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*Protecting California's environment and
economy from invasive plants*

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Cal-IPC Dispatch

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FROM THE DIRECTOR'S DESK

Biodiversity connections

By Executive Director Doug Johnson

In 2018, then Governor Jerry Brown issued an executive order declaring the importance of California's biodiversity and, together with a "Roadmap for the California Biodiversity Initiative," calling for a suite of actions to protect biodiversity. Under current governor Gavin Newsom, the state's Natural Resources Agency has begun putting infrastructure in place to increase the state's capacity for protecting biodiversity under the umbrella of the California Biodiversity Collaborative, whose four goals are to understand, protect, and restore biodiversity, and to engage and empower all Californians in this work.

The Collaborative comprises two convening bodies. The California Biodiversity Council, which has been around for thirty years, will serve as a forum for coordination between state and federal agencies. A new Biodiversity Network will bring together experts from many arenas — including agencies, tribes, universities, and nonprofit organizations — to guide future action.

At this fall's Cal-IPC Symposium, we released a new publication: "Stewarding

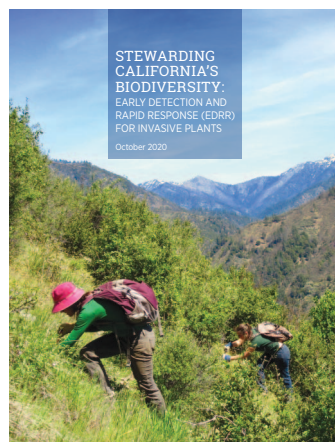
California's Biodiversity: Early Detection and Rapid Response (EDRR) for Invasive Plants" (available for download in the Resources Library on our website). The report describes the importance of strengthening the state's invasive plant response and makes recommendations for state agencies. This includes longtime goals such as funding county

Weed Management Areas (WMAs) and newer goals such as increased involvement from the state's Dept. of Fish and Wildlife.

The report was prepared in partnership with the California Landscape Stewardship Network, which brings together regional collaborations working on landscape-level management goals. Our

landscape-level EDRR strategies synch perfectly with this approach, and many of the principal partners involved in the Network are also deeply involved in the wildland weed management community.

We will be joining forces with Network partners to advocate for stronger EDRR support in Sacramento this spring. Thank you for your year-end donations — they make this work possible!



ON THE COVER

College intern Isabella Brown removes stinkwort (*Dittrichia graveolens*) from Valley Water Calero Pipeline site in Morgan Hill. The nonprofit Grassroots Ecology coordinates volunteers in San Mateo and Santa Clara counties to engage and educate the public to restore local ecosystems. Photo by Melisa Cambron-Perez, Grassroots Ecology.

Wildland Weed News

CAL-IPC UPDATES

2020 Symposium – Thanks to the more than 600 people who brought the Symposium alive online! Presenters, attendees, and sponsors collaborated to make our first ever online Symposium a success. See page 7.

New grants – Cal-IPC has been awarded a grant from the San Francisco Bay Restoration Authority for the next two years of the Invasive Spartina Project. Along with removing invasive Spartina hybrids from Bay marshes, the project revegetates project sites and monitors Ridgeway's rail numbers.

Regional prioritization – In partnership with the California Dept. of Food & Agriculture, Cal-IPC is collecting information on current invasive plant management priorities from counties across the state as a foundation for establishing coordinated regional priorities.

EDRR report – As described on page 2, Cal-IPC and the California Landscape Stewardship Network released a report describing the importance of early detection and rapid response. The groups will work together this winter and spring to encourage state agencies to implement key recommendations.

Non-chemical methods – With funding from the Cal. Dept. of Pesticide Regulation, Cal-IPC has worked with the University of California's Integrated Pest Management (IPM) program to compile best practices for controlling weeds without herbicides. We are now building an online decision-support tool to help practitioners find practices most appropriate to their situation.

OTHER UPDATES

EPA on glyphosate – The Environmental Protection Agency has published its draft Biological Evaluation of the impact of glyphosate products on endangered animals. Though "glyphosate is practically non-toxic to terrestrial and aquatic animals on an acute exposure basis" chronic exposure through agricultural application is likely to have an adverse effect.

Knotweed biocontrol – USDA has applied for approval to release the knotweed psyllid *Aphalara itadori* as a biological control agent for Japanese, giant, and Bohemian knotweeds.

NEPA for weeds – The USDA Forest Service completed a revision of their National Environmental Protection Act categorical exclusions, including invasive species control.

Cutting green tape –

Partners in the California Landscape Stewardship Network (CLSN) are working with the state's Natural Resources Agency to increase the pace and scale of ecological restoration by making regulation more efficient. See the newly released report in the resource library on CLSN's website.

Western states' lists – A retired professor in Montana is compiling invasive plant lists and other information from each western state at www.invasiveplantswesternusa.org.

Tegus – A new invasive reptile spreading from Florida is the Argentine tegu, which spells trouble for native wildlife.

Weed laws – A paper in *BioScience* (Lakoba et al., Sep. 2020) analyzed state weed lists across the US and found a discordance between biology and policy.

