Vol. 24, No. 2 Summer 2016

Cal-IPC News

Protecting California's Environment and Economy from Invasive Plants

Newsletter of the California Invasive Plant Council

Celebrating park stewardship

Sarah Minnick, Stewardship Coordinator of Ring Mountain Preserve for Marin County Parks, with a young volunteer.

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Editors: Doug Johnson & Elizabeth Brusati.

Rats on islands

By Executive Director Doug Johnson

Islands invaded by rats are some of the clearest examples of invasive species' impact to biodiversity. They are also among the best examples of the potential benefits of eradication.

Islands have historically provided critical breeding habitat for seabirds. And because of their isolation, they hold a preponderance of the world's endangered biodiversity. As sailors circled the globe and visited remote islands, they inadvertently spread rats, which prey extensively on chicks and eggs and damage vegetation. In one example, Australia's Lord Howe Island in the South Pacific, 30 wildlife species have disappeared since rats arrived in 1918.

New Zealand started working on this problem some 40 years ago. To date, over 400 islands have been cleared of rats. The typical technique is spreading poisoned bait from the air. Groups like Island Conservation, headquartered in Santa Cruz, are taking the work global. Their projects span from protecting black oystercatchers in the Aleutian archipelago to the endangered Peruvian diving petrel on Choros Island off the Chilean coast.

Most recently, the world's largest ever rodent extermination was completed in 2015, removing rats from South Georgia Island in the south Atlantic. About 95% of the bird life has been lost due to rat depredation, but with time, is expected to recover. In a sign of things to come, the world's most southerly songbird, the endemic South Georgia pipit, was found for the first time in living memory to be nesting on the main island.

Few invasive species control efforts are as clear-cut as removing rats from islands. For invasive plant control efforts , we are tasked with sorting through the severity and types of impacts and the feasibility of control, and putting that all into the context of what's best for an evolving ecosystem. Still, the principle is the same, and it's great to see the potential for success.

For a detailed telling, see William Stolzenburg's 2011 *Rat Island: Predators in Paradise and the World's Greatest Wildlife Rescue.* Visit Island Conservation's website at *www.islandconservation.org*. And see a video of results ten years after removal of rats from Anacapa Island (pictured below) in the Channel Islands off the California coast at *www.youtube.com/watch?v=RDJgMt19GRI*.

Channel Islands Restoration

Cal-IPC Updates

Symposium program set. Join us near Yosemite for the 25th annual Cal-IPC Symposium! More details page 6.

Submit photos and videos. Joining our annual Photo Contest is our new "Weed Workers of California" video project. We want to hear from weed workers around California about the work you do and why it's important to you. Send your video of up to 60 seconds from the field (or the lab). See links for Photo Contest and Video Submission on the Symposium webpage. Open July 15-Sept. 15.

Mapping arundo in the Central Valley. Cal-IPC and project partners including the Sonoma Ecology Center, River Partners, and the California Dept. of Water Resources are mapping giant reed (*Arundo donax)* across the San Joaquin and Sacramento River watersheds using aerial imagery.

Screening underway for emerging weeds. Cal-IPC has begun screening 200 watch list species to determine their potential for becoming invasive in California.

Algerian sea lavender being treated. Cal-IPC is controlling invasive *Limonium ramossisimum* at ten salt marsh sites around San Francisco Bay. This species is a relatively new invader of upper marsh habitats and has been spreading.

Nature Reserve of Orange County. Cal-IPC is delivering a five-year plan for invasive plant management and early detection/rapid response (EDRR) for the 17,000-acre Coastal Subregion of the reserve.

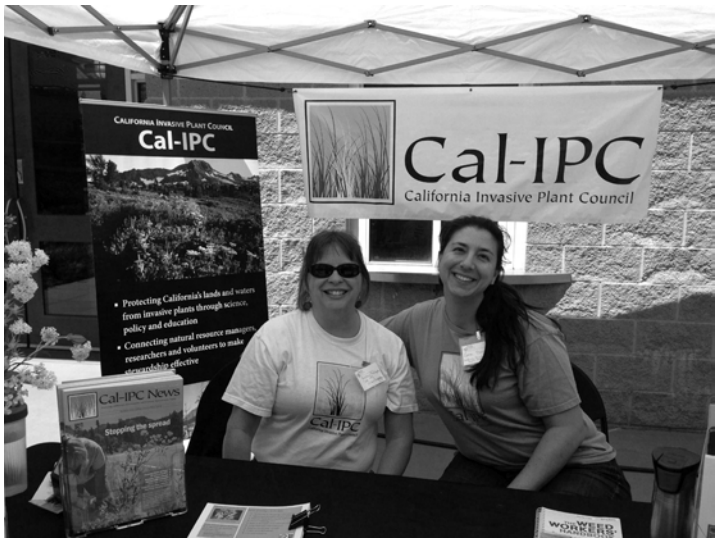
Media contacts. *High Country News* interviewed Cal-IPC about invasive plants and climate adaptation, and *Bay Nature* interviewed us about how new gene drive technology might impact invasive species management.

Spreading the word. We presented a at the SERCAL restoration conference in North Lake Tahoe, exhibited at the Bay Area Open Space Council's annual conference in Richmond, and gave out "Don't Plant a Pest!" brochures at the Roseville Greener Garden Expo.

Wildland Weed News

California Invasive Species Action Week. The California Department of Fish and Wildlife sponsored the second annual CISAW June 4-12. To see what happened and get ideas for next year, go to *www.wildlife.ca.gov/Conservation/Invasives/Action-Week*

Spring campaign a success. Thanks to everyone who contributed, we raised $46,000 in May to support an update to the Invasive Plant Inventory and other Cal-IPC work. Thank you! If you missed the Spring Campaign, you can support Cal-IPC through our San Francisco Marathon runners! *www.crowdrise.com/cal-ipc1*.



Shelley Phillip and Cal-IPC Vice-President Gina Darin handed out Cal-IPC information at the Roseville Greener Garden Expo.

