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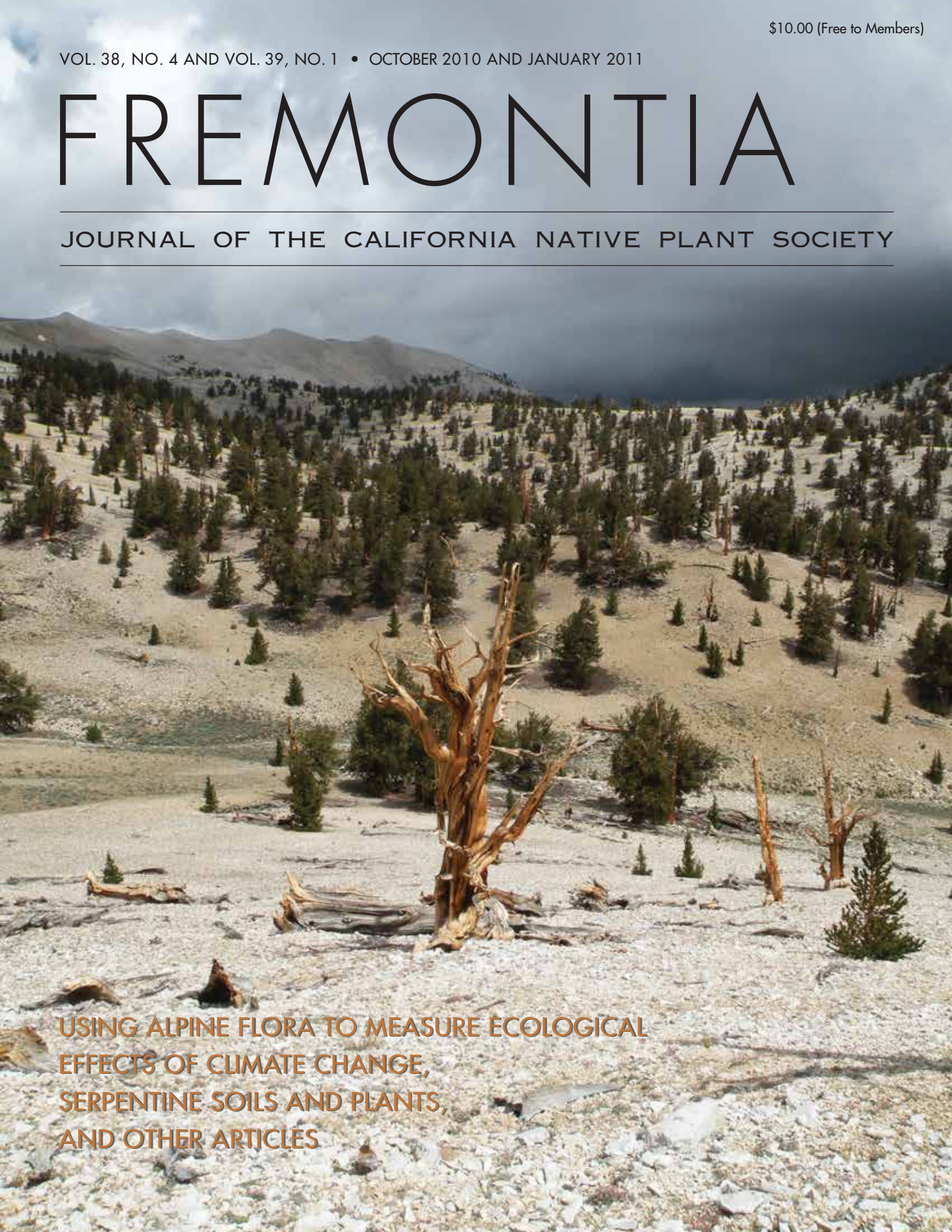


