Sierra Nevada Network
Inventory & Monitoring Program

Inventory and Monitoring Division
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The Sierra Nevada Monitor

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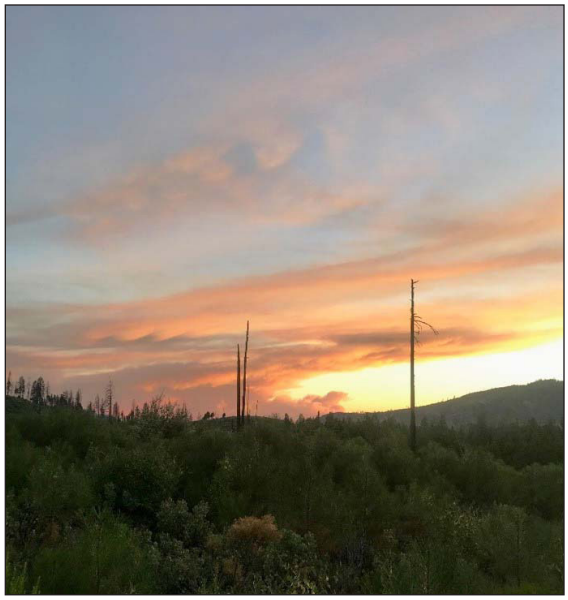
Snow, Water, and Fire Challenge Field Crews

Approaching the east side of Black Rock Pass, Sequoia National Park, July 23, 2017. Photo by Mandy Holmgren, The Institute for Bird Populations.



The Detwiler Fire created dramatic sunsets and logistical challenges in Yosemite. Crews relocated to Sequoia & Kings Canyon during the fire. Photo by Keven Griffen.

Keven Griffen, Geoscientist-in-the-Parks intern who joined the Sierra Nevada Network wetlands crew in 2017, highlights the flexibility required of field crews during a season with a record snowpack and multiple fire events.

Throughout this field season, the unusually high snowpack in the Sierra Nevada presented our monitoring crews with a number of challenges. Beginning in early June, when snowy conditions forced crews to delay their start dates, this season was a lesson in flexibility, one that I got to experience firsthand as the Geoscientist-in-the-Parks (GIP) Intern for the Sierra Nevada Network wetlands crew. Although each crew faced unique challenges based on the locations of our plots and the components of our protocols, we all came to more deeply appreciate the power of a strong Sierra winter as we shifted from Plan A, to Plan B, to Plan C and beyond in order to balance safety and accessibility with data collection priorities. For the Wetlands crew in particular, one of the most difficult limitations posed by the snowpack was the changes in phenology in many of our plots. Phenology—the study of the timing of biological events such as flowering—is an important component of the wetlands protocol, which includes identifying every plant species in our plots. Since many plants are difficult to identify without flowers, it is ideal (and more accurate) for us to arrive at a plot when the majority of the plants are in full bloom. Getting the timing right was more difficult this year due to snow covering our meadows until far later than normal—in fact, some of our plots were still not clear by early August. This snow cover reduced the amount of time that plants were able to grow and develop, delaying peak phenology by many weeks. Although we worked around this in most cases by simply targeting the lowest elevation plots first – the lower elevation plots generally had more time to melt out, allowing flowers to bloom and plants to

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What's Inside?

Snow, Water, and Fire Challenges

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fully develop – the delayed phenology kept us on our toes as we selected which plots to read throughout the summer.

Another common challenge was accessing our plots. With many trails in the high country buried under snow until mid-July, safe travel for our crews was a top priority. In early June, we had the opportunity to attend a Snow and Ice Travel training with wilderness rangers Rob and Laura Pilewski in the Mineral King area of Sequoia National Park, where we practiced the proper use of ice axes, crampons, and other traction devices. Although we don't cross snowfields requiring ice axes due to safety concerns, the training improved our skills in evaluating snowfields and crossing them safely when possible given the equipment we carry. Raging creeks and rivers blocked access to several high elevation areas for weeks, and this training also taught us how to assess potential stream crossing sites in order to cross safely if feasible.

A late summer snowstorm did not stop wetland crew members from installing a plot at Ribbon Meadow in Yosemite, but collecting the plant and invertebrate data has to wait until next season due to snow covering the plants! NPS photo: Roxanne Kessler.