Other News

WHO clarifies: glyphosate not a risk. A joint statement from the United Nations and World Health Organization (WHO)says that glyphosate (the active ingredient in RoundUp herbicide) does not pose a cancer risk, clarifying the confusion over the WHO's recent designation of glyphosate as a carcinogen. For an explanation of the the difference between hazard potential and actual risk, see *www.wired.com/2016/05/monsantos-roundup-herbicide-cause-cancer-not-controversy-explained/*

Stopping mudsnails in Redwood National Park. New Zealand mud snails are exotic mollusks present in many waterways of the western United States. In northern California's Redwood National Park they were first found in 2009. A study testing the response of snails to water conductivity and calcium concentrations found that snails could survive in many conditions, but their reproductive output was low in both natural waters and experimental low-calcium conditions. The results suggest that naturally-occurring differences in water chemistry may reduce the spread of mudsnails in the park. Vazquez et al. 2016. *Biological Invasions*. 18(6):1523-1531.

Homeowners willing to have invasive trees removed. A study in South Africa surveyed homeowners who had invasive trees in their gardens. More homeowners who had had exposure to media on invasive species knew their tree was invasive. While most were not interested in removing the tree themselves, most (83%) said they would be willing to have the tree removed if it was taken down at no charge by an appropriate agency. The study was conducted in conjunction with new regulations that went into effect in South Africa in 2014. Shackleton, C.S. and R. T. Shackleton. 2016. *Biological Invasions*. 18(6):1599-1609.

Keep current...

...on the latest happenings in the weed world by keeping your Cal-IPC membership up to date! Check your membership status on the mailing label of this newsletter. Renew online or with the enclosed envelope. Thank you for supporting our work!

Oxalis pes-caprae control trials

By Lew Stringer, Restoration Ecologist, Presidio Trust, LStringer@presidiotrust.gov

Type *Oxalis pes-caprae* into the search bar of online mapping tools like Calflora or iNaturalist and you will see an almost solid line of occurrence points that run the length of the California coast from Tijuana estuary at the Mexican border to Lanphere dunes in Humboldt County. Imagine clicking on each of those points to reveal a trove of hidden photos, like a database subconscious, of managers wringing their hands and waving herbicide wands at this rapidly wandering weed. You would have found a picture of me in 2004 standing over a clip board scheming an end to its crowding out of the little rare annuals that we try to protect in the Presidio of San Francisco.

Native to South Africa, oxalis has spread to all Mediterranean climate regions of the world. It has been observed forming dense carpets in plant communities such as grasslands and sand dunes that harbor rare and endangered plants. In the late nineties and early aughts, our stewardship program spent many hours of staff and volunteer time ineffectively hand weeding oxalis from areas managed for rare annuals. To improve our management we conducted two informal trials in the Presidio to compare the efficacy of mechanical, cultural and chemical controls of oxalis. In the first trial in 2004, we measured the impact of hand weeding versus tarping on oxalis cover and density. A follow up study was conducted in 2009 to test the efficacy of herbicide on those parameters.

Methods

2004 Manual Trial: At two sites in the Presidio (sand dune and serpentine grassland) 18 permanent 0.5 x 0.5 m plots were established in January 2004. Plots were located in areas where *O. pes-caprae* percent cover was relatively high. Six treatments (including control) with 6 replicates were randomly assigned to the 36 plots (see table). Prior to the application of treatments, baseline measurements were taken in all 36 experimental plots. Percent canopy cover for *O. pes-caprae* was estimated over the 0.5 x 0.5 m area of each plot and *O. pes-caprae* stem density was counted.

In February 2004, prior to corm formation, all manual treatments were applied. In plots receiving the pick treatment, *O. pes-caprae* was removed by hand with the assistance of a hand pick. Plots receiving the hula-hoe treatment were scraped with a hula-hoe. All vegetation and approximately 3 cm of top soil were pulled from the plots in this treatment. The scraped material was then removed from the sites. One set each of the pick plots and the hula-hoe plots received a repeat treatment one month later. Plots receiving the tarp treatment were covered with Lumite® 300, black UV stabilized polypropylene shade fabric and pinned with metal fabric stakes. The tarps were removed in October 2005. Stem density and percent cover were re-measured in January 2005.

2009 Herbicide Trial: Twenty permanent 1 m x 1 m plots were established in November 2009. Plots were located in areas where *O. pes-caprae* percent cover was relatively abundant. Four herbicide treatments with 5 replicates were randomly assigned to the 20 plots. On November 25, 2009, prior to the application of treatments, stem density was counted from a 0.5 m x 0.5 m quadrat at the center of each 1 m^2 plot to reduce edge effects. On December 17, 2009, prior to corm production, all herbicide treatments were applied by Shelterbelt Builders to randomly assigned 1 m^2 plots. Stem density was recounted in December 2010.

Counting oxalis stem density.

Results and Discussion

2004 Manual Trial: Tarping was the only treatment that significantly controlled oxalis in the 2004 study. When the Lumite tarps were removed in late October 2005 after 9 months staked to the ground, etiolated shoots could be observed having recently germinated from corms. Most of these shoots were unable to recover. (See figure next page.)