USING ALPINE FLORA TO MEASURE ECOLOGICAL EFFECTS OF CLIMATE CHANGE, SERPENTINE SOILS AND PLANTS, AND OTHER ARTICLES

MANAGING A MOUNTAIN: THE SAN BRUNO MOUNTAIN HABITAT CONSERVATION PLAN

by Patrick Kobernus

In 1982, the first Habitat Conservation Plan (HCP) in the nation was approved for San Bruno Mountain. Over the past 30 years most of the mountain, approximately 2,830 acres (82%), has been conserved as habitat for three endangered butterfly species, wildlife, and plants; and approximately 350 acres (10%) of the mountain has been developed. An additional 260 acres (8%) of land remains undeveloped, and it is likely that a majority of this land will ultimately be set aside as conserved habitat.[1] As of 2012, most of the development on the mountain has been completed.

Management of invasive species to protect the endangered species habitat on the mountain has been largely successful over the past 30 years. However, coastal scrub succession, in combination with expanding populations of invasive species, continue to overtake grassland habitat on the mountain. The future conservation of the endangered species and their habitats, now more than ever, depends upon implementation of a more comprehensive habitat management program to protect these species for future generations.

[1] Most of the remaining "unplanned parcels" will likely be conserved due to these lands being located on very steep slopes with no infrastructure (roads, utilities) for development. The HCP requires that a minimum of 40% of this land be dedicated as conserved habitat.

The San Bruno Mountain Habitat Conservation Plan—adopted in 1982 and the first HCP in the nation—is responsible for protecting host plants for three endangered butterflies, and conserving the area's diverse native flora and fauna. All photographs by the author unless otherwise indicated.

MOUNTAIN FLORA AND FAUNA

San Bruno Mountain is located in northern San Mateo County, adjacent to San Francisco. It consists of approximately 2,830 acres of open space, and is bordered by the urban and suburban portions of Daly City, South San Francisco, Colma and Brisbane. Though it is isolated by urbanization, the mountain is considered the northernmost part of the Santa Cruz Mountains.

The famed botanist James Roof asserted that San Bruno Mountain supports one of the last and the most expansive areas of a unique and highly diverse grassland and shrubland flora, which he referred to as "Franciscan" (Edwards 2000). This Franciscan

flora was once common throughout the hills of San Francisco but has been almost entirely destroyed in the city by development and planting of nonnative trees.

The grassland on San Bruno Mountain is actually a combination of different types of grasslands intergrading and sharing some of the same wildflower and shrub associates. Grassland types vary on the mountain depending on elevation, exposure, and soil type. The dryer southern exposures tend to have stands of purple needle grass (*Nassella pulchra*), while the more fog-shrouded grasslands near the summit are dominated by California fescue (*Festuca californica*), red fescue (*F. rubra*), and Idaho fescue (*F. idahoensis*). There are also stands of California oat grass (*Danthonia californica*), blue wild rye (*Elymus glaucus* var. *glaucus*), Pacific reed grass (*Calamagrostis nutkaensis*), June grass (*Koeleria macrantha*), and tufted hair grass (*Deschampsia cespitosa* ssp. *holciformis*).

As a biologist hired to monitor the three endangered butterfly species on San Bruno Mountain for 13 years, I can attest to its unique beauty. Each spring and summer, I would hike the mountain repeatedly while I recorded my observations of the mission blue, San Bruno elfin, and callippe silverspot butterflies, and the status of their grassland habitats.

The San Bruno elfin's host plant, Pacific stonecrop (*Sedum spathulifolium*), grows in coastal prairie and on rocky outcrops and roadcuts. The Callippe silverspot's host plant, Johnny jump up (*Viola pedunculata*), grows in coastal prairie and in nonnative annual grasslands. The mission blue's host plants, silver lupine (*Lupinus albifrons* var. *collinus*), varied-colored lupine (*L. variicolor*), and summer lupine (*L. formosus* var. *formosus*) grow within coastal prairie, nonnative annual grassland, rocky outcrops, roadcuts, and on cut slopes.