An example of the high, powerful stream flows this season brought: the Conness Creek Bridge in Yosemite National Park washed 30 yards downstream from its original location. Photo by Mark Fincher, June 6, 2017.

When the snow finally began to disappear and the waters diminished, the final consequence of all that ice and water was fire – specifically, the Detwiler Fire near Yosemite, which took advantage of the explosion of plant growth that occurred during the wet winter and burned nearly 82,000 acres in July. Both the Wetlands and Forests crews were lucky to be able to escape the smoke by shifting our work to Sequoia & Kings Canyon while firefighters brought the blaze under control—just another average week in what was a very eventful season.

Looking back on my season as a Wetlands crew member, I am immensely proud of all that we accomplished. Despite the unusual circumstances, we continued to get out into the wilderness and to learn more about our wetland ecosystems each day. In our ongoing monitoring of vital signs in the Sierra Nevada, I'm hopeful that our hard work this season will help us to see the effects of this winter where it counts the most: in the data!

Join us for a day of birding
César E. Chávez National Monument

On Saturday, February 10th, Sierra Nevada Network staff are planning a birding event at César E. Chávez National Monument. We developed a draft bird checklist with data from an April 2016 BioBlitz event and eBird observations. We are looking forward to adding more winter birds to the list, and engaging local birders from communities near the monument and from network parks.

Please contact Linda Mutch at 559-565-3174 or linda_mutch@nps.gov to get on an Email list for this event.

Anna's Hummingbird in memorial garden, with gravesite of César Chávez in the background. Photo: © Susie King.

A New Phase: Beyond Protocol Development!

With the recent completion and approval of our River Hydrology and Wetlands Ecological Integrity monitoring protocols, the Sierra Nevada Network is celebrating moving to a new phase of our program — focused entirely on implementing and reporting on our monitoring projects.

These protocols cover the why, what, who, where, and when for the monitoring project, and they go beyond field data collection to data management, analysis, reporting, staffing & budget, and safety. The protocols went through a thorough peer review process. Many people beyond our current staff were involved in decision-making or development, including park staff, outside cooperators from other agencies and organizations, detailees, and former network staff. Too many to name here, we thank all of these people for their contributions. We do want to call out the first authors on each protocol who did a tremendous amount of work in developing the initial drafts: Jennie Skancke for the rivers protocol and Ed Gage for wetlands.

Current Sierra Nevada Network staff are feeling happy about moving beyond protocol development (L to R: Andi Heard, Sylvia Haultain, Linda Mutch, Alex Eddy, Jenny Matsumoto, and Jonny Nesmith. Photo by Anne Kelly.

Recent Publications, Protocols, and Reports

Jules, E. S., J. I. Jackson, S. B. Smith, **J. C. B. Nesmith,** L. A. Starcevich, and D. A. Sarr. 2017. Whitebark pine in Crater Lake and Lassen Volcanic National Parks: Initial assessment of stand structure and condition. Natural Resource Report NPS/KLMN/NRR—2017/1459. National Park Service, Fort Collins, Colorado.

Moore, P. E., O. Alvarez, **S. T. McKinney**, W. Li, M. L. Brooks, and Q. Guo. 2017. Climate change and tree-line ecosystems in the Sierra Nevada: Habitat suitability modelling to inform high-elevation forest dynamics monitoring. Natural Resource Report NPS/SIEN/NRR—2017/1476. National Park Service, Fort Collins, Colorado.

Pierson, E. D., and W. E. Rainey. 2017. Bat Inventory for Sequoia and Kings Canyon National Parks and Devils Postpile National Monument. Unpublished report to the Sierra Nevada Network Inventory and Monitoring Program, Three Rivers, California.

Rhodes, C., A. Bingham, **A. M. Heard**, J. Hewitt, J. Lynch, R. Waite, and M. D. Bell. 2017. Diatoms to human uses: linking nitrogen deposition, aquatic eutrophication, and ecosystem services. Ecosphere Special Feature: Air Quality and Ecosystem Services 8(7) DOI 10.1002/ecs2.1858.

