016.

Camp Name (Meadow Name)	Camp ID (Mdw ID)	Preferred Fire Ring		Stock Use Mean (Max) 2004-2016	Mdw Suit. for Use	MOD ClassA	Grazing Capacity			Stock Site Evaluation	
		UTME	UTMN				5%	25%	35%	Visit Status[B]	BMPs by Resource[C]
Rodger's Lake	93 (none)	280851	4208435	2.5 (32)	No meadow	No meadow	No meadow	No meadow	No meadow	Not Visited	Wildlife
Rodger's Meadow (North)	94 (3642)	279013	4207358	Not included	Mod	Late	Not included	Not included	Not included	Partial	Arch, Wildlife
Rodger's Meadow (South)	-3629	Not Found	Not Found	Not included	Mod	Late	Not included	Not included	Not included	Partial	Arch, Wildlife
Rodger's Meadow	-3331	Not Found	Not Found	Not included	–	Early	51	256	359	Not Visited	Wildlife
Slide Mountain Trail Camp Admin. Site	43 (none)	287095	4219377	5.2 (20)	No meadow	No meadow	No meadow	No meadow	No meadow	Partial	Arch, Wildlife
Smedberg Lake-South	92 (3501)	282181	4210051	50.3 (177)	Low	Mid	13	65	90	Full	Arch, VER, PHYS, Wildlife
Smedberg Lake-Southeast	40 (3506)	282166	4210135	–	Low	Mid	Not included	Not included	Not included	Full	Arch, VER, PHYS, Wildlife
Smedberg Lake Trail Camp Admin. Site	146 (3501)	281940	4210464	–	Not included	Not included	Not included	Not included	Not included	Full	Arch, VER, PHYS, Wildlife
Smith Meadow	1 (3001)	257822	4200809	Not included	Not included	Late	Not included	Not included	Not included	Partial	Arch

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[C] Site-specific BMPs by resource include: cultural ("Arch"); water-quality and soil ("PHYS"); terrestrial or aquatic ("Wildllife), and; botanical "VER".

Table C-1c (continued). *Tuolumne*: Synthesized results for pack stock studies in Yosemite Wilderness described and referenced within this report including meadow suitability for use, meadow opening dates (“MOD Class” for an average water year), grazing capacity (by three utilization rates), and stock site evaluation. Identifiers are by Camp and Meadow Name, Camp ID# and Mdw ID#, UTM coordinates (NAD 1983, Zone 11N) for preferred fire ring, if known. Reported stock use level is for 2004 to 2016.

Camp Name (Meadow Name)	Camp ID (Mdw ID)	Preferred Fire Ring		Stock Use Mean (Max) 2004-2016	Mdw Suit. for Use	MOD ClassA	Grazing Capacity			Stock Site Evaluation	
		UTME	UTMN				5%	25%	35%	Visit Status[B]	BMPs by Resource[C]
Stubblefield Trail Camp Admin. Site	66 (none)	272718	4215607	3.8 (26)	No meadow	No meadow	No meadow	No meadow	No meadow	Partial	Arch
Ten Lakes-East	75 (2833)	279561	4197828	Not included	Not included	Not included	Not included	Not included	Not included	Partial	Arch
Ten Lakes-East Lake	104 (none)	278745	4197771	Not included	No meadow	No meadow	No meadow	No meadow	No meadow	Partial	Arch
Ten Lakes-West	74 (2833)	277832	4198417	Not included	Not included	Mid	Not included	Not included	Not included	Partial	Arch
Tilden Lake (North)	46 (4321)	271168	4220005	53.8 (163)	Mod	Early/Mid	20	101	142	Full	Arch, VER, PHYS
Tilden Lake (Northeast)	-4342	()	()	53.8 (163)	Not included	Early/Mid	16	80	111	Full	Arch, VER, PHYS
Tilden Lake-South (Southeast)	85 (4189)	271356	4219697	53.8 (163)	Mod	Early	12	59	82	Not Visited	Not included
Tilden Lake-South (Southwest)	-4145	()	()	53.8 (163)	Mod	Early	12	62	87	Not Visited	Not included
Tilden Lake-Northwest (West)	86 (4172)	270340	4219545	53.8 (163)	Mod	Mid	2	8	11	Full	Arch, VER, PHYS

[A] Findings by Kuhn et al. (in review) and suggested revisions by NPS staff based on professional judgement.

[B] ”Partial” indicates that one or more of the interdisciplinary team member was absent from the site visit.

[C] Site-specific BMPs by resource include: cultural (“Arch”); water-quality and soil (“PHYS”); terrestrial or aquatic (“Wildllife), and; botanical “VER”.

Table C-1c (continued). *Tuolumne*: Synthesized results for pack stock studies in Yosemite Wilderness described and referenced within this report including meadow suitability for use, meadow opening dates ("MOD Class" for an average water year), grazing capacity (by three utilization rates), and stock site evaluation. Identifiers are by Camp and Meadow Name, Camp ID# and Mdw ID#, UTM coordinates (NAD 1983, Zone 11N) for preferred fire ring, if known. Reported stock use level is for 2004 to 2016.

Camp Name (Meadow Name)	Camp ID (Mdw ID)	Preferred Fire Ring		Stock Use Mean (Max) 2004-2016	Mdw Suit. for Use	MOD ClassA	Grazing Capacity			Stock Site Evaluation	
		UTME	UTMN				5%	25%	35%	Visit Status[B]	BMPs by Resource[C]
Tiltill Valley (East and West)	6 (3287 and 3284)	263072	4206753	Not included	Not included	Late/Mid	Not included	Not included	Not included	Partial	Arch
Tiltill Valley Trail Camp Admin. Site	(3287 and 3284)	()	()	13.8 (90)	Not included	Late	Not included	Not included	Not included	Partial	Arch
Tim's Camp Admin. Site (North)	132 (3869e)	267126	4215728	Not included	Not included	Mid	10	51	71	Full	Arch, VER
Tim's Camp Admin. Site (South)	(3869w)	()	()	Not included	Not included	Late	12	59	82	Full	Arch, VER
Twin Lakes-North	48 (none)	266672	4224646	11.8 (44)	No meadow	No meadow	No meadow	No meadow	No meadow	Partial	Arch
Twin Lakes-South	49 (4413)	267462	4224256	11.8 (44)	Low	Early/Mid	7	36	50	Partial	Arch
Upper Lyell - Rock Camp (North)	60 (2040)	300835	4186326	286.2 (586)	Mod	Mid	12	61	85	Full	Arch, VER, PHYS, Wildlife
Upper Lyell - Trail Camp Admin Site (South)	62 (1987)	301001	4185003	–	High	Late	38	188	263	Full	Arch, VER, PHYS

[A] Findings by Kuhn et al. (in review) and suggested revisions by NPS staff based on professional judgement.

[B] "Partial" indicates that one or more of the interdisciplinary team member was absent from the site visit.

[C] Site-specific BMPs by resource include: cultural ("Arch"); water-quality and soil ("PHYS"); terrestrial or aquatic ("Wildllife), and; botanical "VER".

Table C-1c (continued). *Tuolumne*: Synthesized results for pack stock studies in Yosemite Wilderness described and referenced within this report including meadow suitability for use, meadow opening dates ("MOD Class" for an average water year), grazing capacity (by three utilization rates), and stock site evaluation. Identifiers are by Camp and Meadow Name, Camp ID# and Mdw ID#, UTM coordinates (NAD 1983, Zone 11N) for preferred fire ring, if known. Reported stock use level is for 2004 to 2016.

Camp Name (Meadow Name)	Camp ID (Mdw ID)	Preferred Fire Ring		Stock Use Mean (Max) 2004-2016	Mdw Suit. for Use	MOD ClassA	Grazing Capacity			Stock Site Evaluation	
		UTME	UTMN				5%	25%	35%	Visit Status[B]	BMPs by Resource[C]
Upper Lyell - Emergency Overflow (South)	84 (1987)	301026	4185319	–	–	–	–	–	–	Full	Arch, VER, PLSE
Upper Lyell - Peninsula (South)	124 (1987)	300870	4186032	–	–	–	–	–	–	Full	Arch, VER, PLSE
Wilma Lake-West	31 (3945)	267866	4217277	11.3 (44)	Mod	Mid	10	51	71	Full	Arch
Wilma Lake-East	65 (3945)	268000	4217312	11.3 (44)	Mod	Mid	10	51	71	Full	Arch
Virginia - Avalanche Camp	123 (3482)	292292	4210115	19.8 (98)	Not included	Mid	Not included	Not included	Not included	Full	Arch
Virginia - Castle Camp	39 (3519)	293073	4210529	25.2 (74)	Mod	Mid	Not included	Not included	Not included	Mid	12
Virginia - Junction Camp	37 (none)	294876	4213601	0.7 (9)	No meadow	No meadow	No meadow	No meadow	No meadow	Full	Arch
Virginia - Roger's Camp	99 ()	294855	4212532	4.8 (63)	Not included	Not included	Not included	Not included	Not included	Full	Arch
Virginia - Table Camp	98 (none)	293868	4211382	6.2 (46)	No meadow[F]	No meadow[F]	No meadow[F]	No meadow[F]	No meadow[F]	Full	Arch

[A] Findings by Kuhn et al. (in review) and suggested revisions by NPS staff based on professional judgement.

[B] "Partial" indicates that one or more of the interdisciplinary team member was absent from the site visit.

[C] Site-specific BMPs by resource include: cultural ("Arch"); water-quality and soil ("PHYS"); terrestrial or aquatic ("Wildllife), and; botanical "VER".

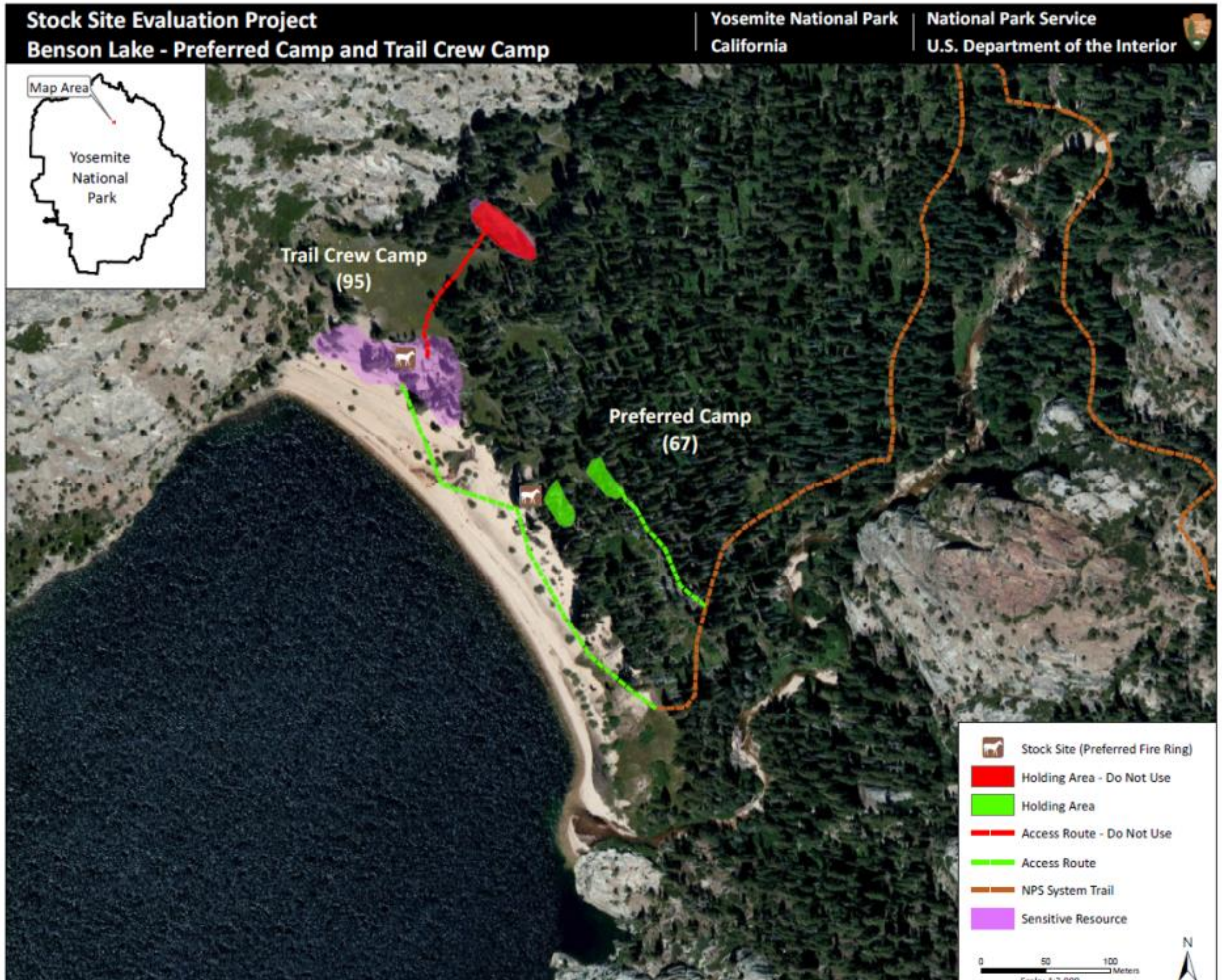
Appendix D – Stock Handling Practices (Stock User Stewardship)

Yosemite National Park recommends implementation of wilderness stock handling practices based on leave no trace principles (https://www.bcha.org/education/leave-no-trace/) by pack stock users as stewards of wilderness character and the protection of natural and cultural resources.

