# Sierra Nevada Network Lake Monitoring Protocol

# SOP 1. Lake Monitoring Sites

*Version 1.00, May 2008*

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**Revision History Log**

| Previous Version # | Revision Date | Author | Changes Made | Reason for Change | New Version # |
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This SOP documents the extensive lakes selected for monitoring. Extensive sites were probabilistically selected using a generalized random tessellation stratified (GRTS) design that incorporated unequal inclusion probabilities. Inclusion probabilities were based on a cost-surface model that computes relative travel times to sites based on factors such as the presence of trails, vegetation type, and slope angle (Frakes et al. 2007). Data from GIS layers were used to compute the travel time across the park landscapes and for each site in the target population; the inclusion probability for each site is inversely proportional to this time. Lakes that are quicker to access (i.e. closer to trails and trailheads or accessed via 'easier' cross country terrain) had a higher probability of being selected. The revisit design is: a [(1-0), (1-3)] revisit design; sampling 25 lakes per year with 8 visited annually and 17 visited per year in the alternating panels. Please refer to the Protocol Narrative for a complete description of the sampling design.

We created a cost-surface model for each park following methods in Frakes et al. (2007). We drew the GRTS sample using the R workspace 'spsurvey' (Kincaid 2006). Original files, including the R code, sample frame data, input files, model output, GRTS output, etc., along with metadata are stored in the appropriate folders under the I&M directory structure.

Access routes will vary by year and depend on current backcountry conditions, suite of sites selected for the year, crews abilities, and the many logistical considerations (e.g., housing locations, crew schedules). Over the first four years as we visit the sites, we will create a file for each site that documents previous routes and provides helpful location information for future crews.

This SOP includes park cost surface maps (Figure SOP 1.1 and Figure SOP 1.2), site maps (Figure SOP 1.3 and Figure SOP 1.4), and a list of sites in table format (Table SOP 1.1). A large oversample was drawn. These sites are not listed in this SOP, but are available in the shapefiles. For detailed information and planning purposes refer to the GIS shapefiles and electronic maps.

## Literature Cited

Frakes, B., C. Hurst, D. Pillmore, B. Schweiger, and C. Talbert. 2007. Travel time cost surface model. Rocky Mountain Network, National Park Service, Fort Collins, CO.

Kincaid, T. 2006. User guide for spsurvey, Version 1.4 - Probability survey design and analysis function. http://cran.r-project.org/.

