California Invasive Plant Council
2015 Symposium Abstracts

Presentations will be posted at ***http://www.cal-ipc.org/symposia/archive/index.php***

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Assessing herbicide impacts to pollinators. Speaker TBD, California Department of Pesticide Regulation.

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Heat-related illness and herbicide use. Carmen Cisneros, Cal OSHA.

A presentation on heat-related illnesses and how they can be prevented when applying herbicides.

Understanding and preventing herbicide drift. Joel Trumbo, California Department of Fish and Wildlife. Joel.Trumbo@wildlife.ca.gov

A presentation on herbicide drift including the factors that contribute to it and how impacts can be reduced.

Thursday, October 29

Session 1. Habitat Conservation Planning and Invasive Plant Management

Lessons learned and the future of Habitat Conservation Planning in California. Alejandro E. Camacho, Elizabeth M. Taylor*, Melissa L. Kelly, University of California, Irvine, Law Center for Land, Environment, and Natural Resources, Irvine, CA. etaylor@law.uci.edu

Area-wide, multi-agency Habitat Conservation Plans and Natural Community Conservation Plans (HCPs/NCCPs) have achieved significant conservation outcomes in California, while also running up against limitations. Experiences to date offer valuable lessons that can help improve existing HCPs/NCCPs and provide direction for future efforts. . Research, interviews, and dialogue sessions organized by the University of California, Irvine Law Center for Land, Environment, and Natural Resources (CLEANR), in conjunction with the non-profit Center for Collaboration in Governance, examine the experience with habitat conservation planning in California, with a focus on lessons from area-wide, multi-agency HCPs/NCCPs. In consultation with dialogue participants and other experienced practitioners involved in habitat conservation planning, CLEANR identified four topics about which area-wide, multi-agency HCPs/NCCPs provide particularly valuable insights: 1) managing geographic, ecological, and temporal scales; 2) fostering effective inter-jurisdictional problem solving; 3) allocating funding; and 4) managing uncertainty and change. These topics, and the lessons provided for each, are interrelated: the uncertainties, funding challenges, and difficulties of inter-jurisdictional problem-solving accelerate as the geographic scale of planning widens, the ecological scope deepens, and the temporal duration lengthens. As some of the first experiments in large-scale, ecosystem-based, inter-governmental and adaptive conservation planning, California's area-wide, multi-agency HCPs/NCCPs illustrate the inherent conflicts in comprehensive habitat conservation planning and governance. Particularly in light of the limited and unreliable amounts of funding provided for habitat conservation planning, these tensions have resulted in clear tradeoffs between scale, number of species covered, duration, cost, certainty, efficacy, and flexibility. However, the experience to date of area-wide, multi-agency HCPs/NCCPs suggests that close attention to these underlying tradeoffs—along with recognition of conditions conducive to success and careful institutional design—can maximize the likelihood of effective habitat conservation at the landscape scale.

Innovations in landscape-level invasive plant management. Doug Johnson. California Invasive Plant Council, Berkeley CA. dwjohnson@cal-ipc.org

The spread of an invasive plant species across the landscape is a biogeographic phenomenon, one which has often been described as a "wildfire in slow motion." Addressing a biological invasion at the landscape level has the same fundamental requirements as addressing a wildfire: timely response, extensive coordination, spatially explicit strategy, appropriate tools, and sustained effort. Shifts in agency programs, technology, and awareness of invasive species have led to innovations in how we address these requirements when managing wildland weeds in California. Key innovations include: (1) the

Weed Management Area structure, which brings local stakeholders together to plan projects; (2) online data sharing tools like Calflora, EDDMapS and iMapInvasives; (3) online decision-support tools like CalWeedMapper and WHIPPET; (4) risk assessment for emerging weeds, like that employed by the Bay Area Early Detection Network and the new Plant Risk Evaluation tool from UC Davis ; and (5) the ability to use bond-funded grants for invasive plant eradication projects. Cal-IPC and partners are leveraging these innovations to design and implement landscape-level projects, such as the recently funded North Coast Knotweed Eradication Project, and to engage land managers in an "Early Detection Network" reporting system. Regional invasive plant management is an excellent fit with the goals of regional habitat conservation planning, but proactive integration is critical to realizing benefits.

Session 2. Stopping New Invaders

Initiating the San Diego Regional Invasive Plant Early Detection and Rapid Response (EDRR) Program in support of NCCP. Jason Giessow*[1] Mark Martinez[2], Carolyn Martus. [1]Dendra Inc. jgiessow@cox.net, 2San Diego County AWM.

All of western San Diego County is in an approved or soon-to-be approved Natural Communities Conservation Plan (NCCP). An Invasive Plant Species Strategic Plan (IPSP) was completed addressing the full spectrum of invasive plant control priorities, from Early Detection and Rapid Response (EDRR), to landscape level control programs, to reserve level control around MSP priority species and habitats. A key component of IPSP implementation has been the initiation of an EDRR program for invasive plants that are impacting habitat and species conservation. The EDRR program is led by San Diego County Agriculture Weights & Measures (AWM) with funding support from SANDAG's Environmental Mitigation Program (EMP) as well as CA Dept. of Food & Agriculture and the Wetland Recovery Project (WRP). The EDRR program is completing detailed mapping, obtaining Right of Entry agreements (ROEs), and initiating work on the ground for ten priority EDRR invasive plant species in the region. Developing a network of target plant observers has been a critical component of the program, accomplished by engaging land managers (SDMMP meetings), biologists (WMA meetings and directed outreach), and citizen volunteers (directed outreach) across the region. The IPSP plan and GIS data are available at www.SDMMP.com.

A CNPS Chapter model for early detection and effective response to emergent invasive weeds. Jutta Burger, Thea Gavin, Celia Kutcher, David Pryor, Dan Songster and Ron Vanderhoff*. California Native Plant Society – Orange County Chapter, P.O. Box 54891, Irvine CA 92619-4891 California. rvanderhoff@sbcglobal.net

Many counties in California lack an effective process to identify, communicate on and coordinate the local management of emergent invasive plant species. Recent state and local funding cuts for regional programs such as Weed Management Areas have only worsened the situation. The Orange County Chapter of the California Native Plant Society is uniquely qualified to adopt this role because it has members with the expertise to provide local plant knowledge, a thorough understanding of invasive plant issues, an existing internal infrastructure (including website) and a strong partner network. Furthermore, OC-CNPS is not encumbered by the jurisdictional, political or procedural constraints that land managers and land owners typically face. In less than one year

and largely through volunteer efforts, we have been able to create a detection, communication, and management support system for local emergent invasive plants, complete with online resources. Here, we describe our County-wide Emergent Invasives Program in the expectation that this program can serve as a model for other CNPS Chapters or regional groups to facilitate action where funds may be limited. The specific functions of the program are to provide: 1. Trained "eyes on the ground" to accurately report new populations of high priority emergent weed species, 2. Facilitation and communication of response through coordination with land managers, land owners, support groups and potential labor forces for control, and 3. Labor where needed to remove populations that may otherwise not be managed. We describe website resources, prioritization methods, recent achievements, and next steps.