TOP: **A freshly emerged male mission blue butterfly (*Icaricia icarioides missionensis*), found in San Bruno Mountain's grassland habitat. It is an endangered species.** • MIDDLE: **A mission blue larva feeding on silver lupine (*Lupinus albifrons* var. *collinus*) on the west peak of San Bruno Mountain.** • BOTTOM: **A San Bruno elfin larva foraging on the flowerheads of its host plant, Pacific stonecrop (*Sedum spathulifolium*) near the summit of San Bruno Mountain.**

The mountain is not only home to three endangered butterfly species but also supports a wide diversity of other native flora and fauna. Many varieties of wildflowers can be found on the mountain, including coast rock cress (*Arabis blepharophylla*), Pacific stonecrop, varied-color lupine, Johnny jump up, goldfields (*Lasthenia californica*), shooting stars (*Dodecatheon hendersonii*), blue larkspur (*Delphinium decorum*), farewell to spring (*Clarkia rubicunda*), and owl's clover (*Castilleja densiflora*), among many others. Each patch of grassland is a uniquely beautiful "natural garden" that has been constructed through the forces of nature and time. Each March through June, the grasslands and wildflowers emerge and change into new combinations of color and beauty as the season progresses.

There are several rare plant species including two that are state and/or federally listed, San Bruno Mountain manzanita (*Arctostaphylos imbricata*) and San Francisco lessingia (*Lessingia germanorum*). There are also several California Rare Plant Rank 1B species (formerly CNPS List 1B) such as Montara manzanita (*Arctostaphylos montaraensis*), Pacific manzanita (*Arctostaphylos pacifica*), Diablo helianthella (*Helianthella castanea*), San Francisco spineflower (*Chorizanthe cuspidata* var. *cuspidata*), and San Francisco campion (*Silene verecunda* ssp. *verecunda*). Other rarities include an arachnid, incredible harvestman (*Banksula incredula*); a solitary bee (*Dufourea stagei*); and several range-limited endemic plants.

Plant communities on the mountain include northern coastal scrub,

coast live oak woodland, coastal terrace prairie, freshwater marshes and seeps, central coast riparian scrub, nonnative gorse and broom scrublands, nonnative eucalyptus forest, and nonnative annual grassland. The most dominant vegetation on the mountain is northern coastal scrub and nonnative annual grassland.

FIRST HABITAT CONSERVATION PLAN IN U.S.

Since 1982 the mountain has been the site of the first Habitat Conservation Plan (HCP) in the nation. HCPs were created as a mechanism to balance private property rights and endangered species protection, by allowing limited "taking" (destruction) of endangered species and their habitat, provided that the taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild, as specified in section 10(a)(1)(B) of the federal Endangered Species Act.

View of housing development and mission blue butterfly host plant, silver lupine (*Lupinus albifrons* var. *collinus*) on the southeast ridge of San Bruno Mountain. Development is no longer the most serious threat to the grassland habitat on the mountain. A greater threat is coastal scrub succession and the expansion of invasive species.

This mechanism has been used as a tool for settling land disputes by allowing landowners to economically develop portions of their properties, while simultaneously ensuring long-term protection of endangered species through dedication of conservation areas, habitat management and monitoring, and/or other mechanisms. As of 2010, over 700 HCPs have been permitted in the U.S. by the U.S. Fish and Wildlife Service (USFWS 2010).

The primary purpose of the San Bruno Mountain HCP is to protect the grassland habitat that supports the three endangered butterfly species, while allowing limited development to occur. Prior to the formation of the HCP, approximately 1,950 acres of land on San Bruno Mountain had been purchased and/or donated to create the San Bruno Mountain State and County Park. This land contained virtually the entire habitat for the San Bruno elfin butterfly on the mountain. However, it did not include the prime habitat areas for the mission blue and callippe silverspot butterflies, which were located on the eastern portions of the mountain.