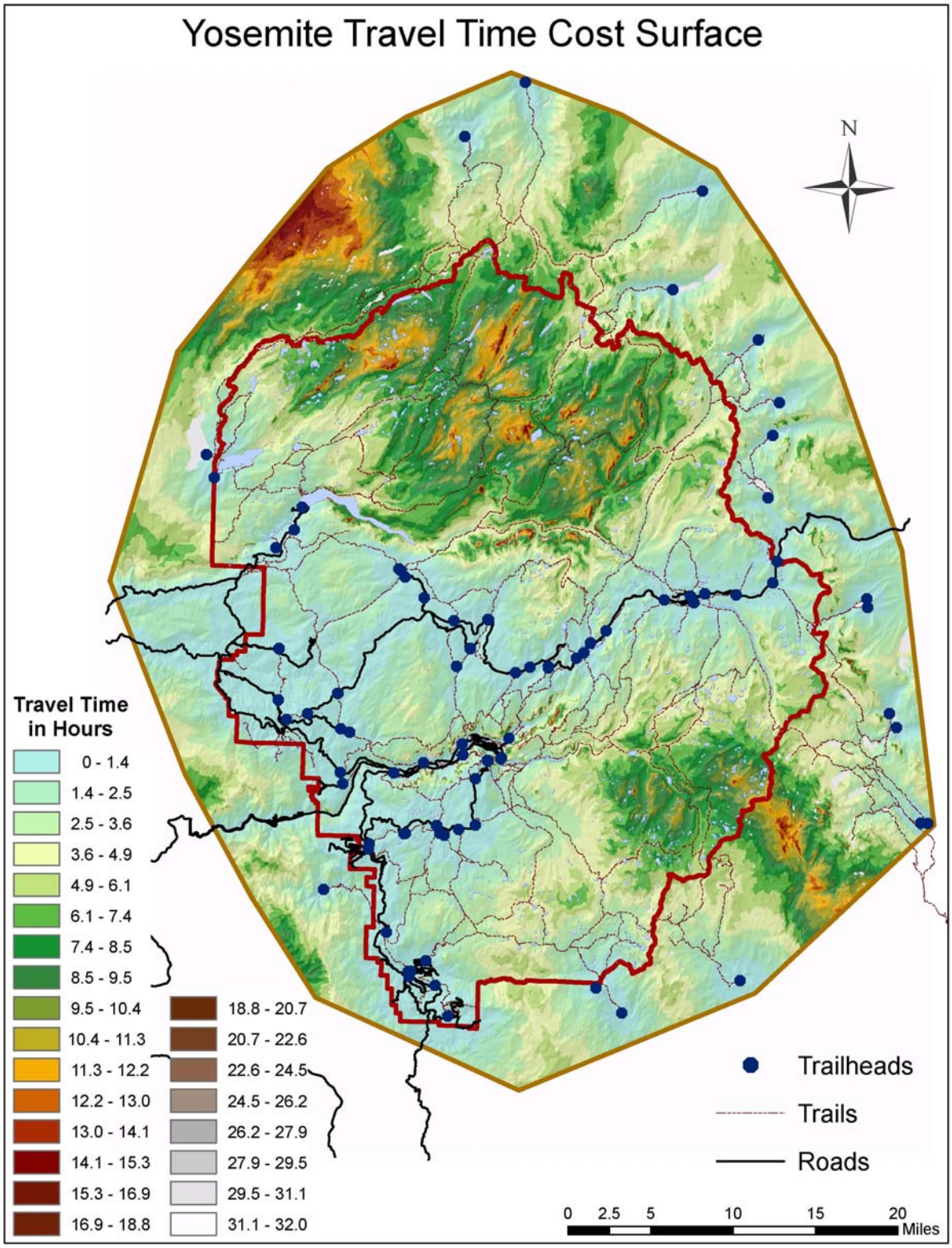


**Figure SOP 1.1.** Cost surface model for Yosemite. Travel times are relative and do not represent actual travel times to park locations.