1) Stock use is limited to no more than ¼ mile off trail travel, except at routes and locations specified in the annual Superintendent's compendium.
2) Use designated highline areas (or previously used areas if not designated) for holding of stock.
3) Stock should only be held in vicinity of campsite long enough to load or unload.
4) If stock are to be hard tied for holding (i.e., overnight, or for supplemental feeding), they must be on a highline, other than when being loaded or unloaded.
5) Highline ropes should be padded at contact points with their support trees, and stock should not be attached closer than 10 feet from base of tree. Avoid using fallen, unstable, blazed trees, or wooden components of existing (historic) structures, as part of stock operations.
6) If while being held in the vicinity of the campsite, stock are causing damage to tree or soil around tree, they must be moved back to highline immediately or hand-held. Actions such as hobbling, applying insect spray, and/or moving away from other animal may quiet stock and prevent damage from occurring.
7) Stock should be saddled and unsaddled at highline, not in campsite.
8) Manure in grazing areas and holding area should be spread (either raked or kicked) and moved away from water sources before departure.
9) Manure within 100 feet of campfire ring should be removed and spread (broadcast) away from camping area and water sources.
10) Temporary electric fences for grazing exclosures or enclosures to protect resources or hold stock should be moved at least once per day.
11) Stock should be directed to travel on trail tread when being ridden or led, preferably in single-file.
12) Loose herding or free trailing of pack animals, except in exceptional circumstances, should be avoided; rather, pack stock should be tied together in a string or hand-led.
13) While being ridden or led, stock must travel on designated trails or stock routes and avoid short-cutting trails or switchbacks, and avoid trail braiding by maintaining stock in single-file line.
14) While traveling on the trail stock may be taken up to ¼ mile off trail for temporary stops. This off-trail travel should avoid wet areas. During this time, stock may be tied to trees as long as no damage occurs. Other than in this situation, stock are not to be ridden off trail or off designated routes.
15) When watering stock, avoid impacts to stream banks. Choose armored (rocky) banks with as little slope as possible.
16) If picketed, stock should be greater than 100 feet from any stream, lake, spring, or water body.
17) Wetlands (perennial or intermittent areas of wet soil) are susceptible to damage at almost any time of year. Activities that disturb or compact soils in these areas such as grazing and through-travel, should be avoided to the extent feasible.
18) Carry extra grain or pelletized feed in areas where grazing is prohibited or sparse. All supplemental grain and pelletized feed is required to be certified weed-free by the State of California and should be processed (i.e., rolled, ground, or otherwise treated) to prevent germination.

Appendix E – Site-Specific Maps

An example of maps produced from findings of the stock site evaluation project. A supplemental to this report provides similar maps for each of the 99 sites recommended for commercial stock use.

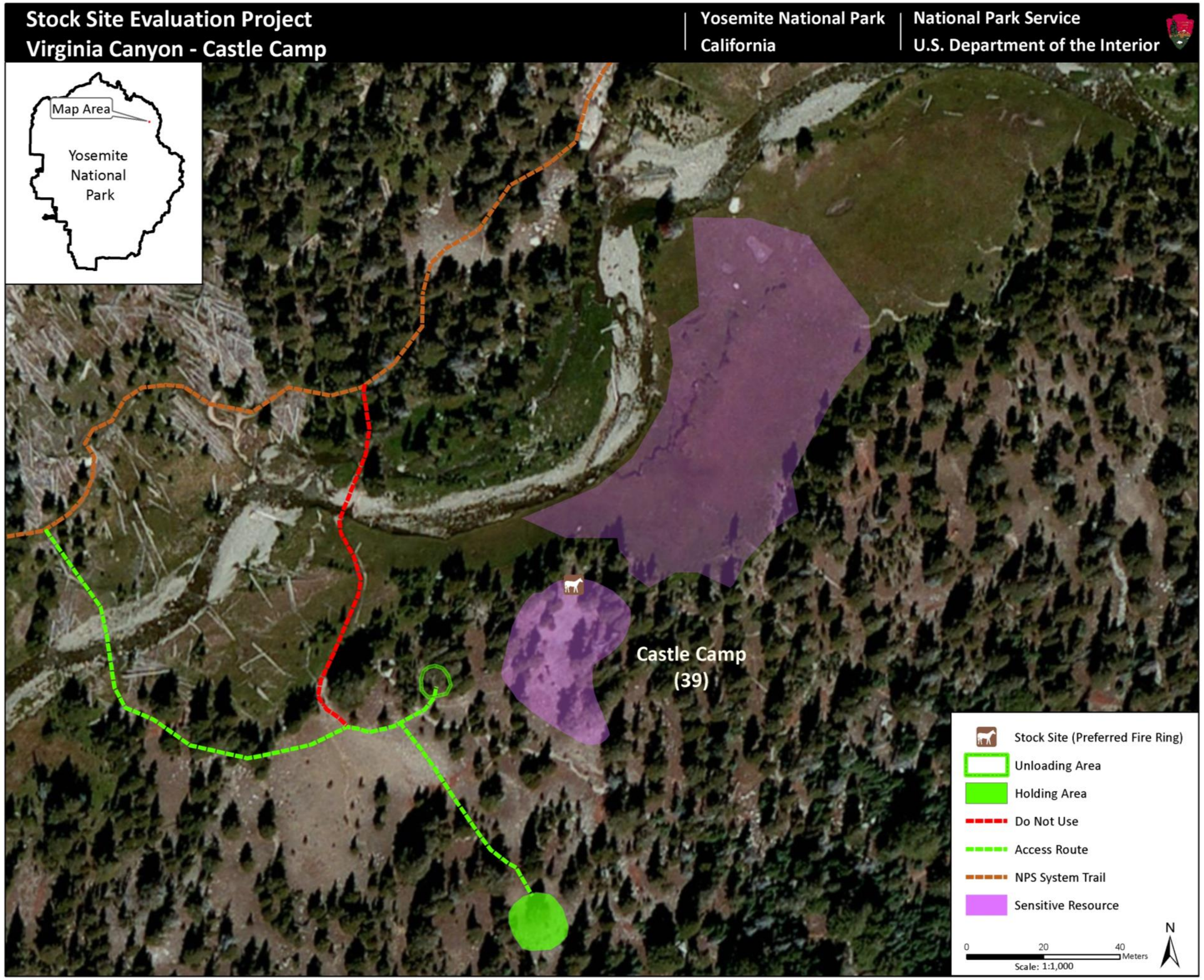


Forage Area: Large understory grazing area between NPS system trail, drift fences, steep bedrock outcrops, and the lake.

Benson Lake - Preferred Camp
Camp ID: 67
Fire Ring: 278,422mE x 4,211,075mN
Handling Practices: This is the preferred site at Benson Lake. The access route goes to the end of the NPS system trail and then heads along the beach to the fire ring. The unloading area is at the fire ring. There is a holding area 20 m east of the fire ring. A second holding area is in the forested area approximately 40 m east of the fire ring. This holding area is on the east side of a drift fence and can be access by following the northern edge of the fence where it intersects with the NPS system trail.

Benson Lake - Trail Crew Camp
Camp ID: 95
Fire Ring: 278,325mE x 4,211,181mN
Handling Practices: This site is the second option at Benson Lake and should only be used as a drop camp. This is due to concerns about stock use causing potential impacts to the sensitive resource on or near the site. The access route goes to the end of the NPS system trail and then heads along the beach to the fire ring. The unloading area is at the fire ring. The holding area is located in the forested area near the preferred camp. This is accessed by heading back to the NPS system trail and following the north edge of a drift fence that intersects with the trail. Do not use the holding area that is north of the camp and accessed by crossing a meadow. This holding area and access route are disturbing sensitive resources.

Figure E-1. Benson Lake stock site map of recommended access route, holding area, and camp site if known, and list of associated site-specific best management and stock handling practices.



Forage Area: Meadow on both sides of river. Keep animals out of sensitive resource area shown on map, as this is a wet meadow area. This may require use of electric fencing or supplemental feed.

Virginia Canyon - Castle Camp

Camp ID: 39

Fire Ring: 293,073mE x 4,210,529mN

Handling Practices: Do not use the former access route northwest of the site. This route has damaged meadow areas and crosses the creek at an unstable location. Use the preferred access route west of the camp. Use unloading area approximately 30 m southwest of fire ring. Do not unload or load animals within the sensitive resource area where the fire ring is located. Use holding area up the slope approximately 80 m south of the fire ring as shown on the map. Do not hold stock in sensitive resource area where fire ring is located.

Objects older than 50 years are considered historical and can be significant pieces of our collective history. A concentration of these materials is called an archeological site and these sometimes overlap with stock camps. These materials are protected by the National Historic Preservation Act of 1966, as amended, and the Archeological Resources Protection Act of 1979. Removal of artifacts from their location destroys essential information needed to understand who was here and how they lived. It is illegal to collect artifacts or intentionally disturb archeological sites and can result in fines and other penalties.

Figure E-2. Castle Camp stock site map of recommended access route, holding area, and camp site if known, and list of associated site-specific best management and stock handling practices.

