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CAN WE CREATE A SUSTAINABLE FUTURE?

CONSERVATION AT CALIFORNIA'S EDGE

THE CONSORTIUM OF CALIFORNIA HERBARIA

THE RUSSIAN WILDERNESS:
A LEGACY CONTINUED



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PLANT SOCIETY

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Since 1965*

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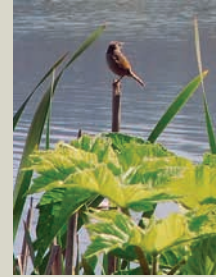
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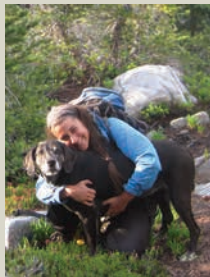


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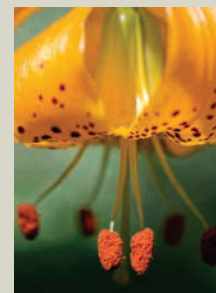
The Consortium of California Herbaria (CCH) has helped bring herbaria into the 21st century and join the global effort to share data that was formerly stored only in collections. CNPS members play an important role in the CCH, and by doing so contribute to conservation and education efforts focused on the California flora.



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In 1969 Humboldt State University (HSU) professors John Sawyer and Dale Thornburgh conducted over 200 vegetation surveys cataloging the plant diversity of the Klamath Mountains in an area known as the “Miracle Mile.” Forty-five years later a group of graduate students and colleagues at HSU resampled the plots to examine how this biodiversity hotspot may be changing due to a warming climate and fire suppression.

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THE COVER: Researchers from Humboldt State University camp out next to Little Duck Lake in the Russian Wilderness to resurvey vegetation plots first established by John Sawyer and Dale Thornburgh in 1969. The lake is located within the “Miracle Mile” that contains the highest diversity of conifers recorded in the world (18 species). Photograph by James Adam Taylor, 2014.



Water purification, Arcata Marsh. Arcata uses restored and constructed native wetland communities to help filter contaminants and treat the city's wastewater before discharge into Humboldt Bay. The marsh, which is on the Pacific Flyway, has hosted over 300 bird species. Photograph by Leslie Scopes-Anderson of the Arcata Marsh and Wildlife Sanctuary.

SAVE THE PLANTS, SAVE THE PLANET, SAVE OURSELVES: CAN WE CREATE A SUSTAINABLE FUTURE?

by Emily Brin Roberson

At the 2015 CNPS Conservation Conference in San Jose, three of the Progress and Promise presentations were notable for the unusual themes they shared. They called upon CNPS to acknowledge and act upon problems that might



Illustration from op-ed by Douglas Tallamy from the New York Times, March 11, 2015, symbolizing the central role of plants to the web of life. Permission to reprint courtesy of Courtney Wotherspoon, spoonstudio.com/index.html.

seem outside the scope of native plant supporters and researchers: 1) the fact that human population growth and overconsumption are rapidly destroying the environment, and 2) the need to fundamentally restructure our societies and economies if we are to avoid adding ourselves to the list of species whose imperilment or extinction we have caused.

Acclaimed science fiction writer Kim Stanley Robinson, distinguished author and ecologist Paul Ehrlich, and celebrated botanist Peter Raven all presented grim and sobering analyses of the state of our species

and our planet. Runaway overconsumption, population growth, climate change, toxification of air, soil and water, and loss of biological diversity were all cited as leading to a seemingly inevitable demise of the human race and many other species. All three speakers asserted that only profound changes to our economy and society can avert the coming disaster.

I interviewed these speakers to explore their ideas and seek guidance about how native plant enthusiasts can fight the trends that are endangering our planet, our flora, and ourselves.

OVERPOPULATION

All three speakers stressed that there are simply not enough resources to support continued population growth. Paul Ehrlich wrote the landmark *The Population Bomb* in 1968, calling attention to the population explosion and its threats to human survival. In 1968, according to the US Census, the global population was about 3.5 billion. By the year 2000 it had grown to about 6 billion. Today the earth supports 7 billion people, every one of whom uses space, water, food, fiber, and air, and produces waste.

Increasing greenhouse emissions and climate change are among the many destructive consequences of population growth. Globally, 2014 was the warmest year on record; 14 of the last 15 years were the warmest in history. Certainly no one living in California can fail to notice the changes in our weather and consequent impacts to plants and wildlife. Raven noted that some predictions have the world warming to a “virtually uninhabitable” level by the end of this century.

LOSS OF BIOLOGICAL DIVERSITY AND ECOSYSTEM SERVICES

Loss of biological diversity and ecosystem services also follow overpopulation. As the number of humans increases, we expand into more land in search of resources and space. We displace other species, take over their habitats, and inexorably reduce genetic and species diversity. This weakens the ability of the biosphere, particularly native plants, to deliver the ecosystem services humans require for survival.

A March 11, 2015 *New York Times* op-ed by ecologist Douglas Tallamy described plants as follows:

Plants are as close to biological miracles as a scientist could dare admit. After all, they allow us

and nearly every other species to eat sunlight, by creating the nourishment that drives food webs on this planet. As if that weren't enough, plants also produce oxygen, build topsoil and hold it in place, prevent floods, sequester carbon dioxide, buffer extreme weather, and clean our water (Tallamy 2015).

These are only some of the ecosystem services that Ehrlich and others have called our “life support system.” Native plant communities also buffer our climate and sustain our food and water supplies through pollination, pest control, water purification, groundwater recharge, and nutrient cycling, among other processes. According to Botanic Gardens Conservation International, worldwide over half a billion people who live in poverty depend directly on wild plant resources.

As we lose biological diversity we destabilize these services and the communities that depend upon them. Raven and Ehrlich both referenced the “Biodiversity-Stability Paradigm.” Studies at Stanford's Jasper Ridge, the University of Minnesota, and elsewhere (e.g., Tilman and Downing 1994, Schulze and Mooney 1994) demonstrate that diverse native ecosystems are more resilient under stress than homogeneous ones. In diverse ecosystems, many species are capable of performing similar functions. As the environment fluctuates—during an historic drought, to pick a random example—different locally adapted species are able to step in and maintain ecosystem function. Healthy diverse native ecosystems are more likely than damaged or fragmented ones to be climate-resilient, to reliably deliver ecosystem services when environmental conditions change. As we lose diversity, we not only lose part of our life support system, we weaken what remains, compromising the stability of such necessities as food and water supplies.

CONSUMPTION, GROWTH, AND INEQUALITY

The speakers all stressed that population stabilization alone cannot stop the demise of the biosphere. The ways we use and distribute resources also must change. All spoke vehemently about the necessity to curb overconsumption and exploding economic inequality.

Our current economy depends on consumption, often of more than we need or of things we do not need at all. We celebrate wealth as a virtue. People proclaim their “success” through excess. The few who can will buy the biggest cars, smallest computers, and newest gadgets, while their discards overflow the landfills. This occurs with little thought given to reasons or consequences. As Raven put it, many think that if they buy the products advertised on Thursday night football, all is well in their lives.

Similarly, the success and stability of nations and industries is measured by “growth,” each unit of which, by definition, reflects increased consumption of resources and increased generation of waste. Each speaker reiterated that the current rate of consumption and waste production already exceeds the carrying capacity of this planet.

Ehrlich and Robinson both referenced the Global Footprint Network (GFN) (footprintnetwork.org/en/index.php/GFN/), which compares available resources with humans' consumption of them. Raven pointed out that the Global Footprint Index calculates that we are currently 50% over-capacity, or as the GFN website explains, “It now takes the Earth one year and six months to regenerate what we use in a year.”

This orgy of consumption is not producing health or security for most people. Raven noted that at least 100 million people are so malnourished as to be on the verge of starvation, while at least 800 mil-

lion are suffering physically and mentally from lack of food. That is because our resource use is not merely excessive, it is fundamentally unequal. Different nations, classes, races, and genders control and consume vastly different amounts of resources and produce widely varying levels of waste.