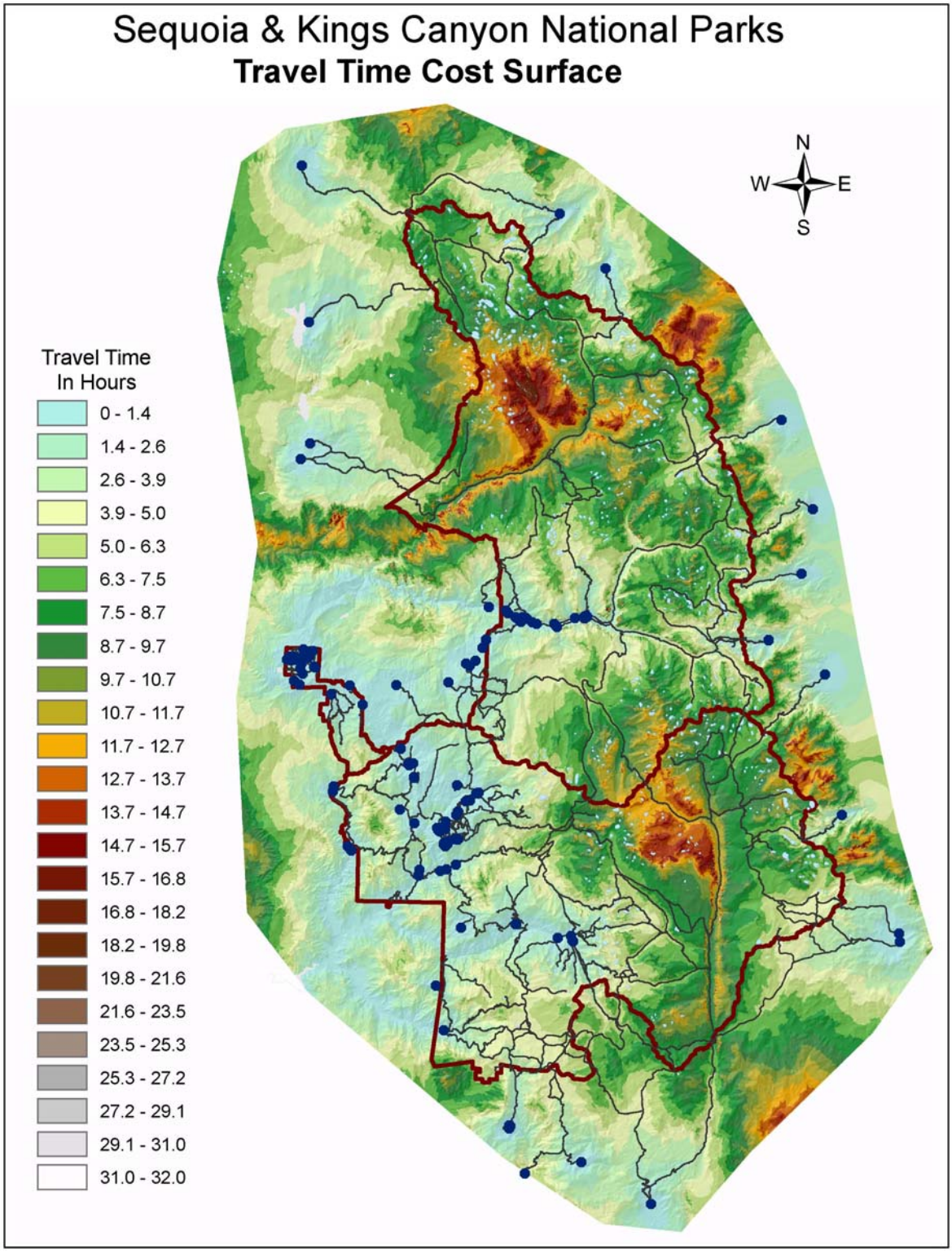


**Figure SOP 1.2.** Cost surface model for Sequoia and Kings Canyon. Travel times are relative and do not represent actual travel times to park locations.