Stopping the spread of *Volutaria* across the California desert. Christopher McDonald* University of California Cooperative Extension, 777 E. Rialto Ave, San Bernardino CA, 92415. cjmcdonald@ucanr.edu

Volutaria tubuliflora was discovered in the small California desert town of Borrego Springs. The initial infestation was spread across several miles and consisted of several patches of thousands of plants, with a moderate abundance on a few hundred acres. This is the first known occurrence of this species in North America. This species continues to spread across Borrego Springs despite drought conditions in the desert. Volunteer efforts have been successful in reducing the population of volutaria at some sites, however the total number of plants removed continues to increase each year. Mapping efforts continue to find new patches, so the total extent of this invasion is unknown. This species is native to the Mediterranean and is found in a wide variety of habitats in its home range. *Volutaria tubuliflora* has also been discovered in Chile and has spread across an approximately 80-mile stretch of the Atacama Desert in at least 30 years. This presentation will describe the early detection and rapid response program developed to eradicate this species as a case study for others who discover a new and highly invasive weed across many land-use types. Information will also include the current distribution of the species, efforts to contain it, newly discovered populations, funding opportunities, and efforts to work with a variety of landowners. In addition, there is a dearth of information about the ecology of this species, from seed longevity to water requirements, thus the reaction from those whose property is at risk of infestation ranges from uninterested to fearful. An overview of the many lessons learned in this fledgling program will be discussed.

Rose colored glasses for sale! Weed Free Forage and Mulch is the *enemy* of the perfect! Bobbi Simpson, National Park Service, California Exotic Plant Management Team, Point Reyes Station, CA., bobbi_simpson@nps.gov

The most effective, economical, and ecologically sound method of managing invasive plants is to prevent their invasion in the first place. Resources can be spent most efficiently on proactive activities that focus on stopping the movement of plant seeds and other reproductive parts to new areas. Invasive weed seeds and root fragments can be moved in hay and straw used for animal feed and bedding, or in materials used for erosion control. Seeds can also be transferred in animal manure if the animal has recently ingested invasive plants in infested feed or while grazing. The Weed Free

Forage and Mulch (WFF&M) program in California has gone through two significant spurts of effort to pull together this rather extensive 58-county program. This presentation is designed to update folks on the improvements over the last couple of years and to cover some of the issues that still need to be resolved. The truth of the matter is WFF&M certification in California is not a perfect instrument; however if managers understand the limitations and know their growers, they can significantly reduce the rate of introductions. Reviewing the solutions to the hurdles and the advances that have been made will provide an overview that will help managers decide if the material has enough advantages to go to the extra expense. Caltrans and Yosemite NP have made strides in requiring WFF&M products, and Yosemite has compelling evidence of the effects of using this prevention measure. Prevention measures do work, however not all managers will consider the existing WFF&M program sufficient to meet their needs, so alternatives to weed free forage will also be covered.

Session 3. Drones and Phones: New Tools for Invasive Plant Management

How the U.S. Department of the Interior is using UAS for conservation. Bruce Quirk, US Geological Survey, quirk@usgs.gov

Unmanned Aircraft Systems (UAS) are evolving as an effective, efficient, economical and environmentally friendly tool to monitor environmental conditions, analyze the impacts of climate change, respond to natural hazards, understand landscape change rates and consequences, conduct wildlife inventories and support related land management missions. The U.S. Geological Survey (USGS) is participating in an operational test and evaluation of UAS to see how this technology supports the mission of the USGS and the Department of the Interior (DOI). Over the last 5 years, the USGS, working with many partners, has been actively conducting proof of concept UAS missions which are designed to evaluate the potential of UAS technology to support the mandated DOI scientific, resource and land management missions. Using small UAS, the USGS is able to tailor solutions to meet project requirements by obtaining very high-resolution remote sensing data, including thermal imagery, to generate GIS-ready products. UAS technology is providing a mechanism to collect timely remote sensing data at a low cost and at low risk over DOI lands that can be difficult to monitor and consequently enhances our ability to provide unbiased scientific information. This presentation describes the UAS technology and infrastructure being employed, pilot application projects already accomplished, lessons learned and the future of UAS within the DOI.

Aerial spraying with UAVs for wildland weed control: Applications and potential deployment. D. Ken Giles[1]* and Mark Heath[2]. [1]Department of Biological and Agricultural Engineering, University of California, Davis. Davis, CA 95616. [2]Shelterbelt Builders, Inc. *dkgiles@ucdavis.edu.

Development of small, unmanned aircraft vehicles (UAVs) provides an opportunity for herbicide spray application in wildland weed situations. Such applications could provide the ability to treat weeds more easily in areas where accessibility by ground for vehicles and personnel is challenging and potentially unsafe. An additional advantage is that the applicator can be removed from close proximity of the spray discharge. Currently, a

commercial UAV-mounted spray system is being deployed for broadcast application of herbicides to high-value specialty crops in California. The UAV is a gasoline-powered helicopter (RMAX, Yamaha Motor Co. USA, Cypress, CA USA) developed for spraying rice crops in Japan. The 100-kg aircraft is powered by a two-stroke, 250-cm^3 displacement, liquid-cooled, 13.6-kW engine. Control of the aircraft was through a radio-linked, 60-mW, dual-joystick handheld transmitter operating in the 72 MHz band. Operation is not fully autonomous but rather is limited to a 400-m "line of sight" range and manual control. The system offers significant operational potential for complex weed control tasks. For example, control of giant reed (*Arundo donax*) can exceed $50,000 per hectare and long linear riparian zones can be difficult to navigate and treat. Similarly, rugged remote areas such as the Channel Islands and Merced River canyons provide challenges for invasive species control, and deployment of small UAVs for highly-targeted spray treatment can significantly improve the areas treated, safety of applications, and expense of operations. While UAV technology is developing rapidly, especially for sensing and mapping, the associated technology for payload delivery, including the handling of herbicides, is less developed. Spot treatment, rather than broadcast treatment, presents additional challenges, though early efforts are underway to develop suitable technology. Additionally, the regulatory environment for UAV operations in natural areas and the release of chemicals is unsettled, with issues of operator certification and herbicide labeling still being resolved.