The problem is that we do not share resources—we compete for them. Raven described human society as in “a hunter gatherer mode where those who are stronger [simply] get more, and that is not questioned [by society or its leaders].” As a result, the richest one percent of the population today control nearly half the world’s wealth. Meanwhile, as Raven noted, half the people in the world—three bil-

lion, mostly in Asia and Africa—live on less than \$2 per day. And inequality is accelerating. According to Oxfam (oxfam.org)—a confederation of 17 organizations working around the world to find solutions to poverty and injustice—the share owned by the wealthiest one percent has increased by fully 10% since 2009.

THE WAY FORWARD: CONSERVING BIOLOGICAL DIVERSITY

The speakers agreed that conservation of our remaining biological diversity is necessary for a sustainable future. We need to conserve and restore native ecosystems to sus-

tain the life-supporting services they supply. They emphasized that conservation of biodiversity is also needed to allow us to repair the damage we have done to the biosphere. Our remaining biological diversity contains the tools to rebuild or restore damaged ecosystems.

Native plant communities and ecosystems are invaluable, irreplaceable reservoirs of ecosystem services, genetic diversity, and information. Native plants and animals have evolved to exploit local soils, geology, and microclimates. Site-specific adaptations have allowed them to withstand fluctuating conditions over many thousands of years. If we ever achieve a society where restoration of ecosystems and their services becomes a priority, we must



Mature coast redwood forest, Humboldt County. Native plants are specifically adapted to local conditions such as fire regime, soils, and microclimate. They are more likely to survive stresses such as climate change and help ecosystems reliably deliver critical services such as pest, flood and landslide control, carbon sequestration, and pollinator habitat. Photograph by Gordon Leppig.

have sources of the locally adapted species and ecotypes that are the building blocks of those communities. Robinson noted:

Imagine the world 1,000 years from now. Will humans be gone?...What will they use to do landscape restoration and steward a healthy biosphere? Many things, but those native plant communities that haven't gone extinct will be a big part of their efforts.

Ehrlich cited conservation pioneer Aldo Leopold, who famously advised land and ecosystem managers that "to save all the pieces" "is the first precaution of intelligent tinkering." Clearly, what has been happening on this planet is neither intelligent nor mere tinkering, but that only increases the importance of saving as many "pieces" as possible. For this reason, the speakers said that conservation of native species and communities at all scales is needed, from the garden to the watershed. All agreed that one source of hope is in the many efforts underway around the world to conserve and restore native species and ecosystems, including, notably, those of CNPS.

EQUITY VS. COMPETITION: THE "POST-CAPITALIST" ECONOMY

However, the speakers also emphasized that we will never effectively conserve or restore the biosphere without basic change in our societies and economies. Society's central organizing concept must be changed from competition, consumption, and economic growth to one of equity, stability, and sustainability.

Relentless competition for land and resources has produced widespread desperation along with inequality. People who are starving do



Native plants provide essential habitat for native pollinators. Native bees, birds, and other species pollinate billions of dollars of food crops in the US each year. Photograph by Rich Hatfield, the Xerces Society.

not worry about which species they may endanger by gathering wild food, or about the environmental impacts of the mass-produced food that is all they can afford. People frightened about how to feed their children naturally stockpile as many resources as possible—land, fuel, water—to minimize risk and maximize security. Survival today is more important than sustainability for the future.

Conversely, as long as people perceive accumulation and consumption as indicators of achievement and security, they will continue to accumulate and consume as much as possible whether it is sustainable or not, and whether they need to or not.

Thus, under the current system, there are few incentives for either the rich or poor to consider the impacts of their actions on the biosphere or the planet. In fact, studies have shown that economic inequality is correlated with imperilment of biological diversity at global and regional scales (Mikkelsen et al. 2007) So the first step is to change the system, to attack both desperation and excess. We need a society based on security and sustainability rather than competition and fear. For this reason, all speakers stated forcefully that capitalism in its current form cannot be the economic system in a sustainable future. We need to develop what Robinson called a "post-capitalist" economy.

GENDER EQUITY

All three speakers stressed that progress cannot be achieved without improvement—not only in economic equity—but in gender equity as well. Robinson noted:

What we have seen in the last half-century is that in countries where women have experienced a sudden success in increasing their legal rights and in access to education, work, and property, the population growth ... has dropped just as suddenly. The more a country has social justice and women's rights, the lower the population growth rate is. In other words, our relations with each other are a crucial component of our relationship to the biosphere.

Ehrlich and Raven deplored the loss of intellectual capital—the "sheer mass of lost ideas" that has resulted from the exclusion of women from political and economic power. They suggested that we think of this as we do the loss of species diversity. Few species persist for long on this planet without taking advantage of a range of traits exhibited by individual members in order to survive variable and challenging times. Similarly, our species cannot long expect to survive our current ecological crisis if women, who make up at least half of our population, are not fully part of the decision-making process.

EDUCATION AND COALITION BUILDING

All three speakers called on us to speak out to educate the public and decision makers. They observe a frightening and widespread lack of awareness of the degradation of our environment and its implications for our future. Ehrlich not so jokingly described his decades of efforts to call attention to the dan-

gers of overpopulation: “I think of myself as a total failure.” Raven summed up perceptions of resource supply: “Ask [the] average person on the street, [and] they will say there is plenty of everything...”

What can be done to create greater awareness? Raven, a member of the Pontifical Academy of Sciences, which advises the Pope, contended that “What is needed is a moral revolution [to promote economic and social equity]. Religious groups could play a big role.” Since his historic and groundbreaking encyclical this past June, Pope Francis has called for precisely the kinds of changes in our relationships with each other and the environment that the speakers described.

On the other hand, Ehrlich suggested that faith is often used to

avoid seeing and acting on the empirical evidence of things like climate change and overpopulation. He asserted that we need to agitate for “an evidence-based world.” He urged us to write letters to politicians, publications, and anyone who will listen to take action, particularly on overpopulation and the perils of uncontrolled economic growth.

All three stressed that a broad and varied coalition will be necessary for change. In 2000 Ehrlich helped found the Millennium Alliance for Humanity and the Biosphere (MAHB) (mahb.stanford.edu/welcome/). MAHB is multidisciplinary and includes conservation, civil rights, and scholarly groups, as well as businesses and individuals. It seeks to build a global community that draws on a wide variety of per-

spectives “to build a secure and sustainable world for all humanity.” MAHB focuses on battling the “human behavior and collective actions [that are] leading to global collapse.”

Robinson also stressed the need for broad coalitions and tolerance among allies. He cautioned against the debilitating results of falling into [Sigmund Freud’s] “narcissism of small differences,” in which you fight people on your own side who don’t quite see things as you do, rather than fighting the outright enemies of your cause.

Raven said he finds hope in the ideas and courage of individuals. He recommends identifying successful and charismatic individuals and projects to copy or collaborate with. He also suggested working with religious leaders and building inter-

GLOBAL STRATEGY FOR PLANT CONSERVATION

In 2002, the sixth meeting of the Conference of the Parties of the Convention on Biological Diversity at The Hague adopted a Global Strategy for Plant Conservation (GSPC). CNPS representatives, includ-

ing Emily Roberson, participated in the development and adoption of the GSPC. The Strategy recognizes that “without plants, there is no life.” It therefore seeks to “halt the continuing loss of global plant diversity.”

The GSPC includes five objectives covering plant science, conservation, management, and education. It identifies 16 quantitative global targets to help each nation work towards those objectives. Targets include an online flora, in situ conservation of most threatened plants, protection of important areas for plant diversity, conservation of wild-harvested species, and increased capacity for botanical training.

The United States is the only nation on the planet that is not a Party to the Global Convention on Biological Diversity. Therefore, the US does not formally participate in the implementation of the GSPC. More information is available online at the Global Strategy for Plant Conservation website: cbd.int/gspc/default.shtml.



The late Wangari Maathai (above right), a Nobel Peace Prize winner, founded Kenya’s Greenbelt Movement to plant native trees to empower women, control erosion, provide food and fuel, and mediate climate change. She said: “If you destroy the forest then the river will stop flowing, the rains will become irregular, the crops will fail, and you will die of hunger and starvation.” Photographs courtesy of the Greenbelt Movement.