The results of this study and subsequent tinkering with tarping has refined our management of oxalis. We now use 6 mm polyethylene black sheeting instead of Lumite® as it is more effective at blocking photosynthetically active radiation. Timing is also important. Tarping is now done in early to late-November or about 4 weeks after oxalis has emerged with fall rains. At this life stage, most oxalis corms have germinated and have used up the carbohydrate reserves stored in below

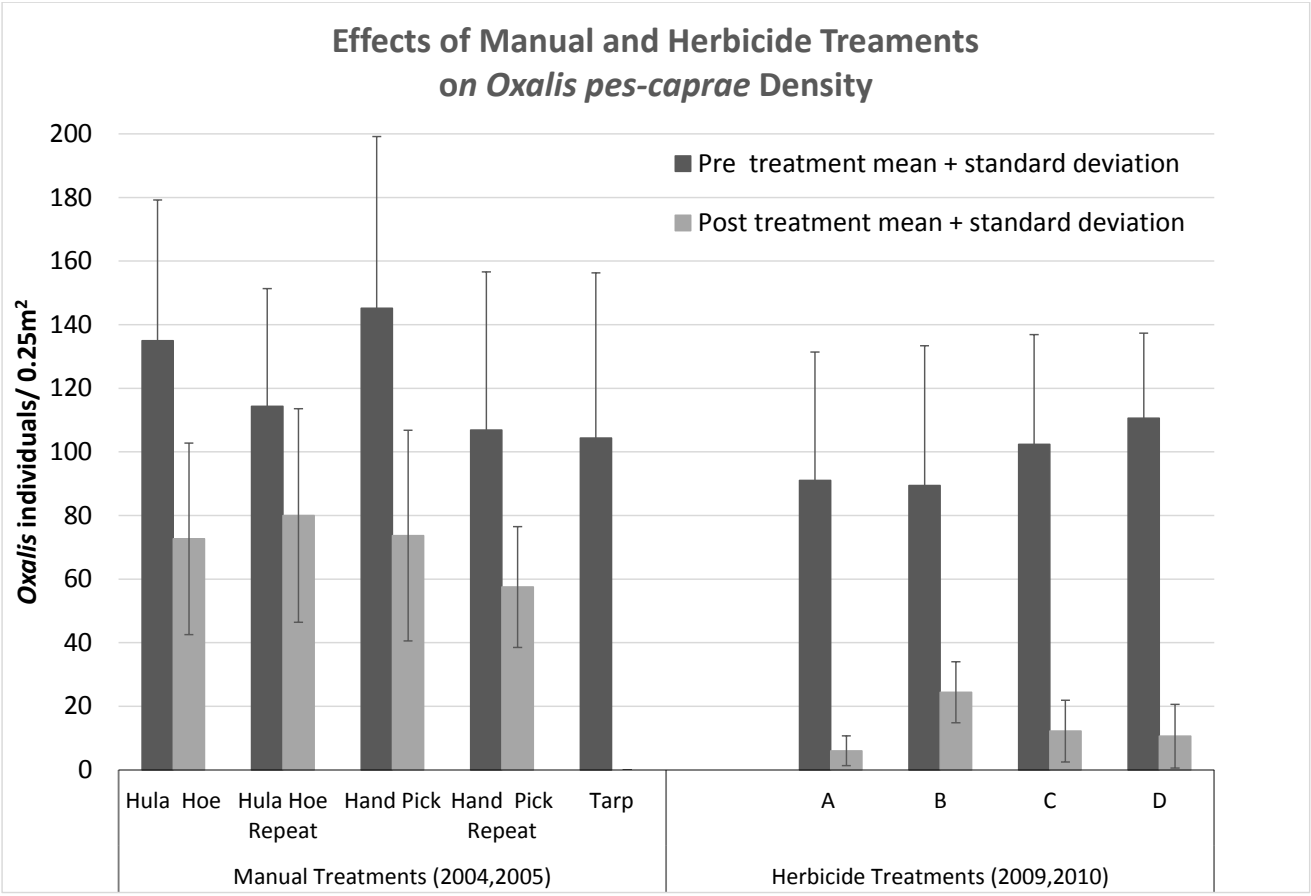
ground corms. New corm formation has not yet begun at this stage. Most oxalis stems die within 6 to 8 weeks of tarping. Collateral damage to desirable vegetation makes this treatment undesirable in certain areas, however we have observed that several species of perennial forbs and grasses are able to recover after being covered for the 8 week duration needed to eliminate oxalis.

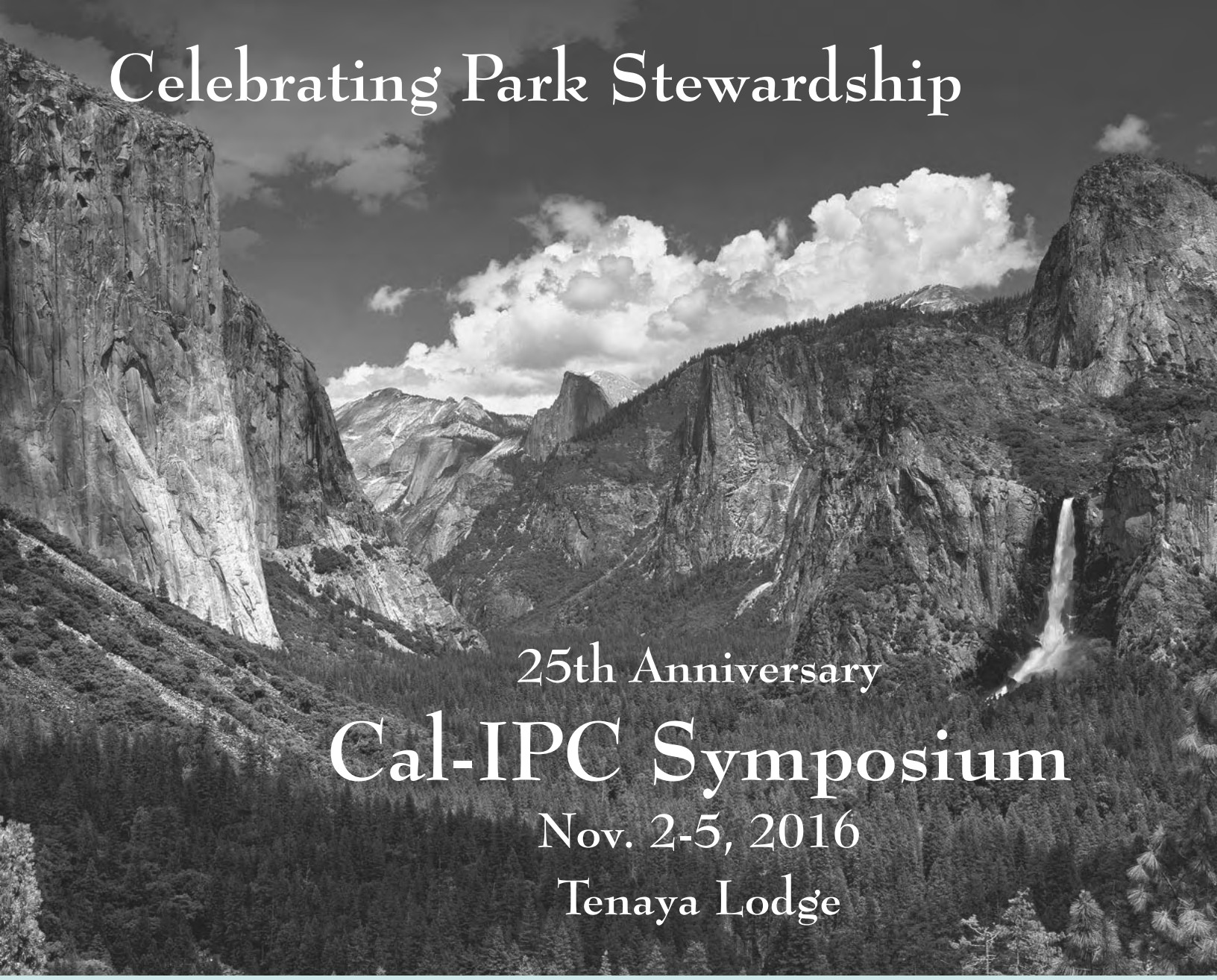
2009 Herbicide Trial: A significant change in *O. pes-caprae* stem density was observed between pretreatment (November 25, 2009) and a year after treatment (December 1, 2010). It was a mistake not to include a control in this trial; however, unquantified visual observations of surrounding untreated areas, while anecdotal, showed much higher density than those in plots. A one-way analysis of variance revealed a significant difference between the change in mean number of oxalis individuals pre- and post-treatment ($p<0.05$). Only Treatment B was significantly different that Treatments A, C and D in 2010.