The HCP provided a mechanism by which an additional 800+ acres of habitat would be conserved and added to the Park, and all of the conserved land within the park would be managed and monitored for the endangered species as well as for other native flora and fauna. Within the current 2,830-acre conservation area, approximately 90% of the mission blue and callippe silverspot butterflies' habitat, and 100% of the San Bruno elfin butterfly's habitat has been protected.

The development permitted through the HCP is primarily relegated to the lower slopes of the mountain, thereby protecting the majority of higher quality butterfly habitat on the upper ridges and hilltops. For the callippe silverspot, this was critical, because this species requires hilltops for mate selection. Male callippes stake out territories on the highest hilltops or ridgelines available to encounter and attract females for mating.

The conservation areas also included protection of several rare plant species, with the exception of most of the San Francisco lessingia and San Francisco spineflower populations, which are located on private property on the west side of the mountain. These populations are still extant, however development and invasive species are potential threats.

The HCP specified the importance of management and monitoring of the butterflies' habitat and provided a funding mechanism to support these activities—an annual monetary assessment on every residence and business that is built within the HCP boundary. This assessment rises with the annual inflation rate, and has provided a consistent level of funding since the creation of the HCP.

The HCP fund is managed by the HCP Trustees (the City Managers of Daly City, Brisbane, and South San Francisco, and the San Mateo County Manager). Monitoring and habitat management is implemented by San Mateo County Parks Department, and implementation of the plan is overseen by the U.S. Fish and Wildlife Service.

THREATS FROM INVASIVE SPECIES

In 1982, an assortment of aggressive invasive plant species were

identified and mapped on the mountain. Gorse (*Ulex europaeus*), the most aggressive of these plants, was introduced to the mountain in the 1930s and by 1982 had expanded to cover several hundred acres of the mountain. Based on the rate of expansion of this plant and that of other invasive weeds, combined with illegal off-road vehicle use and coastal scrub succession, it was estimated that the habitat for the endangered butterfly species on the mountain could be completely wiped out within 50 to 200 years (San Bruno Mountain HCP Steering Committee 1982).