Los Padres plan – The central coast National Forest completed an environmental review for implementing its forest-wide invasive plant treatment program.

Arizona restoration – Dr. Elise Gornish, former Cal-IPC board member, has established a portal for ecological restoration materials through the University of Arizona Cooperative Extension at <https://ecorestore.arizona.edu>.

What to expect – A study projects a 36% increase in invasive

species from 2005-2050, with 74 new invasives predicted to establish in North America. Seebens et al. *Global Change Biology*, Oct. 2020.

Spread from shipping – A study found that seeds attached to refrigerated shipping containers represent a substantial risk of

nonnative plant species introduction and establishment. Rima et al. in *Scientific Reports*, Sep. 2020.

Global biodiversity outlook – A UN Environmental Programme report says none of the twenty biodiversity targets have been achieved, though target 9 on invasive species is declared "partially achieved".

Classifying invasives – The International Union for the Conservation of Nature (iucn.org) launched a new standard classification system for invasive species, with impact levels ranging from moderate to massive.

Oregon cuts – The Oregon Dept. of Agriculture's Noxious Weed Control Program lost funding that supports grants for projects across the state. Sep. 3, 2020, *Capital Press*.

Extinction denial – Efforts by conservation scientists to draw public attention to the biodiversity crisis are increasingly met with denialist rhetoric. A paper in *Nature Ecology & Evolution* (Lees et al., Aug. 2020) summarizes denialist approaches and outlines strategies to counter misinformation.

YOUR MEMBERSHIP

Thank you for keeping your membership current. Note that your expiration date is shown on the mailing label of this newsletter. Cal-IPC's success in meeting its mission depends on your vital support.



Knotweed psyllid and eggs. Courtesy Fritz Grevstad, Oregon State University.



Tegu photo courtesy Everglades Cooperative Invasive Species Management Unit

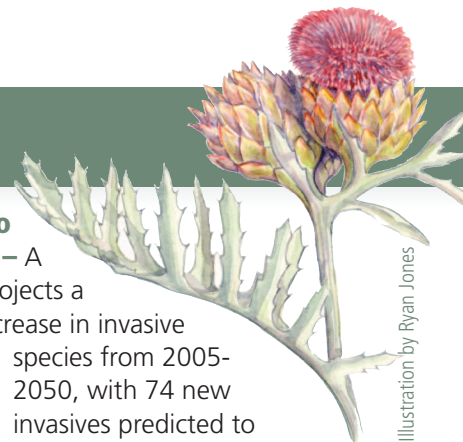


Illustration by Ryan Jones

Arundo wasp established in Central Valley

Dr. Patrick J. Moran, USDA-Agricultural Research Service,
Invasive Species and Pollinator Health Research Unit

A *rundo* or giant reed (*Arundo donax*) is a major invasive weed of sensitive riparian habitats in California and throughout the southwestern U.S. As described in detail in Cal-IPC's 2020 mapping and impact report covering *Arundo* in the Central Valley, this giant grass consumes water, obstructs flood control, alters stream geomorphology, and creates fire hazards. Natural resource agencies in California have spent tens of millions of dollars on *Arundo* control over the past 30 years.

USDA-Agricultural Research Service (ARS) laboratories in Texas and California discovered and tested several biological control agents of *Arundo* beginning in the 1990s, verifying that they are host-specific and capable of having impact. In 2009, USDA-ARS received a permit and released the *Arundo* wasp, *Tetramesa romana*, in the Lower Rio Grande Basin of Texas and Mexico. This small (less than 1 cm or 1/4 inch) black wasp is harmless to people.

Wasp females reproduce without mating and lay eggs in the shoot tips of main and side shoots of *Arundo*, creating galls, inside which the larvae feed and pupate. New adults chew their way out of the galls, leaving distinctive round 'exit holes,' which can be used to diagnose the presence of the wasp in the field.

In several published studies, ARS scientists documented a 30-40% decline in live *Arundo* biomass along the Rio Grande by 2016, seven years after wasp release, with concomitant increases in abundance of other plant species. In combination with another *Arundo* biocontrol agent, the *Arundo* armored scale (*Rhizaspidiotus donacis*), live biomass had decreased by an additional 50% by 2018.

Here in California, studies in the



Arundo wasp under microscope (40x magnification). Photo: John Goolsby, USDA-ARS

mid-2000s by researchers at UC Santa Barbara's Marine Science Institute had found the *Arundo* wasp occurring in adventive populations (accidentally introduced at an unknown point in time) in the Santa Clarita, Ventura, and Santa Ana River watersheds in southern California. However, no wasp populations were known from the Central Valley or northern California.

The California Dept. of Food and Agriculture obtained wasps from ARS in Texas in 2010 and released small populations, but they failed to establish. Beginning in 2013, the ARS Invasive Species and Pollinator Health Research Unit located in Albany,

CA released the *Arundo* wasp at sites in the northern Sacramento River watershed. In 2015, releases were initiated in the Sacramento-San Joaquin Delta, and in 2017, at sites in the southern San Joaquin River watershed.