2004 Manual Trial Treatments	2009 Herbicide Trial Treatments
1) control (no treatment)	A) 1% Garlon 4 Ultra + Competitor
2) hula-hoe	B) ½% Garlon4 Ultra + Competitor
3) repeat hula-hoe	C) 1% RoundUp Pro Max + Trifol water conditioner
4) hand pick	D) 1% Rodeo Aquamaster + Syltac + Trifol water conditioner.
5) repeat hand pick	*Note: We did not include a "no treatment" plot*
6) tarp	

It is often helpful to identify the least amount of herbicide necessary to provide effective kill. One important finding is that ½% Garlon4 Ultra with Competitor was significantly less effective than 1%. While, there was no significant difference between the effectiveness of 1% Garlon4 Ultra with Competitor and 1% RoundUp Pro Max + Trifol water conditioner and 1% Rodeo Aquamaster + Syltac + Trifol water conditioner, 1% Garlon4 Ultra with Competitor had the smallest variance in its effectiveness, with plots that ranged from 2-12 individuals after treatment. The Rodeo and Roundup treatments both had plots with outliers in the high 20s. Having included a higher number of replicates in this study may have provided better clarity.

While this experiment only tested the effects of each herbicide treatment on *Oxalis*, the known impacts of each herbicide on other plants and animals provides greater flexibility when working to control *Oxalis* in different situations.





Program Highlights

Plenary sessions focus on invasive plant management as an integral part of park stewardship, with speakers including:

Don Neubacher, Superintendent of Yosemite National Park

Terri Hogan, National Invasive Plant Program Manager, National Park Service

Jay Goldsmith, Natural Resources Division Director, Pacific West Region, National Park Service

Jay Chamberlin, Natural Resources Division Chief, California State Parks

Mark Hylkema, Santa Cruz District Archaeologist & Tribal Liaison, California State Parks (on cultural resources)

Katherine McEachern, Ecologist, US Geological Survey (on intersection with listed species)

Mary Beth Hennessy, Deputy Director, Ecosystem Planning, US Forest Service (on intersection with wilderness designation)

Jun Kinoshita, Fire Archeologist, National Park Service (on intersection with fire management activities)

Dozens of other speakers and poster presenters will share findings on the latest in management techniques, research, and related land management topics. Continuing education credits will be appliced for from the California Dept. of Pesticide Regulation (12 units Other/2 units Laws & Regs)and Nevada Dept of Agriculture. Final program to be posted on Cal-IPC website in July!

Registration Open!

Early-bird rates through Sept. 15. Member: $295 / Non-Member: $350 / Student: $50

Register online at www.cal-ipc.org/symposia

Trainings (Nov. 2)

Using Certified Weed-Free Forage and Mulch (11am-5pm, $60): Straw mulch used in restoration projects can introduce weed seeds. So can hay used for horses or livestock. Learn how to specify, source, and inspect hay or straw for use in wildlands.

Calflora's Weed Manager Applications (1-5pm, $50): Map weeds on a smartphone and track treatment, using a custom interface designed for your organization? Calflora's Weed Manager suite of tools is designed to do this and more.

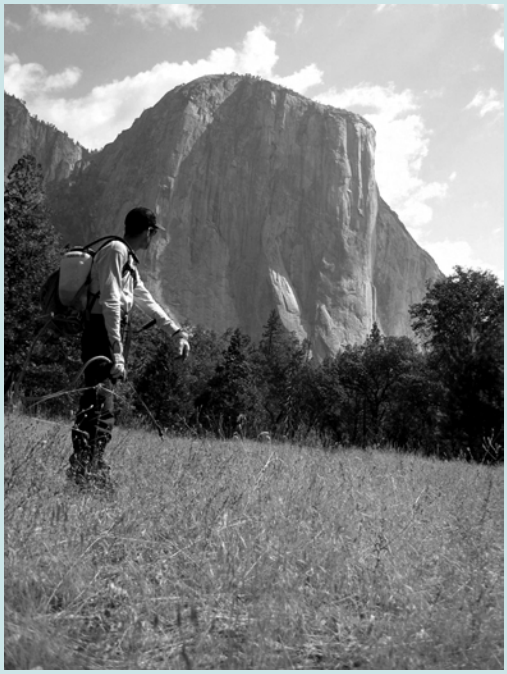
Invasive Plant Management 101 (11am-5pm, $60): New to the field, or never got a full background on weed management? Get context for plant ID, weed biology, mapping, strategic prioritization, IPM control approaches, monitoring, permitting, and more.