***i*MapInvasives: collaborative invasive species data management.** Jami Kuzek. Arizona Game and Fish Department, Phoenix, AZ. jkuzek@azgfd.gov

*i*MapInvasives is an online data management tool that stores invasive species information and facilitates data sharing and utilization by land managers, the public and other organizations. The iMapInvasives project is founded on collaboration with NatureServe and is directed by a network of participating states known as the Lead Partner Organizations (LPOs). Within the past decade, iMapInvasives has become a vital tool for several states, organizations and agencies in the battle against some of the most threatening invasive species infestations. At its most basic level, this database supports data management of simple species location information. In addition, it supports advanced information management including the capability to input treatment records, survey records, track infestations over time, create collaborative projects, and even track hours and volunteer efforts spent on projects. From the perspective of Arizona, an iMapInvasives network member, this tool has provided a standardized, central location in which to store invasive species information. It has also aided in data sharing across local and state boundaries on both regional and national scales. Its applicability to on-the-ground management of invasive species is proving to be invaluable as evidenced by the work conducted by organizations in Arizona using the tool. As current efforts expand, additional prospective uses of iMapInvasives are continually identified.

Calflora's Weed Manager System. Cynthia Powell[1]*, Ed King[2] * Pete Frye[3]*, John Malpas[1]. [1]Calflora. Berkeley, CA, [2]Placer County Agriculture Department, [3]Marin County Open Space District. cpowell@calflora.org

Calflora's Weed Manager System (WM) helps agencies to track occurrences, assessments, treatments, and changes in invasive plant populations. WM is based on current Calflora weed tracking applications and the desktop Geoweed system and is sometimes referred to as "Geoweed in the Cloud." WM's primary purpose is to track weed infestations over time, how they change (percent cover, polygon size, phenology, etc.) and the treatments applied to those infestations.

As of June 2015, WM is used by a dozen agencies across the state and the complementing phone application "Observer Pro" is used by over 500 individuals. Each subscribing organization or agency may choose which fields and reporting mechanisms are relevant and implement those. Each agency will use a private copy of the system, but will have the option of sharing their data with other subscribing organizations within the system, other Calflora users, and with other systems such as CalWeedMapper.

Each organization configures certain aspects of how they want to use the system -- for instance, by choosing which fields are required, or which extra fields they want to collect for an assessment. The core data fields and the core methodologies remain standard across all organization subscribers, however, thus enabling data exchange and integration.

Session 4. Invasive Plant Research (I)

Herbivores as mediators of an exotic grass invasion. Cody Ender*, Caroline Christian, and Hall Cushman. Sonoma State University, Rohnert Park, CA. ender@seawolf.sonoma.edu

Given the large economic and ecological effects of many exotic plant species, it is vital to understand the factors that control the success of these invaders. Herbivores can have major influences on the invasion process, both promoting and deterring the success of exotic taxa through grazing, trampling, and deposition of metabolic wastes. Although the reintroduction of extirpated native ungulates has been increasing worldwide, the complexity of community dynamics makes it unclear if and how long-absent taxa may impact target plant invasions, especially over long time periods. Here, we use an 18-year-old exclosure experiment at Point Reyes National Seashore to address the effects of a reintroduced mammalian herbivore, tule elk (*Cervus canadensis nannodes*), on the growth, reproduction, and abundance of a dominant exotic grass, *Holcus lanatus*, and whether short-term effects differ from longer-term effects. Preliminary results indicate that elk significantly reduced the abundance of *Holcus* in 2002 and that the number of plots containing *Holcus* has increased since that time. Data collected this past spring and early summer will provide greater insights into the long-term effects of elk on this problematic invader. Addressing these issues enhances our understanding of the role of herbivores in aiding or hindering plant invasions and will help land managers to more effectively control perennial exotic grasses, such as *Holcus lanatus*, in grazed landscapes.

Biology and control of *Sesbania punicea* seed banks by solarization. Robin Hunter[1]*, Gretchen Coffman[1], Andrew Rayburn[2], and Trevor Meadows[3]. [1]University of San Francisco, San Francisco, CA. River Partners, Chico, CA.

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The exotic shrub *Sesbania punicea* is an increasingly problematic weed along California rivers, because it displaces native vegetation, disperses rapidly downstream and can increase hydraulic roughness in the river channel. Current control methods focus on manual removal followed by herbicide application. These methods are effective at removing mature stands. However, the presence of a large seed bank results in rapid germination and growth of new *S. punicea* seedlings. Solarization has been an effective method to control the seed bank of many weeds, including woody members of the Fabaceae family. Sustained inundation is also a potential control method in riparian settings, and field observations suggest that *S. punicea* may be negatively impacted by flooding. Our study evaluated the effects of solarization and inundation on seed banks of *S. punicea*. Experimental solarization plots were established along the San Joaquin River and an adjacent pond near Fresno in 2014. We also measured the abundance of viable *S. punicea* seeds beneath low and high density stands and found a significantly higher abundance under high density stands. In addition, lab experiments measured the effects of high temperatures and sustained inundation on germination of *S. punicea* seeds. *Sesbania punicea* seed banks appear to be resilient to solarization as a control method, at least in these settings. After two months of monitoring following solarization, there was no significant difference between control and treatment plots for *S. punicea* seedling number or seedling height. There was a significant difference in seedling numbers between pond and river sites. Preliminary lab results show germination is reduced only by extended exposure to temperatures of 60°C, while sustained inundation does not significantly affect germination. With these results and the high labor costs involved in implementing solarization in a riparian environment, solarization is not recommended as a control method for this species.

Santa Rosa Plateau Habitat Studies and Restoration Program: integrating research and environmental education to restore native California grasslands. Justin Valliere[1]*, Edith Allen[1], Susan Balch[2], Carole Bell[3], Ginger Greaves[4], Scott Hanson[5], Laura Hanson[6] and Bridget Hilbig[1]. [1]University of California, Riverside, Botany & Plant Sciences, [2]Shivela Middles School, Murrieta, CA, [3]Santa Rosa Plateau Ecological Reserve, Murrieta, CA, [4]Santa Rosa Plateau Nature Education Foundation, Murrieta, CA, [5]Mesa High School, Murrieta, CA, [6]Curran Elementary School, Murrieta, CA.
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Native perennial grasslands in California are heavily invaded by nonnative species, which threatens the diversity, function and ecosystem services of this important habitat. California also faces statewide educational challenges that could influence training of the next generation of scientists, land managers and policy makers. The Habitat Studies and Restoration Program is a collaboration between the Santa Rosa Plateau Foundation, California Fish & Wildlife, Riverside County Regional Parks and researchers from the University of California, Riverside that seeks to address both of these issues through field-based education programs for multiple age groups. We involve local elementary, middle and high school classes from Murrieta School District in long-term field experiments exploring different techniques for perennial grassland restoration, including seed bank studies, a mulching experiment and a multi-year mowing experiment. Since 2012, each spring half of the study area is mowed before annual grasses

have set seed. Our goal is to reduce seed inputs over the long term to promote natives, especially *Stipa pulchra*. Middle school students measure abundance and cover of native and nonnative species in plots multiple times throughout the year while receiving training in botany and plant ecology. After two years, mowing significantly reduced annual grass cover and led to a slight increase in native bunchgrass cover. Students also showed remarkable understanding of the importance of their work and the relevant complex ecological concepts. While long term monitoring is necessary to evaluate potential as a more widespread management strategy, this program shows promise on multiple levels. The integration of environmental education programs with research, management and restoration priorities could be a creative solution to both educational and environmental challenges in California.