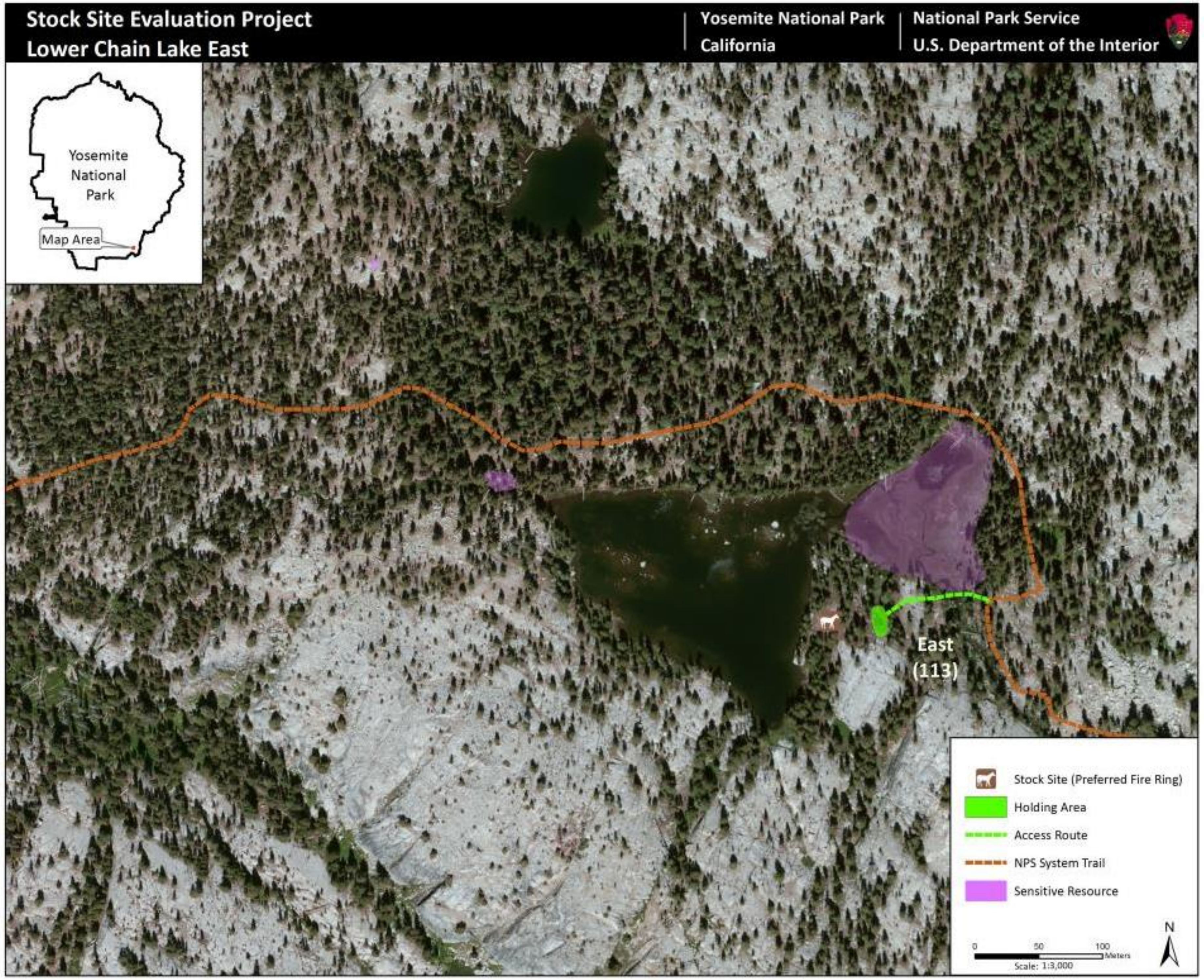
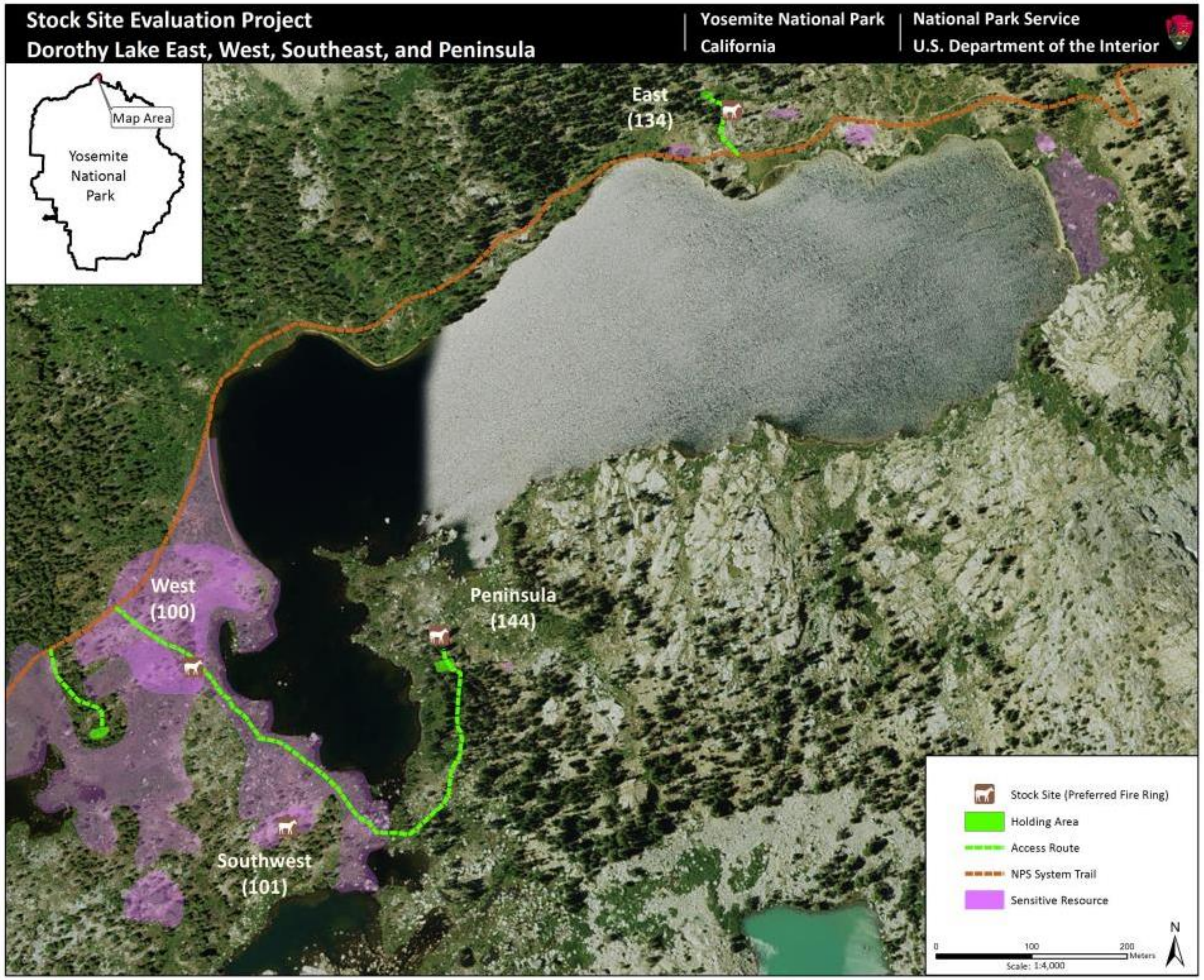


Figure E-3. Chain Lake (Lower) stock site map of recommended access route, holding area, and camp site if known, and list of associated site-specific best management and stock handling practices.



Forage Area: For the three camps on the west side of the lake there are multiple meadows and understory grazing. For the camp on the east side of the lake there are small meadows and understory. Avoid use of sensitive resource areas indicated on map.

Dorothy Lake - West

Camp ID: 100
Fire Ring: 272,754mE x 4,228,263mN
Handling Practices: Preferred use as drop camp only, due to concerns about stock use causing potential impacts to sensitive resources on or near this site. Use signed access route. The unloading area is next to the fire ring. Hold stock in area southwest of site following NPS system trail and access route shown on map.

Dorothy Lake - Southwest

Camp ID: 101
Fire Ring: 272,853mE x 4,228,096mN
Handling Practices: Do not use this camp if other camps are available. Do not hold stock here due to concerns about stock use causing potential impacts to sensitive resources on or near this site.

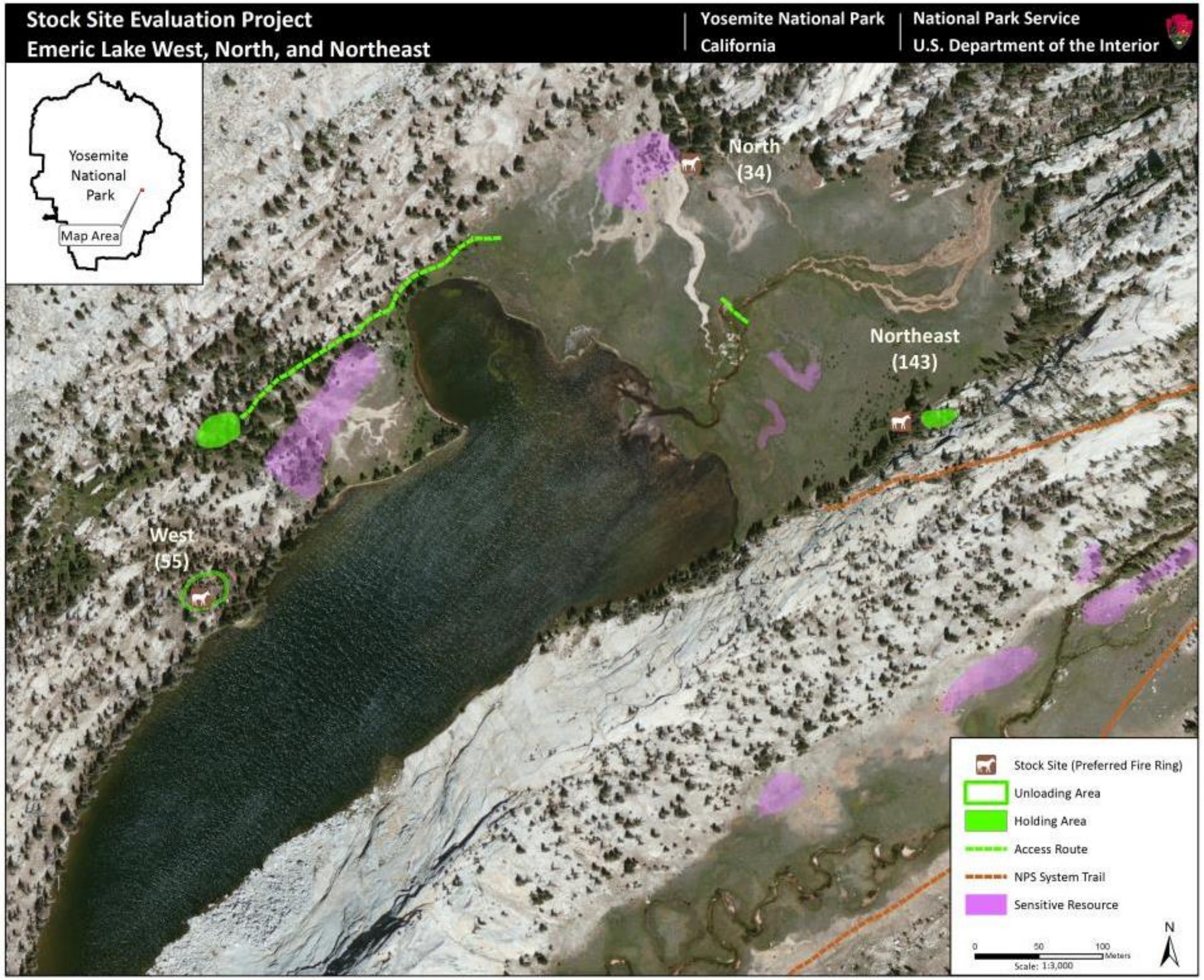
Dorothy Lake - East

Camp ID: 134
Fire Ring: 273,317mE x 4,228,847mN
Handling Practices: This camp will support small groups but has limited forage. The access route diverges from the NPS system trail and heads up the slope north between two bedrock outcrops 50 m to the fire ring. The unloading area is at the fire ring. The holding area is up the slope 25 m to the northwest.

Dorothy Lake - Peninsula Camp

Camp ID: 144
Fire Ring: 273,011mE x 4,228,297mN
Handling Practices: This is the preferred camp. Follow signed access route to camp. Unload stock at fire ring. Holding area is down the slope 20 m to the south of the fire ring. Do not use camp until seasonal pond used as holding area is dry and able to support stock with minimal soil disturbance.

Figure E-4. Dorothy Lake stock site map of recommended access route, holding area, and camp site if known, and list of associated site-specific best management and stock handling practices.



Forage Area: Large meadow and surrounding understory bordered by bedrock outcrops. Keep animals out of two sensitive resource areas (wetlands) shown on map southeast of the creek crossing.

Emeric Lake - North

Camp ID: 34
Fire Ring: 290,195mE x 4,184,159mN
Handling Practices: This site is the third option at Emeric Lake and should be used as a drop camp. This is due to its proximity to sensitive resources. The fire ring is also too close to the seasonal drainage that feeds into the lake. Follow the NPS system trail to the meadow and cross the creek at location indicated on the map. Unload stock at the fire ring. Do not hold stock at this site.