Field Trips (Nov. 5)

Sierra National Forest and Nelder Grove of Giant Sequoias (8:30am-12:30pm, $25) Join Forest Service natural resource managers to visit the leading edge of yellow starthistle and medusahead moving up into the mountains, and walk in the giant Sequoias.

Merced River Canyon (8:30am-4:30pm, $50) See where a multi-agency campaign has knocked back dense infestations of yellow starthistle, Italian thistle and tree-of-heaven, including extraordinary treatments on steep rocky slopes using rope systems and high-powered truck-mounted spray rigs.

Yosemite Valley Tour – Weeds and Waterfalls (8:30am-4:30pm, $50) See Yosemite Valley through the lens of three invasive plant challenges: Himalayan blackberry, velvet grass, and annual grasses. and hear about research on native genotypes resilient to climate change.



Hunting for invasive blackberry in El Capitan Meadow. *Photo by Garrett Dickman, Yosemite National Park.*

Plus...

Discussion Groups ◆ Poster and Exhibitor Session ◆ Student Paper and Poster Contests Student Chapter Lunch ◆ Awards Banquet Social Hour with Auction & Raffle

Photo Contest and Video Montage!

Submit your best photos (weed workers, scary infestations, specimen shots, humor, before and after) to our annual Photo Contest. Your contributions help Cal-IPC communicate about the work you do.

And new this year, submit a short (up to 60 second) video for our "Weed Workers of California" montage. We want to hear about the work you do and why it's important to you. Details at www.cal-ipc.org/symposia.

Both open July 15 to Sept. 15!

Golden Gate National Parks Conservancy interns pull yellow starthistle. 2014 Cal-IPC Photo Contest. *Photo by Suzanne Whelan, Marin Municipal Water District.*

Celebrating park stewards

Our 2016 Symposium celebrates park stewardship in honor of the National Park Service's Centennial. We asked a few Cal-IPC members about their work in national, state, and local parks.

Athena Demetry, Restoration Ecologist, Sequoia and Kings Canyon National Parks

In 2001, I ushered Sequoia and Kings Canyon National Parks into the 21st century by starting the parks' first invasive plant management program. Our 865,964 acres are 97% wilderness, and we're fortunate that large extents of the parks are relatively free of nonnative plants, so we focus on prevention and early detection. Our control work targets invasive perennial grasses (reed canarygrass and velvet grass) in meadows, a highly-valued ecosystem. Although these species are challenging to control—reed canarygrass builds a dense thatch layer that excludes native plant recolonization—they are of limited distribution in the parks and eradication may be possible. Wearing my "disturbed lands restoration" hat, I've also planned and implemented the removal of nearly 300 buildings plus roads and parking lots from the parks' premier giant sequoia grove, Giant Forest, and the restoration of a deeply eroded wetland, Halstead Meadow, crossed by the parks' main highway. I feel fortunate to live and work in such a large, biologically diverse, and intact landscape. A personal goal is to insure that yellow starthistle remains excluded during my tenure here!

Athena carrying plants for restoration.

Sarah Minnick, Stewardship Coordinator, Marin County Parks

[Pictured on cover.]

As the Ring Mountain Stewardship Coordinator, I protect and restore serpentine grasslands that are home to numerous native and rare species, one of which (the Tiburon mariposa lily) grows nowhere else in the world. It may be a small preserve in a sea of residential development, but it holds great importance for preserving the region's sensitive biodiversity. With many edges, neighbors, visitors, and trails, weeds come in from all directions. I focus my efforts on those that are able to infiltrate harsh serpentine soils, such as thistles in the genus *Centaurea* and French broom with its ability to alter soil nutrients and eliminate grassland habitat. I am always keeping an early detection eye out for new threats like barbed goatgrass. I engage the local community of residents, schools, and businesses in volunteer work as a way to share the importance of this preserve and encourage participation in its stewardship. It takes the coordinated efforts of volunteers, contractors, and staff work groups to keep the worst weeds under control. Thanks to such efforts, we eradicated yellow starthistle from the preserve in 2007, and we continue to control pampas grass. Marin County Parks is part of a multi-year partnership with The Nature Conservancy that allows us to devote additional resources toward coordination, prioritization, and monitoring, all of which are important in protecting rare species and their habitat at Ring Mountain.

Jim Dempsey, Environmental Scientist, California State Parks

I am the natural resources manager for the Northern Buttes District, which includes 15 park units in nine inland counties north of Sacramento. I grew up in Chico and 16 years ago returned to live here, a town that is very lucky to have the awesome Bidwell Park (a 3,670 acre wildland city park). I was talking with my 89-year-old dad recently about Spanish broom spreading down the watershed into the park, and we reminisced about treasured family memories of spring wild flower displays with rich scents of nectar, now largely disappeared due to exotic grasses. Today, intrepid hikers venturing into the upper reaches of Bidwell Park can still catch remnants of those historic treasures, while they last. Sometimes we need someone with clear memories over a generational time span to remind us what has been lost, and what more may be lost. It's easy to lose track in our everyday rush. What will the next generation bring? I work to stop weeds wherever I can, and encourage everyone to get out there and enjoy our wildlands today!

Jim with a group of Boy Scouts.

Native soil bacteria as biocontrol

By Travis Bean, UC Riverside and Elise Gornish, UC Davis, bean@ucr.edu

Biological control of invasive plants can have many advantages over more conventional management methods, namely the potential for regional scale control of target species over the long term if the control agent can be effectively established. It also avoids the often-unpopular use of herbicides and the habitat disturbances involved with mechanical and physical control. However, because biological control often relies on moving the control agent from one region to another, it can require extensive research to ensure there is neglible risk of unwanted impacts on non-target native or desirable organisms. In the best case, the control agent would be native to the region, just not present in sufficient numbers to cause the desired effect on the target invader.