Effects of altered precipitation and invasion on ecosystem processes in coastal sage scrub.

Ellen Esch[1]*, Elsa Cleland[1], and David Lipson[2]. [1]University of California San Diego, [2]San Diego State University. eesch@ucsd.edu

Southern California is predicted to face decreasing precipitation with increased interannual variability in the coming century. Native shrublands in this area are increasingly invaded by exotic annual grasses, though invasion dynamics can vary by rainfall scenario, with wet years generally associated with high invasion pressure. Interplay between rainfall and invasion scenarios can influence carbon stocks and community composition. Here we asked how invasion alters ecosystem responses under drought versus high rainfall scenarios in either native shrub or exotic grass dominated communities, as quantified by biomass production and decomposition rates. To do this, we performed a rainfall manipulation experiment with paired plots dominated either by native shrubs or exotic herbaceous species, subjected to treatments of 50%, 100%, or 150% of ambient rainfall. The study site was located in a coastal sage scrub ecosystem, with patches dominated by native shrubs and exotic grasses located in San Diego County.

During two growing seasons, we found that native, herbaceous biomass production was significantly affected by rainfall treatment ($p<0.05$ for both years), though was not affected by dominant community composition. Exotic biomass production showed a significant interaction between dominant community composition and rainfall treatment, and both individual effects ($p<0.001$ for all). Decomposition rates of the exotic grass were much faster overall than rates observed for native shrub decomposition ($p<0.001$), though shrub litter decomposition was less affected by rainfall treatment than was exotic grass decomposition. Furthermore, native shrub litter shows significantly faster decomposition with shrub-associated microbial communities, suggesting that recalcitrant litter decomposition is highly affected by microbial communities. In combination, these results show that production and decomposition of exotic species is more sensitive to rainfall than are rates associated with native shrubs. With decreased overall precipitation, greatest carbon storage may occur in shrub-dominated communities, but with increased precipitation, this trend is reversed.

Session 5. Invasive Plant Management

Controlling invasive species on Fort Ord National Monument: finding weeds while avoiding bombs. Susan Hubbard. Bureau of Land Management, Fort Ord National Monument, CA. shubbard@blm.gov

The Bureau of Land Management (BLM) has been conducting invasive plant control on 15,000 acres of what is now Fort Ord National Monument (FONM) for 20 years. FONM, located on the central coast of California near Monterey, is divided into 2 areas of almost equal size. One portion is managed by the Bureau of Land Management and is open to the public. This area has a diversity of habitats and along with that a diversity of invasive plant species – 28 species were treated in 2014 mostly using manual techniques. The other portion is almost exclusively maritime chaparral. It is managed by the U.S. Army who is overseeing ordnance removal prior to its transfer to BLM. Invasive plant control focuses on spraying jubata (*Coraderia jubata*), iceplant (*Carpobrotus edulis*), and French broom (*Genista monspessulana*) which can spread rapidly in this area of high disturbance.

I have managed this program for 15 years. This talk will focus on practical lessons learned during this time including working in an area where active ordnance cleanup is occurring, making headway in face of numerous safety rules and regulations, and the challenges of conducting follow up in large sites. It will cover what has worked well and not so well.

Barbed Goatgrass (*Aegilops triuncialis*) Eradication on Naval Weapons Station Seal Beach, Detachment Fallbrook; adaptive management for invasive plant eradication

Barbed goatgrass (*Aegilops triuncialis*) eradication on Naval Weapons Station Seal Beach, Detachment Fallbrook; adaptive management for invasive plant eradication. D.M. Lawson - U.S. Navy, dawn.lawson@navy.mil; C.M. Wolf U.S. Navy, christy.wolf@navy.mil; and A. R. Dyer, USC Aiken, Dept. of Biology and Geology, andyd@usca.edu

A population of barbed goatgrass (*Aegilops triuncialis*), an annual grass native to the Mediterranean, was discovered in southern California in 2006, over 250 km from the nearest known population, and targeted for eradication. This species forms dense monocultures and is difficult to manage because unlike most non-native annual grasses in California's annual grasslands it has dormant seed and can reestablish from the seed bank. Seed longevity in the field was unknown. Initial spot herbicide treatments were meant to minimize pesticide use while providing for eradication. Although plant density was greatly reduced, detectability declined and after initial population reductions the population rebounded. In 2011, an adaptive management program was designed to eradicate this population while minimizing long-term costs and herbicide use. We addressed the key data gap of seed longevity with a buried seed study running parallel to herbicide applications and focused surveys for any undetected plants nearby. We present our adaptive management program, data on population change under spot treatments, and results from our buried seed study. For seed collected in 2011, 2012 and 2013, our population had lower dormancy than the Northern California populations. We also found lower seed viability than expected (68% to 79%). Seed longevity declined with depth of burial with the longest lived seed on the soil surface. Herbicide treatments will continue until seed bank has been exhausted.

Barb goatgrass strategies and results for the 2014/15 treatment season. Pam Beitz, East Bay Regional Park District. PBeitz@ebparks.org

In 2015, the IPM Department of the East Bay Regional Park District utilized an integrated approach in their initial attempts at establishing a barb goatgrass management strategy. IPM student interns focused on mapping the extent of known barb goatgrass populations and discovered that distribution was substantially larger than previously thought. Precipitation amount ranged from 75-94% of average and forage production was good. However, during the 2014/15 grazing season, ranchers stocked District lands in low numbers in anticipation of another low production year. It is possible that this lack of pressure resulted in the expansion of barb goatgrass and medusahead on District lands. Our integrated approach included mulch cutting with line trimmers and follow up herbicide spot application and hand pulling where feasible. Here we describe lessons learned and planned adjustments to next season's strategies in our attempt to eliminate locally this noxious grass while developing a long term strategy of monitoring and rapid intervention with future re-introductions.