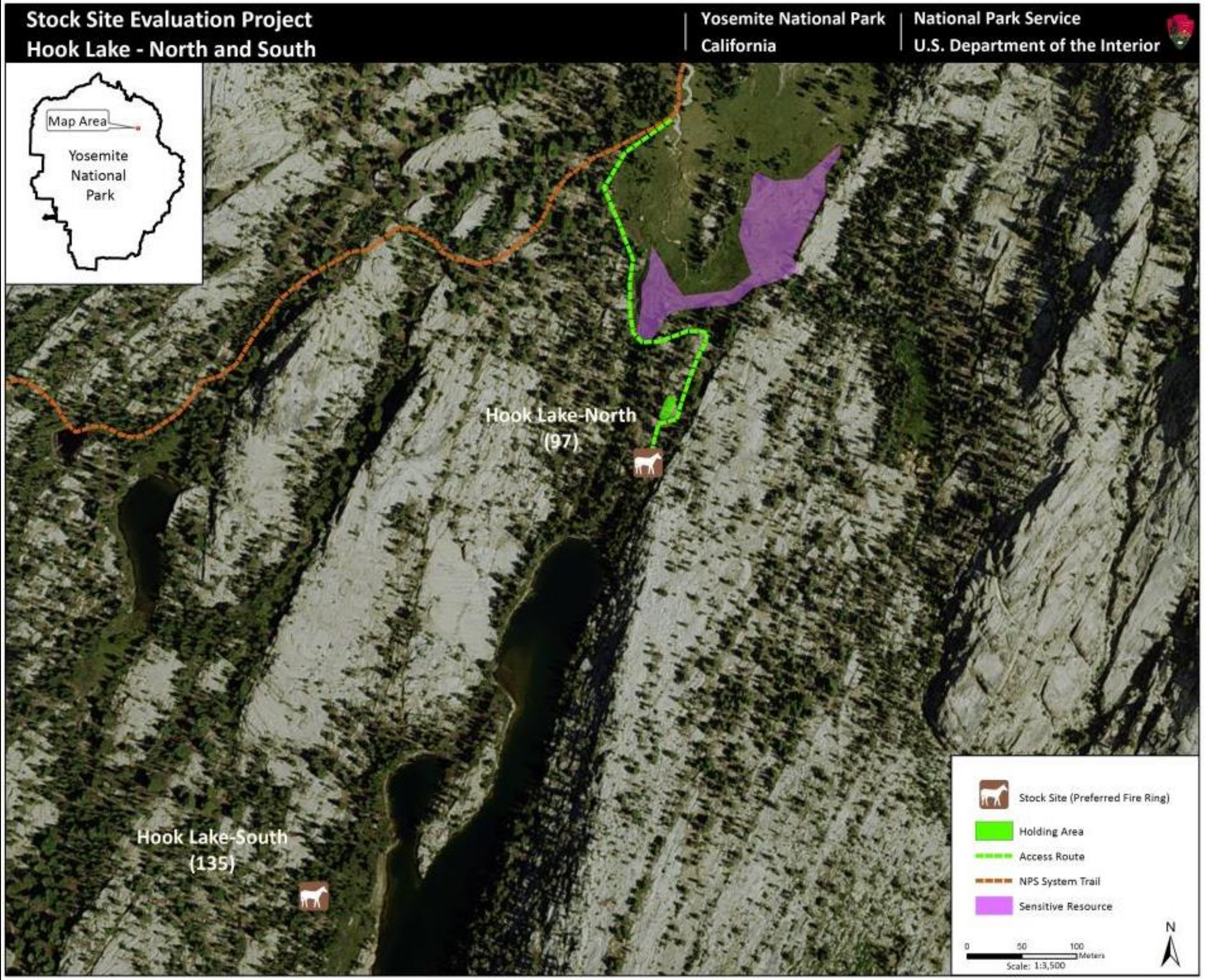
Emeric Lake - West

Camp ID: 55
Fire Ring: 289,811mE x 4,183,818mN
Handling Practices: Follow NPS system trail to meadow and cross creek at location indicated on map. Avoid sensitive resource areas when releasing stock to graze, and when exiting the site.

Emeric Lake - Northeast

Camp ID: 143
Fire Ring: 290,360mE x 4,183,960mN
Handling Practices: Follow the NPS system trail to the meadowand head northeast along edge of bedrock to fire ring. Unload animals at fire ring and holding area is up the slope 10 m east on a bedrock outcrop.

Figure E-5. Emeric Lake stock site map of recommended access route, holding area, and camp site if known, and list of associated site-specific best management and stock handling practices.

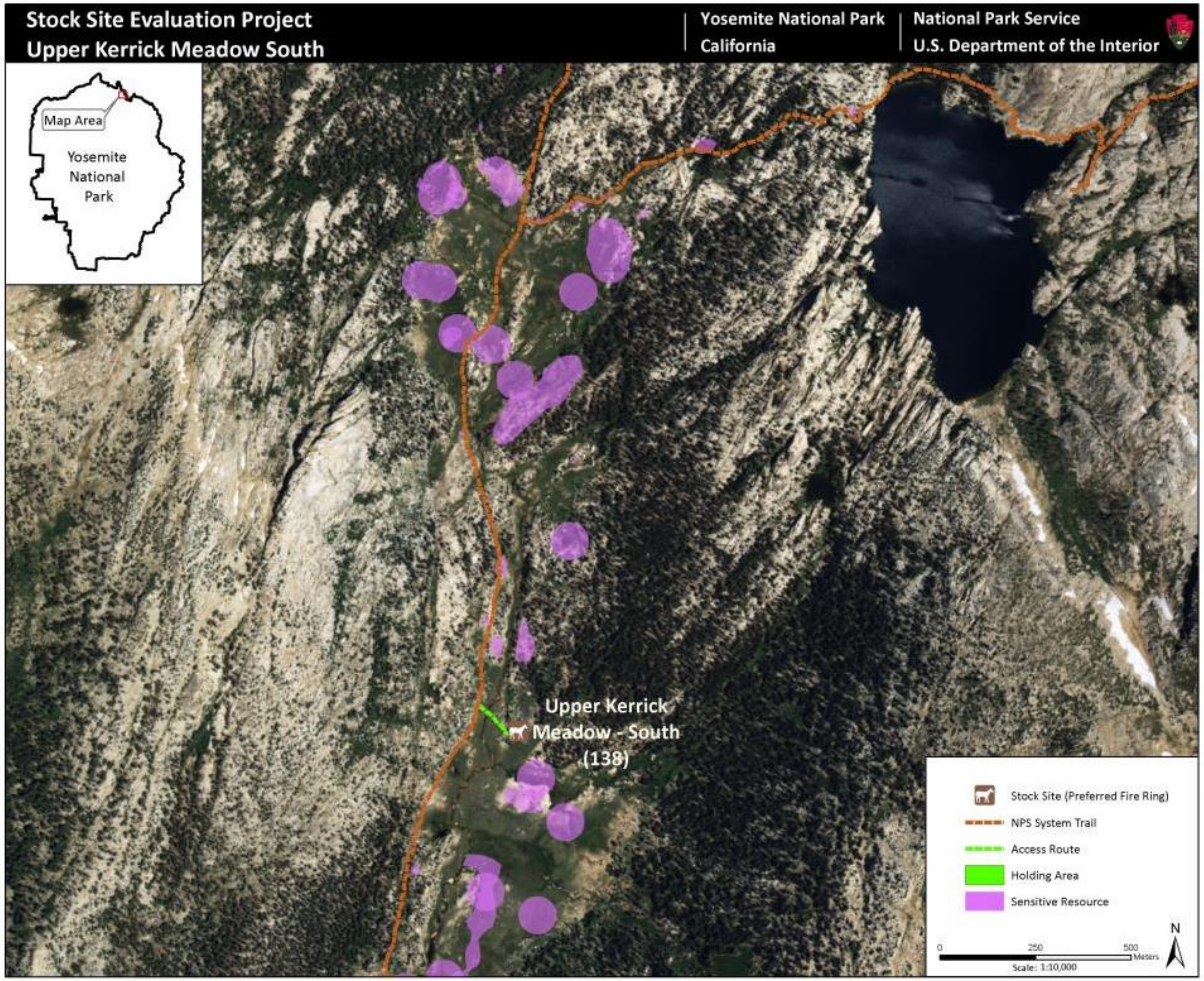


Grazing Area: The primary forage areas are the large meadow north of the lake and the small meadow on the southwest side of the lake. However, there are multiple sensitive resources in these areas. Grazing here may also have an increased potential impact to the ecosystem given the elevation of the area (9,400 feet). Grazing is not allowed at or above 9,600 feet. In consideration of these issues, it is recommended that sites at Hook Lake be used primarily as drop camps, that operators bring supplemental feed, or use the meadows for minimal grazing. If grazing is planned, keep animals out of the sensitive resource areas shown on the map.

Hook Lake-North
Camp ID: 97
Fire Ring: 288,599mE x 4,208,154mN
Handling Practices: Preferred use as drop camp only. Use access route that passes along western edge of meadow. The unloading area is next to the fire ring. The holding area is 40 m down the slope north of the fire ring.

Hook Lake-South
Camp ID: 135
Fire Ring: 288,294mE x 4,207,758mN
Handling Practices: Use camp on north end of lake. If this camp is occupied, only drop clients at this location.

Figure E-6. Hook Lake stock site map of recommended access route, holding area, and camp site if known, and list of associated site-specific best management and stock handling practices.



Forage Area: This area has been intermittently closed to grazing; for updated information on the status of grazing, please see the most recent Superintendent's Compendium and the Plan Your Visit webpage (https://www.nps.gov/yose/planyourvisit/wildcond.htm).

When meadows are closed to grazing, stock must be held and fed with supplemental feed in the designated holding area during the duration of stay.

When meadows are open to grazing, specific sensitive resource areas may remain closed, and the following conditions apply:

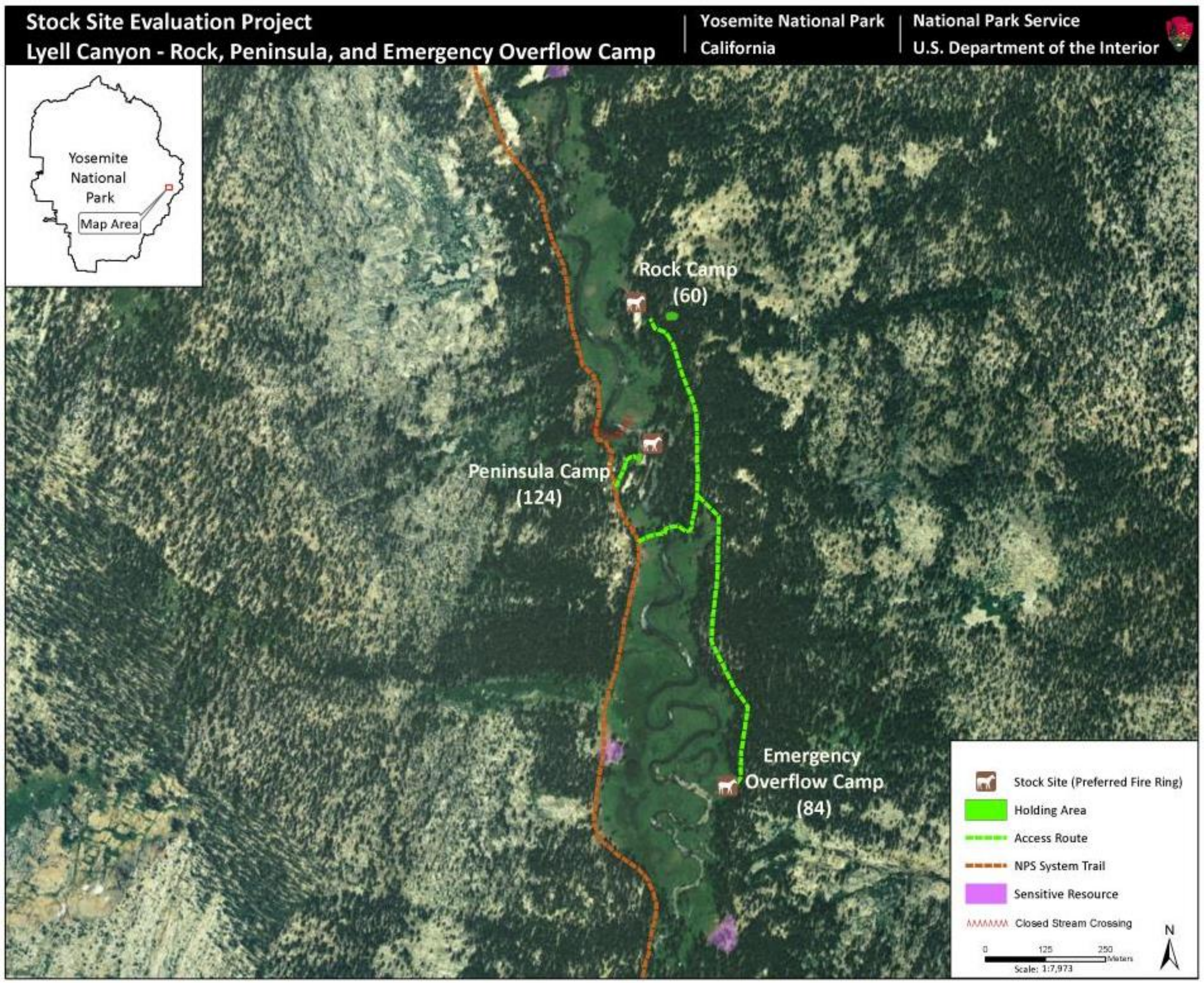
- Approved methods to prevent grazing in closed areas include hobbling, high lining, electric fence, hand grazing and any combination thereof.
- Electric fences will be placed at least 100 feet from all avoidance areas.
- Electric fences should not be placed in areas that have been previously used by stock parties earlier in the season.
- Stock use is limited to designated access routes and stock holding areas when not grazing.