This is an actual scenario that may yield a novel tool for managing invasive Eurasian winter annual grasses in the western United States, thanks to USDA-ARS researchers in Oregon and Washington. They have recently publicized the results of a long-term field trial investigating the utility of native soil bacteria for selective control of the cheatgrass (*Bromus tectorum*, a.k.a. downy brome), jointed goatgrass (*Aegilops cylindrica*), and medusahead (*Taeniatherum caput-medusae*), while not adversely impacting native plant species.

Research into this promising management tool started in the 1980s in eastern Washington when *Pseudomonas* (a common genus of soil bacteria native to much of the western U.S. and elsewhere) was found on the roots of stunted winter wheat and associated with a reduction in tiller number in affected plants. Recognizing that many of the Eurasian winter annual grasses which are ecosystem transformers in the western U.S. are close relatives of wheat, researchers wondered if the bacteria might also negatively affect these invaders and offer a potential management tool to mitigate their negative effects on biodiversity and productivity of range and croplands. To investigate this possibility, researchers have screened over 20,000 potential bacterial candidates through greenhouse experiments and field trials over the last 20 years located around the inland Pacific Northwest for selective control of cheatgrass, medusahead, and jointed goatgrass.

Cheatgrass invades pinyon/juniper/sagebrush country in the intermountain west, changing the vegetation community by altering the wildfire regime. *BLM photo from the Salt Lake Tribune.*

Recently, they made a breakthrough with *Pseudomonas fluorescens* strain ACK55. By using ACK55 similarly to a pre-emergent herbicide, researchers found that at a rate of one pint of active culture (1 x 108 colony forming units mL^{-1}) per acre, sprayed in the fall prior to emergence of the target invasive plant species, *P. fluorescens* ACK55 is extremely effective at controlling cheatgrass, jointed goatgrass, and medusahead by inhibiting root cell elongation and tiller initiation. In fact, a single application appears to be adequate for almost eliminating these annual weeds from the seed bank in the long-term (4-5 years). This is about the normal lifespan of *P. fluorescens* in the soil.

Other positive results that would increase its utility in an Integrated Pest Management (IPM) program for Eurasian winter annual grasses include tests of over 200 non-target plants demonstrating that the bacteria do not affect crop or native species, meaning that *P. fluorescens* can provide selective control of the target invaders. In the presence of *P. fluorescens*, crops and natives are able to competitively dominate the suppressed weeds and increase in cover. Research has also found that *P. fluorescens* does not inhibit fish, birds, bees, and other insects. Moreover, since the strain has no known anti-fungal or anti-bacterial activity, it is not expected to disturb the native microbial communities.

As is the case with pre-emergent herbicides, which this biological control agent most resembles in terms of application protocols, researchers have stressed that several other factors, such as soil properties, temperatures, and precipitation, can

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New pest-disease complex threatens California forests

By Shannon Lynch, Akif Eskalen, Gregory S. Gilbert, UC Riverside and UC Santa Cruz. shannon.lynch@ucr.edu

Together with the avocado industry, land managers of native forest communities in southern California face the imminent threat of a new emergent pest-disease complex: *Fusarium* dieback – Shot Hole Borers (FD-SHB). Our work points to a path forward to make informed decisions on best approaches to management.

The beetle gallery in an infected tree.

Controlling emergent pests in the critical early stages of invasions is generally difficult because costly management decisions must be made with insufficient data. Which areas are most vulnerable to an infestation? How do invaders spread across a landscape? What management options are most effective?

Decision-making is further entangled when invaders spread across multiple land-use jurisdictions. Such uncertainty can cause delays and inefficient and ineffective use of resources. Our research team has developed an approach to reducing this uncertainty to confront FD-SHB with both short- and long-term control solutions.

A Complex Management Problem

The dieback is caused by the combined effects of two ambrosia beetles (the polyphagous and Kuroshio shot hole borers; PSHB, KSHB, both *Euwallacea* spp.) and the specific fungal pathogens each beetle carries (*Fusarium euwallaceae* and *Fusarium* sp.)

In 2003, a single PSHB beetle was caught in a California Department of Food and Agriculture trap in Long Beach. The beetle went unnoticed until 2012 when it was found damaging backyard avocado and urban forest trees in the Los Angeles basin. A rapid monitoring response uncovered the broad host range of the pest-disease complex, but its ability to establish in native vegetation was only gradually recognized.

Since 2012, these pests from Southeast Asia have killed or caused dieback of 41 tree species on which the beetles can reproduce, including 17 California natives (see sidebar, page 12). Another 262 species in 64 families are attacked but do not support beetle reproduction. However, they provide a substrate from which the beetle may find reproductive hosts.

This broad host range makes native

After the beetles leave, the *Fusarium* fungal pathogens continue to colonize the wood.

Ambrosia beetles, also known as shot-hole borers, interact with fungus to cause dieback of trees. *Photo by Shannon Lynch*

riparian, oak woodland, and mixed evergreen communities highly susceptible to invasion and mortality by FD-SHB (Eskalen et al., 2013). By October 2015, FD-SHB infested over 280,000 native trees in the Tijuana River Valley in San Diego County, including arroyo willow (*Salix lasiolepis*), Goodding's black willow (*S. gooddingii*), and mule fat (*Baccharis salicifolia*) (see figure, pg. 13, Boland 2016). We continue to confirm FD-SHB attacking native vegetation in many new areas throughout San Diego, Los Angeles, Orange, and Riverside Counties (Eskalen and Lynch pers. obs.).

These particular plant communities are critical breeding habitat for endangered species such as the least bell's vireo (*Vireo bellii pusillus*), southwestern willow flycatcher (*Epidomax traillii extimus*) and arroyo toad (*Anaxyrus californicus*). As FD-SHB kills willows, cottonwood, and mule fat, it can make riparian habitats more susceptible to invasion by giant reed (*Arundo donax*) and saltcedar (*Tamarix* spp).