In 2019 and early 2020, ARS researchers surveyed nine 2017-2018 release sites, three each in the Sacramento River watershed, the Delta, and the San Joaquin watershed. At one site on Stony Creek near Orland (Glenn County) in the Sacramento watershed, exit holes were found in 55% of 99 survey points, some up to 200

meters from the release plots. At one site on Cottonwood Creek near Madera (Madera County) in the San Joaquin watershed, exit holes were found at 90% of 30 survey points.

(Continued on page 6)



Arundo wasp laying eggs in *Arundo* shoot tip at a site on Cottonwood Creek, Madera County, June 2020. Photo: Valle Rogers, USDA-ARS.

“Working Together Against Weeds” in our National Parks

Brent Johnson, Vegetation Ecologist/IPM Program Manager, National Park Service, Interior Regions 8, 9, 10, 12

California’s National Parks contain some of our most protected and least invaded lands in the state.

While this is reassuring, these areas are not immune to future weed invasion.

Park managers are increasingly aware that some of the most significant risks of invasive plant introduction and spread in National Parks do not come from outside threats, but from their own management actions. Operational activities such as road and trail maintenance, construction, administrative stock animals, research, hiking, backpacking, and yes, even invasive plant control and restoration can all play a role in the introduction and spread of invasive plants.

An effective and efficient approach to prevent introduction and spread is to implement specific prevention practices into park operations, such as making sure construction equipment is clean when brought into a park or using weed-free feed for stock. These types of prevention practices are often organized into recommendations called Best Management Practices (BMPs). Cal-IPC



Park staff members inspect construction vehicles and discover seed-filled mud in the undercarriage. Photo courtesy National Park Service.

has put together some terrific resources to help land managers establish their own BMPs, which can be downloaded from the resource library on Cal-IPC’s website.

Even with their relatively low costs and demonstrated effectiveness, it can be

challenging to put effective BMPs into action on the ground. Implementing BMPs can mean a change in how work is done for work groups that have been doing things a certain way for decades. Contractors, outside partners, and internal work groups — each on tight timelines and budgets, and with varying levels of understanding on the devastating effects of invasive plant management — can make following through and getting buy-in on BMPs challenging.

Ten years ago, a small group of plucky National Park Service managers concerned with how park internal operations may be contributing to the spread of weeds developed a framework for a workshop called “Working Together Against Weeds” (WTAW). They proposed a travelling team of biologists visit interested parks to help develop a suite of park-specific BMPs. Various work groups such as fire crews, road and trail crews,

(Continued on page 6)



Construction staff clean equipment thoroughly before hauling it to a worksite. Photo courtesy National Park Service.

Arundo wasp established in Central Valley

(Continued from page 4)

Galled main shoots were observed at both sites, indicative of wasp impact on these young shoots. A few exit holes or adult wasps were recently found at two other sites in Madera County, and at two sites in the western Delta. ARS is now beginning to monitor impact, using baseline live *Arundo* biomass and shoot density data taken at the time of wasp release.

Additional releases are being conducted at sites at which wasp establishment has not already been confirmed. The *Arundo* wasp holds promise as an important biological control tool in integrated management of *Arundo* in the Central Valley.

For more information, contact the author at Patrick.Moran@usda.gov.



Exit holes made by emerging *Arundo* wasps on side shoot gall. Photo: John Goolsby, USDA-ARS.



Stunted, bent *Arundo* main shoot with gall at a site on Stony Creek, Glenn County, July 2019. Photo: Patrick Moran, USDA-ARS.

“Working Together Against Weeds” in our National Parks

(Continued from page 5)

archaeologists, and biologists would all come together to work on the BMPs.

This collaborative development process is an effective way to raise awareness of inadvertent weed spread, get buy-in, and provide an opportunity for the park to consider the challenges of each work group faces with implementing their BMPs. Collectively, the process greatly increases the likelihood that the BMPs will be realistic, reasonable, and feasible for work crews and project managers to put into action. Working Together Against Weeds has visited more than a dozen different park units in California over the past decade.

Each year, the program aims to reach at least one or two parks. Most recently, the Working Together Against Weeds Team visited Death Valley National Park to facilitate a WTAW Workshop. Death Valley National Park, the largest national park in the lower 48 states, protects more than 3.4 million acres and has a long history of road maintenance and construction. Despite limited staffing, the

park prioritizes invasive species inspections for construction vehicles and equipment.

Although the park’s maintenance division had long-standing practices in place for vehicle inspection, the workshop revealed that these procedures were not documented in writing, nor applied to other park operations such as concessioners and special use permit holders. In fact, during the WTAW workshop, the park’s engineer ran out of the room to intercept a gravel tractor trailer load that had failed to stop at the park boundary for the required vehicle inspection.

Since the workshop, the weed inspection Standard Operating Procedure has been finalized and shared with concessioners, neighbors, and all special use permit applicants. The park is also initiating a pilot program for invasive species inspections. Under this program, the park will collaborate with businesses that routinely provide extremely clean equipment and trucks to job sites. This pilot program has numerous benefits. It will reduce park staff time required to

perform inspections and reduce lost time and cost for contractors and suppliers due to an extended inspection process. The pilot program will also educate the participating companies on invasive species problems at construction sites, and hopefully help to create a broad network of companies who collaborate with Death Valley National Park to reduce the spread of invasive species.