Coal produces more greenhouse emissions than any other fuel. It is also a leading source of toxic water pollution. Nonetheless, global coal use increased more quickly than any other fossil fuel in 2013. Coal still makes up 39% of US electric generation. Shown here is coal being mined in South Africa. Photograph courtesy of the United Nations.

national partnerships. For example, the United Nations declared 2015 the “International Year of Soils” (fao.org/soils-2015/en/) and launched a public relations campaign to build awareness about soils and ecosystem services. The Global Strategy for Plant Conservation (see sidebar on page 6) created a framework within the Convention on Biological Diversity for nations to conserve botanical resources.

START TODAY

This planet is in crisis. The climate is changing. We are losing species, ecosystems, and their services at an alarming rate. Plant scientists and conservation advocates have crucial roles to play in any solution. We have no future without aggressive conservation of biodiversity in general, and plant diversity in particular. We cannot hope for a stable or sustainable future unless we protect and restore the biosphere and the ecosystem services—the “life support system”—it provides. *Fremontia* readers know this.

What has been less recognized

in conservation circles is what these speakers pointed out: we have little chance to save our flora or our biosphere unless we create equitable societies and economies. Humans have exploited each other even as we exploit our environment. We treat each other with the same greedy, entitled, thoughtless, and destructive disregard as we treat the rest of the biosphere, and with similar destructive and perilous consequences.

As long as we are forced to compete with one another for resources, as long as millions are desperate, as long as accumulation is equated with security and success, we have no hope of slowing, let alone reversing, the ravages to plant communities and our planet.

These speakers tell us that we cannot successfully conserve plants, or the life support systems they anchor, without creating societies and economies based on equity rather than competition, sustainability rather than exploitation. Native plant advocates, and the broader conservation community, must recognize that basic link and incorporate so-

cial and economic justice into our goals, partnerships, education, and political action.

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CONSERVATION AT CALIFORNIA'S EDGE

by Evan Meyer, Jorge Simancas, and Nick Jensen

Northwest Baja California is a land of contrasts. It's a landscape of ocean and desert, sky and scrub, arroyo and ridge. In many ways it contrasts with its northern neighbor, but it also shares a lot with California, USA, including the unique North American Mediterranean climate. Conservation goals and challenges are shared by the two states as well. One of these is shared by much of the world: how to conserve biodiversity in the face of increasing human population growth, agricultural development, globalization, climate change, and the demand for natural resources.

In northwest Baja California, this

conflict plays out every day. Legal protection of parcels of pristine land and increasing local awareness of the region's unique biodiversity contrasts with large-scale habitat loss and degradation. In this article, we describe some of the threats to the region's irreplaceable biodiversity, highlighting land conservation efforts along the coastal regions of northwest Baja California.

NORTHWEST BAJA: A BIODIVERSITY HOTSPOT

Stretching for more than 1,200 kilometers between the Pacific Ocean and the Gulf of California, the Baja California peninsula is one

of the longest in the world. The northwestern portion of the peninsula, from the US border to just north of the town of El Rosario is considered to be part of the California Floristic Province (CFP). The CFP, or the portion of California, southern Oregon, and northwest Baja California under the influence of a Mediterranean Climate, has been identified as one of 35 worldwide biodiversity hotspots (Myers et al. 2000.) Like other biodiversity hotspots, the CFP showcases a high level of endemism combined with imminent threats to biodiversity and is a globally recognized target area for conservation.

A suite of widespread and domi-



Stunning coastal vistas and untouched wild landscapes can still be found in northwest Baja California. All photographs by Evan Meyer unless otherwise noted.



Reserva Valle Tranquilo occurs at the southern limit of the California Floristic Province. Its rocky ridges and sandy arroyos host a diverse flora.

nant Baja California species reach their northern limit at or near the border, while many species more characteristic of southern California reach their southern limit in northern Baja. To the south, the end of the CFP and northern reaches of the great Vizcaino desert are demarcated by the presence of the otherworldly boojum tree (*Fouquieria columnaris*) and cardon (*Pachycereus pringlei*) forests.

A high diversity of habitat types occurs in the CFP portion of Baja. Perhaps the most common in the coastal belt is Maritime Succulent Scrub (MSS). Moving east, as eleva-

tion rises, MSS gives way to chaparral, then high-elevation conifer forests in the Sierra Juarez and Sierra San Pedro Martír. Vernal pools and other rare plant communities occur throughout the region. These communities are typical of the southern CFP, but also contain many species unique to Baja. In many cases, they have been subject to less development pressure and disturbance than their US counterparts.

In the CFP as a whole, nearly 61% of the more than 3,500 plant species are considered endemic—occurring nowhere else on Earth. In northern Baja, a unique combi-

nation of climate, soil, and historical and current ecological interactions has led to the evolution of numerous globally rare species with limited distributions. Plants such as Wiggins' evening primrose (*Oenothera wigginsii*), restricted to coastal sand dunes south of San Quintín, and Anthony's liveforever (*Dudleya anthonyi*), known from the volcanic cinder cones of San Quintín Bay, are examples of plants whose narrow ranges make them especially vulnerable to extinction. The challenge of conserving rare plants in the face of increasing threats from burgeoning human populations is a conflict

that is all too familiar to the readers of *Fremontia*.

THREATS TO BIODIVERSITY

An imminent and continuing threat to the biodiversity in northwest Baja is loss of habitat. Close to the border, accelerated loss of coastal habitat can be attributed to the Baja real estate boom of the early 2000s

where availability of cheap ocean-front property led to the construction of many new vacation homes, condos, and hotels. During the economic downturn of the late 2000s, many of these projects were abandoned. Today, the coast between Tijuana and Ensenada is littered with half-finished buildings and disturbed coastal habitat.

In addition to residential devel-

opment, the clearing of scrub for agriculture, grazing, or simply to denote land ownership, is an increasing problem in northwest Baja California. A prime example of this loss of habitat can be seen at the Colonet Mesa, an area that has been recognized for its plant diversity (Harper et al. 2011). This threat has led to the initiation of the “Piensalo 2 Veces: La Importancia de No Desmontar” campaign (“Think twice, the importance of not clearing”) by the newly-formed Baja California CNPS Chapter. This campaign seeks to increase local awareness of the value of intact vegetation.

In the San Quintín area, the major loss of habitat can be attributed to large scale agriculture and poorly planned urbanization. Farming has increased dramatically in the last 50 years, with tremendous impact not only on the landscape, but also to water resources. Overexploitation via surface water diversion and groundwater pumping has caused the intrusion of saltwater and pollution, leading to decreased water quality. Saline intrusion has been implicated in a loss of plant species diversity, especially in vernal pools (Vanderplank et al. 2013). The impact on the biota of surface water diverted from the Sierran foothills has not been well studied. A common sight throughout this area is working farm land as well as fallow fields—the tell-tale sign of temporary agricultural conversion for short-term gain. Once plowed, diverse native MSS does not recover quickly. It is usually replaced by a monoculture of the invasive African ice plant (*Mesembryanthemum crystallinum*).

STATE OF LAND PROTECTION

San Quintín Bay is the southernmost large bay in the CFP, and unlike the other large bays to its north (Ensenada, San Diego, Long Beach, Ventura, etc.) has seen relatively



Baja California is a biodiversity hotspot. CLOCKWISE FROM TOP: Shaw's agave (*Agave shawii* ssp. *goldmaniana*), *Eriodictyon sessilifolium*, *Hazardia berberidis*, totem pole cactus (*Lophocereus schottii*). Certain species do not have English common names. Agave and *Hazardia* photographs by James Riley; other photographs by Evan Meyer.



WHAT IS MARITIME SUCCULENT SCRUB?

Maritime Succulent Scrub (MSS) is a unique habitat type that is only found in the lowest portion of the California Floristic Province. Beginning in isolated patches just north of the US-Mexican border, MSS is the dominant plant community on the west coast of Baja California between Ensenada and El Rosario. This community is a hotspot for endemism and diversity. In addition to the many endemic species, plants from the adjacent Sonoran Desert and Coastal Sage Scrub communities converge here, forming a unique assemblage.

MSS gets its name from the many succulent species that grow within it. Some iconic species include Shaw's agave (*Agave shawii*), golden cholla (*Bergerocactus emoryi*), liveforevers (*Dudleya* spp.), and cliff spurge (*Euphorbia misera*).