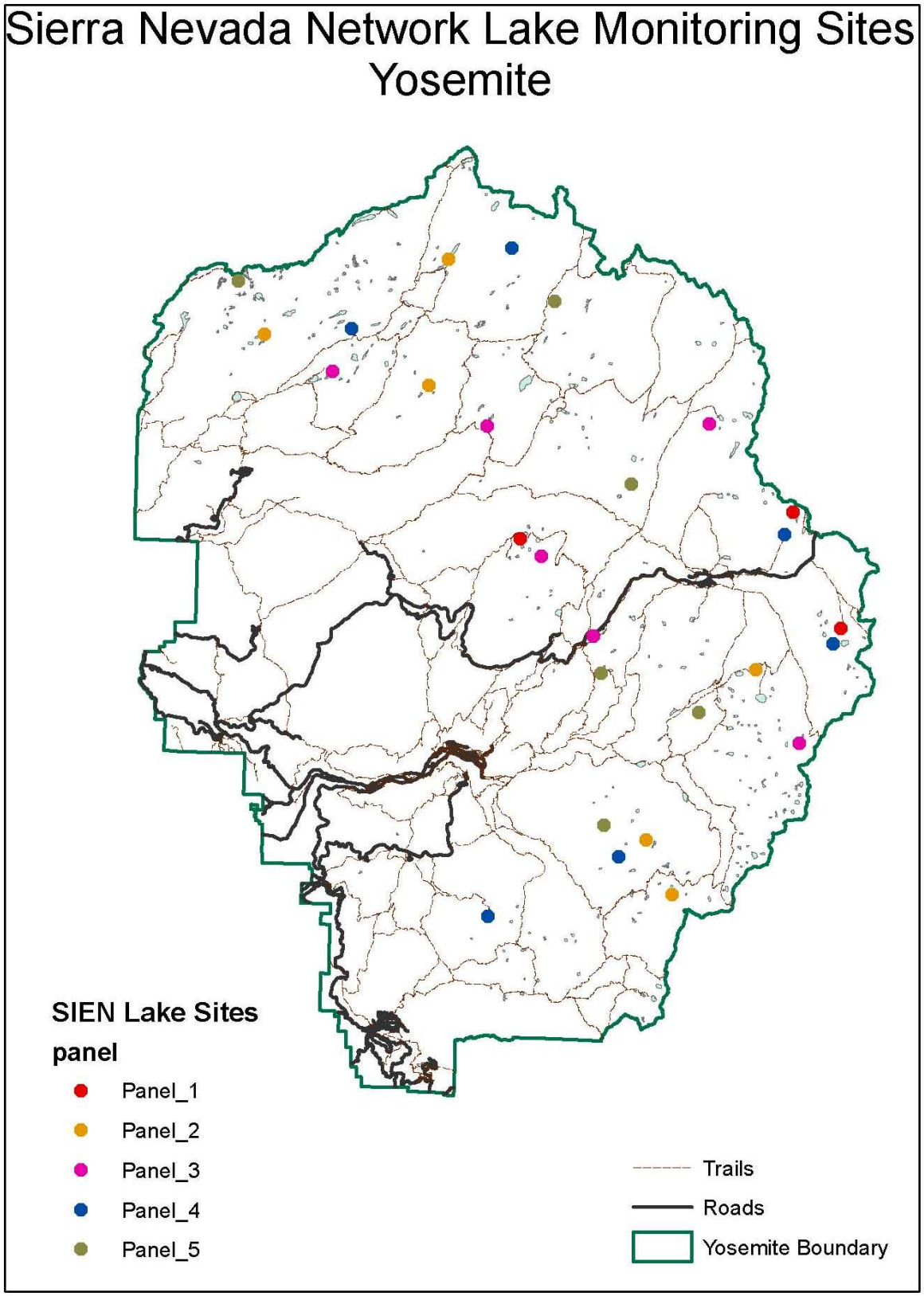


**Figure SOP 1.3.** Sampling locations in Yosemite.

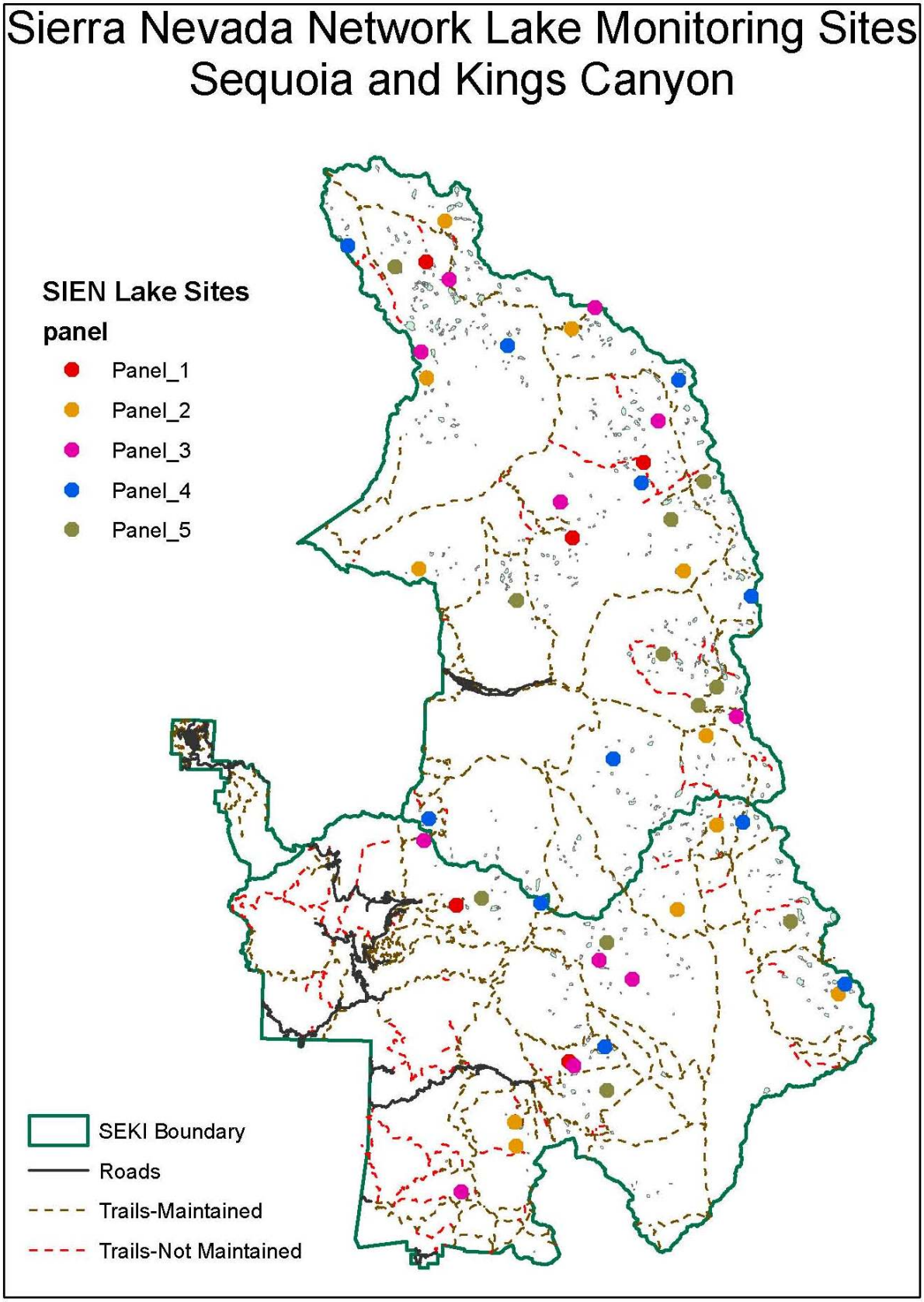


**Figure SOP 1.4.** Sampling locations in Sequoia and Kings Canyon.

**Table SOP 1.1.** Lake sites.

| Site Id | Lake Name | Panel | UTMx | UTMy | Elevation (m) |
|---|---|---|---|---|---|
| YOSE_Lake-001 | SPILLWAY LAKE | Panel_1 | 303562.89 | 4190559.06 | 2920 |
| YOSE_Lake-002 | GRANITE LAKE, UPPER | Panel_1 | 299668.88 | 4200048.47 | 1359 |
| YOSE_Lake-003 | TEN LAKES #3 | Panel_1 | 277537.76 | 4197878.36 | 3018 |
| SEKI_Lake-001 | | Panel_1 | 367530.51 | 4093892.54 | 3370 |
| SEKI_Lake-002 | McGee Lakes | Panel_1 | 346972.75 | 4112852.92 | 3297 |
| SEKI_Lake-003 | Spring Lake | Panel_1 | 360485.08 | 4037358.21 | 3066 |
| SEKI_Lake-004 | Aster Lake | Panel_1 | 349828.70 | 4052110.24 | 2774 |
| SEKI_Lake-005 | State Lakes | Panel_1 | 360792.08 | 4086801.18 | 3359 |