In addition to prevention measures, the park has ramped up its early detection and control of invasive species program, particularly Sahara mustard, along roadsides. With the closing of visitor centers and campgrounds due to COVID-19, park interpretation and fee collection staff may be available to assist with weed detection and control.

The WTAW workshop at Death Valley National Park served to reinforce the prevention measures already occurring in the park, identify early detection areas for improvement, and achieve buy-in for weed prevention from multiple park divisions and management.

Inclusion in Conservation

Doug Johnson, Cal-IPC

At this year's Symposium, we held three discussion groups on ways to broaden the conservation field. Topics of JEDI — justice, equity, diversity, and inclusion — are front and center this year, with the highly visible fight for social justice. National politics impacted our JEDI working group when a dedicated member and employee of a federal agency had to step down from the group following an executive order from the Trump administration that constrains diversity training. As one way to help actively broaden the conservation field, Cal-IPC provided our second year of Diversity Scholarships to attend the Symposium. Here, we share written excerpts from the 2020 awardees to convey the range of new voices in the conversation on conservation.

"I diversify representation in the conservation field as a Teochew-Vietnamese queer non-binary femme invested in community-engaged approaches to land stewardship. Successful conservation is an effort that engages not only college educated folks like myself, but folks like my mother — a non-English speaking refugee from Vietnam — to the folks running the taqueria across from my home. Through this accessible and engaging partnership from folks of all walks of life, we will create a culture that celebrates and actively practices healthy stewardship of our natural environment."

"I am a first-generation college student of Latin and Native American descent. I come from a low-income family and struggled throughout my early years with my queer identity. Nonetheless, I have overcome obstacles to further my dream of a career in conservation. By highlighting the barriers that people in a similar position face when entering this branch of work, I believe that my life experiences can be used to elevate marginalized communities in a career with plant conservation."



Screenshot showing a small portion of the Allyship Gathering, an evening discussion to share resources and help each other learn how to actively stand up for the rights of marginalized communities in the conservation field. Photo: Gina Darin

"Coming from a low-income home with mostly immigrants, developing a career in pest management was a new idea to most of my family. In California, a huge portion of the workforce for agriculture and horticulture are Latino. Yet rarely do we stand in a position higher than the fruit picker or the gardener. I bring a form of communication others may not have, such as my ability to speak Spanish and learn about the people I work with. It makes me proud to know that I stand in a place that contributes so much to the world while staying true to the community that works extremely hard to keep the world fed."

"As a non-binary, Latinx femme, I have yet to meet a person like me in the field of conservation. I can be a representation for future biologists like myself interested in this field. As I advance in my career, I plan to continue doing local outreach to teach the youth in the city I'm from about the importance in caring and supporting the native flora around them."

"I am a first-generation Salvadorian woman. I grew up as a timid and shy person. School was hard to navigate and I struggled to find my voice, but I loved

learning. Having immigrant parents, I did not know how to navigate the college system or even what careers were available. Through volunteering with a group called Los Angeles Rooted, I was able to learn about land stewardship and realized I can have a career working outdoors. This is where my journey started in the outdoor conservation field."

"As a Mexican American woman and a first-generation college graduate, it is important for me to help make spaces in science, ecology, conservation, and stewardship more inclusive. It is crucial to recognize how people with diverse backgrounds bring diverse perspectives in their respective fields... The scholarship granted me the opportunity to explore new and emerging topics in invasion biology. It also gave me the chance to connect with research entomologists from the USDA. I just had a chat with one of them today and he offered valuable career and grad school advice; I have an upcoming meeting with the other to further discuss research in biological control. As a young professional and aspiring scientist, I thank the Cal-IPC community for this opportunity!"

2020 Cal-IPC Symposium

Cal-IPC's 29th Annual Symposium, held in late October, looked unlike previous events. "Zooming" in from socially-distanced offices or home-offices across the state — and from as far away as New Zealand — we "gathered" more than 670 land managers, researchers, and volunteers. Though our staff and board missed seeing our community face-to-face, the lack of travel costs allowed for a much larger group to participate; some attendees were able get field work done and attend sessions on the same day! Over four days, attendees shared the latest in invasive plant biology and management with talks, posters, and discussion groups, united by the theme, "Recovery and Resilience: Confronting Fire, Weeds, and Forest Pests." On the next four pages, we share highlights.

Welcome from Board President Laura Pavliscak

Cal-IPC Board of Director President Laura Pavliscak is Restoration Manager with the Santa Clara River Conservancy in Ventura County. She opened the Symposium with the following inspirational words of welcome from a field site where she works with numerous partners to restore one of the largest and most biologically diverse watersheds in southern California.