For more information on the plant diversity of MSS see

Riley et al. 2015. Conservation and management of this habitat is incredibly important to sustain the complex web of biodiversity that is unique to MSS. We urge *Fremontia* readers to join ongoing efforts to conserve this amazing region.



The succulent plants that give Maritime Succulent Scrub its name include (CLOCKWISE FROM TOP) liveforevers (*Dudleya* spp.), golden cholla (*Bergerocactus emoryi*), dagger cactus (*Stenocereus gumosus*), and fishhook cactus (*Mamillaria dioica*).



limited development. The bay is an incredibly important ecological area for the entire Pacific Coast, supporting large stands of eelgrass that provide habitat for a diverse array of vertebrate and invertebrate species. The bay supports up to 55% of the Pacific flyway population of black brant (*Branta bernicla nigricans*) during the nonbreeding season (Mallek 2010) and is an important site for thousands of shorebirds and other migratory and resident birds.

One of the great conservation success stories in northwest Baja California was the acquisition and protection of a portion of the tidal estuary and sand dunes at San Quintín Bay. Punta Mazo, a large and pristine dune system that forms the western edge of the bay was at one time eyed by developers as prime real estate for a large hotel and recreation complex. In 2012, through the hard work of American and Mexican nongovernmental organi-

zations (NGOs), Punta Mazo was purchased and made into a nature reserve. This healthy, intact dune system is a refuge for rare coastal plants that once occurred more abundantly in California such as beach spectacle pod (*Dithyrea maritima*) and coast woolly heads (*Nema-caulis denudata* var. *denudata*).

To see these plants thriving in their native habitat is truly remarkable, but it is also a reminder of the widespread loss of this unique coastal habitat that has occurred north of the border. Terra Peninsular, a binational NGO focused on land conservation in northwest Baja California, was instrumental in the acquisition of Punta Mazo and is now in negotiations to secure adjacent parcels to preserve more of this irreplaceable coastal habitat.

To the south of San Quintín lies another nature reserve known as Reserva Natural Valle Tranquilo. Managed by Terra Peninsular, it is



The clearing of land for agriculture is a major threat to Baja's coastal dunes. In many areas the land is left fallow and soon becomes a monoculture of the highly invasive, non-native African iceplant (*Mesembryanthemum crystallinum*).



The sand dunes at Punta Mazo (TOP) support a healthy dune flora, which includes robust populations of several species which are rare north of the border such as Beach spectacle pod (*Dithyrea maritima*) (LEFT) and coastal woolly heads (*Nemacaulis denudata*) (RIGHT).

comprised of nearly 16,000 hectares. The reserve contains ridges covered in thick MSS, rocky arroyos with a more desert-like appearance and shaded canyons filled with disjunct populations of mission manzanita (*Xylococcus bicolor*) at the southern limit of its distribution.

Robust, healthy populations of northwest Baja California endemics such as *Hazardia rosarica*, *Amsinckia inepta*, *Mammillaria brandegeei*, and *Eriogonum fastigiatum* (none have

English common names) are found throughout the area. The reserve occurs at the very southern edge of the CFP, and is the transition between the succulent scrub and the desert. Amidst the Californian vegetation one sometimes finds plant outliers from the adjacent Vizcaino desert, such as the boojum and cardon.

Aside from these two privately managed reserves, the only other large protected areas in northwest

Baja occur in the high mountains. Two federal parks—the Sierra San Pedro Martír National Park and the smaller Constitution 1857 National Park—preserve important mountainous habitat but do not offer any protection to coastal landscapes. With such natural diversity and endemism contrasted by the region's increasing development, urbanization, and agriculture, there is a critical need to create additional nature reserves in coastal northwest Baja.



ABOVE: *Acmispon distichus* is a showy mound-forming species endemic to sandy coastal areas in western Baja California. • LEFT: Munz's sage (*Salvia munzii*) grows throughout the coastal region of northwest Baja. In the US it is limited to a few populations in San Diego County. • RIGHT: The rare Tecate cypress (*Hesperocyparis forbesii*, CRPR 1B.1) is endemic to the Peninsular Ranges of Southern California and northwestern Baja California. This photo comes from a large stand near the town of San Vicente.



POSITIVE DIRECTIONS

The momentum to conserve the unique CFP habitats of Baja is strong and growing. The incorporation of the Baja California CNPS Chapter in May of 2013 and the forthcoming opening of the first botanical garden of the San Quintín Valley in 2016 provide evidence of the local interest in habitat conservation and the desire for binational partnerships. Conservationists from both sides of the border realize that there is still time to protect habitat in coastal CFP Baja, but it must happen soon. With a growing human presence on the landscape, acquisition of key habitat, wildlife corridors, and diverse areas is essential to prevent a major loss of biodiversity. This effort needs the support of all. We urge *Fremontia* readers to support land conservation efforts in the area, to get involved with the CNPS Baja Chapter and with the Jardín Botánico San Quintín, and to conduct biodiversity research in northwest Baja. Those

BELOW: The cinder cones of San Quintín Bay are home to Anthony's liveforever (*Dudleya anthonyi*) (inset), a narrowly endemic species of northwestern Baja. Photograph by James Riley.





Looking south at Punta Mazo, a sand spit which forms the western edge of the San Quintín Bay. In 2012 Punta Mazo was made into a protected natural reserve.

interested in supporting these efforts should contact the Baja chapter of CNPS (contacto@spnbc.mx), Jardín Botánico San Quintín (jardinbotanico_sq@gmail.com), and/or Terra Peninsular (cesarguerrero@terrapeninsular.org).

These natural areas are at a crossroads. While significant habitat has already been lost, there are still real opportunities to preserve untouched land. On a recent trip down the Baja coast south of Ensenada we found many beautiful, intact stands of MSS covering marine terraces high above the azure waters of the Pacific. But increasing residential and agricultural development is making these pristine habitats smaller and much more fragmented. The loss of habitat that has occurred north of the border in the coastal region is extensive. In northwest Baja, the opportunity for a more sustainable development exists, where cities and agriculture are balanced with intact, diverse habitat. We can all help make this a reality.

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The next generation learns about propagation of Baja California native plants at a ranch in the Guadalupe Valley. This event, organized by the Mexican federal agency Conafor, promoted knowledge of native plant production for restoration of disturbed landscapes.

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Gaps in our floristic knowledge: The Cima Cinder Cones of eastern San Bernardino County is a vast region that has only recently received attention from botanists. There are many similarly unexplored regions in California where data gaps exist, especially in the deserts. Photograph by Jim André.

A POWERFUL RESOURCE FOR PLANT CONSERVATION EFFORTS: THE CONSORTIUM OF CALIFORNIA HERBARIA REACHES TWO MILLION SPECIMENS

by Staci Markos, Richard L. Moe, and David Baxter

Plants are all around us. They provide food, medicine, shelter, beauty, and ecosystem functions. There are approxi-

mately 350,000 plant species worldwide and 50,000 to 75,000 remain to be described (P. Raven, pers. comm. 2014). In the face of unprec-

edented rates of climate change, an important component of conserving biodiversity is the protection of wildlands. These areas will serve as

refugia for species (and their genes), and it is from these areas that species will migrate and adapt to new environments. To understand what areas need the most protection in California, we need to understand what species occur in the state, how those species are related to each other, and how they are distributed across the landscape.

Describing and cataloging plant diversity is a daunting task, but botanists have been formally doing this work since the mid 18th century. It continues today with initiatives like the *Jepson eFlora* that contains taxonomic treatments and identification keys for over 8,000 native and naturalized plant taxa occurring in wildlands or otherwise outside of cultivation in California (ucjeps.berkeley.edu/IJM.html). This work relies on botanical collections stored in herbaria. It is here that the foundations of our understanding reside. From these collections, we have a window into our past and can understand more deeply the present. And with DNA sequencing, improved phylogenetic techniques, digitization of herbarium collections, and powerful new modeling techniques, scientists have been able to depict future scenarios related to biodiversity and how it might be distributed across the globe.

WHAT IS A HERBARIUM?