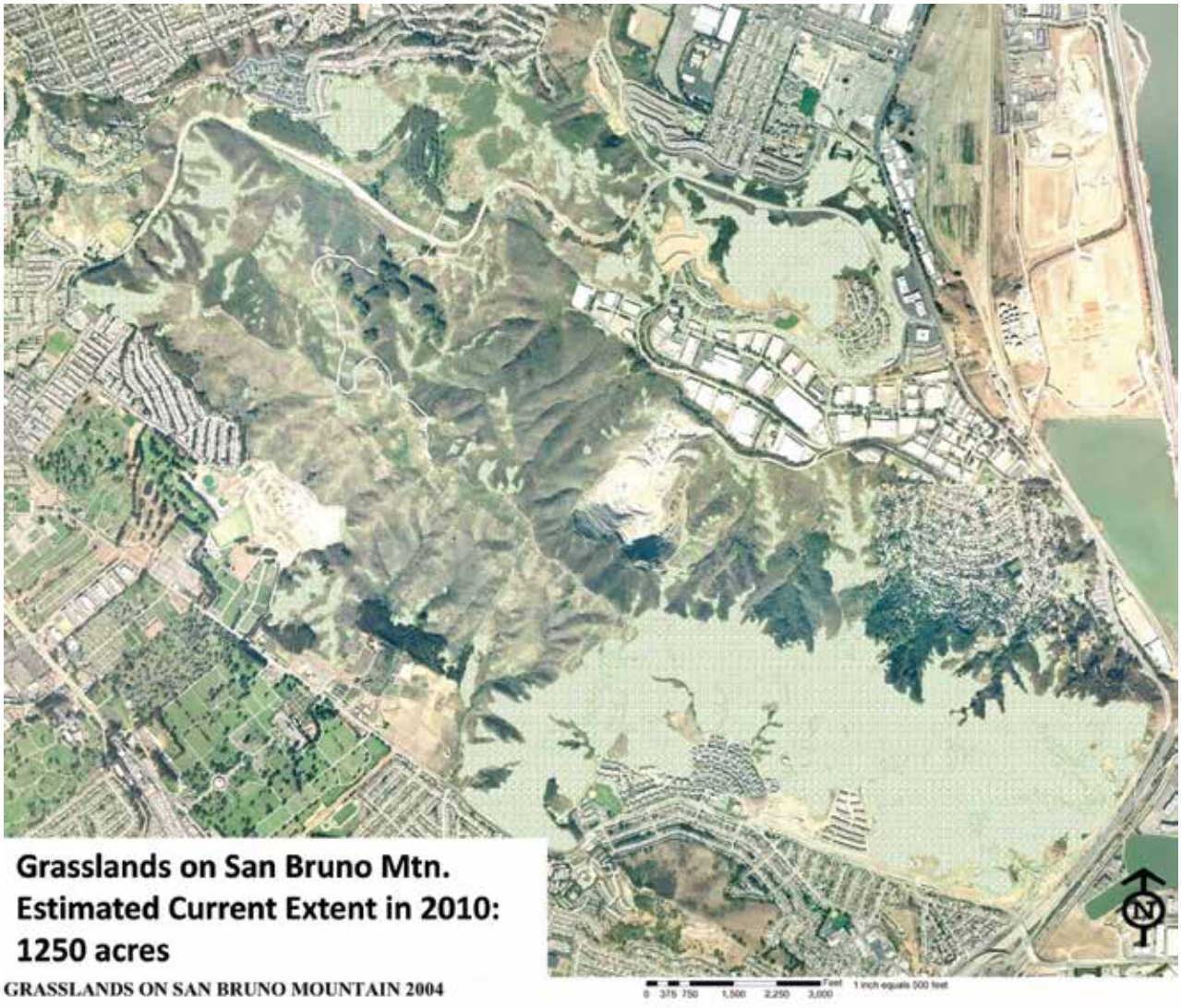
As a result, the funding and implementation of ongoing habitat management with an emphasis on controlling invasive species became an important component of the San Bruno Mountain HCP. Due to the lack of information on the feasibility of habitat restoration at the time of the inception of the HCP, the HCP's primary goal has been focused on the conservation and management of existing habitat for the butterflies (San Bruno Mountain HCP Steering Committee 1982).

Though the HCP has often been criticized for the lack of restoration work that has been conducted, the strategy of focusing efforts on protecting the existing habitat has proven to be successful in maintaining most of the habitat for the endangered species over the 30-year span of the HCP. While the reductions of large infestations has been effective, it is the less noticeable habitat maintenance work that is done year in and year out by HCP work crews and volunteer groups that serves to protect the majority of the butterfly habitat on the mountain.

HABITAT RESTORATION

Restoration of mission blue and callippe silverspot habitat is required by the HCP within areas that were disturbed by grading activi-

Extent of grasslands on San Bruno Mountain as mapped in 2004. Map produced by TRA Environmental Sciences and provided courtesy of San Mateo County Parks Department.



ties adjacent to the developments. These areas have steep slopes that were engineered to protect against landslides. Restoration of butterfly habitat has not been successful on most of these slopes, due to the difficulty in establishing native plants in poor soil conditions. This is especially true for the host and nectar plants for the callippe silverspot butterfly. Propagating and replanting of the callippes' host plant Johnny jump up has shown to be expensive, with very little success to date. Johnny jump up is difficult to grow under nursery conditions, and has had a very low survival rate when transplanted into restoration sites. For the mission blue however, its host plants (especially silver lupine) have been reestablished on several restoration slopes because these plants are adapted to disturbed rocky slopes with thin or poor soil conditions.

CURRENT THREATS AND MANAGEMENT

While efforts have been successful in reducing the large, woody invasive species on San Bruno Mountain, control work has been less effective at stemming the tide of coastal scrub succession. An independent analysis of almost 20 years of butterfly data collected over the course of the HCP revealed that the overall distribution of the mission blue and callippe silverspot butterflies remained stable. However, geographic areas of concern were identified for each species.