Welcome to our 29th annual Symposium and our first ever virtual conference, prompted by these most unusual and challenging times. Recovery and Resilience is our theme this year — particularly resonant in this moment across so many critical aspects of our shared



Cal-IPC Board President Laura Pavliscak. Photo courtesy Laura Pavliscak.

experience. From record wildfires and weather events catalyzed by climate change, to profound social upheaval, to

Congratulations to our student winners!



The only student talk chosen for a full-length presentation: Joanna Tang, UC Santa Barbara, "Positive feedback loops of invasive grasses: breaking the cycle." Photo courtesy Joanna Tang.



Lighting Talks First Place Winner: Clarissa Rodriguez, UC Riverside, "Assessing chemical management options for the control of stinknet (*Oncosiphon piluliferum*)." Photo courtesy Clarissa Rodriguez.



Poster First Place Winner: Mark Mazhnyy, Cal State Polytechnic, Pomona, "Using careful site selection and plastic tree shelters to improve post-fire ecological restoration of highly invaded California native plant communities." Photo courtesy Mark Mazhnyy.

Other student winners – Lightning Talks Second Place Winner: Katherine Brafford, UC Davis, "Is yellow starthistle (*Centaurea solstitialis*) adapting to serpentine soils?"; Lightning Talks Third Place Winner: Stuart Schwab, UC Riverside, "Intact stands of stinknet (*Oncosiphon piluliferum*), providing possible refugia post prescribed burn"; Poster Second Place Winner: Justin Luong, UC Santa Cruz, "Functional traits and phylogenetics can help explain coastal grassland restoration planting survival and community change during extreme drought"; and Poster Third Place Winner: Andrew Lopez, UC Santa Cruz, "Characteristics of plant communities invaded by *Dittrichia graveolens* (Asteraceae), as it spreads away from roadsides in Santa Clara County."

Mark your calendars: Next year the Symposium will be at CSU Chico October 26-29!

a global pandemic, we are enduring truly radical times. It has never been more important to engage in and move forward the causes we hold most dear.

The mission of Cal-IPC is to protect California's environment and economy from invasive plants and all of us are here today, gathered from corners throughout

California and beyond, to address, inspect, learn, and share aspects of that mission. It is remarkable that in these challenging times when we've perhaps never been so socially isolated, this will be Cal-IPC's most well attended symposium with more than 600 participants. To me, that speaks to the wellspring of

environmental commitment and passionate engagement in this extraordinary community of land managers, scientific researchers, public leaders, restorationists, volunteers, students, and stewards. We're grateful for your attendance, for your shared expertise and concern, and for your interest in making this world a better place.

Participants at this symposium are tuning in from all over California, home to nearly 200 tribal nations, including where I stand here in Ventura County, home of the Chumash. As we begin this event, let's acknowledge the original inhabitants of our various regions, both past and present, and take a moment to honor these ancestral grounds that we are collectively gathered upon. For many millennia to the present day and into tomorrow, the knowledge, management, experimentation, and collaboration of these first nations, the original stewards, have created and maintained the diverse ecological systems we work in and enjoy today.

Thanks for joining us here and thanks for your engagement in these critical conservation issues. As my dear friend and mentor, the Lorax, said, "Unless someone like you cares a whole awful lot, nothing is going to get better. It's not."

Congratulations to our 2020 Photo Contest winners!



Alligator weed (Alternanthera philoxeroides) in the Feather River at the Thermalito Afterbay outlet. This aquatic weed can also grow on land, and is expanding in northern California. Kevin Moncrief, Cal. Dept. of Water Resources. [First place winner]



Stinknet (Oncosiphon piluliferum, yellow flowers) between prickly pear cactus (I spp.) and native dodder (Cuscuta spp., orange in foreground) at the San Diego Zoo Safari Park Biodiversity Reserve in Escondido. Stinknet has been spreading quickly in southern California and was recently found in the San Francisco Bay Area. Emily Burson, San Diego Zoo. [Second place winner]



Pulling smilo grass (Stipa miliacea var. miliacea), not smiling, in Santa Monica Mountains National Recreation Area. Gabriel Valbuena, Cal State Northridge Biology Dept. [Third place winner]

2020 Symposium talks sampler

The 2020 Symposium included presentations on a range of topics, from the complications of fire and invasive plant management to strategizing effective weed control at the landscape level. Here is a sampler of some intriguing presentations. Find these and more in the Symposium archive on our website.

WORKING DOGS FOR CONSERVATION (WD4C)

WD4C's Aimee Hurt in Montana described how trained detection dogs have been used to find invasive plants. The canine sense of smell can distinguish between individual plant species. The amount of area that can be covered effectively depends on factors such as the detection distance for a given plant species, the density of plants, and what actions happen upon detection. For a plant with a high detection distance, a dog and handler can cover up to 20 acres/hour. The cost to hire a team is on the order of \$3,000/week.

Weeds that have been successfully surveyed include perennial pepperweed (*Lepidium latifolium*), spotted knapweed (*Centaurea stoebe*), dyer's woad (*Isatis tinctoria*), yellow starthistle (*Centaurea*



Dog and handler in the field. Photo courtesy WD4C.