Skancke, J. R., **A. M. Heard**, **L. Chow**, and **A. L. Chung-MacCoubrey**. 2017. Sierra Nevada Network river hydrology monitoring protocol: Narrative version 1.0. Natural Resource Report NPS/SIEN/NRR—2017/1518. National Park Service, Fort Collins, Colorado.

Whitebark pine on Gaylor Ridge, Yosemite. Photo: © Micahel Durham.

Foxtail pine near Timber Gap, Sequoia NP. NPS photo.

Managing for Persistence in Devils Postpile

Participants in the August 24-25 climate change refugium workshop included NPS staff from Devils Postpile National Monument, Sequoia & Kings Canyon National Parks, Yosemite National Park, the Sierra Nevada Network, and the Pacific West Region, along with scientists from academia, the US Geological Survey, and the US Forest Service. Photo by: Dan Cayan.

*Devils Postpile National Monument may harbor **climate change refugia**, or areas "relatively buffered from contemporary climate change that enable persistence of valued physical, ecological, and socio-cultural resources" (Morelli et al. 2016). Complex topography with steep slopes, valleys where cold air pools, deep snow drifts that provide late-season water, trees that shade the ground, large deep lakes, and cold groundwater sources can contribute to reduced rates of climate change in some areas.*

Over two perfect summer days in August, scientists, managers, and interns gathered at Devils Postpile National Monument to discuss climate change refugia management as an adaptation strategy. A shared passion for the Sierra Nevada and a strong resolve to understand and maintain the high biodiversity, ecosystem function, beauty, and wildness in a changing climate brought this group together.

With rugged topography and a steep elevational gradient, the Sierra Nevada harbors numerous potential climate change refugia. To begin exploring how to manage these areas and apply the seven-step Climate Change Refugia Conservation Strategy (Morelli et. al. 2016), Devils Postpile National Monument (described as, "large enough to be meaningful and small enough to be manageable" by Superintendent Deanna Dulen) was chosen as a case study.

Soda Springs Meadow has both physical and biological attributes including cold air pooling, a river fed by high elevation snow melt, complex topography and substantial tree canopy that may contribute to its potential as a climate change refugium. In addition, Belding ground squirrel (*Urocitellus beldingi*), a species that is extirpated from many other lower elevation sites, still occurs in Soda Springs Meadow.

Dulen opened the workshop remarking, "With the wealth of scientific partnerships at the monument and the manageable scale to plan and apply actions, the efforts here will contribute to scientific learning and provide reference studies which may be transferable to developing adaptation strategies for larger meadow systems."

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View of Soda Springs Meadow and the Middle Fork of the San Joaquin River in Devils Postpile. NPS photo.

Managing for Persistence

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Case Study Approach

Following the seven step strategy, the group focused on the overall purpose of the workshop, reviewed climate impacts and vulnerabilities, developed several management goals, discussed refugial features of the area, identified key features, summarized current and needed data, and brainstormed potential actions. Using the case study approach, the group discussed questions, extensively exploring desired goals and appropriate time scales to develop action plans.

For example, the group considered the effects of fire on the landscape and the necessity of integrating fire management strategies into the adaptation strategy in the short and long term. Actions discussed included reducing the risk of catastrophic fires in the adjacent forest, using fire as a tool for managing lodgepole pine migration into the shrinking meadow habitat, and restoring fire as a disturbance process on the greater landscape.

Obstacles

The group also discussed obstacles including lack of knowledge, resistance to experimentation, changing hydrology, catastrophic natural disturbance (e.g., severe wildfire), conifer encroachment (related to changing hydrology), encroachment of non-native or native species not usually found in meadows, effective monitoring, increasing visitor impacts, and politics. For example, with warmer and drier periods, non-native species such as Kentucky bluegrass (*Poa pratensis*) that are not currently a concern may expand in range and require management actions to maintain diverse wetland

Emphasis on Persistence

Most approaches to resource management focus on increasing resistance and resilience of species and habitats, but the group found that when thinking about climate change refugium management, the focus is more on persistence. Therefore, when managing these areas, scientists and managers alike have to think outside the box and perhaps be willing to get out of their comfort zone. In managing a climate change refugium for persistence we may intervene more than is typical. However, we need to acknowledge that at some point there may be a tipping point where our management actions to resist change may be too heavy-handed or are futile and we need to step back. As the team gathers more information and develops a 10 to 15 year action plan, we will use science to inform management but hope that management can also inform science for application on larger landscapes.