Herbaria are collections of specimens from all plant groups—angiosperms, gymnosperms, ferns, bryophytes, and algae. Fungi and lichens are also included. Typically, the process of making a plant specimen begins in the field by taking a plant (or part of a plant) and pressing it between two sheets of paper. Field notes accompany each collection and detail the location and other important site features. Once in the plant press, specimens are dried, mounted on acid-free paper, and accessioned into the collection. Botanical specimens are an irreplace-

MAKING A HERBARIUM SPECIMEN

The process of making a herbarium specimen begins in the field where the collector records details including date, location, habitat, features of the plant, and associated species. A documentation field book is often used (pictured is the *Plant Collecting and Documentation Field Notebook*, 3rd Edition, by Michael G. Simpson). Once the plant is collected, it is put in a plant press and dried. The identity of a plant can be determined in the field or laboratory/office using a resource like the second edition of *The Jepson Manual* (pictured) and, if necessary, careful examination with a dissecting microscope. Once dried, the plant and label are mounted on acid-free paper. Each herbarium loads data from labels into a database that is then shared with the Consortium of California Herbaria. Photograph by Staci Markos.



able, tangible record of biodiversity at a particular time and place.

WHY HERBARIA ARE IMPORTANT

In California, herbaria maintain plant collections dating from the mid-1800s to the present. Traditionally, herbaria were used as a resource for identifying plants, establishing their geographic range, and describing new species. Specimens and their associated data are also powerful tools for researchers seeking to answer a wide array of questions ranging from evolution and local patterns of diversity to global climate change. Specimen data have also been used to address questions related to invasive species, conservation, and natural resource management.

WHAT IS THE CONSORTIUM OF CALIFORNIA HERBARIA (CCH)?

The Consortium of California Herbaria is a gateway to informa-

tion from California vascular plant specimens that are housed in 35 participating herbaria (ucjeps.berkeley.edu/consortium/). Through a single interface, the CCH serves over 2 million specimen records, over 71% of which are georeferenced (i.e., include latitude and longitude; Figure 2). With support from the California Digital Library, the CCH began in 2003 with botanical collections from the University and Jepson Herbaria and it quickly expanded into what the CCH is today, a truly collaborative network of herbaria from throughout the state and beyond.

WHY THE CCH IS IMPORTANT

Before the CCH existed, the only way for researchers to access plant specimens and their data was to personally visit a herbarium and go into “the stacks,” where the pressed specimens are stored in herbarium cabinets. A few herbaria had online databases but comparative research entailed accessing data in different formats that could not be readily

TABLE 1. A FULL LIST OF PARTICIPANTS IN THE CONSORTIUM OF CALIFORNIA HERBARIA.

ACRONYM	COLLECTION FULL NAME
BLMAR	Bureau of Land Management Arcata Field Office Herbarium
CATA	Catalina Island Conservancy Herbarium
CAS/DS	California Academy of Sciences (incl. Dudley Herbarium)
CDA	California Department of Food and Agriculture Herbarium
CHSC	Chico State Herbarium, CSU Chico
CLARK	Riverside Metropolitan Museum Herbarium
CSUSB	CSU San Bernardino Herbarium
DAV/AHUC	UC Davis Center for Plant Diversity Herbarium
GMDRC	Sweeney Granite Mountains Desert Research Center
HSC	Vascular Plant Herbarium, Humboldt State University
IRVC	UC Irvine Herbarium
JOTR	Joshua Tree National Park Herbarium
JROH	Oakmead Herbarium, Jasper Ridge Biological Preserve
LA	UC Los Angeles Herbarium
MACF	Fay A. MacFadden Herbarium, CSU Fullerton
OBI	California Polytechnic State University Herbarium
PASA	Pasadena City College Herbarium (in Huntington Botanic Garden)
PGM	Pacific Grove Museum of Natural History
RSA/POM	Rancho Santa Ana Botanic Garden Herbarium (incl. Pomona College Herbarium)
SACT	CSU Sacramento Herbarium
SBBG	Santa Barbara Botanic Garden Herbarium
SCFS	Sagehen Creek Field Station Herbarium
SD	San Diego Natural History Museum Herbarium
SDSU	San Diego State University Herbarium
SFV	CSU Northridge Herbarium
SJSU	Carl W. Sharsmith Herbarium, San Jose State University
UC/JEPS	University and Jepson Herbaria, UC Berkeley
UCR	UC Riverside Herbarium
UCSB	Cheadle Center for Biodiversity and Ecological Restoration (CCBER) Herbarium, UC Santa Barbara
UCSC	UC Santa Cruz Herbarium
VVC	A. Louise Baartz Memorial Herbarium, Victor Valley College
YM	Yosemite National Park Herbarium

EXTRA-CALIFORNIA PARTICIPANTS

HUH	Harvard University Herbaria
NY	Steere Herbarium, New York Botanic Garden
SEINET	Southwest Environmental Information Network

Source: David Baxter, University and Jepson Herbaria, 2015.

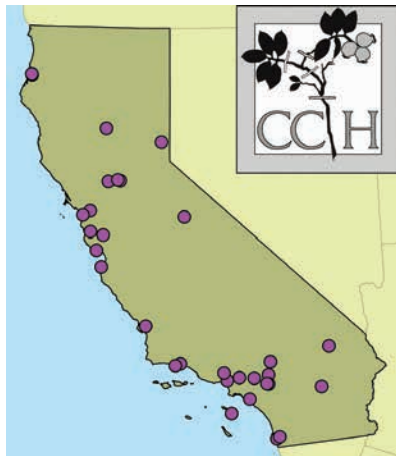
combined. The CCH has revolutionized the way these data can be accessed by collating a tremendous amount of information contained on specimen labels from large and small herbaria and placing these

records online in a way that permits a variety of comparisons.

There are several advantages to having a statewide representation of herbaria participating in the CCH. First, since some herbaria have a

regional emphasis, a broad geographic representation of herbaria significantly strengthens the CCH's power to display a taxon's geographic range (via georeferenced localities). A good example is *Salix*

FIGURE 1. LOCATIONS OF CALIFORNIA HERBARIA PARTICIPATING IN THE CCH.



A wide range of herbaria participate in the CCH. They include collections at colleges and universities, government agencies, private institutions, botanic gardens, and natural reserves and field stations.

Source: David Baxter, University and Jepson Herbaria, 2015.

laevigata (Figure 3). The CCH helps put the puzzle pieces together by displaying a more complete representation of the taxon's geographic range than is represented by any single collection. Second, some areas in California remain under-represented by collections and floristic exploration is still needed. Researchers working at remote herbaria can help fill gaps in our floristic knowledge by adding to the collections and fleshing out patterns of biodiversity in the state. Third, herbaria provide undergraduate students from all over California with training opportunities and exposure to natural history collections, hopefully leading them to a life-long appreciation of nature and interest in protecting native plants.

USES OF DATA FROM THE CCH

The CCH has been cited in over 100 publications including floristic studies, phylogenetic investigations, and studies of invasive species.

Additional research has used data from the CCH to address questions related to climate change, adaptation, and evolution (Google Scholar page, ucjeps.berkeley.edu/consortium/citations/). Importantly, the CCH provides a reliable source of information on the distribution of rare plants and these data help support conservation efforts throughout the state. The California Natural Diversity Database uses the CCH to update occurrence information. The Rare Plant Program of CNPS uses data from the CCH to help determine California Rare Plant Ranks and to prioritize taxa and locations for Rare Plant Treasure Hunts. In addition to aiding with conservation status reviews, information from the CCH such as elevation ranges, blooming periods, species associates, habitat, and edaphic substrates is utilized in the CNPS Rare Plant Inventory, by consulting biologists, and by individual botanists gather-

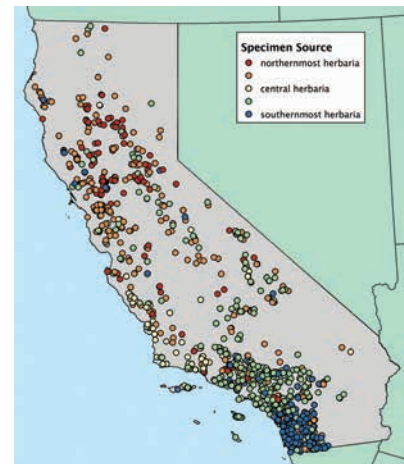
FIGURE 2. DENSITY MAP OF GEOREFERENCED SPECIMENS SERVED BY THE CCH.