Finding tamarisk seedlings. Photo courtesy WD4C.

solstitialis), slender false brome (*Brachypodium sylvaticum*), Scotch broom (*Cytisus scoparius*), and saltcedar (*Tamarix ramosissima*).

And, of course, dogs bring incomparable charisma for outreach!

EYES ON THE LAKE

Jesse Patterson from the League to Save Lake Tahoe presented their community science program for early detection. Aquatic weeds, such as Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*), as well as invasive Asian clam (*Corbicula fluminea*) and feral goldfish (*Carassius auratus*), are threats to Lake Tahoe's ecosystem. Watercraft inspectors make sure that boats going into the lake are clean, while a smart-phone app makes it easy for paddleboarders or other recreationists to report potential sightings. In the last seven years, they have engaged hundreds of people and businesses at various tiers of involvement, integrating into existing local efforts and leveraging universal affection for the lake.



Training video for community scientists. Photo courtesy League to Save Lake Tahoe.



Diver removing curly-leaf pondweed. Photo courtesy League to Save Lake Tahoe.

APOCALYPTIC CHICKENS

They're coming home to roost, according to Christy Bringham from Sequoia and Kings Canyon National Parks. The preservation of giant



Information collected on dying sequoias will help save the next generation. Photo courtesy Sequoia and Kings Canyon National Parks.

sequoias is sandwiched between fire regimes, drought, and bark beetles. Land managers are seeing that the trees are not as invulnerable as once believed. In wetter areas, where a high water table results in shallow roots, it appears that fire damage and hotter drought temperatures leave trees susceptible to

death from bark beetle infestations. This is tricky because sequoias need fire to regenerate. To learn more, managers are mounting an early detection campaign to identify areas across the scattered range of sequoias that are showing signs of stress, like defoliation. In addition to being charismatic megafauna, sequoias provide habitat for a range of sensitive species. Researchers are measuring sap flow, trapping beetles to study their genetics, and testing fuel reduction by clearing ground fuels. As Christy says, it's critical to figure this out soon, given that it takes 2,000 years to grow a new monarch sequoia.

ON INVASIVE SPECIES DENIALISM

As we increasingly see in today's world, discrediting science can be a political strategy. Dan Simberloff, from the University of Tennessee, gave an overview of invasive species denialism, comparing it to climate change denialism. Some of the debate happens in scientific journals, but much of it happens in the public sphere with social commentators drawing parallels between human immigration and non-native species. Perhaps biologists' concern about "nature's go-getters" is simply "green xenophobia." In Simberloff's view, these arguments are symptomatic of a limited perspective — if all you have is a hammer, everything looks like a nail. These arguments are not going away, and scientists need to be clear about what is known and what that knowledge suggests in terms of action. Eradication and management actions have achieved significant successes in protecting biodiversity.

Simberloff also described a major frontier in the future of addressing invasive species: genetic tools, including gene silencing to weaken invasive plants, RNA interference to control insect pests, engineered symbionts to activate honey-bee immunity, transgenic mosquitos to decrease disease spread, manipulation of invasive fish sex ratios to reduce popula-

tions, and more. As gene editing technology gets ever more accessible, the ethical aspects of using these potentially powerful approaches are now hotly debated.



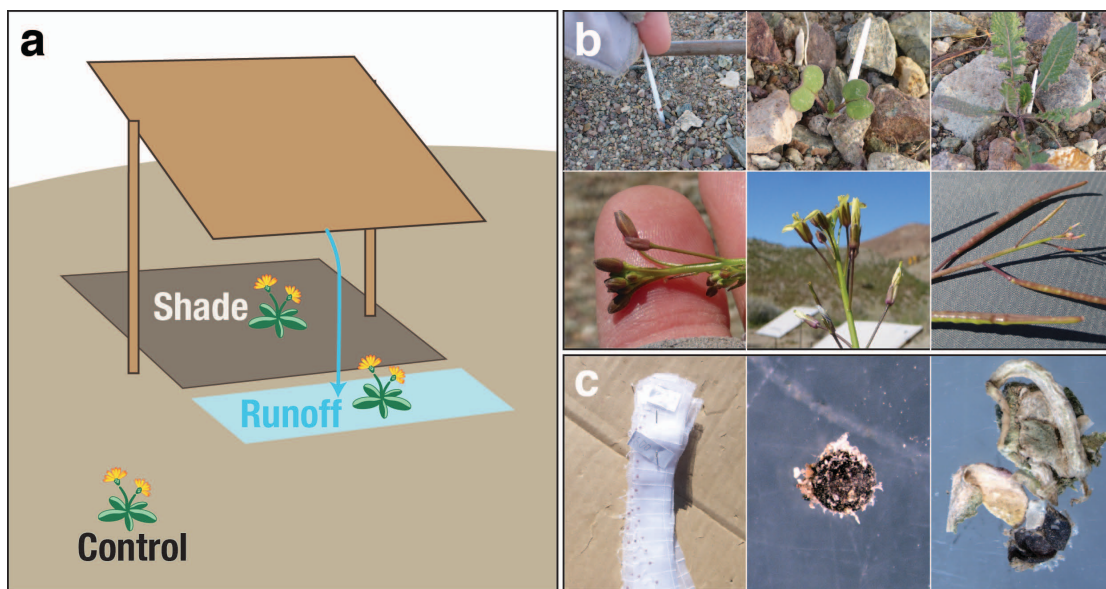
Books countering the scientific consensus that invasive species are a major environmental threat. Image courtesy Dan Simberloff.