Shooting stars (*Primula jeffreyi*) in Soda Springs Meadow. NPS photo.

Exploring climate change impacts and adaptation strategies at Devils Postpile provides many opportunities for partners to join the monument staff in gathering and analyzing data, developing science communication materials, and reporting on the results. The lessons learned as the monument develops and applies an action plan will be invaluable to other land managers as they pursue climate change adaptation strategies.

— *Monica Buhler*
Natural Resource Program Manager
Devils Postpile National Monument

Sierra Nevada Network Ecologist Jonny Nesmith and Monica Buhler of Devils Postpile examine wetland plants. Jonny and SIEN Program Manager Sylvia Haultain assisted with planning and facilitation of this workshop, and also took advantage of their trip to Devils Postpile to re-read the network's wetlands monitoring plot in Soda Springs Meadow. NPS photo by Sylvia Haultain.

Detecting Rare Aquatic Animals with eDNA

by Colleen Kamoroff, Wildlife Biologist, Yosemite National Park and
Caren Goldberg, Assistant Professor, School of the Environment, Washington State University

Freshwater ecosystems make up only 0.01% of the Earth's surface, yet they contain 6% of described species. These ecosystems are experiencing a loss of biodiversity at a rate far higher than that of terrestrial ecosystems. A major cause of this biodiversity loss has been attributed to exotic invasive species. Successful management of exotic invasive species requires cost-effective, rapid, and accurate ways of detecting and identifying organisms. However, detecting organisms at low densities is a challenge that has limited our understanding of aquatic ecology, community structure, and species distributions, which are key components in the conservation and restoration of aquatic systems.

A promising tool for conservation

The analysis of environmental DNA (eDNA) for detecting rare vertebrates in aquatic systems is a promising tool for conservation and restoration projects. Species detection using eDNA methods is accomplished by the collection and identification of trace DNA particles, believed to originate from shed skin cells, feces, etc., that are extracted from water samples. Environmental DNA methods have been used to detect aquatic vertebrate species such as amphibians, freshwater fish, and invertebrates. In addition, the analysis of aquatic eDNA from filtered water samples can reliably detect target species even when the target specimen is rare or elusive. Environmental DNA can be a cost-effective alternative or complement to conventional methods of visual surveys, electro-shocking, or gill-netting, which can be time consuming, have low detection probabilities, and potentially harm both target and non-target species as well as the surrounding habitat.

eDNA and aquatic species management

The aquatic wildlife program in Yosemite National Park is constantly looking for new and innovate ways of detecting rare aquatic organisms to help determine habitat for elusive native species as well as early detection for invasive non-native species. They have teamed up with Washington State University to incorporated eDNA techniques into the aquatic wildlife program. The aquatics program has used eDNA techniques on multiple projects including Yosemite's high alpine lake restoration. All high montane lakes in Yosemite National Park have been stocked with non-native trout for recreational fishing. The introduction of salmonid species to historically fishless mountain lakes

Colleen Kamoroff collecting eDNA samples at a restoration site in Yosemite National Park. Photo by: Jessica Thompson.

has had devastating effects on native flora and fauna, particularly affecting amphibian populations. In Yosemite, non-native trout prey on the tadpoles of an endangered frog species, Sierra Nevada yellow-legged frog (*Rana sierrae*). To protect habitat for this amphibian, Yosemite National Park is removing fish from a subset of lakes that contain non-native fish (<10%). However, determining when a lake is free of fish is a time-intensive and laborious process. It entails delegating personnel to monitor lake gillnets and electro-shock inlets and outlets at backcountry sites for two consecutive years with no fish captures. The aquatics program is now using eDNA to help determine when lakes are devoid of fish and restoration is completed. Yosemite's aquatics program is also using eDNA to detect invasive and rare amphibians such as the invasive bullfrog, the endangered California red-legged frog, the foothill yellow-legged frog (under review for listing status), and an aquatic reptile, the western pond turtle.