At these early stages of the epidemic, preventative and containment measures can fortunately still be effective, providing adequate, rapid assessment of key landscape factors.

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WMAs, who needs 'em? The low desert, for one

By Lynn C. Sweet, UC Riverside, lynn.sweet@ucr.edu

Recently, representatives from state, federal, tribal and county agencies as well as local organizations came together in a small room in Palm Desert. The goal: to resurrect the Low Desert Weed Management Area (LDWMA), which covers parts of Riverside and San Diego counties containing the Colorado and Mojave Deserts. The process was jump-started by members of the community who felt a vacuum in the wake of a Natural Resource Conservation Service-funded coordination program that had brought together partners and stakeholders for several years to work on invasive plant problems, but had flagged after the funding cuts to the California Dept. of Food and Agriculture's WMA program.

For years, WMAs in California benefited from funding for priority on-the-ground weed control projects as well as the much-needed coordination process itself (meetings, project planning, platforms for sharing data). After the cuts, only some WMAs have continued to meet, buoyed by in-kind donations of time, tools and dedicated intentions to coordinate invasive plant management on the ground.

Resurrecting an organization is not easy, and some soul-searching has been part of the process for the LDWMA. The group is diverse. Desert systems in California (and elsewhere) harbor many rare and endemic species, as well as suites of species in ecosystems found nowhere else. While not as ecologically productive as coastal or northern systems, the Colorado Desert has its share of invasive species, plants that can make quick work of open areas during the short winter rainy season or within the riparian and seasonally-wet corridors that snake through the canyons and valleys. Many invaders are native to other arid regions, from which they were imported for windbreaks (such as *Tamarix* species) or were brought in accidently with agriculture, as in the case of Sahara mustard (*Brassica tournefortii*), which was brought in as a contaminant from northern Africa with date palm operations.

In the low desert, focus has been directed in recent years to areas where invasive plants threaten federally endangered species, such as the Coachella Valley fringe-toed lizard, an endemic species that UC Riverside researchers found to be negatively impacted by Sahara mustard. In addition to research on how to utilize phenology and chemical controls, efforts to control Sahara mustard have been primarily the domain of organizations such as the Friends of the Desert Mountains, who mobilize volunteer forces to pull weeds, with some notable successes in priority areas.

An Urban Conservation Corps crew works on tamarisk in Palm Canyon. *Photo by Jennifer Prado, Friends of the Desert Mountains*

The question for the LDWMA and other WMAs is how to coordinate efforts without the push of funding. Members of the LDWMA are discussing these among other questions to target the best directions, aims and goals of a WMA in the sans-funding era. Without having the "carrot" of funding for on-the-ground efforts, what are the concrete benefits of a WMA? How can we best take advantage of Cal-IPC's existing resources? What are the prospects for restoring funding to WMA programs?

Though the ability of the group to initiate projects will be limited by the current lack of seed grants, the LDWMA believes it can nonetheless provide useful coordination in many areas, including: invasive species mapping and monitoring; control project coordination; volunteer mobilization; and information-sharing on environmental review issues. Led by the staff from the Coachella Valley Resource Conservation District and an ad-hoc committee, many of the members of the LDWMA are also involved with monitoring and management through the Coachella Valley Multiple Species Habitat Conservation Program, which provides a strong foundation and existing network of diverse skillsets and experience among the stakeholders.

Also, knowing that Cal-IPC has stepped into a role as regional facilitator across the state, helping WMAs set priorities and pursue funding, gives us a sense that there is some outside support for this effort. A few other regions have successfully secured grants for weed management projects from state restoration programs funded by bond measures, and as we move forward we may investigate the potential for a similar effort in our region.

Finally, we hold out hope that at the state level, funding will be restored because a small ongoing budget for local weed management coordination is an excellent investment in protecting the state's environment. It would certainly provide the basic funding for this essential early detection network and pay dividends for sensitive species, water supply, agriculture, fire safety and a host of other important issues. The LDWMA currently meets quarterly in Palm Desert, CA. To join, contact *lynn.sweet@ucr.edu*.

...Pest-disease from page 12

Current practices in avocado groves and urban forests rely on control measures such as systemic pesticides that are not generally appropriate for use in native habitats. Similarly, chipping infested wood to a size smaller than 1 inch, followed by solarization, kills the beetles, but it is not possible to cull trees that provide nesting habitat for endangered bird species.

An integrated pest management (IPM) program for native vegetation includes (1) developing tools to quickly detect new infestations and identify the beetles and fungi; (2) identifying which habitats are most vulnerable to FD-SHB and are most important in its spread; and (3) evaluating preventive and curative biological, mechanical, and chemical control options appropriate for different habitat types.

Early detection and rapid identification are critical. With two beetle species and at least two fungal pathogens involved in this pest-disease complex (Lynch et al. 2016), molecular tools to quickly and accurately identify the beetles and fungi are being developed to tailor control measures to the appropriate pest-disease complex (Stouthamer unpublished). Rapid identification tools are also essential for accurate mapping of the distribution of FD-SHB. But impacts and site-specific risk cannot be determined based only on where the beetles have already arrived.

Risk Assessment of Habitats

Effective management of an emergent pest-diseases complex requires predicting where it will spread and cause damage. We have begun a systematic survey throughout regional urban-wildland forests and agricultural lands, and are measuring vegetation and landscape characteristics, microclimate, and resident beneficial microorganisms across sites.

By combining these survey data with what we know about host range into an adaptive risk model, we can interpolate likely areas of spread into an interactive map tool to aid managers with decision-making.

Such early detection surveys and site-specific risk assessments help decision-makers focus resources in the face of insufficient data, and have reduced costs of management of invasive ambrosia beetles by 39% compared with no surveillance (Epanchin-Niell et al. 2014). This adaptive model, continuously improved with new survey data and field testing, will help prioritize management efforts to specific sites and avoid unfruitful efforts in low priority sites.