***Brachypodium distachyon*: an adaptive approach to controlling an invasive species to benefit endemic species and sensitive habitats in San Diego, California**. Patricia Gordon-Reedy* and Jessie Vinje, [1]Conservation Biology Institute, San Diego, CA. *pgordonreedy@consbio.org

Brachypodium distachyon is an invasive species with potentially widespread ecological implications for native species, habitats, and ecosystem processes. In recent years, it has increased in extent and dominance in southern California, possibly in response to repeated fires and climatic conditions. *Brachypodium* decreases native species diversity and may alter soil ecology, vegetation community structure and composition, and natural fire regimes. *Brachypodium* is particularly dense on restricted soils where it threatens edaphic endemic plants and native grassland, forbland, and coastal sage scrub communities. These plants and habitats are conservation targets under Natural Community Conservation Planning programs in San Diego County.

We used conceptual models to (1) document life history traits that influence *Brachypodium* persistence and dispersal, (2) identify observed or potential ecological effects, (3) target variables that may respond to control, and (4) predict areas at risk of invasion. Based on these models, we developed a predictive tool for early detection and implemented experimental control treatments.

Brachypodium invasion success is tied to edaphic and climatic conditions, disturbance, and species' biology. Control is highest with grass-specific herbicide, although timing of application is critical due to multiple germination cohorts per season. Mechanical treatment provides some control and is an alternative where herbicide use is not feasible or desirable. Dethatching reduces litter and enhances native species germination from the soil seed bank. Post-treatment native species seeding results are inconclusive, due to drought conditions during the study, but seeding may improve native species diversity in dethatched sites. *Brachypodium* may rebound if control is discontinued prematurely due to high seed output, viability, and minimal dormancy. *Brachypodium* control should be prioritized where dense infestations overlap with rare species and habitats. Study results will refine *Brachypodium* best management practices and assess *Brachypodium* control solutions for landscape-level applications.

Session 6. Panel Discussion

How will habitat conservation planning support strong landscape-level invasive plant management in the future? Moderator: Elizabeth O'Donoghue, Director of Infrastructure and Land Use, The Nature Conservancy (invited).

Given the needs for invasive plant management and current developments in habitat conservation planning, what are the opportunities for strengthening the effectiveness of our approaches? How can the geography of habitat mitigation work together with the geography of landscape-level invasive plant management? Panelists: Susan Wynn, Biologist, U.S. Fish & Wildlife Service (invited); Paul Fromer, Program Administrator, San Diego Management & Monitoring Program (invited); Trish Smith, Senior Project Ecologist, The Nature Conservancy (invited)

Friday, October 30

Session 7. Wildand Weeds of Alta and Baja California Deserts

Current status on the study of exotic plant species in the State of Baja California, México. José Delgadillo- Rodríguez; BCMEX Herbarium, Faculty of Science, Universidad Autónoma de Baja California. Ensenada, Baja California, México. jdelga@uabc.edu.mx

The mission of the National Strategy on Invasive Species in Mexico (ENEI, 2010), is to contribute to the conservation of natural capital (e.g. biodiversity) and human welfare through a National Strategy for the prevention, control and elimination of invasive species in Mexico. It is important for the cooperation and coordination of the proactive participation and responsibility of all stakeholders in the implementation of actions monitoring, detection, control and eradication. The Objective 1 (ENEI) is to prevent, detect and reduce the risk of introduction, establishment and spread of invasive species. An important contribution is relevant, timely and accessible scientific and technical information. Therefore, it presents a review of the current state of research on exotic plant species in the State of Baja California, Mexico, which have focused on different topics including floristic, taxonomic, weeds in agriculture, naturalization, Mediterranean relationship, potential distribution models, monitoring and data bases. Also, the activities currently undertaken by the Network of Exotic Species in Northern Mexico, and the Research Group of the Universidad Autónoma de Baja California are presented.

Some drivers of Sahara mustard invasion: surficial geology and primary, secondary, and tertiary roads. Kristin H. Berry[1]*, Heather E. Schneider[1], and David M. Miller[2]. U.S. Geological Survey, [1]Riverside and [2]Menlo Park, CA. kristin_berry@usgs.gov

We studied early invasion and establishment of Sahara mustard (*Brassica tournefortii*) at two sites, one in the southern Mojave Desert and the other in the eastern Colorado Desert. The Mojave site was at an early stage of invasion, and ranges from an interstate freeway to a graded county road and to dirt roads constructed as part of utility rights-of-way. At this site, roads appeared to be drivers of entry into the desert and the most distant mustard

from the interstate into the desert was ~4.2 km. In contrast, at the Colorado Desert site, the mustard had become established. Significant predictor variables of mustard densities were surficial geology, proximity to the highway, the axial valley ephemeral stream channel (wash), and number of small ephemeral stream channels. Sahara mustard rapidly colonized naturally disturbed areas where geological surfaces were young and soils were weakly developed, whereas the older geological surfaces (e.g., desert pavements) were less vulnerable. At this site, Sahara mustard was able to colonize and become well established 22 km across a valley in 20 years. Weed management specialists can use road types and surficial geology type in monitoring vulnerable entry points for treatment and for limiting future invasions. Rights-of-way roads for utilities are especially important as potential entry points for invaders because they cross vast parts of the desert and intersect major highways. Likewise, ephemeral stream channels commonly intersect linear corridors.

Cryptic invasion and hybridization of *Phragmites australis* (common reed) in the Southwest. Adam M. Lambert[1]*, Kristin Saltonstall[2], Nick Rice[3], and Randy Long[1]. [1]University of California, Santa Barbara, CA. [2]Smithsonian Tropical Research Institute, Panama, [3]Southern Nevada Water Authority, Las Vegas, NV. *alambert@ucsb.edu

Phragmites australis (common reed) is one of the most widely distributed angiosperms in the world. Today it is found across North America where, in many locations, it has become the dominant plant species in wetland communities and an indicator of disturbance. Three distinct lineages are found in North America, with the endemic native subspecies *P.a. americanus* found across much of the continent, the Gulf Coast subspecies *P. a. berlandieri* found distributed across the southernmost states, and the introduced (European) subspecies found throughout the United States and southern Canada. Although classified as the same species, these three lineages are genetically and ecologically distinct, and few hybrid crosses between the lineages have been identified. In California (and the Southwest in general), the native lineage predominates, but the introduced lineage is quickly spreading from urban centers. While hybridization between native and introduced *Phragmites australis* remains a rare event, it poses an ongoing threat to native *P. australis* across its range. This is especially true for native populations in the biologically rich, but sparsely distributed wetlands of the Southwest, which are among the most imperiled systems in North America. We identified widespread hybridization between native and introduced *P. australis* in the Las Vegas Wash watershed, NV, a key regional link to the Colorado River basin. Should hybrids between native and invasive genotypes become common, the genetic integrity of native populations may become compromised by interbreeding or hybrids could display increased vigor and outcompete remaining native populations, which are typically given high conservation priority. The presence of hybrid populations could also complicate ongoing efforts to find suitable biological control agents for introduced *P. australis.* Downstream escape of hybrid plants to Lake Mead and wetlands throughout the lower Colorado River basin is of management concern as these hybrids appear vigorous and could spread rapidly.