This map shows the varying collection density in California. Darker shades of orange indicate a higher number of specimens collected from a grid cell. Note that only specimens with known latitude and longitude data (71% of records) are mapped. Some parts of the state remain to be documented.

Source: Global Biodiversity Information Facility, www.gbif.org, 2015.

FIGURE 3. GEOREFERENCED RECORDS OF *SALIX LAEVIGATA* SPECIMENS SERVED THROUGH CCH.



Points are categorized into five groups according to the latitude of the institution holding the specimen, in order to demonstrate regional emphasis.

Source: David Baxter, University and Jepson Herbaria, 2015.

ing information about rare and common taxa. The CCH is also the largest contributor to the Calflora Observation Database.

Due to the efforts of many individuals and institutions, including administration and software development by the University and Jepson Herbaria (UC Berkeley), the CCH has helped bring herbaria into the 21st century and join the global effort to share data that was formerly stored only in collections. Members of the California Native Plant Society have an important role in the CCH. By supporting herbaria, volunteering in the collections, adding new specimens, and commenting on records in the CCH interface, everyone can contribute to our shared goals of understanding and conserving the California flora.

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REVISTING JOHN SAWYER AND DALE THORNBURGH'S 1969 VEGETATION PLOTS IN THE RUSSIAN WILDERNESS: A LEGACY CONTINUED

by Melissa H. DeSiervo, Erik S. Jules, Michael E. Kauffmann,
Drew S. Bost, and Ramona J. Butz

Shortly after joining the faculty of Humboldt State University (HSU) in 1966, John Sawyer received a letter from one of America's leading evolutionary biologists and California floristic experts, G. Ledyard Stebbins. Stebbins suggested that John visit a remote place in the Klamath Mountains known as Blake's Fork to verify a report of one of California's rarest conifers—Engelmann spruce (*Picea engelmannii*). He encouraged John to record his findings in a new database called the *Inventory of Rare and Endangered Vascular Plants of California* organized by the California Native Plant Society. With conifers calling, John and his friend, fellow

HSU professor Dale Thornburgh, began a journey that would change our understanding of conifer distributions, plant associations, and wilderness in California.

After a successful trip to Blake's Fork and the surrounding Salmon Mountains, John and Dale became enchanted with the region. They planned their next trip with hopes of finding more Engelmann spruce along Sugar Creek, just over the Salmon Crest from Blake's Fork. In the summer of 1968 they walked up Sugar Creek, documenting and collecting plants along the way. Wanderlust found them climbing the south-facing ridge above Sugar Lake, where they found foxtail pines (*Pinus*

balfouriana), and into the Little Duck Lake Basin. At the southern end of the lake, Dale identified the first subalpine fir (*Abies lasiocarpa*) in California, although it took him half-an-hour to convince John! Around the campfire, maps came out and species lists were made. They determined that in a roughly drawn square mile—encompassing the ridges and valleys around Little Duck Lake—17 species of conifers could be found. The “Miracle Mile” was born (Kauffmann 2012).

PRESERVING A BOTANICAL LEGACY

In the summer of 1969, John Sawyer and Dale Thornburgh began formal research in the “Miracle Mile” and the surrounding area. With the help of two undergraduate field assistants, Steve Selva and Dan Franck, they conducted over 200 vegetation surveys in the drainages surrounding Russian Peak and used that data to describe 15 California plant associations (Sawyer 2006, Sawyer 2007). These explorations led to a unique understanding of these forests and the revelation that preservation outside National Forest land was essential. Sawyer and Thornburgh's research was the basis for the preservation of the 12,000-acre Russian Wilderness in 1984. That area contains both the Duck Lake Botanical Area and the Sugar Creek Research Natural Area (RNA), which meet at the “Miracle Mile.”

While Sawyer and Thornburgh recorded 17 conifer species in 1969, the 18th went unnoticed for 40 more years. In 2012 Richard Moore, a resi-

John Sawyer (back) and Dale Thornburgh (front) climbing through chaparral near South Sugar Lake in the Russian Wilderness in summer 1969. Photograph by Steve Selva.





Richard Moore, a resident of Callahan, California and longtime explorer of the Klamath Mountains, discovered the elusive 18th conifer species—western juniper (*Juniperus occidentale*)—in the “Miracle Mile” 40 years after Sawyer and Thornburgh’s expeditions. Mt. Shasta can be seen in the background. Photograph by Michael Kauffman.

dent of the town of Callahan just at the edge of the Russian Wilderness and lifelong explorer of the Salmon-Trinity Mountains, documented western juniper (*Juniperus occidentalis*) on a steep and scarcely traveled hillside near Sugar Lake.

In addition to the area being considered one of the richest assemblages of conifers in the temperate world, the “Miracle Mile” is also home to over 400 understory plants. This diversity exists because the Salmon Crest is the divide between the arid east side (which soon gives way to the Cascades and Great Basin) and the moister west side with a coastal maritime influence. The region is a crossroads where Great Basin species like western juniper mix with species that prefer a more temperate climate, such as Oettinger’s trillium (*Trillium ovatum* subsp. *oettingeri*), California Rare Plant Rank 4.2.3.

RESURVEYING THE SAWYER-THORNBURGH PLOTS

In the spring of 2014 the Jules Laboratory at HSU received the unique opportunity to continue research in Sugar Creek, and continue the botanical legacy initiated by Sawyer and Thornburgh 45 years before. (Sawyer had died in 2012, and Thornburgh in 2013.) The project started as a partnership between HSU and the US Forest Service, with the goal of assessing ecological change in the Russian Wilderness, in particular the impacts of fire suppression and climate change on forest composition and structure.

Our team began by contacting John’s wife, Jane Cole, and his best friend and fellow botanist, J.P. Smith, to help us track down the original Sawyer-Thornburgh datasheets and maps from 1969. With a little dig-



John Sawyer (left), Dan Franck, undergraduate field assistant (middle), and Dale Thornburgh (right) setting up camp in Etna, California, a town near the “Miracle Mile” in the Russian Wilderness, 1969. Photograph by Steve Selva.

ging, they were able to uncover species lists and binders of original plot data along with our golden ticket: a hand-drawn map of plot locations. This data had to be digitized, so we



Common understory plants growing in a seep near Little Duck Lake. TOP: White marsh marigold (*Caltha leptosepala*) and mountain laurel (*Kalmia polifolia*). BOTTOM: Sierra laurel (*Leucothoe davisiae*), a common understory shrub in moist red fir forests and seeps in the Klamath Mountains. Photographs by Melissa DeSiervo.

began by scanning original maps, uploading them to ArcMap, and using computer software to align prominent features such as topographic lines and lakes with aerial imagery. We also found over 1,200 HSU Herbarium specimens collected by Sawyer and Thornburgh in 1969 that could assist us as a reference species list for the area.

In summer 2014 we set off on the first of approximately 25 trips to the Russian Wilderness over

the course of two summers to relocate and resample the Sawyer-Thornburgh plots. With practice we fine-tuned our strategy for plot relocation by navigating to areas that matched the slope, aspect, and topographic position of the original plot descriptions. Then we searched for smaller-scale areas containing the conifer and understory plant species listed on the datasheet.

We were unable to verify exact plot locations because there were no field markers left from 1969. However, we limited our search window to 200 meters (or about 218 yards) from the hand-drawn map points, and only resurveyed plots that matched John and Dale's detailed descriptions. To collect data comparable to 1969, we mimicked the relevé plot protocol described in Sawyer and Thornburgh's report, which included percent cover of all trees in three size classes (overstory, saplings, and seedlings) as well as shrubs and herbaceous plants (Sawyer and Thornburgh 1977). We supplemented our historical data comparison with an extensive survey of individual trees, including detailed data on forest pathogens—something that was not done in the 1969 survey. In summer 2015 we began an additional project measuring the build-up of fuel loads around “legacy pines” (the larger sugar pines, *Pinus lambertiana*) to calculate litter and duff accumulation in lower elevation mixed conifer forests.