| YOSE_Lake-004 | EDNA LAKE, UPPER | Panel_2 | 289840.51 | 4168926.52 | 2946 |
| YOSE_Lake-005 | TILDEN LAKE | Panel_2 | 271742.56 | 4220597.89 | 2716 |
| YOSE_Lake-006 | | Panel_2 | 296669.24 | 4187239.80 | 2481 |
| YOSE_Lake-007 | | Panel_2 | 270111.09 | 4210333.14 | 2513 |
| YOSE_Lake-008 | ADAIR LAKE | Panel_2 | 287720.94 | 4173369.80 | 2960 |
| YOSE_Lake-009 | | Panel_2 | 256788.89 | 4214475.08 | 3274 |
| SEKI_Lake-006 | | Panel_2 | 347041.90 | 4101899.79 | 3444 |
| SEKI_Lake-007 | Sky Blue Lake | Panel_2 | 385954.47 | 4043798.59 | 3519 |
| SEKI_Lake-008 | | Panel_2 | 373450.75 | 4068171.80 | 3150 |
| SEKI_Lake-009 | | Panel_2 | 360723.18 | 4106526.45 | 3274 |
| SEKI_Lake-010 | | Panel_2 | 355476.78 | 4029431.01 | 3115 |
| SEKI_Lake-011 | | Panel_2 | 370678.69 | 4051762.76 | 3510 |
| SEKI_Lake-012 | | Panel_2 | 374456.83 | 4059695.92 | 3650 |