Nonnative grassland control and Otay tarplant (*Deinandra conjugens*) habitat restoration. Jessie Vinje*, John Ekhoff, Kristine Preston, and Trish Smith. [1]Conservation Biology Institute, San Diego, CA. [2]California Department of Fish

and Wildlife, San Diego, CA. [3]San Diego Management and Monitoring Program, San Diego, CA. [4]The Nature Conservancy, San Diego, CA. Jessie.vinje@consbio.org.

The Conservation Biology Institute and partners are conducting a 3-year experimental study on Rancho Jamul Ecological Reserve (RJER) in San Diego County, CA to assess various nonnative grass and forb control techniques and restoration of Otay tarplant habitat. Otay tarplant is a federally and state listed annual plant.

The Otay tarplant population on RJER burned in 2003. Invasive grasses and forbs subsequently invaded the habitat, and the species was not observed for the next decade. After two years of experimental non-native grassland treatments, it was detected in 2014 and again in 2015. Landscape-level restoration treatments included a prescribed winter burn (2012) to remove surface biomass and post-burn herbicide and mechanical treatments to control nonnative grasses and forbs.

A combination of Fusilade II® and glyphosate herbicide treatments provided the most effective control of nonnative grasses in 2013 - 2015; however, nonnative forb richness was highest in the herbicide treatments due to an increase in bare ground associated with the decrease in nonnative grass cover.

In 2015, 1,693 Otay tarplant individuals were counted in the study area. Of that amount, approximately 67 percent of the population was detected in the herbicide treatments. Eighteen percent and 14 percent of the population were detected in the line trim and mow treatments, respectively. Less than one percent of the population was detected in the controls.

Mowing via rotary attachment is the quickest method to significantly reduce nonnative grass cover, but will produce significantly higher amounts of litter, significantly lower amounts of bare ground, and low Otay tarplant germination.

Herbicide application is the second quickest method to significantly reduce nonnative grass cover post-burn. This method also yields significantly lower litter cover, significantly higher bare ground, significantly higher exotic forb richness, and the highest level of Otay tarplant germination.

Session 8. Building Conservation Corps into Invasive Plant Management Projects

Doing more for less: using conservation corps as an organizational capacity multiplier. Kyle Gunderman* and Richard Thiel. American Conservation Experience, 333 Soquel Ave., Santa Cruz, CA, 95062. Sequoia and Kings Canyon National Park, 47050 Generals Highway, Three Rivers, CA 93271. kgunderman@usaconservation.org

Being asked to do more with less is always a daunting task. In these times of shrinking budgets and growing responsibilities, how does an organization ensure the maximum productivity? The utilization of conservation corps has repeatedly proven itself to be beneficial both financially and functionally. This is absolutely the case for the National Park Service (NPS). In 2009 NPS was faced with the daunting task of eradicating *Holcus lanatus* from Kern Canyon in Sequoia National Park. There was uncertainty whether the infestation was already too widespread, too dense, and too remote to realistically expect to control with NPS's very limited long-term resources. The solution was to initiate a 3 year pilot project with American Conservation Experience (ACE) beginning in 2009. Conservation Corps volunteer crew labor was utilized to determine

if the NPS treatment strategy was feasible in the middle of a designated wilderness, over 20 miles from any road. The pilot project was a success and the partnership between ACE and NPS is now in its seventh year and on a trajectory for full control in the near term. The grass populations have been contained and reduced, but more importantly a lasting partnership has been forged between two organizations. This daunting project which has served to protect one of our California backcountry gems never would have occurred without the mutual benefit, co-operation, and most of all, patience between NPS and ACE.

Working with a conservation corps allowed this project to occur. NPS simply did not have the staff to make this project happen. Project planning was also streamlined as NPS stated their needs and the Corps was able to leverage resources to meet those needs. Highly trained and knowledgeable Conservation Corps crew leaders enabled the crews to operate safely in the backcountry and work independently of NPS biologists, leaving NPS staff free to manage the big picture issues of the project and attend to matters such as mapping, survey, and strategic planning. Many lessons were learned when uniting two very different organizations under the common banner of controlling invasive plants. In this talk we will discuss a few of these lessons and offer some guidance to others who are interested in utilizing Conservation Corps to increase organizational capacity and provide an opportunity for our future land stewards to discover their passion and learn the skills necessary to become land management professionals.

River Partners and the Conservation Corps – a win-win partnership for job creation, invasive species removal, and habitat restoration.

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Large-scale invasive species removal and habitat restoration projects are critical for recovery of special-status species and enhancement of valuable ecosystem services, but are often extremely labor-intensive endeavors. In California, many of these projects are implemented in regions characterized by chronic unemployment that often disproportionately affects youth seeking to transition into the workforce. As a result, these projects offer unique opportunities to employ, train and empower young women and men working for the California Conservation Corps (CCC) and Regional Conservation Corps (RCC) to better themselves while engaging in hands-on conservation. Over the past 5 years, River Partners, the CCC, and various RCCs have developed successful state-wide partnerships to create hundreds of skilled jobs in local communities while successfully implementing cost-effective, large-scale invasive species removal and habitat restoration projects. For example, corps members have been trained on the use of hand labor and heavy equipment to treat invasive species including giant reed (*Arundo donax*), red sesbania (*Sesbania punicea*), salt cedar (*Tamarix* spp.), perennial pepperweed (*Lepidium latifolium*), edible fig (*Ficus carica*), Himalayan blackberry (*Rubus armeniacus*), yellow starthistle (Centaurea solstitialis), and tree tobacco (*Nicotiana glauca*).

Corps members have also helped remove trash and other debris from restoration sites, install water-efficient irrigation systems, collect native plant materials, plant native species from seed, cuttings, and potted stock, and support volunteer and outreach events. An overview of these activities and partnerships will be presented, with examples drawn from a diverse range of invasive species control and habitat restoration projects in Southern California, the San Joaquin Valley, and the Sacramento Valley. The job creation and training benefits of these projects will be emphasized, in addition to the important roles that CCC corps members play in on-the-ground project implementation.