- Overnight use of the "Upper Kerrick – South" stock site is limited to one stock party per night.
- Additional restrictions apply to commercial operations utilizing Kerrick Canyon, see the Commercial Use Authorization Permit.

Upper Kerrick Meadow - South

Camp ID: 138
Fire Ring: 282,514mE x 4,220,757mN
Handling Practices: This site is located at the northern edge of a large meadow approximately 0.9 mile south of the junction of the NPS system trails to Peeler Lake and Buckeye Pass. The access route diverges from the NPS system trail and heads southwest across Rancheria Creek. The route continues to the fire ring, which is in a group of lodgepole pines on a rocky knoll overlooking the meadow. The unloading area is at the fire ring. The holding area is 10 m north of the fire ring.

Figure E-7. Upper Kerrick South stock site map of recommended access route, holding area, and camp site if known, and list of associated site-specific best management and stock handling practices.



Forage Area: Meadows along both sides of the river and surrounding understory. The stream crossing to access Rock Camp and the Emergency Overflow Camp was moved and restored in 2014; the newly armored stream crossing is located at the north end of the upper meadow. Though slightly longer, this route is designed to keep stock groups from crossing the river at the old deteriorated crossing.

Lyell Canyon - Rock Camp

Camp ID: 60
Fire Ring: 300,835mE x 4,186,326mN
Handling Practices: The access route is vis the old Calvary trail on the east side of the Lyell Fork, accessed via the stream crossing at north end of the upper meadow. Once across the Lyell Fork, travel approximately 400 m south to the fire ring, located adjacent to a large bedrock slab in lodgepole pines on the edge of the meadow. The unloading area is at the fire ring. The holding area is located directly east and up hill, roughly 100 m, at a large flat area within the forest. Exit the site by following the same access route.

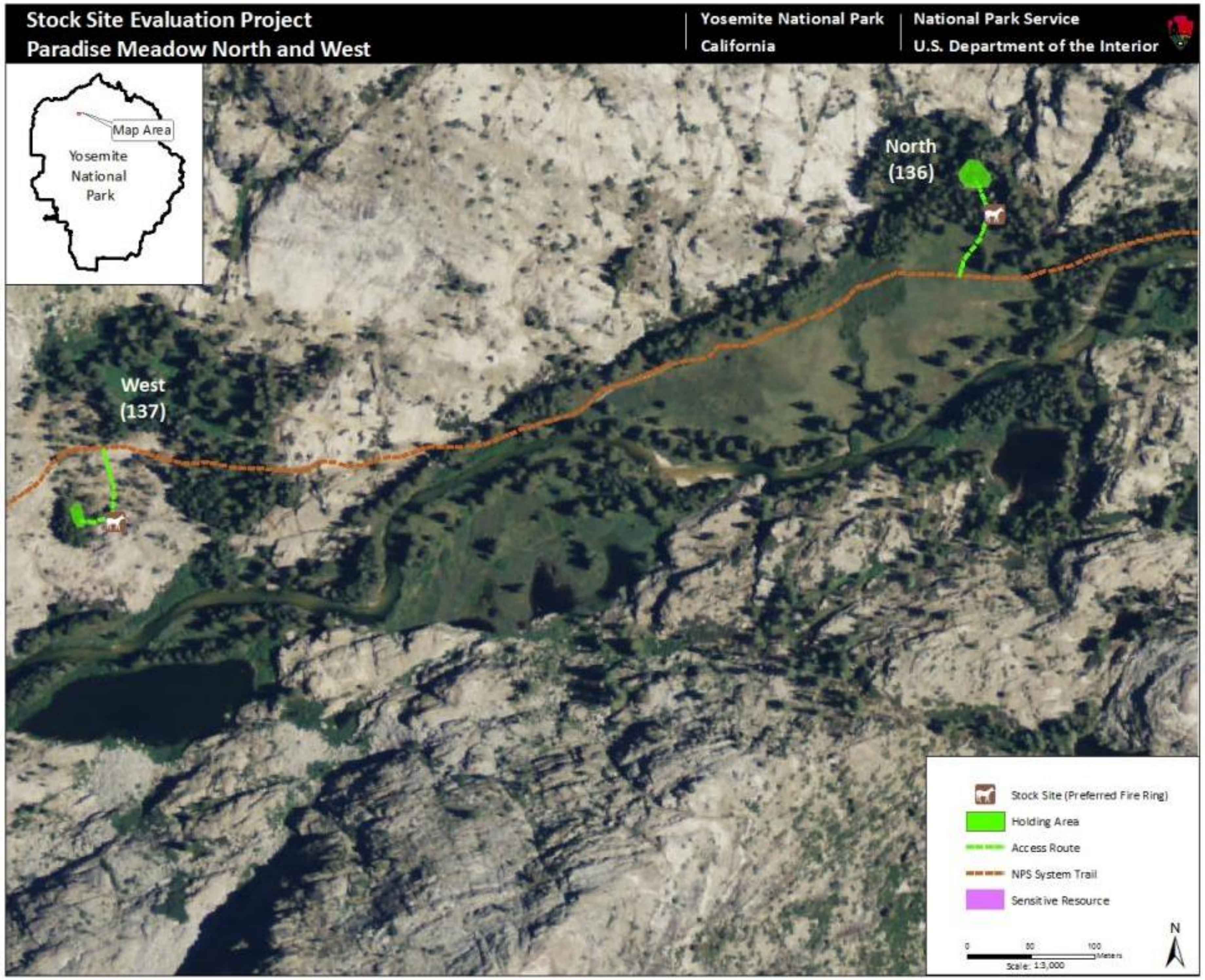
Lyell Canyon - Peninsula Camp

Camp ID: 124
Fire Ring: 300,870mE x 4,186,326mN
Handling Practices: The access route is located within a small patch of lodgepole pine trees between the two meadws of upper Lyell-South and upper Lyell-North, and just past the closed stream crossing. The access route leads directly to the holding area, which can serve as the loading/unloading zone as well. Exit the site by following the same access route.

Lyell Canyon - Emergency Overflow Camp

Camp ID: 84
Fire Ring: 301,025mE x 4,185,319mN
Handling Practices: The access route uses follows the same route that is south of Peninsula Camp to cross the river. Head south on the old Cavalry trail on the east side of the river for approximately 600 m to the fire ring, which is located in a group of lodgepole pines on the edge of the meadow. This lengthy route is designed to keep stock groups from crossing the river in unstable bank areas and to keep groups out of wet meadow areas. The unloading area is at the fire ring. A preferred holding area has not been established, but do not hold stock in meadow areas. Exit the site by following the same access route.

Figure E-8. Lyell Fork stock site map for Rock, Peninsula and the Emergency Overflow camp, with recommended access routes, holding areas, known camp sites, and site-specific best management and stock handling practices.



Forage Area: Both camps can use the large meadow area that is bisected by the NPS system trail and bordered to the south by Falls Creek. There is also understory forage surrounding this meadow. There is a small amount of understory forage at Paradise Meadow - West, but this area is wet for most of the year and to protect sensitive habitat it is preferred for operators to have stock graze in the meadow close to Paradise Meadow - North.

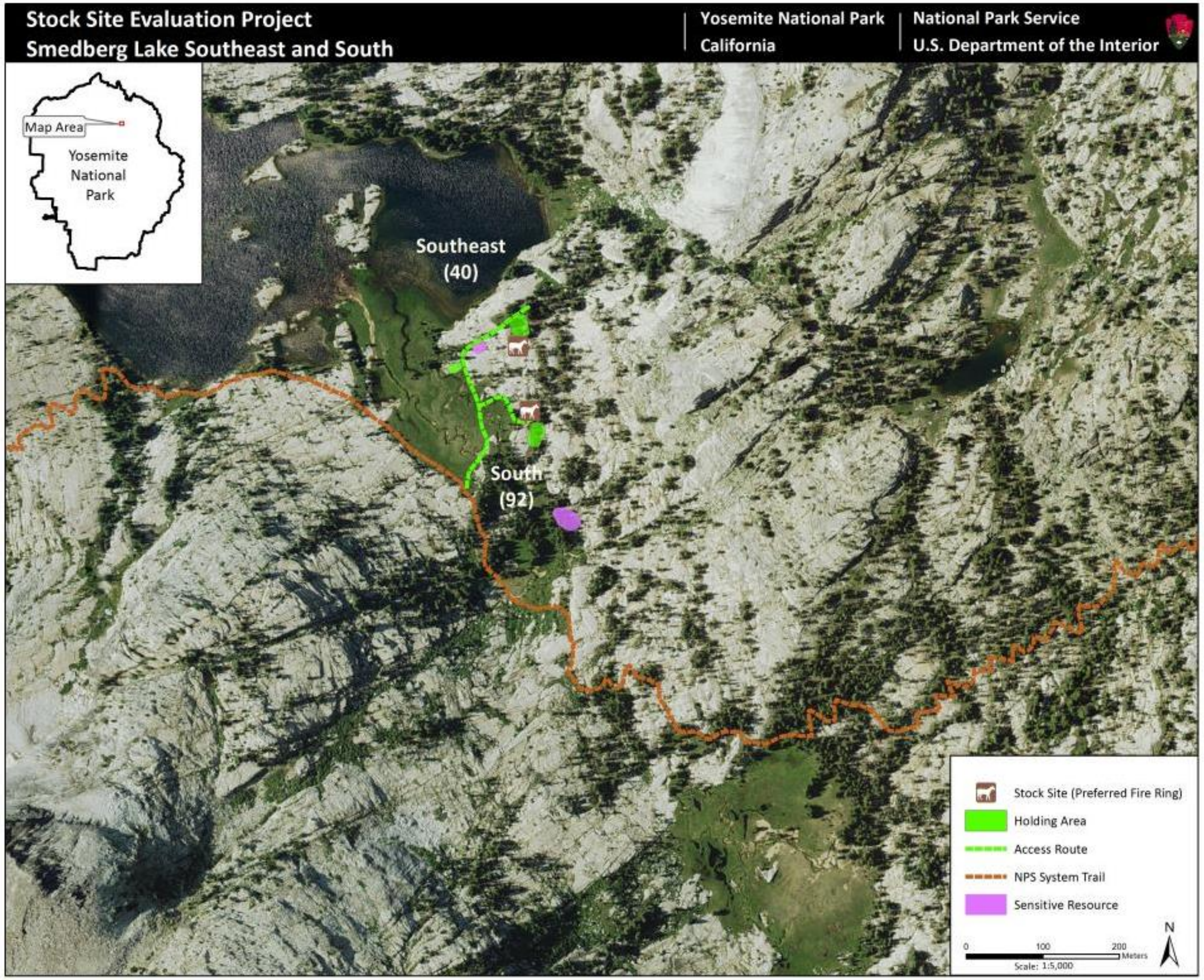
Paradise Meadow - North

Camp ID: 136
Fire Ring: 265,557mE x 4,214,418mN
Handling Practices: This is the primary stock site at Paradise Meadow. The access route diverges from the NPS system trail and heads north into the forested area of the camp. The unloading area is at the fire ring. The holding area is 25 m northwest of the fire ring.

Paradise Meadow - West

Camp ID: 137
Fire Ring: 264,888mE x 4,214,176mN
Handling Practices: The is the secondary site at Paradise Meadow. The access route heads south from the NPS system trail over sandy flats and bedrock areas to the fire ring, which is on the north side of a bedrock wall. The unloading area is at the fire ring. The holding area is on the northern edge of a group of pines 20 m west of the fire ring.