| SEKI_Lake-013 | | Panel_2 | 348773.94 | 4116650.78 | 3408 |
| SEKI_Lake-014 | Swamp Lakes | Panel_2 | 346272.31 | 4083889.54 | 2926 |
| SEKI_Lake-015 | Mosquito Lakes | Panel_2 | 355318.35 | 4031673.21 | 3018 |
| SEKI_Lake-016 | | Panel_2 | 371301.83 | 4083670.51 | 3150 |
| YOSE_Lake-010 | TENAYA LAKE | Panel_3 | 283456.51 | 4189939.05 | 2932 |
| YOSE_Lake-011 | TABLE LAKE | Panel_3 | 274831.14 | 4207034.24 | 2676 |
| YOSE_Lake-012 | | Panel_3 | 300193.79 | 4181260.42 | 3463 |
| YOSE_Lake-013 | | Panel_3 | 262312.40 | 4211474.27 | 2176 |
| YOSE_Lake-014 | | Panel_3 | 279261.75 | 4196424.30 | 2969 |
| YOSE_Lake-015 | | Panel_3 | 292902.04 | 4207218.86 | 2896 |
| SEKI_Lake-017 | | Panel_3 | 368889.94 | 4097801.26 | 3539 |
| SEKI_Lake-018 | | Panel_3 | 349159.39 | 4111198.84 | 3442 |
| SEKI_Lake-019 | Cyclamen Lake | Panel_3 | 360942.17 | 4036964.88 | 3188 |

Table SOP 1.1. Lake sites (continued).