For the period between 1982 and 2004, San Bruno Mountain lost an estimated 122 acres (8.6%) of grassland habitat. This was primarily due to coastal scrub succession within the HCP conservation area (San Mateo County Parks Department 2008). This corresponds to a loss of over five acres of grassland per year. The expansion of coastal scrub vegetation and corresponding loss in grassland has been documented in many regions of California (Murray 2003, McBride and Heady 1968), and is often the result of the removal of grazing and/or burning from a grassland ecosystem.

Historically cattle grazing and brush burning by local ranchers resulted in the control of coastal scrub vegetation on San Bruno Mountain, but also facilitated the spread of invasive plant species. Invasive grasses such as ripgut brome (*Bromus diandrus*), velvetgrass (*Holcus lanatus*), and invasive herbaceous weeds such as fennel (*Foeniculum vulgare*), wild radish (*Raphanus sativus*), and oxalis (*Oxalis pes-caprae*) have proliferated because of the ability of these species to rapidly expand into grasslands (San Mateo County Parks Department 2008). Atmospheric sources of nitrogen pollution (smog) may also be contributing to the spread of these invasive grasses and weeds within the grasslands (Weiss 2006).

As more and more weeds proliferate and die back, the resultant accumulation of live and dead biomass (thatch) reduces the amount of light reaching the soil surface, suppressing the growth of native grassland plants. Increased moisture retention from the shade created by thatch may also facilitate the expansion of coastal scrub into the grassland areas. Furthermore, where invasive control work has been done for decades, there is a significant build-up of thatch from old stalks of fennel, broom, and gorse plants that were left to decay in place.

The level of thatch within the grasslands on San Bruno Mountain was evaluated in 2002 using live and dead above-ground biomass measurements. Values measured within the grasslands on the south slope of the mountain prior to experimental grazing treatments, showed live and dead above ground biomass levels of 5,000 to 9,000 lbs/acre. A large proportion of this was from thatch. As a comparison, the recommended ranges for Residual Dry Matter (live biomass) in coastal prairie grasslands with minimal woody plant cover ranges from 1,200 to 2,100 lbs/acre (UC Davis 2002).

The reduction in wildfires, removal of grazing animals in the early 1960s from the mountain, and atmospheric nitrogen pollution are all likely factors contributing to the proliferation of invasive plants, build-up of thatch, and brush succession on the mountain.

FUTURE MANAGEMENT

The San Bruno Mountain HCP has been an experiment—the first of its kind—to protect endangered species habitat while allowing limited development. For 30 years the plan has been a qualified success in that all three of the endangered butterfly species on the mountain continue to be locally abundant. However, management of the conservation areas will need to adapt to changing conditions and address problems such as coastal scrub succession and invasive weeds in a more comprehensive way. The 2008 San Bruno Mountain Habitat Management Plan spells out in detail the priority areas to protect, the current and emerging threats to the mountain's habitats, and the methods for monitoring and management to address these threats.

FACING PAGE, TOP: **Buckeye Canyon in 1986. This photograph was taken approximately 25 years after cessation of cattle grazing on San Bruno Mountain.** • BOTTOM: **Buckeye Canyon in 2006. This photograph was taken approximately 45 years after the cessation of grazing. Coastal scrub vegetation is overtaking grasslands at a rate of approximately five acres per year. Photographs courtesy of TRA Environmental Sciences and San Mateo County Parks Department.**

View of the ridge above Owl Canyon near the summit of San Bruno Mountain. The area contains prime grassland habitat, including native wildflowers and shrubs, for the Callippe silverspot and San Bruno elfin butterflies, both endangered.