Figure E-9. Paradise stock site map of recommended access route, holding area, and camp site if known, and list of associated site-specific best management and stock handling practices.



Forage Area: Large meadow along southern edge of lake and additional meadow approximately 0.5 mile upslope south of lake.

Smedberg Lake - Southeast

Camp ID: 40
Fire Ring: 282,165mE x 4,210,135mN
Handling Practices: This is the preferred camp. Follow informal trail to camp. Unload stock at fire ring. Holding area Option 1 is 15 m north of fire ring Option 2 is down the slope to west on bedrock next to meadow edge.

Smedberg Lake - South

Camp ID: 92
Fire Ring: 282,181mE x 4,210,051mN
Handling Practices: Use same access route as for other camp, but head east to access camp at base of bedrock area. To extent feasible, avoid stock use of gully and headcut areas near camp.Unloading area is at fire ring. Holding area is south of fire ring in forested area bordered to west and east by bedrock.

Figure E-10. Smedberg Lake stock site map of recommended access route, holding area, and camp site if known, and list of associated site-specific best management and stock handling practices.

Appendix F – List of 130 Stock Sites Considered by Stock Site Evaluation Group 2013-2016 and Current Archeological Clearance Status

Table F-1. List of 130 stock sites considered by stock site evaluation interdisciplinary team (2013-2016) and current archeological clearance status (see also Wills 2016).

Camp ID[1]	Camp Name	Location	Reported Stock Use 2004-2015	Verified Location	Year(s) Evaluated	CUA Camp	Cleared by Archeology	Archeology Stock Use Program Recommendations
1	Smith Meadow	Smith Meadow	2006-2007	Yes	–	Yes	Contingent	Survey and verify location; use trail crew camp north and upslope of trail outside of archeological site boundary; ensure stock use areas (particularly access route) avoid archeological site.
3	Miguel Cabin	Miguel Meadows Ranger Station	2011, 2013-2014	Yes	–	Yes	Sec 106	Restrict activities to previously disturbed areas: provide map of area to be used for stock camp, and specify use of existing trail to access meadow for grazing. The cabin was destroyed in the 2013 Rim Fire and stock use of the area may change.
4	Beehive	Laurel Lake – Beehive	2006-2007, 2009, 2014	Yes	2007, 2009, 2014	Yes	Contingent	To protect archeological site, restrict use to areas further west closer to trail.
5	New City Camp	Rancheria Falls	2007	Yes	2006	No	Yes	Notify operators of archeological site location for avoidance.
6	Tiltill Valley Trail Camp	Tiltill Valley	2009, 2011, 2013	Yes	2006	Yes	Contingent	Ensure that stock users stay on east side of trail and avoid ground disturbance to archeological sites.
7	LeConte Camp	Rancheria Falls	None	No	–	Yes	No	Verify location.
9	Lake Vernon	Lake Vernon	2006, 2008-2010-2014	Yes	2006, 2014	Yes	Yes	None.

[1] Camp ID: Note that camp identification numbers have been retained from the “OperatorSpecifiedPriority” shapefile created by Gavette (2009). This has led to numbers that are not continuous and extend beyond the 130 camps listed in the table.

Table F-1 (continued). List of 130 stock sites considered by stock site evaluation interdisciplinary team (2013-2016) and current archeological clearance status (see also Wills 2016).

Camp ID[1]	Camp Name	Location	Reported Stock Use 2004-2015	Verified Location	Year(s) Evaluated	CUA Camp	Cleared by Archeology	Archeology Stock Use Program Recommendations
11	Pleasant Valley	Pleasant Valley	2009	Yes	–	Yes	Contingent	Closed to trail crew, thus closed to commercial operators. If approved for stock, use alternative trail camp site east of creek, but ensure access trail avoids archeological sites.
13	Isberg Lake-West	Isberg Pass Lake	2010-2015	Yes	2007, 2010	Yes	Yes	Ensure access trail avoids two archeological sites in close proximity to camp.
16	Middle Chain Lake-Northwest	Middle Chain Lake	2004, 2007-2008, 2012-2013	Yes	2014	No	Yes	Suitable for drop camp and ok for small groups with supplemental feed, but is not included in list of CUA camps.
17	Lower Chain Lake-West	Lower Chain Lake	2004, 2007-2008, 2010-2014	Yes	2014	No	Yes	There are displaced camping impacts to nearby archeological site. Stock users should one of the fire rings further to the east.
18	Upper Chain Lake-Southwest	Upper Chain Lake	2004, 2007-2008, 2012-2013	Yes	2014	No	Yes	Removed from shapefile as there are no suitable overnight or drop camp locations here and only one camp was approved for use at Upper Chain Lake.
19	Middle Chain Lake-South	Middle Chain Lake	2004, 2007-2008, 2012-2013	Yes	2014	No	Yes	Removed from shapefile as there are no suitable overnight or drop camp locations here and only two camps were approved for use at Middle Chain Lake.
21	Upper Chain Lake-West	Upper Chain Lake	2006-2007	No	2014	No	Yes	Suitable for drop camp and ok for small groups with supplemental feed, but is not included in list of CUA camps.

[1] Camp ID: Note that camp identification numbers have been retained from the “OperatorSpecifiedPriority” shapefile created by Gavette (2009). This has led to numbers that are not continuous and extend beyond the 130 camps listed in the table.

Table F-1 (continued). List of 130 stock sites considered by stock site evaluation interdisciplinary team (2013-2016) and current archeological clearance status (see also Wills 2016).

Camp ID[1]	Camp Name	Location	Reported Stock Use 2004-2015	Verified Location	Year(s) Evaluated	CUA Camp	Cleared by Archeology	Archeology Stock Use Program Recommendations
22	South Fork Merced	South Fork Merced	None	No	2007	No	Sec 106	Closed to trail crew, thus closed to commercial operators. Alternative camping at Chain Lakes. No open meadow grazing in this location. This is a trail crew camp and a field evaluation determined stock use was not appropriate in this location.
24	Givens Creek	Givens Creek	None	Yes	2007, 2015	No	No	Could not relocate camp in 2007 or 2015. This campsite may have been incorrectly plotted on earlier maps and there are no suitable camping areas at the southern junction of the trail and Givens Creek. Stock groups should use nearby camping options less than two miles away at Buck Camp and Givens Lake.
25	Gravelly Ford Trail Camp	Gravelly Ford	2000	No	2015	Yes	Sec 106	Recommend archeological testing. Trail crew still uses camp with stipulations to set up some camp elements outside of site boundaries. There are no clear alternative locations in the area that are not either unsuitable for camping, or also on an archeological site.
26	Johnson Lake	Johnson Lake	None	Yes	–	Yes	No	Verify location.
27	Crescent Lake	Crescent Lake	None	Yes	–	Yes	No	Verify location.
28	Buena Vista Lake-East	Buena Vista Lake	None	Yes	2015	No	Yes	Removed from shapefile, as only one stock camp is suitable for Buena Vista Lake, and use of this camp should be discontinued in favor of the trail crew camp to the west.

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Table F-1 (continued). List of 130 stock sites considered by stock site evaluation interdisciplinary team (2013-2016) and current archeological clearance status (see also Wills 2016).

Camp ID[1]	Camp Name	Location	Reported Stock Use 2004-2015	Verified Location	Year(s) Evaluated	CUA Camp	Cleared by Archeology	Archeology Stock Use Program Recommendations
29	Chilnualna Lakes	Chilnualna Lakes	None	Yes	2015	Yes	Yes	None.
30	Illilouette Creek-West	Illilouette Creek	None	Yes		Yes	No	Verify location.
31	Wilma Lake-West	Wilma Lake	2008, 2010-2015	Yes	2014	Yes	Yes	None.
32	Glen Aulin	Glen Aulin	2004-2005, 2007-2009, 2011-2015	Yes	2006; 2014	Yes	Yes	None.
33	Sunrise Lakes	Sunrise Lakes	2005, 2011, 2013-2014	Yes	2009	Yes	Yes	None.
34	Emeric Lake-North	Emeric Lake	2004-2014	Yes	2007, 2014	Yes	Contingent	Move to alternative campsite or conduct Section 106 compliance. Camp not preferred for stock use - too close to water and there are better options. The fire ring should be moved northeast approximately 20-30 m.
35	Washburn Lake	Washburn Lake	2004-2006, 2008, 2010, 2013-2014	Yes	2010	Yes	Yes	None.
36	Sierra Camp	Virginia Canyon	None	Yes	2006, 2007	No	Contingent	Closed to commercial stock use in 2011 per interdisciplinary team decision.

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Table F-1 (continued). List of 130 stock sites considered by stock site evaluation interdisciplinary team (2013-2016) and current archeological clearance status (see also Wills 2016).

Camp ID[1]	Camp Name	Location	Reported Stock Use 2004-2015	Verified Location	Year(s) Evaluated	CUA Camp	Cleared by Archeology	Archeology Stock Use Program Recommendations
37	Junction Camp	Virginia Canyon	2004-2012, 2014	Yes	2006, 2007, 2014	Yes	Contingent	Hold stock at northern holding area outside of site boundary; remove social trail to old holding areas and ecologically restore them; maintain fire ring in current position; and monitor for any new impacts to the site. This camp is preferred for use by backpackers.
39	Castle Camp	Virginia Canyon	2004-2005, 2009-2010, 2012-2014	Yes	2006, 2007, 2013, 2014	Yes	Contingent	Following mitigating measures based on findings from Lee and Montague 2013 and field studies from Wills 2016. If use of the area as a commercial stock camp continues, the following protection measures are recommended: 1) Restrict stock loading and unloading to areas south of the site, and stabilize devegetated areas of the site; 2) Maintain the current campfire ring in place; 3) Ensure that commercial stock permittees provide an educational message to their clients, so that surface artifacts are not removed and/or displaced; and 4) Monitor the site on a regular basis to ensure that protection measures are followed and integrity remains intact.
40	Smedberg Lake-Southeast	Smedberg Lake	2004-2005, 2007-2010, 2012-2015	Yes	2007, 2013	Yes	Yes	Make sure stock operators used designated stock use areas (fire ring, access trail, unloading/loading area, holding area) and monitor archeological sites for stock impacts.

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Table F-1 (continued). List of 130 stock sites considered by stock site evaluation interdisciplinary team (2013-2016) and current archeological clearance status (see also Wills 2016).

Camp ID[1]	Camp Name	Location	Reported Stock Use 2004-2015	Verified Location	Year(s) Evaluated	CUA Camp	Cleared by Archeology	Archeology Stock Use Program Recommendations
41	Lower Kerrick Meadow	Lower Kerrick Meadow	2004, 2008-2009, 2012-2013	Yes	2007, 2013	Yes	Contingent	Establish access route north of site through meadow, maintain holding area northwest of site boundary, and move campfire ring farther to northwest away from site boundary. If this is not feasible investigate other camping options in area or proceed with Section 106 if necessary.
43	Slide Mountain Trail Camp	Slide Canyon	2004, 2013-2014	No	2010	Yes	Contingent	Keep stock use on east side of creek and consider moving existing fire ring further from creek. As of 2013 the camp is mostly covered in tree fall and use of the area may require a new fire ring or heavy saw work to keep use away from archeological sites.
45	Laurel Lake	Laurel Lake	2005, 2009, 2011-2013	Yes	2007	Yes	Yes	None.
46	Tilden Lake	Tilden Lake	2004-2006, 2008-2009, 2012-2015	Yes	2014	Yes	Yes	None.
47	Grace Meadow	Jack Main Canyon	2014	Yes	2006, 2014	Yes	Yes	Make sure camp location matches 2014 location, which has been approved for use.
48	Twin Lakes-North	Twin Lakes	2004, 2008-2009, 2012-2014	No	2006	Yes	Yes	None.
49	Twin Lakes-South	Twin Lakes	2004, 2008-2009, 2012-2014	Yes	2006	Yes	Yes	None.

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Table F-1 (continued). List of 130 stock sites considered by stock site evaluation interdisciplinary team (2013-2016) and current archeological clearance status (see also Wills 2016).