The perfect partnership! (engage & train urban youth, garner additional funding, get the job done). [1]Dan Knapp*, [1]Robert Skillman, [2]Rhody Soria, [3]Baldeo Singh, [4]Josh Volp, [5]Robert Chavez, and [6]Kyle Gunderman. [1]Los Angeles Conservation Corps, Los Angeles CA, [2]California Conservation Corps, San Diego CA, [3]Sacramento Regional Conservation Corps, Sacramento CA, [4]Orange County Conservation Corps, Anaheim CA, [5]Urban Corps of San Diego County, San Diego CA, [6]American Conservation Experience, Santa Cruz CA. dknapp@lacorps.org.

With programs operating from Oregon to Mexico and the Channel Islands to Nevada, conservation corps' are active in just about every corner of the State of California. First and foremost youth development agencies, corps programs engage youth and young adults in a variety of conservation and community benefit activities in a range of environments including urban centers, the urban wildland interface, and back country wilderness. Conservation as a means for youth development is at the core of corps programs. Of course conservation partners such as public and private land managers are essential to engaging conservation corps participants in meaningful and rewarding projects where the proverbial triple or quadruple bottom line (corps participants are engaged and trained, project partners achieve their conservation goals, habitat is preserved or restored, and societal benefits of workforce investment/development are achieved) is sought. This panel discussion with representatives from a myriad of conservation corps programs from across the State will highlight the benefits of partnering with a conservation corps, how to collaborate with a corps program, determining the role of the corps in your project, how the corps can contribute or provide funding for your project (Yes, the corps can possibly help fund your project!!), corps program capacity and expertise (every corps is unique and expertise and capacity varies) and your role in the development of corps participants.

Session 9. Discussion Groups

See separate page with discussion group descriptions.

Session 10. Strategies for Eradication Success

Eradication 101. John Knapp, 532 E. Main St. Suite 200, Ventura, California 93001. jknapp@tnc.org

What's in a name? Eradication is the complete removal of a target species from a site, but why then is the term so often used to describe the control programs? This interactive presentation will cover the introductory information regarding invasive plant eradications presented in the Eradication Session, focusing on: terminology, eradication criteria, eradication vs.

control projects analysis, and the risks and benefits of attempting plant eradications. Lessons from plant and vertebrate eradication case studies will be used to highlight how and when to consider eradication as a management goal and when do you know you are done.

Eradication of invasive species on islands in Mexico. L. Luna-Mendoza*, A. Aguirre-Muñoz, A. Ortiz-Alcaraz, F. Méndez-Sánchez, A. Samaniego-Herrera, J.C. Hernández-Montoya, and Y. Bedolla-Guzmán. Grupo de Ecología y Conservación de Islas, A.C., Ensenada, Baja California, México. luciana.luna@islas.org.mx

During the past two decades, following national restoration priorities to protect native and endemic species from the threat of invasive alien species, Mexico has succesfully completed 58 eradications of invasive mammals on 37 islands, from temperate to desert to tropical. Eradicated species include mice, rats, cats, dogs, goats and sheep. Eradication methods have ranged from the traditional —trapping and ground hunting— to the most sophisticated —aerial hunting, aerial broadcast of bait, DGPS, GIS use, and tailored-made software. Throuought these years, a key element has been the integration of a strong partnership between GECI, the federal government, local fishing communities, academia, other civil society organizations, and national and international donors. This has resulted in the social construction of a national shared vision towards the conservation of the Mexican islands, which is envisioned in the National Strategy for the Conservation and Sustainable Use of the Mexican Insular Territory, published in 2012. As well, eradication best-practices and island conservation management programmes are being formulated and implemented. Moreover, a national program for island biosecurity—a pre-condition for any eradication program— is being developed and put into place to prevent further introductions of invasive species. Finally, other important complimentary tools are being implemented: the social attraction of seabirds to restore breeding colonies; the active restoration of degraded vegetation communities; and programs on environmental education, art and conservation culture in collaboration with local communities.

Prioritizing Miconia calvescens survey areas on O‘ahu. Julia Parish[1]* and Jean Fujikawa[2]. [1]The Catalina Island Conservancy, Avalon, CA, USA; formerly with Pacific Cooperative Studies Unit, University of Hawai’i at Mānoa, and Oahu Invasive Species Committee, Honolulu, HI, USA, [2]Pacific Cooperative Studies Unit, University of Hawai’i at Mānoa, and Oahu Invasive Species Committee, Honolulu, HI, USA

Miconia (*Miconia calvescens*) has been a top priority target species for the O‘ahu Invasive Species Committee (OISC) for over a decade. It is a highly invasive tree that has been cited as among the top threats to Hawai‘i's rainforest ecosystems. Miconia's prolific, long lived seed bank combined with a robust growth rate, shade tolerance and effective seed dispersal mechanisms create the need for a long term management strategy for island wide eradication to be plausible. OISC's management strategy aims to survey areas where miconia is likely to occur, 800m around a mature plant location, and may contain outlier plants while controlling plants as they are found. The goal is to prevent reproduction and to continue control until the seed bank is exhausted. This methodology has served OISC well, however,

funding and staffing short falls combined with access permission challenges create survey delays. Our data shows that 99% of the immature plants found fall within 400m of a mature plant. To address survey delays, OISC adjusted its survey strategy to prioritize surveys areas within 450m of mature plants. Analyzing survey data, we will see if creating a prioritized buffer of 450m around mature plants lead to effective control of miconia.

Taking the leap: watershed-wide *Arundo donax* eradication in Santa Barbara County.
Katrina Olthof* and Morgan Ball. Wildlands Conservation Science, PO Box 1846, Lompoc, CA 93438. katrina@wildlandscs.org

The Santa Ynez River is the largest watershed in Santa Barbara County that drains approximately 24% of its area. The diverse array of habitats along its 92-mile span support various special status species including: California red-legged frog, western pond turtle, tidewater goby, southern California steelhead, southwestern willow flycatcher, least Bell's vireo and yellow-billed cuckoo. However, these species and the health of the riverine system is threatened by the encroachment of invasive plants such as *Arundo donax* (Arundo). This large Eurasian reed displaces native plants and wildlife, monopolizes soil moisture, reduces water quality, and increases flood and fire risk within the river.

Recognizing the concern, the County of Santa Barbara Agricultural Commissioner's Office obtained grant funding to perform an Arundo survey of the river in order to develop and implement a comprehensive eradication program. The aerial survey was conducted in 2008 and the first of five years of consecutive treatment began in 2012. This presentation details evolving strategies, project successes and difficulties, coordinating landowner concerns, avoiding sensitive species, and the management of a progressing dataset of a watershed-wide eradication program. Lessons learned from this project can guide efforts to eradicate species in other watersheds or can prove helpful to target other invasive plants such as Tamarisk for eradication within the Santa Ynez basin.