Until 2010, threats to native habitats on San Bruno Mountain could not be addressed comprehensively given the existing management budget. However, as a result of an agreement reached between developers, the city of Brisbane, San Mateo County Parks Department, and the U.S. Fish and Wildlife Service, an additional four million dollars will be generated through development fees and placed into an endowment for the mountain. Once collected, these funds would increase the HCP annual budget for habitat management by two to three times its former level. These funds need to be used to manage more grassland areas on the mountain.

With accelerated changes expected to occur from global climate change, it is important to preserve as much potential grassland habitat as possible to buffer the endangered species from occasional large-scale declines in habitat quality. For example, in the extremely wet El Niño year of 1998, the numbers of mission blue butterflies on San Bruno Mountain declined markedly in areas where silver lupine was the dominant host plant. Silver lupine experienced a widespread die-off due to a fungal infestation brought on by the excessive wet soil conditions. This impact was observed throughout the range of the species (including the Marin headlands and at Twin Peaks, San Francisco).

In contrast, habitat areas on San Bruno Mountain that supported the alternative host plant summer lupine were unaffected by the fungus, and mission blue butterfly numbers in these areas remained stable. In the subsequent 14 years, silver lupine plants have rebounded significantly, as have the mission blue numbers in the areas impacted by the fungus. Protecting areas of different habitat quality, slope aspect, and within different microclimates is important because habitat quality can be expected to fluctuate over time, due to plant senescence and climatic factors, and these fluctuations may become more extreme in the future.

While prescribed burning may continue to be difficult to imple-

ment on San Bruno Mountain due to public safety concerns, grazing and/or mowing should be implemented to reduce vegetation fuel loads between parkland areas and homes and businesses. Stewardship grazing or mowing of 100–500-foot buffer zones on regular intervals would reduce fuel loads near populated areas and could potentially allow for the safe use of controlled burns in some areas of the mountain. Also, grazing or mowing within lower elevation areas between parklands and developments would not impact the more intact stands of coastal prairie, which are more concentrated on the upper slopes of the mountain.

Grazing, mowing, and/or burning will need to be applied to address scrub succession and invasive weed infestations on San Bruno Mountain. These tools will need to be used in combination with other weed control methods to manage areas effectively. There must be a prescriptive approach that is tailored in timing, duration, and frequency to each area of the mountain, depending upon the grassland type, surrounding terrain, presence of rare and endangered species, and public safety concerns.

CONCLUSIONS

Over the years, the San Bruno Mountain HCP has received a substantial amount of criticism from environmental groups regarding the lack of successful habitat restoration on the mountain. In contrast, resource managers have emphasized the positive aspects of the HCP and how it has worked to protect the endangered species habitat and native plant communities. The reality is that both groups are right. The restoration work has been largely unsuccessful on the graded slopes, while the habitat management has been successful in protecting the endangered species populations within the conservation areas.

The primary focus of environmental groups has been on fighting development on San Bruno Mountain, under the assumption that development is the major threat to the endangered species. In reality, though, the permitted development has impacted approximately 10% of the mountain and was relegated to lower slopes, generally of lesser habitat value. The development is now nearing completion. The only way to protect the endangered species and the plant communities of San Bruno Mountain for future generations will be to manage the remaining conserved habitat more effectively.

The 2008 Habitat Management Plan for San Bruno Mountain established a goal of maintaining between 1,200–1,800 acres of native and non-native grassland on the mountain. Currently the area of grassland is approximately 1,250 acres, but it is decreasing at a rate of approximately five acres per year. Slowing the rate of coastal scrub succession and increasing the amount of grassland will require that brush control programs be implemented sooner rather than later.

The San Bruno Mountain story is not unique: brush succession and invasive species have been negatively impacting grasslands and meadows throughout California for several decades. The San Bruno Mountain HCP is unusual, however, in that it has had a mandate and funding to address these issues for 30 years. It will take a coordinated effort on the part of biological monitors, habitat managers, oversight agencies, environmental groups, and the community to work cooperatively and creatively to ensure that the mountain's endangered species and unique Franciscan flora are protected for the next 30 years.

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