CHANGES IN FOREST COMPOSITION AND STRUCTURE

After two summers of data collection, we had successfully resampled 155 of the Sawyer-Thornburgh plots, measuring over 3,300 trees and recording hundreds of understory plant species. Our data analysis thus far shows a few important changes in forest composi-

tion and structure over the last 45 years. For example, we found significant increases in coverage of white fir (*Abies concolor*) throughout our study area, which is consistent with other historical resurvey projects in the Pacific Northwest (Dolanc 2012). Furthermore, our data shows that white fir (considered a fire intolerant species) is appearing at higher elevations than it was 45 years ago.

Aside from the few acres that burned in the 2014 Whites Fire, the majority of the Russian Wilderness has not experienced a large-scale wildfire in over 100 years. Historically, the Klamath Region is described as having had a mixed-severity fire regime, with a fire return interval of about 15 years in lower elevation mixed conifer forests (Taylor and Skinner 1998, 2003). Based on these estimates, lower elevation forests in the Sugar Creek basin have missed anywhere between three and six fire cycles, which has led to a dense overcrowding of fire-intolerant taxa such as white fir, and to a lesser extent in this region, Douglas-fir. Other tell-tale signs of fire suppression in this region include heavy accumulations of litter and duff around large pines, and conifer encroachment into upper montane and subalpine meadows.



Original plot datasheet from 1969 research expedition to the “Miracle Mile.” Photograph by James Adam Taylor.

MORTALITY OF SHASTA RED FIR

Shasta red fir (*Abies magnifica* var. *shastensis*) inhabits the upper montane and subalpine zones of southwestern Oregon and northwestern California (Shasta, Siskiyou, and Trinity Counties) and is considered a hybrid between California red fir (*Abies magnifica* var. *magnifica*) and the more northern species, noble fir (*Abies procera*) (Mathiasen and Daugherty 2008).

Several recent studies in the Pacific Northwest have shown declines in California red fir (Bulaon and Mackenzie 2007, Mortenson 2011). In addition, annual aerial detection surveys that the USDA has conducted from 2009 to the present in Northern California have revealed significant mortality in both Shasta and California red fir (Heath et al. 2009, 2013).

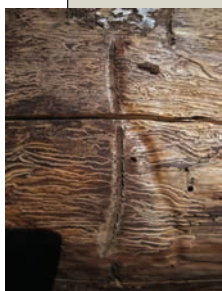
Red fir decline is generally attributed to a complex array of climatic factors such as decreased snowpack and warmer temperatures that trigger increases in native pathogens. These include dwarf mistletoe (*Arcuthobium* spp.), canker-forming fungi (*Cytospora* spp.), root diseases (*Heterobasidion annosum*, *Armillaria ostoyae*), and fir engraver beetle (*Scolytus ventralis*). Dwarf mistletoe and *Cytospora* infection frequently occur in combination, with signs and symptoms of unhealthy trees including tumefactions (swelling of branches) and brooming (dense aggregations of abnormal branch and twig growth), and flagging (dead branches). In highly affected stands, there is often significant canopy dieback and many trees with dying and/or dead tops.

Trees that are drought stressed and/



Many Shasta red fir stands in the Russian Wilderness show signs of true fir dwarf mistletoe (*Arcuthobium abietinum*) infestation and cytospora (fungal) cankers causing crown dieback. Within a few years most of the trees in these highly affected stands will die. • INSET: True fir dwarf mistletoe is a native parasitic plant that extracts water and nutrients from its host and can cause considerable stress on the tree. Approximately one-fifth of the live Shasta red firs sampled in 2014 and 2015 contained mistletoe infestation. Photographs by Melissa DeSiervo.

or contain other pathogens are often attacked and killed by fir engraver beetle. Signs of fir engraver attack include “buckshot” holes in the bark (exit holes of adult beetles) and substantial pitching on the bole (main stem) of the tree. In stands with significant mortality, many downed logs and branches will contain the distinctive fir engraver beetle galleries, and many dead trees will sprout fruiting bodies of the fungi *Cryptoporus volvatus*.



ABOVE: Fir engraver beetle (*Scolytus ventralis*) infestation is largely responsible for the ongoing mortality event of Shasta red fir in the Russian Wilderness, and the beetle's gallery patterns can be seen on many standing dead trees and fallen logs. The adult female beetle bores a thick, horizontal gallery and lays her eggs in the perpendicular side galleries, creating a distinctive pattern that is distinguishable from other bark beetle species. • RIGHT: Another indication of bark beetle induced mortality is the white round fruiting bodies of the fungi *Cryptoporus volvatus* on standing dead trees and logs. The fungus spores are carried into the tree by bark beetles and woodborers and help to decay the sapwood of the tree that has been killed by bark beetles.





Humboldt State University researchers Drew Bost, Stefani Brandt, Emily DeStigter, and Melissa DeSiervo near Bingham Lake in 2014. They were part of the team that resurveyed vegetation work done 45 years earlier by John Sawyer and Dale Thornburgh. Photograph by a friendly, but nameless, hiker.

Another pivotal finding of our research thus far is a current, large-scale mortality event for Shasta red fir (*Abies magnifica* var. *shastensis*). Over the course of two years, we sampled over 700 Shasta red fir trees across the Russian Wilderness of which approximately one-quarter

were dead, and one-third were categorized as “unhealthy” or “sick” based on signs and symptoms of forest pathogens such as dwarf mistletoe, fir engraver beetle, and probable *Cytospora* (fungal) infection (see sidebar). We believe that these native pathogen outbreaks are strongly tied to the increasingly warmer and drier climate, which is making trees more water stressed and thus less resistant to pathogens. We hypothesize that Shasta red fir is a particularly vulnerable species because it inhabits the “upper montane zone” and is heavily reliant on snow-

pack, which has decreased dramatically over the past 15 years. Again, the lack of fire leading to dense overcrowding throughout this region may be another reason why usually innocuous pathogens are now having a deleterious effect on forest stands.



Humboldt State University graduate Melissa DeSiervo, and canine assistant Tundra, collecting data in a subalpine fir stand in 2014. Photograph by Drew Bost.

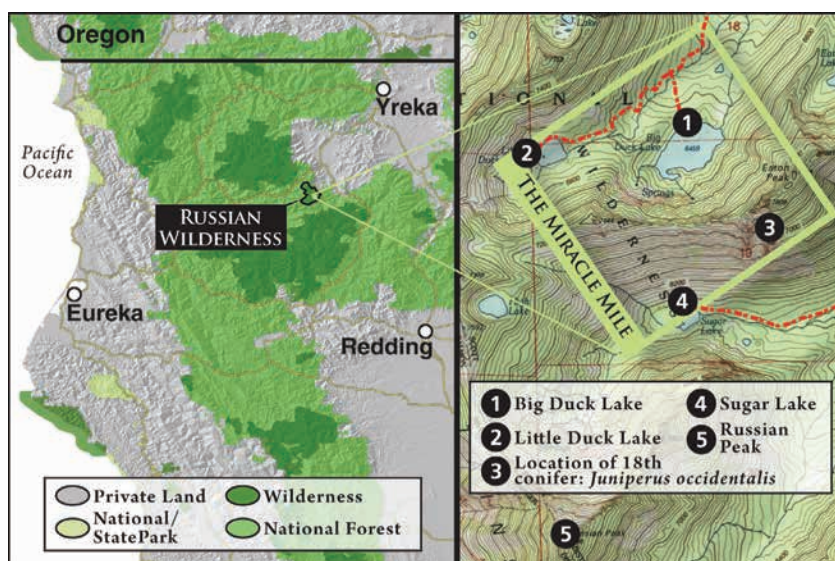
FUTURE WORK

The Russian Wilderness is subject to the complex threats of global climate change, and our research aims to describe how the ecology of this biodiversity hotspot is shifting. Using the Sawyer-Thornburgh historical dataset, we have been able to detect some important changes in forest composition and structure in this diverse area over the past 45 years, including an increase in a fire-intolerant species, white fir, and an extensive mortality event for a drought sensitive, higher elevation species, Shasta red fir. In addition to digging deeper into our tree dataset, we are currently in the process of analyzing the historical and present understory plant data and expect to publish our findings soon. We hope that this work will advance a botanical legacy and establish a pre-eminent understanding of one of the most species-rich temperate coniferous forests on Earth.