Focus on Forests for Video Project

In addition to hiking to remote foxtail and whitebark pine stands to install or re-measure 28 forest plots, the forest monitors were also movie stars this season. Videographer Michael Durham visited Sequoia and Yosemite national parks in mid-September to film the crew in action in the field and conduct interviews of network and park staff. Sean Auclair, crew lead, and crew members Tressa Gibbard, Hanna Mohr, and Sam Zuckerman demonstrated plot installation and measurement with skill and enthusiasm. The Yosemite portion of the video highlighted whitebark pine, and an unusual early fall snowstorm gave us a chance to film these beautiful pines amidst new snow. This video is one of eight videos being developed in Pacific West Region networks this year. We look forward to sharing the final product in 2018.

Forest crew hiking through a foxtail pine stand in Sequoia National Park during the filming of the video. Photo: ©Michael Durham.

White Pine Blister Rust Re-survey

Biological Technician Jenny Cribbs supported data analysis and reporting on a white pine blister (WPBR) re-survey. Funded by the US Forest Service, this is a collaborative project among the Sierra Nevada Network (SIEN), the US Geological Survey, and the University of California-Berkeley to quantify change in the occurrence of WPBR in white pine populations. Jenny split her time between office data and reporting work and joining the crew for several sampling trips. She worked with the crew to complete fieldwork for the WPBR project as well as the 6th season of our forest monitoring project.

What have we learned so far?

To date, monitoring data suggest that the whitebark pine and foxtail pine populations in areas sampled in Sequoia & Kings Canyon and Yosemite currently have extremely low incidence of white pine blister rust and mountain pine beetle. While other lower elevation forests within the parks have experienced substantial mortality due to the significant drought that affected the southern Sierra Nevada 2012-2016, signs of significant mortality remained extremely rare in the subalpine.

Lake Monitoring Tenth Anniversary

Liz Bartholomew collects water samples at a lake in Sequoia and Kings Canyon National Parks. NPS photo by: Roxanne Kessler.

Liz Bartholomew and Rosa Cox, with help from the forest crew, completed our tenth season of lake monitoring this year. We took a well-deserved, planned break and only sampled the eight annual panel sites this season. This periodic resting of protocol sampling for a season is part of SIEN's long-term sustainability strategy. Trend analyses and a synthesis report are underway.

SIEN and Sequoia, Kings Canyon, and Yosemite national parks are partners in a recently funded collaborative project with the US Geological Survey to conduct algal bloom research on mountain lakes in the Sierra Nevada and Rocky Mountains. Algal sampling will occur at SIEN lake monitoring sites in 2018 and 2019 to better understand the spatial extent and variability of algal blooms and how these data relate to ongoing water chemistry monitoring.

Early Birds Find Winter Lingering

Our bird crews are the earliest to start the monitoring season, with their schedule tied to the breeding season of birds from May through July. Bird monitors Mandy Holmgren and Rosa Cox (Sequoia & Kings Canyon) and Graham Montgomery and Charlotte Cumberworth (Yosemite) sampled the lowest elevation sites first, but soon ran into sites that required snow travel to reach. While late-lying snow and high stream crossings prevented access to three sites, these crews were able to reach 94% of their sites, thanks to flexible logistics, staff with strong wilderness skills, and help from Dana Maurer and Rodney Seigel who sampled a site in Yosemite. Former bird monitors Liz Bartholomew and Stephanie Bartlett surveyed Devils Postpile.

Table 1 shows the five most common birds seen at each site this season. The similarities reflect similar habitats among the parks, and the differences partially reflect the parks' different elevation ranges.

Bird crew members Mandy Holmgren and Rosa Cox thrilled to reach Forester Pass, Sequoia & Kings Canyon. Photo: Mandy Holmgren.

Table 1. The five most common bird species detected in 2017 for each park, or set of parks for SEKI.