Camp ID[1]	Camp Name	Location	Reported Stock Use 2004-2015	Verified Location	Year(s) Evaluated	CUA Camp	Cleared by Archeology	Archeology Stock Use Program Recommendations
54	Babcock Lake-North	Babcock Lake	2005, 2007, 2009, 2011	Yes	–	Yes	No	Needs to be identified and will likely be cleared, since most of the area has been surveyed. There are many fire rings in the area, but only one small one at plotted location. All mapped fire rings are in surveyed areas.
55	Emeric Lake-West	Emeric Lake	2004-2014	Yes	2007, 2014	Yes	Contingent	Delineate access trail to preferred holding area as indicated on map, make sure stock use areas avoid archeological sites, and remove access trail tread on archeological sites.
56	Foerster Creek	Isberg Pass Lake	2006-2007	Yes	–	No	No	Removed from shapefile as there is no evidence of stock camping in this location, it is illegal to have fire rings at this elevation (above 9600 feet), the camp is too far from water, the creek dries up here early in the season, minimal camping options, and there is minimal forage (no meadow and sparse understory vegetation at this elevation).
59	Ireland Creek Junction	Lyell Canyon	2006-2007	No	2006	No	Contingent	Closed to stock, per TRP guidance.
60	Rock Camp	Lyell Canyon	2004-2010, 2012-2015	No	2006	Yes	Yes	None.
61	Rock Camp	Lyell Canyon	2004-2010, 2012-2015	No	2006	No	Yes	Camp removed from shapefile as this is a duplicate with Camp ID 60.

[1] Camp ID: Note that camp identification numbers have been retained from the “OperatorSpecifiedPriority” shapefile created by Gavette (2009). This has led to numbers that are not continuous and extend beyond the 130 camps listed in the table.

Table F-1 (continued). List of 130 stock sites considered by stock site evaluation interdisciplinary team (2013-2016) and current archeological clearance status (see also Wills 2016).

Camp ID[1]	Camp Name	Location	Reported Stock Use 2004-2015	Verified Location	Year(s) Evaluated	CUA Camp	Cleared by Archeology	Archeology Stock Use Program Recommendations
62	Upper Lyell Canyon Trail Camp	Lyell Canyon	2004-2015	Yes	2006	Yes	Sec 106	Closed to stock, per TRP guidance.
63	Echo Valley-Southeast	Echo Valley	2005, 2008, 2011	Yes	2010	No	Yes	This camp was removed from the stock camps shapefile. There isn't a site in this location and the area was surveyed in 2010. There has been a significant change in vegetation cover on the landscape, making this location unsuitable for stock groups.
64	Dorothy Lake Trail Camp	Jack Main Canyon	2006-2007	Yes	–	Yes	No	Needs to be visited by stock site evaluation group to determine adequacy of camp for use by stock groups.
65	Wilma Lake-East	Wilma Lake	2008, 2010-2015	Yes	2006, 2014	Yes	Contingent	Operators must use existing unloading/loading area, holding area, and fire ring.
66	Stubblefield Canyon Trail Camp	Stubblefield Canyon	2012-2013, 2015	Yes	–	Yes	Contingent	Stock use areas must remain outside of archeological sites.
67	Benson Lake	Benson Lake	2004-2015	Yes	2007, 2013, 2014, 2015	Yes	Yes	This is the primary camping option for any stock groups at Benson Lake.
69	Pate Valley Trail Camp	Pate Valley	2006-2009, 2011, 2013-2015	Yes	–	Yes	Contingent	Recommend relocating trail crew camp hearth to the fire ring at the south end of the archeological site area.
70	Harden Lake-East	Harden Lake	2006-2007	Yes	–	Yes	No	Verify location.
71	Harden Lake-West	Harden Lake	2006-2007	Yes	–	Yes	No	Verify location.

[1] Camp ID: Note that camp identification numbers have been retained from the “OperatorSpecifiedPriority” shapefile created by Gavette (2009). This has led to numbers that are not continuous and extend beyond the 130 camps listed in the table.

Table F-1 (continued). List of 130 stock sites considered by stock site evaluation interdisciplinary team (2013-2016) and current archeological clearance status (see also Wills 2016).

Camp ID[1]	Camp Name	Location	Reported Stock Use 2004-2015	Verified Location	Year(s) Evaluated	CUA Camp	Cleared by Archeology	Archeology Stock Use Program Recommendations
72	Yosemite Creek	Yosemite Creek	2006-2007	No	–	No	No	Removed from shapefile as this is a duplicate with Camp 102, which is a more accurate reflection of the camp location in this area.
73	Lower Grant Lake	Lower Grant Lake	None	Yes	–	Yes	No	Verify location.
74	Ten Lakes-West	Ten Lakes	2006-2007	Yes	2015	Yes	Yes	None.
75	Ten Lakes-East	Ten Lakes	2006-2007	Yes	2015	Yes	Yes	Ensure that stock use avoids archeological site.
76	Matterhorn Canyon-Junction Camp	Matterhorn Canyon	2004-2015	Yes	2007, 2013	Yes	Yes	None.
77	Matterhorn Canyon-North	Matterhorn Canyon	2004-2015	Yes	–	Yes	Yes	None.
78	McCabe Creek	McCabe Creek	2014-2015	Yes	–	Yes	Yes	None.
79	Long Meadow	Long Meadow	2012	Yes	2016	Yes	Yes	None.
81	Triple Peak Fork Trail Camp	Triple Peak Fork	2010, 2012-2014	No	2010	Yes	Yes	None.
82	Washburn Lake	Washburn Lake	2004-2006, 2008, 2010, 2013-2014	Yes	2010	No	Yes	Removed from shapefile as this is a duplicate site with Camp 35.
83	Echo Valley Trail Camp	Echo Valley	2005, 2008, 2011	Yes	2010, 2016	No	Sec 106	Echo Valley should be investigated to find an alternative camp.

[1] Camp ID: Note that camp identification numbers have been retained from the "OperatorSpecifiedPriority" shapefile created by Gavette (2009). This has led to numbers that are not continuous and extend beyond the 130 camps listed in the table.

Table F-1 (continued). List of 130 stock sites considered by stock site evaluation interdisciplinary team (2013-2016) and current archeological clearance status (see also Wills 2016).

Camp ID[1]	Camp Name	Location	Reported Stock Use 2004-2015	Verified Location	Year(s) Evaluated	CUA Camp	Cleared by Archeology	Archeology Stock Use Program Recommendations
84	Lyell Canyon Emergency Overflow Camp	Lyell Canyon	2004-2010, 2012-2013	Yes	2006	Yes	Yes	None.
85	Tilden Lake-South	Tilden Lake	2004-2006, 2008-2009, 2012-2015	Yes	2007	Yes	No	Verify location.
86	Tilden Lake-Northwest	Tilden Lake	2004-2006, 2008-2009, 2012-2015	Yes	–	No	Yes	Recommend removal from shapefile as this camp shows no sign of use, is too close to water, and there is a preferred alternative stock camp close by on north side of lake. This camp is more appropriate for backpacker use.
87	Kerrick Canyon	Kerrick Canyon	2004-2007, 2010, 2015	Yes	2007	Yes	Contingent	Move stock camp to coincide with trail crew camp and ensure access trail is routed around archeological site.
88	Jose's Camp	Lower Kerrick Meadow	2004-2009, 2012-2015	Yes	2013, 2015	Yes	Contingent	Reroute stock access trail and outside of archeological site.
89	Middle Kerrick Meadow	Kerrick Meadow	2004, 2014	Yes	2007	Yes	Sec 106	Should be visited in the future by stock site evaluation group to identify alternative in Middle Kerrick, or conduct Section 106 compliance at archeological site.

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Table F-1 (continued). List of 130 stock sites considered by stock site evaluation interdisciplinary team (2013-2016) and current archeological clearance status (see also Wills 2016).

Camp ID[1]	Camp Name	Location	Reported Stock Use 2004-2015	Verified Location	Year(s) Evaluated	CUA Camp	Cleared by Archeology	Archeology Stock Use Program Recommendations
90	Upper Kerrick Meadow-North	Kerrick Meadow	2004-2007, 2009, 2011-2015	No	2007, 2009, 2011, 2013	Yes	Contingent	Stock use should avoid archeological sites.
91	Matterhorn Canyon Trail Camp	Matterhorn Canyon	2004-2015	Yes	2013	Yes	Yes	Periodically monitor archeological sites.
92	Smedberg Lake-South	Smedberg Lake	2004-2005, 2007-2010, 2012-2015	Yes	2013	Yes	Contingent	Discontinue use of old access route, fire ring, and holding area, and make sure stock users use camp 120 m to the north.
93	Rodger's Lake	Rodger's Lake	2006-2007	Yes	–	Yes	No	Verify location.
94	Rodger's Meadow	Rodger's Meadow	2006-2007	Yes	–	Yes	Yes	None.
95	Benson Lake Trail Camp	Benson Lake	2004-2015	Yes	2007, 2009, 2013, 2014, 2015	Yes	Sec 106	Close camp/move holding area, use previously identified camp in central beach area, and change current stock camp location into just backpacker use. Perform additional archeological research if effects to archeological sites cannot be avoided.
96	Miller Lake	Miller Lake	2004, 2007-2010, 2012, 2014-2015	Yes	2013	Yes	Yes	None.
97	Hook Lake-North	Hook Lake	2004, 2008-2010, 2013-2015	Yes	2013	Yes	Yes	None.
98	Table Camp	Virginia Canyon	2013-2014	Yes	2006, 2007	Yes	Yes	None.

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Table F-1 (continued). List of 130 stock sites considered by stock site evaluation interdisciplinary team (2013-2016) and current archeological clearance status (see also Wills 2016).

Camp ID[1]	Camp Name	Location	Reported Stock Use 2004-2015	Verified Location	Year(s) Evaluated	CUA Camp	Cleared by Archeology	Archeology Stock Use Program Recommendations
99	Roger's Camp	Virginia Canyon	2004-2010, 2012-2014	Yes	2006, 2007	Yes	Yes	None.
100	Dorothy Lake-West	Dorothy Lake	2004-2006, 2008-2010, 2012-2015	Yes	2006, 2014	Yes	Sec 106	Move access trail and holding area to proposed locations outside of archeological site, regularly reduce fire ring and remove other rings, and perform additional archeological research if effects cannot be avoided.
101	Dorothy Lake-Southwest	Dorothy Lake	2004-2006, 2008-2010, 2012-2015	Yes	2006, 2014	Yes	Sec 106	Consider discontinuing use by stock groups, or perform additional archeological research if effects cannot be avoided.
102	Yosemite Creek	Yosemite Creek	2006-2007	Yes	–	Yes	No	Verify location is outside of archeological site.
103	Half Moon Meadow	Ten Lakes—Halfmoon Meadow	2006-2007, 2013	No	2015	Yes	Contingent	Reroute access trail around archeological site and ensure that unloading/loading areas and holding areas are not established within site boundaries.
104	Ten Lakes-East Lake	Ten Lakes	2006-2007	Yes	2015	Yes	Yes	Ensure that stock groups use camp on west side of lake and use recommended access route and proposed holding area to avoid disturbance to archeological sites.
105	Sunrise Creek Trail Camp; Camp Many Bears	Sunrise Creek	2005, 2011-2015	Yes	–	Yes	Yes	None.
106	Babcock Lake-South	Babcock Lake	2005, 2007, 2009, 2011	Yes	2007	Yes	Yes	None.

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Table F-1 (continued). List of 130 stock sites considered by stock site evaluation interdisciplinary team (2013-2016) and current archeological clearance status (see also Wills 2016).

Camp ID[1]	Camp Name	Location	Reported Stock Use 2004-2015	Verified Location	Year(s) Evaluated	CUA Camp	Cleared by Archeology	Archeology Stock Use Program Recommendations
107	Lower Ottoway Trail Camp	Lower Ottoway Lake	2004, 2008, 2013	Yes	2014	Yes	Yes	None.
108	Lower Merced Pass Lake	Lower Merced Pass Lake	2006-2007	No	2014	No	Contingent	Recommend removal from shapefile as actual camp is at Upper Merced Pass Lake at Camp ID 129.
110	Moraine Meadows	Moraine Meadows	2007	No	2007, 2014	Yes	Yes	None.
111	Upper Chain Lake-Northwest	Upper Chain Lake	2004, 2007-2008, 2012-2013	Yes	2014	No	Yes	Camp was removed from shapefile as there are no suitable overnight or drop camp locations here and only one camp was approved for use at Upper Chain Lake.
112	Middle Chain Lake-Southwest	Middle Chain Lake	2004, 2007-2008, 2012-2013	No	2014	No	Yes	Suitable for drop camp and ok for small groups with supplemental feed, but is not included in list of CUA camps.
113	Lower Chain Lake-East	Lower Chain Lake	2004, 2007-2008, 2010-2014	Yes	2014	Yes	Yes	None.
116	Royal Arch Lake	Royal Arch Lake	2004-2005, 2011-2013	Yes	2015	Yes	Yes	None.
117	Buena Vista Lake-West	Buena Vista Lake	None	Yes	2015	Yes	Yes	This is the preferred camping location for Buena Vista Lake.
118	Turner Meadow	Turner Meadow	2012	Yes	2007	Yes	Yes	None.
119	Illilouette Creek-East	Illilouette Creek	2006-2007	Yes	–	Yes	No	Verify location.