Controls in Development

Two approaches are being studied to effectively control FD-SHD. The first approach uses pesticides. Several systemic pesticides identified in preliminary field experiments show promise for controlling the beetles and fungi on individual trees if applied prior to infestation (Eskalen et al. unpublished data). Our landscape-based risk assessment will help reduce the environmental impacts of such pesticides by targeting their use as they continue to be tested and developed.

The second approach uses endophytes for biological control. Endophytic fungi and bacteria live inside plant tissues, and are analogous to the gut microorganisms that play a role in our own immune systems. We have already isolated several endophytes from local avocado and sycamore trees that escaped disease, and found they reduced the growth of the *Fusarium* pathogens. Our preliminary results additionally show that *Fusarium* spp. cannot colonize young avocado and sycamore plants inoculated with beneficial endophytes.

We are currently working with land managers to collect endophytes from additional surveyed native trees and test their biocontrol potential. We are conducting experimental trials to test if these protective endophytes can be inoculated prophylactically into seedlings and saplings of native plants to facilitate restoration of habitats and improve landscaping even where FD-SHB has become established.

Our risk model will be used to evaluate locations where resident endophytes may reduce vulnerability and where endophyte treatments may be most useful.

Native trees and shrubs affected:

Box elder (*Acer negundo*)

California sycamore (*Platanus racemosa*)

Red willow (*Salix laevigata*)

Black willow (*Salix nigra*)

Arroyo willow (*Salix lasiopeis*)

Cottonwood (*Populus fremontii*)

Black cottonwood (*Populus trichocarpa*)

Engelmann oak (*Quercus engelmannii*)

Valley oak (*Quercus lobata*)

Palo verde (*Parkinsonia aculeata*)

Mule fat (*Baccharis salicifolia*)

Big leaf maple (*Acer macrophyllum*)

Coast live oak (*Quercus agrifolia*)

White Alder (*Alnus rhombifolia*)

Blue palo verde (*Parkinsonia florida*)

Mesquite (*Prosopis velutina*)

Goodding's black willow (*Salix gooddingii*)

Summary

Appropriate management protocols for FD-SHB are contingent on a number of different landscape factors. Understanding these factors is time-sensitive and will result in long-term cost savings. Landscape assessments are urgently needed to provide managers with the information they need to prioritize use of limited funds. Individual stakeholder agencies can play a critical role by helping us document current impacts to better inform an integrated landscape risk model of the spread of FD-SHB. For updates and more information, visit *www.eskalenlab.ucr.edu* and *www.pshb.org*.

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...Soil bacteria from page 9

mediate treatment effectiveness, specifically noting that the bacteria may not perform as well under hot and arid conditions experienced in summer months. As with all invasive plant management and restoration methods, timing is critical; along with cooler temperatures, precipitation is required within two weeks of application for the bacteria to effectively colonize the soil. This means that successful application relies heavily on seasonal precipitation and a lack of unseasonably warm fall weather, which may be more limiting in future years under some climate change scenarios.

P. fluorescens ACK55 is currently undergoing the EPA registration process, which can take about 17 months. If accepted by EPA, the inoculate could be available for widespread use. In California, pathogens intended for controlling weeds require authorization from the California Department of Pesticide Regulation, and other states may have similar requirements.

Other than state-specific restrictions on using pathogens for invasive plant control, there are also the hurdles of propagation: what is the cost of growing enough of the bacteria to supply it to farmers, ranchers and conservationists interested in using it to control invasive winter annual grasses in the western U.S.? Because it's likely to be cost-prohibitive to apply the bacteria to all of the millions of acres currently infested by these problem species, the researchers suggest that a more targeted approach be considered. One approach would be direct application of the bacteria to leading edges of existing infestations to quarantine existing populations and prevent spread into new areas. Other priority targets are firebreaks to control wildfire spread and recently burned areas where the existing population of invasive grasses is restricted to the seed bank, allowing the bacteria to have the largest impact.

Additionally, site-specific factors may limit effectiveness of the bacteria for invasive grass control. As we often hear restoration ecologists and practitioners emphasize, control tools are most effective when used as part of an IPM program, rather than as a stand-alone treatment. In fact, as the researchers themselves suggest, the bacteria is unlikely to be successful if simply applied to invasive grass monocultures, as the grasses will simply regenerate given sufficient time. Instead, researchers suggest that post-emergent herbicides be applied to reduce the standing crop of invaders, while also applying the bacteria to attack germinating seedlings and provide seed bank control over the longer term. Seeding or planting natives or desirable forage species can help reestablish a diverse and resilient plant community that can resist or prevent recolonization by invasive grasses.

For more information:

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July 17-20, Madison, WI
www.conbio.org/groups/sections/north-america

Central California Invasive Weed Symposium
October 6, Marina
www.cciws.org

Natural Areas Conference
October 21-22, Davis
www.naturalareas.org

Cal-IPC 2016 Symposium
November 2-5, Tenaya Lodge, Yosemite
www.cal-ipc.org

Bay Delta Science Conference
November 14-17, Sacramento
scienceconf2016.deltacouncil.ca.gov

Do No Harm: Non-Native Species in Restoration
November 15, UC Davis
ucanr.edu/sites/UC_ANR_Do_No_Harm

California Association of RCDs
November 16-19, Ontario
www.carcd.org

North American Invasive Species Forum
May 9-11, 2017, Savannah, GA
www.invasivespecies2017.org

"Researchers have been desperately looking for a way to overthrow cheatgrass's reign for decades, and have tried some wacky experiments in the process — from fungal pathogens like the macabre Black Fingers of Death to changing soil texture to introducing super absorbent polymers into the ground to soak up water. Now, after nearly 30 years of trials and research, Ann Kennedy has found the innocuous cure — native soil bacteria."

~ From "Researchers find an answer to invasive cheatgrass". Gloria Dickie, High Country News, *Oct. 16, 2015, www.hcn.org/articles/researchers-find-formidable-foe-for-invasive-cheatgrass*