Parks	Five most common birds detected
Devils Postpile (DEPO)	Dark-eyed Junco Mountain Chickadee Steller's Jay Western Wood-Pewee Dusky Flycatcher/Fox Sparrow (tied)
Sequoia & Kings Canyon (SEKI)	Dark-eyed Junco Yellow-rumped Warbler Mountain Chickadee Western Tanager Steller's Jay
Yosemite (YOSE)	Dark-eyed Junco Yellow-rumped Warbler Mountain Chickadee Dusky Flycatcher Steller's Jay

A few of the reported rare bird sightings done in addition to monitoring transects included: Swainson's Thrushes singing in a cluster at an unusually high elevation in Yosemite, Black-backed Woodpeckers at both SEKI and YOSE, several observations of Black Swifts in SEKI and YOSE including the creative description from Graham – *large, dark, personal-pizza sized swifts with long curving wings and notched tails...* A Peregrine Falcon observation at SEKI described the bird's appearance, then said *it had prey in its talons and as it flew, it ripped out chunks of the body (fur? feathers? flesh?) and dropped them*. Birding is not for the squeamish.

This project is conducted as a partnership between The Institute for Bird Populations and the Sierra Nevada Network.

River Hydrology Monitoring Rolls Ahead

With the approval and publication of the Rivers Hydrology Monitoring Protocol, SIEN marked the first year of full implementation of this project. Devils Postpile and Yosemite staff and cooperators overseeing stream gages in parks play important roles in collecting, managing, and sharing data that SIEN will be reporting on. With warming temperatures and diminishing snowpack in recent decades, streamflow is of high interest ecologically within the parks and in the larger region that relies on snowpack and surface water for agriculture and urban water supplies.

Andi Heard takes discharge measurements in Yosemite. NPS photo by Jennie Skancke.

Wet Meadow or Fen?

Before the wetlands monitoring crew can install a new plot, they have to determine the type of wetland - whether it is a wet meadow or fen. To do this they examine a soil profile, among other characteristics.

A **fen** accumulates peat (decayed vegetation), and bits of grass and other plants are visible in the soil profile.

A **wet meadow** does not have peat but has high organic content. The soil can display color patterns (gray and pale yellowish brown) formed by oxidation and reduction of iron and/or manganese caused by saturated conditions in the soil.

Upper photo is a fen soil profile with fragments of decayed vegetation. Lower photo is from a wet meadow, showing the gray and brown/yellow soil colors. NPS photos.

Wetlands crew lead Roxanne Kessler and crew members Wesley Meyers, Stephanie Bartlett, and Keven Griffen visited a total of 17 sites (1 DEPO, 9 YOSE, 7 SEKI) to conduct re-measures, new installations, or scouting for future plot installations. They collected data on groundwater hydrology, macroinvertebrate communities, and plant species composition from 21 plots. See the article on page 1 by Keven Griffen to learn how snow, high water, and fire challenged sampling logistics!

With the approval of the wetlands protocol in August 2017, Ecologist Jonny Nesmith can direct more attention to data analysis and reporting in addition to preparations for next year's field season.

Inventories 2.0 Update

In 2016, the Inventory and Monitoring Division (IMD) began scoping for Inventories 2.0, the next generation of inventory activities. They reviewed available park Foundation documents to define the 30 potential inventory ***types***, reflecting the data needs of park managers and scientists.

They next conducted a survey of staff from parks, regional offices, and WASO to solicit feedback on the types of inventories identified. Over 800 individuals responded to the survey — two-thirds from parks — clarifying which inventory types were needed and by whom.

IMD led or coordinated 50 workshops to gather input on how Inventories 2.0 products would be used at the park, network, regional, and national levels. The Sierra Nevada Network had its scoping workshop in early May. Results of these workshops are being used to inform a plan describing the ten highest priority inventory needs and how they will be met. A draft of this plan is expected by late December 2017.

To learn more, National Park Service staff can watch a recording of the November webinar by Joe DeVivo, Deputy Chief for Science with the Inventory and Monitoring Division and the lead for this effort. This is an excellent webinar for learning about progress to date and what to expect in the coming months.

— Sylvia Haultain
SIEN Program Manager

Sierra Nevada Network

The Sierra Nevada Network is one of 32 National Park Service inventory and monitoring networks that monitor vital signs to assess the condition of park ecosystems and contribute to a body of scientific knowledge that informs park management decisions.

Parks in the network are:
*César E. Chávez National Monument (CECH)
Devils Postpile National Monument (DEPO)
Sequoia & Kings Canyon National Parks (SEKI)
Yosemite National Park (YOSE)

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*Established in 2012, César E. Chávez NM is not included in the vital signs monitoring program.