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Table F-1 (continued). List of 130 stock sites considered by stock site evaluation interdisciplinary team (2013-2016) and current archeological clearance status (see also Wills 2016).

Camp ID[1]	Camp Name	Location	Reported Stock Use 2004-2015	Verified Location	Year(s) Evaluated	CUA Camp	Cleared by Archeology	Archeology Stock Use Program Recommendations
120	Horsethief Canyon	Horsethief Basin	2007-2014	Yes	2007, 2014	Yes	Yes	None.
121	Paradise Meadow-South	Paradise Meadow	2005, 2012-2014	Yes	2007, 2014	Yes	Yes	Stock use not recommended for this location as the access route, fire ring, and camping areas are too close to water and the camp is covered in sensitive wet meadow vegetation.
122	Relief Camp	Virginia Canyon	None	Yes	2007	No	Yes	Stock use not allowed at this camp as of 2011 CUA.
123	Avalanche Camp	Virginia Canyon	2011-2014	Yes	2007, 2013	Yes	Yes	None.
124	Peninsula Camp	Lyell Canyon	2004-2010, 2012-2015	Yes	–	Yes	Yes	None.
125	Mattie Lake	Mattie Lake	None	Yes	–	Yes	No	Verify location.
126	Avonelle Lake	Avonelle Lake	None	Yes	–	Yes	No	Verify location.
127	Givens Lake	Givens Lake	2005-2008	Yes	2015	Yes	Yes	None.
128	Miwok Lake	Miwok Lake	None	Yes	–	Yes	No	Verify location.
129	Upper Merced Pass Lake	Upper Merced Pass Lake	2006, 2012, 2014	Yes	2014	Yes	Contingent	Delineate preferred access route and ecologically restore original access route to avoid disturbance to archeological sites.
130	Doc Moyle's	Lyell Fork of the Merced	2004, 2007, 2010-2014	Yes	2010	Yes	Yes	None.
131	Triple Peak Fork	Triple Peak Fork of the Merced	2010, 2012-2014	Yes	2010	Yes	Yes	Commercial use is appropriate using identified access route and fire ring.

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Table F-1 (continued). List of 130 stock sites considered by stock site evaluation interdisciplinary team (2013-2016) and current archeological clearance status (see also Wills 2016).

Camp ID[1]	Camp Name	Location	Reported Stock Use 2004-2015	Verified Location	Year(s) Evaluated	CUA Camp	Cleared by Archeology	Archeology Stock Use Program Recommendations
132	Tim's Camp	Jack Main Canyon	2013-2014	Yes	2014	No	Sec 106	Discontinue use of camp or conduct Section 106 compliance.
133	Turner Lake	Turner Lake	2010	Yes	2010	No	Yes	The camp should be removed from shapefile as it is outside of legal stock camp boundary (more than 1/4-mile from trail), and is too close to water (less than 100 feet).
134	Dorothy Lake-East	Dorothy Lake	2004-2006, 2008-2010, 2012-2013, 2015	No	2014	Yes	Yes	Make sure stock operators use approved camp location.
135	Hook Lake-South	Hook Lake	2004, 2008-2010, 2013-2015	Yes	2014	Yes	Yes	Secondary option at lake or should not be used to issues with access trail; no grazing in fen meadow.
136	Paradise Meadow-North	Paradise Meadow	2005, 2012-2014	Yes	2014	Yes	Yes	Primary camping option for Paradise Meadow area.
137	Paradise Meadow-West	Paradise Meadow	2014	Yes	2014	Yes	Yes	Second camping option in Paradise Meadow area.
138	Upper Kerrick Meadow-South	Upper Kerrick Meadow	2014-2015	Yes	2013	Yes	Yes	Primary camping option for Upper Kerrick Meadow.
139	Givens Meadow	Givens Meadow	2013	Yes	2014, 2015	No	Yes	Camp removed from shapefile as 1989 Wilderness Management Plan specified only six stock camps could be more than 0.25 mile from trail, and this camp is not one of those listed. The camp also shows no signs of use in 2014 or 2015.

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Table F-1 (continued). List of 130 stock sites considered by stock site evaluation interdisciplinary team (2013-2016) and current archeological clearance status (see also Wills 2016).

Camp ID[1]	Camp Name	Location	Reported Stock Use 2004-2015	Verified Location	Year(s) Evaluated	CUA Camp	Cleared by Archeology	Archeology Stock Use Program Recommendations
140	Lake Vernon Cabin	Lake Vernon	2006, 2008-2010-2014	Yes	2014	No	Yes	None.
141	Buck Camp	Buck Camp	2006, 2011, 2013-2015	Yes	2015	No	Yes	None.
142	Isberg Lake-East	Isberg Lake	2010-2015	No	2014	Yes	Yes	None.
143	Emeric Lake-Northeast	Emeric Lake	2004-2014	Yes	2014	Yes	Yes	Secondary camping option at Emeric Lake.
144	Dorothy Lake-Peninsula Camp	Dorothy Lake	2004-2006, 2008-2010, 2012-2015	Yes	2014	Yes	Yes	Preferred camping option at Dorothy Lake.
145	Merced Lake Ranger Cabin	Merced Lake	2004-2015	Yes	2010, 2014	No	Yes	None.
146	Smedberg Lake Trail Camp	Smedberg Lake	2004-2005, 2007-2010, 2012-2015	Yes	2013	No	Yes	None.
147	Smokey Jack	Cold Canyon	2004-2006, 2008, 2010, 2012-2015	Yes	2014	Yes	Yes	None.
148	Echo Lake	Echo Lake	2005, 2008	Yes	2008	No	Yes	Camp removed from shapefile as 1989 Wilderness Management Plan specified only six stock camps could be outside of 0.25 mile from trail, and this camp is not one of those listed.

[1] Camp ID: Note that camp identification numbers have been retained from the "OperatorSpecifiedPriority" shapefile created by Gavette (2009). This has led to numbers that are not continuous and extend beyond the 130 camps listed in the table.

Table F-1 (continued). List of 130 stock sites considered by stock site evaluation interdisciplinary team (2013-2016) and current archeological clearance status (see also Wills 2016).

Camp ID[1]	Camp Name	Location	Reported Stock Use 2004-2015	Verified Location	Year(s) Evaluated	CUA Camp	Cleared by Archeology	Archeology Stock Use Program Recommendations
149	Lewis Creek	Lewis Creek	2008	Yes	–	Yes	Contingent	Needs to be visited by stock site evaluation interdisciplinary team to determine adequacy of camp for use by stock groups.
150	Empire Meadows	Empire Meadows	None reported since 1960	No	–	Yes	No	Needs to be visited by stock site evaluation interdisciplinary team to determine adequacy of camp for use by stock groups.
152	Rock Island Pass Trail Camp	Rock Island Pass	2008, 2014	No	–	No	Yes	None.
153	Cathedral Lake	Cathedral Lake	2005, 2010-2015	Yes	2016	Yes	Yes	None.

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Appendix G – Prioritization System for Archeological Sites Requiring Section 106 Compliance of the National Historic Preservation Act.

Table G-1. Scoring system for prioritization of Section 106 of the NHPA.

Assessment Question	Explanation	Lower Scoring	Higher Scoring
What is the quality of site documentation?	Sufficient archeological data is necessary to develop and implement management recommendations.	Site documentation is robust and may include subsurface data.	Site documentation is minimal. Archeological surface or subsurface survey and a significant site record update are necessary to clarify alternative stock use locations.
What is the estimated data potential of the archeological site?	This considers the potential for the site to address important research questions, and if it contains unique or uncommon artifacts or features, and the amount of cultural material present.	The site has already been evaluated and recommended ineligible for the National Register. The site has very limited and non-sensitive cultural constituents.	The site has been evaluated and recommended eligible for the National Register, or it has the potential to address many significant research questions and is intact. The site has a large amount of cultural material, sensitive features, and/or contains unique features or artifacts.
What is the current and expected level of stock and visitor use on the site?	This considers how much stock use has been documented by the Yosemite Wilderness Office and Business Revenue and Management staff. Some locations are heavily used for their natural attractions and close proximity to popular access routes and park facilities.	There is little to no documented or expected stock or visitor use at this site.	Use in this location has historically been high and the camp is in an area that will continue to receive heavy use.
What is the level of documented and potential stock use disturbance to the site?	This considers if stock use disturbances have impacted the site or may in the future. Some sites are less susceptible than others to stock use disturbance, and the severity of disturbance varies.	There are little to no documented or anticipated stock or visitor use disturbances to the site.	The site has already been heavily disturbed, and use patterns of the area will increase site damage. There are features on the site that have a higher potential for visitor or stock use disturbance, such as abundant and easily visible stone tools, historical artifact scatters, and features that have been damaged.

Table G-1 (continued). Scoring system for prioritization of Section 106 of the NHPA.

Assessment Question	Explanation	Lower Scoring	Higher Scoring
Are there non-stock or visitor use disturbances that could be addressed?	There may be natural or park management/construction disturbances that give a site a higher ranking, particularly if there are significant threats or ongoing disturbances.	There are little to no other disturbances that need to be addressed.	Significant non-stock or visitor use disturbances have occurred or are expected to occur on the site (e.g. heavy erosion, hazard fuel buildup, fire, and proposed construction).
Are alternative stock use areas available?	If there is a suitable alternative stock use area that is not on an archeological site, the camp should be moved.	Alternatives are available and can be easily used by stock groups.	Current data suggest there are no alternative stock use areas in this location and disturbance of the archeological site will continue.
What is the feasibility of implementing site avoidance measures and will they be effective?	Even if an alternative camping option is available, if might be difficult to ensure that stock use is discontinued at the original camp. This could require creation of entirely new camp, complete with heavy ground disturbance to both establish stock use areas and obscure remnants of stock use at the old location.	Site avoidance measures can be implemented with minimal effort.	It will be very difficult or impossible to implement site avoidance measures, or the alternative stock use area will not be used without significant new ground disturbance. The camp is currently placed in the most sensible location for stock use, particularly areas surrounded by steep slopes or boulders, at trail junctions, or near the only good source of forage.

Table G-2. Prioritization score for archeological resources and stock use overlap at sites that have yet to be evaluated under Section 106 of the NHPA.

Camp ID	Camp Name	Site	Data Potential	Documentation Quality	Level of Use	Stock use Disturbances	Other Disturbances	Alternative Stock Use Area	Feasibility of Implementing Avoidance Measures	Total Score	Priority Rank
25	Gravelly Ford Trail Camp	CA-MAD-2295	3	2	3	1	2	4	3	18	4
83	Echo Valley Trail Camp	CA-MRP-0450	2	2	2	1	1	2	2	12	8
3	Miguel Meadows Cabin	CA-TUO-0023/80/148/H	5	3	2	1	4	3	3	21	3
132	Tim's Camp	CA-TUO-4294	3	2	2	2	2	2	2	15	6
100	Dorothy Lake-West	CA-TUO-4309	2	2	5	5	2	3	4	23	1
101	Dorothy Lake-Southwest	CA-TUO-4310	1	2	4	3	2	2	2	16	5
95	Benson Lake Trail Camp	CA-TUO-4312/H	2	2	5	4	2	4	3	22	2
89	Middle Kerrick Meadow	CA-TUO-4745	3	1	1	1	1	1	2	10	9
62	Upper Lyell Canyon Trail Camp	CA-TUO-4869	1	2	2	4	2	1	2	14	7

The Department of the Interior protects and manages the nation’s natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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