Do solar panels mean sunny times for Saharan mustard?

Karen E. Tanner¹, Ingrid M. Parker¹, Sophia Haji¹, Kara A. Moore-O’Leary², Rebecca R. Hernandez²

Solar development is expanding in California’s desert region, where abundant sunshine, inexpensive land, and low human occupancy provide a favorable environment for energy production. Although solar energy offers clear benefits in terms of reduced carbon emissions, power plants can incur ecological costs. Construction and maintenance activities can introduce weed seeds and create new focal points of invasion. In addition, novel shade and moisture gradients under arrays may favor the establishment and spread of invasive plants. We set out to investigate the impacts of solar panel installations on one of these potential invaders, Saharan mustard (*Brassica tournefortii*).

Introduced from Eurasia nearly a century ago, this species is increasingly prominent in California’s deserts, where it competes with native species and contributes to altered fire regimes (Winkler et al. 2018, Barrows et al. 2009). Saharan mustard is known to germinate under a wide range of conditions, exhibits a strong increase in fecundity with size, and performs better in wet years in deserts (Bangle et al. 2008, Trader et al. 2006). At solar energy facilities, panels create novel local microhabitats (Figure 1a). In the shade of the panels, conditions are cooler and drier (Tanner et al. 2020), and runoff from rainfall or panel washing has the potential to increase soil moisture along



1: (a) Experimental panels create shade and runoff microhabitats at an array installed north of Barstow, California. (b) A seed glued to a toothpick (top left), an emergent seedling (top center), and a juvenile plant (top right); a budding plant (center left), flowering plant (center), and a fruiting plant (center right). (c) Fabric seed bank packets ready for burial (bottom left), an intact seed recovered from a buried packet (bottom center), and a germinated seed recovered from a buried packet (bottom right).

the downslope edge of panels. Do these altered microhabitat conditions promote the invasion of Saharan mustard?

We installed an array of simulated solar panels in the western Mojave Desert, in an area with an existing population of Saharan mustard. After confirming that sunlight (photosynthetically active radiation) was reduced similarly between our experimental panels and a full-scale mockup, we used the array to test panel microhabitat effects on aboveground life stages of Saharan mustard. To estimate seedling emergence, we prepared toothpicks with a single seed glued to their midpoint, inserting the seeds and toothpicks into each microhabitat (Figure 1b). That allowed us to track seedlings from germination to the end of the growing season and to calculate survivorship and seed production. We used these methods to estimate demographic transition rates in three growing seasons (2017 – 2019) for use in

microhabitat-specific population growth models.

Saharan mustard germinates in response to fall and winter rainfall in the western Mojave Desert, usually emerging at our field site around midwinter and maturing seeds in late spring or early summer. By chance, our study captured a superbloom year in 2017. The next year was very dry, and plants died as juveniles across all microhabitats — highlighting the strong link between plant performance and rainfall in the desert. We observed a much higher seedling emergence rate, higher survivorship, and greater seed production in the wet year compared to the dry year (Figure 2b, c, d).

Ants are important seed predators and dispersers in the desert. In our superbloom year, we also saw a lot of ants, and they do gather the seeds of Saharan mustard. That in itself was not surprising, but it was interesting to discover how diligently they track down these seeds. To our great surprise, we

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observed ants clamber onto toothpicks, turn head-down, and dig in the sandy soil at the base of the toothpick until it toppled over. The ants then detached the seed glued to the toothpick and carried it away! Fortunately, we were able to overcome this experimental obstacle.

So far, the discussion has focused on aboveground plant response — but what about the seeds? For invaders with annual life histories, seed dynamics are a critical driver of demographic performance, and panel-altered microhabitats may have different effects on

aboveground plants versus seeds. To estimate panel effects on seed bank survival, we sowed seed into fabric packets that were distributed across the Control, Shade, and Runoff microhabitats (Figure 1c). These packets were buried under a thin layer of soil, and a set of packets was exhumed from each microhabitat in late spring from 2017 – 2019. We counted the number of intact, dormant seeds recovered from packets to estimate seed bank survival after burial for one, two, or three growing seasons. We found that the number of dormant seeds (averaged across all microhabitats) dropped from ~12% in the first year of burial to ~6% in the second year of burial (Figure 2a), consistent with the high germination rates previously documented for this species (Bangle et al. 2008).