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FIGURE 1: THE “MIRACLE MILE”



Location of the “Miracle Mile” within the Russian Wilderness, a biodiversity hotspot first discovered by Humboldt State University professors John Sawyer and Dale Thornburgh in 1969.

Source: Michael Kauffmann, 2015.

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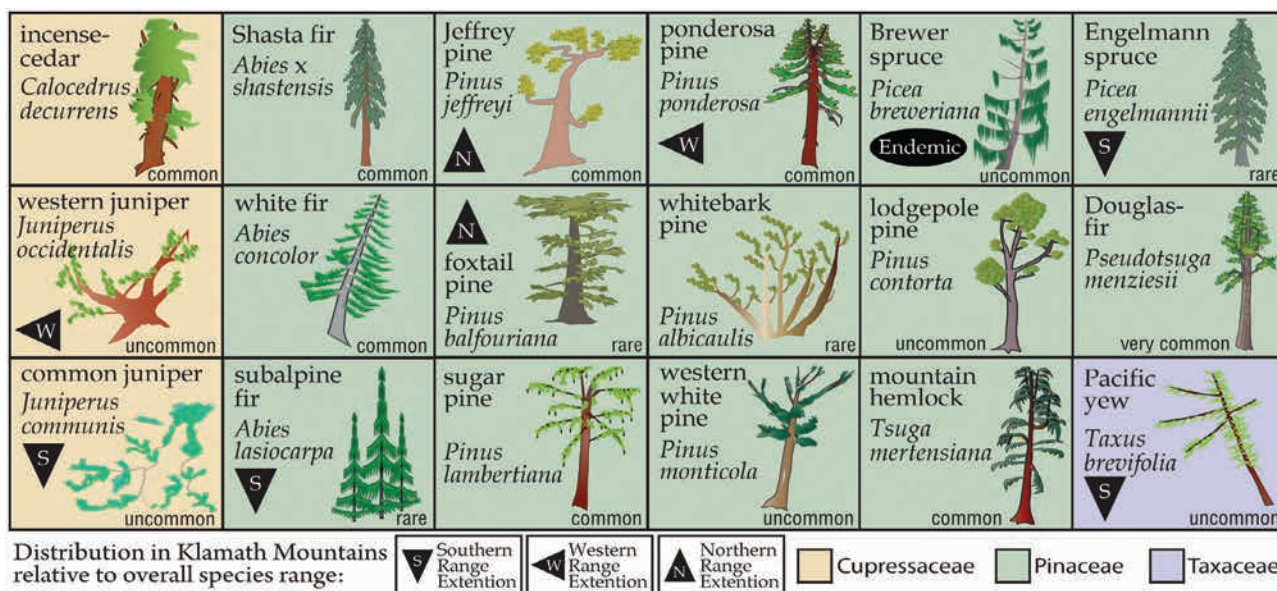
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FIGURE 2: CONIFERS OF THE “MIRACLE MILE”



The “Miracle Mile,” a square mile area located in the Russian Wilderness in the Klamath Mountains contains 18 species of conifers, the highest diversity of conifers on record anywhere in the world.

SOURCE: Michael Kauffmann, 2015.

HONORABLE MENTIONS FROM THE BOTANICAL ART AND PHOTOGRAPHY CONTESTS: CNPS 2015 CONSERVATION CONFERENCE

[Editor's Note: Images of the First, Second, Third Place, and Conference Choice winners for both contests appeared in the September 2015 issue of *Fremontia*.]

BOTANICAL ART CONTEST WINNERS



Terry Smith
Sisyrinchium bellum, blue-eyed grass



Maria Cecilia Freeman
Notholithocarpus densiflorus, tanoak



Margo Bors
Symphyotrichum chilense,
Pacific or California aster



Eliza Jewett
Quercus agrifolia,
coast live oak

Julie Himes
Piperia transversa,
royal rein orchid





Melissa Mooney
Enceliopsis Sky

PHOTOGRAPHY CONTEST WINNERS



Jeb Bjerke
Lilium kelleyanum, Kelley's lily

Judy Kramer
Ladybug on Tidytip
(*Layia fremontii*)



Keir Morse
Bouteloua gracilis,
blue grama



Dylan Neubauer
Calochortus albus, white fairy
lantern/white globe lily



Paul G. Johnson
A Swertia by Any Other
Name Would Taste as Sweet



Amanda Vasquez
Native Youth Gathering Manzanita



Paul G. Johnson
Mono Pass

Natalie Rossington
Layia jonesii, Jones tidytips,
in San Luis Obispo



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CORRECTIONS

In Hazel Gordon's article from the last issue, the names of three past CNPS presidents—Jonathan Libby, Lori Hubbard, and Jake Sigg—were misspelled on page 10. The Willis Jepson Chapter was inadvertently omitted from the chapter list on page 11. Sincere apologies to the chapter. In Randall Morgan's bio on page 43, the correct spelling is the Zayante Sandhills, and in the Danielsens' bio on page 44, the name of the East Bay Chapter nursery should have been Native Here Nursery.

And from R. Mitchell Beauchamp: "The *Fremontia* 43(3):38 article indicated that the journal's name was proposed by Robert Ornduff. Actually there was a contest to name it and several entrants had chosen *Fremontia*; however, my entry was the first to arrive. At the time I was a graduate student at the City University of New York and New York Botanical Garden. Dr. Ornduff sent me a copy of his popular UC publication on California vegetation as the prize. I think I still have the little book, and the card notifying me as the contest winner. The name of the journal, however, did not sit well with G. Ledyard Stebbins, Jr. He was very vocal in pointing out the savage proclivity of General Frémont with the native Americans, not to mention that the plant depicted as the magazine's logo was actually in the genus *Fremontodendron* while *Fremontia* was a synonym of some homely chenopod!"



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FROM THE EDITOR

This will be my last issue as editor of *Fremontia*. My involvement with CNPS's botanical journal began some 15 years ago in 2001 when then editor Linda Vorobik asked me to serve as her copy editor. She was an excellent person from whom to learn the inner workings of a journal, as she set a high standard. Later, in 2009, following Bart O'Brien's editorship, I was invited to take over the helm of *Fremontia*, while remaining editor of CNPS's quarterly newsletter, the *CNPS Bulletin*. Managing both publications was challenging in terms of the work load and meeting deadlines, but it also provided special opportunities to coordinate content.

Fremontia is a journal that looks somewhat like a magazine, but without all the ads. Like other journals, it contains articles of a serious, scholarly nature and is peer-reviewed. Unlike most journals, however, which cater to a narrow readership and tend to be written in a dry, highly technical manner, *Fremontia* is what I've come to regard as a "hybrid" journal. Its readership is quite diverse and includes scientists, agency staff, consultants, policymakers, conservationists, home gardeners, business people, students, educators, and others.

The challenge in producing such a journal is in how its articles are written. They must be understood by those with limited scientific background, yet be scientifically robust. Most important, they must be written in an engaging manner. This is why I've always asked authors to think in terms of telling a story about science, rather than merely presenting facts and findings. When that happens, people want to read what's there.

Thanks one more time to all who have contributed to *Fremontia*'s enduring success: our proofreaders, editorial board members, CNPS staff, and the authors.

—Bob Hass

(continued on inside back cover)



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The rare *Calochortus plummerae*, Plummer's Mariposa Lily, Photo: Amber Swanson

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Carrizo Plain National Monument.
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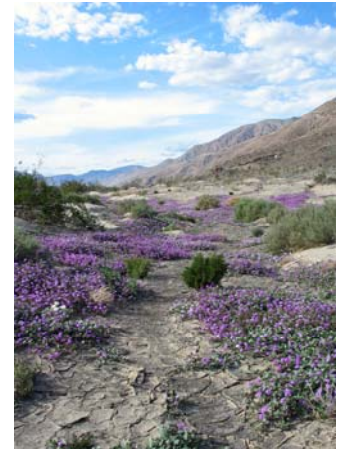
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CNPS members on field trip at Yolo Bypass. Photo: Gary Hundt



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Pine Hill Flamebush
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