| Site Id | Lake Name | Panel | UTMx | UTMy | Elevation (m) |
|---|---|---|---|---|---|
| SEKI_Lake-020 | Twin Lake | Panel_3 | 346743.08 | 4058212.01 | 2871 |
| SEKI_Lake-021 | Horseshoe Lakes | Panel_3 | 359686.78 | 4090199.01 | 3200 |
| SEKI_Lake-022 | | Panel_3 | 346479.42 | 4104358.64 | 3359 |
| SEKI_Lake-023 | Nine Lakes | Panel_3 | 363299.45 | 4046925.25 | 3481 |
| SEKI_Lake-024 | Kearsarge Lakes | Panel_3 | 376304.50 | 4069918.46 | 3220 |
| SEKI_Lake-025 | | Panel_3 | 362915.30 | 4108500.94 | 3627 |
| SEKI_Lake-026 | Hockett Lakes | Panel_3 | 350269.86 | 4025111.10 | 2615 |
| SEKI_Lake-027 | | Panel_3 | 366488.67 | 4045136.46 | 3510 |
| YOSE_Lake-016 | OSTRANDER LAKE | Panel_4 | 274920.68 | 4167212.31 | 3121 |
| YOSE_Lake-017 | | Panel_4 | 302942.38 | 4189358.42 | 3395 |
| YOSE_Lake-018 | GAYLOR LAKE, LOWER | Panel_4 | 299007.22 | 4198197.27 | |
| YOSE_Lake-019 | ARDETH LAKE | Panel_4 | 263836.17 | 4214915.61 | 2097 |
| YOSE_Lake-020 | | Panel_4 | 285535.23 | 4171995.53 | 2926 |
| YOSE_Lake-021 | | Panel_4 | 276861.90 | 4221514.43 | 2979 |
| SEKI_Lake-028 | | Panel_4 | 376904.04 | 4059978.77 | 3710 |
| SEKI_Lake-029 | | Panel_4 | 339565.22 | 4114392.01 | 3347 |
| SEKI_Lake-030 | | Panel_4 | 347207.51 | 4060304.98 | 2832 |
| SEKI_Lake-031 | Lonely Lake | Panel_4 | 357814.36 | 4052347.39 | 3287 |
| SEKI_Lake-032 | Stocking Lake | Panel_4 | 377673.73 | 4081316.28 | 3478 |
| SEKI_Lake-033 | | Panel_4 | 367309.96 | 4091976.55 | 3400 |
| SEKI_Lake-034 | | Panel_4 | 354691.77 | 4104919.94 | 3405 |
| SEKI_Lake-035 | Big Five Lakes | Panel_4 | 363862.18 | 4038755.82 | 3127 |
| SEKI_Lake-036 | Sphinx Lakes | Panel_4 | 364687.75 | 4065948.23 | 3205 |
| SEKI_Lake-037 | | Panel_4 | 370850.90 | 4101667.29 | 3545 |
| SEKI_Lake-038 | | Panel_4 | 386563.92 | 4044724.78 | 3750 |
| YOSE_Lake-022 | | Panel_5 | 292022.60 | 4183728.67 | 3383 |
| YOSE_Lake-023 | ARNDT LAKE | Panel_5 | 280325.17 | 4217173.42 | 2815 |
| YOSE_Lake-024 | | Panel_5 | 284330.76 | 4174596.07 | 2847 |
| YOSE_Lake-025 | | Panel_5 | 254690.67 | 4218806.83 | 2283 |
| YOSE_Lake-026 | SUNRISE LAKE, (X) MIDDLE | Panel_5 | 284111.08 | 4186919.94 | 2798 |
| YOSE_Lake-027 | MATTIE LAKE, LITTLE | Panel_5 | 286575.51 | 4202326.24 | 1518 |
| SEKI_Lake-039 | | Panel_5 | 364086.70 | 4048635.72 | 3469 |
| SEKI_Lake-040 | Charlotte Lake | Panel_5 | 372682.10 | 4070984.91 | 3165 |
| SEKI_Lake-041 | | Panel_5 | 373230.93 | 4092091.49 | 3478 |
| SEKI_Lake-042 | Granite Lake | Panel_5 | 355550.63 | 4080907.66 | 3076 |

Table SOP 1.1. Lake sites (continued).

| Site Id | Lake Name | Panel | UTMx | UTMy | Elevation (m) |
|---|---|---|---|---|---|
| SEKI_Lake-043 | | Panel_5 | 381447.70 | 4050627.73 | 3570 |
| SEKI_Lake-044 | Gardiner Lakes | Panel_5 | 369414.03 | 4075828.83 | 3214 |
| SEKI_Lake-045 | | Panel_5 | 344048.27 | 4112394.59 | 3455 |
| SEKI_Lake-046 | | Panel_5 | 364076.91 | 4034665.85 | 3310 |
| SEKI_Lake-047 | | Panel_5 | 352210.74 | 4052789.74 | 3139 |
| SEKI_Lake-048 | | Panel_5 | 374447.92 | 4072716.10 | 3450 |
| SEKI_Lake-049 | | Panel_5 | 370144.91 | 4088550.99 | 3469 |