We also found that panel effects depended on rainfall. We saw some intriguing aboveground trends in the wet year: higher seedling emergence but lower seed production in Shade compared to the Control, and higher survivorship and seed production in the Runoff compared to the Control (Figure 2b, c, d). Seed bank survival rates were similar across microhabitats in the wet year, but we found fewer intact seeds in the Shade compared to the Control in

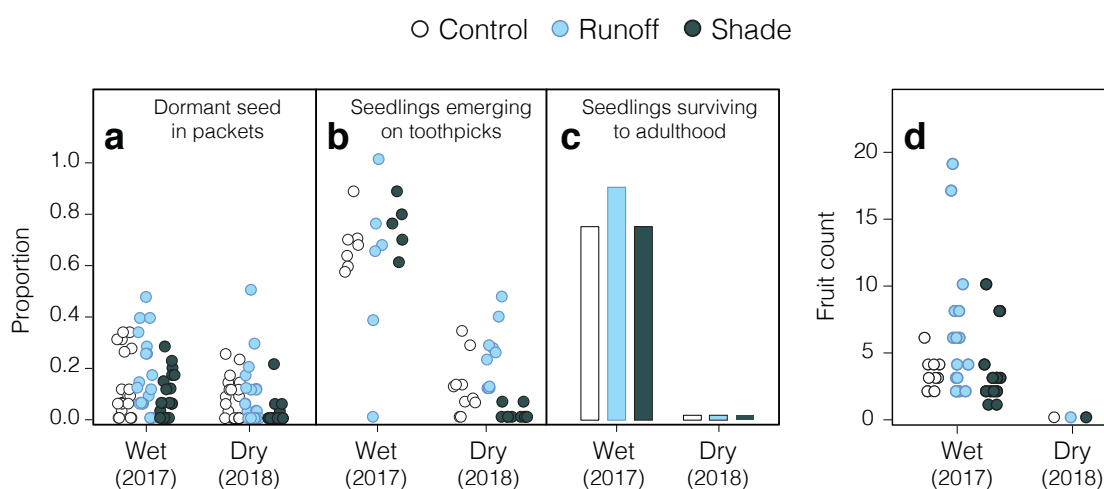


Figure 2: Microhabitat effects on life stage transitions for seeds belowground and plants aboveground in a wet year (2017) and a dry year (2018). (a) The proportion of intact seeds recovered from seed bank packets, which provides an estimate of the seed bank survival rate when packets were buried for one or two growing seasons (all packets were buried in fall 2016). (b) The proportion of seedlings emerging from seeds sown on toothpicks in each year. (c) The proportion of seedlings surviving to reproductive maturity. (d) The fruit count for both years (fruits typically contain ~7-30 seeds).

the dry year (Figure 2a). This pattern could result if more seeds germinated in the Shade, or if more seeds died and decayed in this location. Because we also observed the lowest seedling emergence rate in Shade during the dry year (Figure 2b), we think the seeds died. Microhabitat conditions imposed by panels may favor seed pathogen activity and affect mortality; a study by Li et al (2019) linked Saharan mustard seed dynamics to shifts in fungal pathogen activity when temperature was manipulated.

Could the subtle effects we observed on individual demographic rates exert an influence on overall weed performance and invasion? Our next step is to combine all this detailed data into population models. Demographic models are powerful tools because they integrate effects over the full life cycle and project population trajectories across generations. They also help us identify key life stages to target for weed control. We are building models of how solar panel microhabitats will affect Saharan mustard population dynamics in the desert, which we hope will provide insights into the impacts of solar infrastructure on these invasive weeds and suggest effective strategies for their management.

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Portable washers aid prevention

Field staff from Olofson Environmental, Inc., the Coastal Conservancy's lead partner on the San Francisco Estuary Invasive Spartina Project, use a portable washer to clean gear before leaving a treatment site so they don't transport propagules or soil pathogens. They are following sanitation guidelines established as part of the East Bay Regional Park District's decontamination protocol.



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January 25 – February 25, Online
cwss.org

Public Lands Alliance Convention and Trade Show

February 9 – 12, Online
publiclandsalliance.org/what-we-do/convention

Riparian Restoration Conference

February 16 – 19, Grand Junction, CO
riversedgewest.org/annual-conference

National Invasive Species Awareness Week

February 20 – 28
naisma.org/programs/nisaw/

Western Society of Weed Science

March 1 – 4, Online
wsweedscience.org/annual-meeting

California Trails & Greenways Conference

April 14 – 16, Modesto, CA
parks.ca.gov/?page_id=24151

California Invasive Species Action Week

June 5 – 13
wildlife.ca.gov/conservation/invasives/action-week

Society for Ecological Restoration, World Conference

June 19 – 24, Online
ser2021.org/

“The cheapest weed to control is the first one.”

Scott Marsh, State Weed and Seed Specialist at Kansas Department of Agriculture, during work session on early detection and rapid response at the annual meeting of the Western Weed Coordinating Committee, Dec. 1 – 3, 2020.

“Evidence-based scientific debate (i.e., informed skepticism) indicates a healthy discipline; however, repeating unsupported claims and disregarding decades of evidence negates knowledge progression, adversely affects public attitudes, and misleads policy makers.”

Ross Cuthbert and 18 others, “Invasion costs, impacts, and human agency: response to Sagoff 2020” in Conservation Biology, July 30, 2020.