Session 11. Invasive Plant Research (II)

Root trait variation and its relevance to seedling growth across 18 native and invasive coastal sage scrub species exposed to drought.
Julie Larson* and Jennifer Funk. Schmid College of Science and Technology, Chapman University, Orange, CA USA. *jlarson@chapman.edu

Roots play a critical role in plant water and nutrient uptake; consequently, interspecific variation in root traits and plasticity could be key in differentiating performance when resources are limiting. While drought frequency is expected to increase in southern California, we currently have a limited understanding of belowground strategies across natives and invasive species of various life forms, or how these are affected by drought. In this study, we measured seedling root traits and growth across three watering levels for 18 native and invasive coastal sage scrub species comprising 6 life history groups. Drought was generally associated with increases in root diameter and root mass fraction (RMF) and decreases in specific root length (SRL) and rates of root elongation (RER), root mass growth, plant nitrogen (N) uptake and plant growth. However, the extent of plasticity varied widely and was not explained by life history group. Across watering treatments, we detected a single axis of correlated root traits representing

a tradeoff between belowground strategies of resource conservation (high root diameter, RMF) and acquisition (high root elongation and SRL) which was tightly tied to plant growth rate. Native subshrubs were widely separated from other life history groups at the conservation-end of this spectrum, while native shrubs shared intermediate root attributes. Within-group variation was higher among annual and perennial grasses and forbs, including substantial differences between annual invasive species. Accordingly, we conclude that life history may not capture belowground strategies and growth, and that traits themselves should form the basis for predictions across natives and invasive species. Our findings suggest that general patterns of root morphology and plasticity will be identifiable across a diversity of species, but links between this variation and performance in the field remain to be tested.

Effects of plant invasions on invertebrate diversity and feeding guilds: a meta-analysis and review. Denise Knapp[1],[2]*, [3]Karen Stahlheber, and [2]Tom Dudley. [1]Santa Barbara Botanic Garden, Santa Barbara, CA, [2]University of California, Santa Barbara, CA, [3]Kellogg Biological Station, Hickory Corners, dknapp@sbbg.org

Exotic plant invasions are a major ongoing component of global environmental change. Invertebrates can be effective indicators of the consequences of these invasions owing to their functional roles in ecosystem dynamics. A meta-analysis of plant invasion effects on invertebrate diversity was conducted at two spatial scales, incorporating invader cover and time since establishment as two mechanisms potentially responsible for these effects. These results were combined with a review of published information on richness responses to plant invasions by feeding guild to examine general patterns of impacts. Invertebrate species richness was 31% lower in areas dominated by exotic plants than in areas dominated by native plants. With diversity indices that consider relative abundances, invertebrate diversity was 14% lower. Negative effects tended to decrease as time since establishment increased, and increase as invader cover class increased, with a threshold around 70% cover after which effects were strongest. Among feeding guilds, only pollinators showed a consistent (negative) response. The increased plant litter associated with plant invasions only resulted in increased detritivore richness in half the studies. Restored plots were more species rich than intact native plots relative to invaded plots, perhaps in response to higher plant richness and cover. These results show that plant invaders are negatively impacting invertebrate biodiversity, and that these effects can be partially predicted by the stage of invasion. They also indicate that varying responses by different feeding guilds are modulating the overall effect of plant invaders on invertebrate biodiversity.

Current research at the European Biological Control Laboratory. Lincoln Smith*, René Sforza, Marie-Claude Bon, Javid Kashefi, and Livy Williams. USDA, Agricultural Research Service, European Biological Control Laboratory, Montferrier-sur-Lez, France. Link.Smith@ars.usda.gov

The European Biological Control Laboratory (EBCL) is operated by USDA-ARS to conduct research on biological control of invasive weeds and insect pests affecting the USA. We have a laboratory and quarantine facilities in southern France and a satellite laboratory in Thessaloniki Greece, and cooperate with scientists in other countries including Italy, Turkey, Bulgaria, Russia, and China. CABI, in Delémont,

Switzerland, conducts complementary research on many targets. Research involves foreign exploration to discover prospective biological control agents, taxonomic identification, molecular genetics, plant pathology, and insect physiology and behavior to evaluate host specificity and potential efficacy. Weed research targets currently include African wire grass (*Ventenata dubia*), French broom (*Genista monspessulana*), giant reed (*Arundo donax*), hoary cress (*Lepidium draba*), medusahead (*Taeniatherum caput-medusae*), Russian olive (*Elaeagnus angustifolia*), Russian thistle (*Salsola tragus*), Sahara mustard (*Brassica tournefortii*), Scotch thistle (*Onopordum acanthium*), and yellow starthistle (*Centaurea solstitialis*). Current status of these projects will be presented. This laboratory provides an opportunity for American scientists to collect organisms and to conduct cooperative research in Europe and Asia.

Selective control of velvet grass in a California coastal prairie. Lewis Reed*[1] and Suzanne Olyarnik[1]
[1]University of California Davis Bodega Marine Reserve, 2099 Westside Rd, Bodega Bay, CA 94923; lkreed@ucdavis.edu or svolyarnic@ucdavis.edu .

Non-native invasive species present a major challenge in coastal prairie restoration and, in sites with existing native cover; managing non-native species may be the primary restoration action. Management of non-native invasive species is particularly vexing when invaders are functionally similar to native members of the affected community. As part of a broader study comparing different strategies for controlling velvet grass (*Holcus lanatus*) at five sites, we evaluated the effectiveness of the grass-specific herbicide Poast® as a selective management tool for controlling velvet grass in coastal prairies at the Bodega Marine Reserve (Sonoma County). All plots had similar velvet grass cover during baseline surveys but we observed reductions by 41%, 42%, and 81% in the three years following initial application when comparing treatment plots to reference sites. Native cover was sustained in treatment plots throughout the study period but some exotic species (other than velvet grass) increased after the application. Cover of monocots other than velvet grass varied between years but there was generally no difference between treatment plots and reference sites for this parameter with the exception of the second post treatment year in which herbicide plots had higher monocot cover than reference sites. The results indicate that carefully timed application of grass-specific herbicide may be an effective way to selectively reduce velvet grass while sustaining native cover in coastal prairie restoration.

Session 12. The Future of Invasive Plant Management

Weed Alerts 2015. Dean Kelch, California Department of Food and Agriculture. Sacramento, CA. DKelch@cdfa.ca.gov

This annual update will cover new invasive plants that have been reported in the last year as well as existing weeds that are spreading into new areas.

Mexico-US cross-border collaborations to restore islands. Luciana Luna-Mendoza . Grupo de Ecología y Conservación de Islas, A.C. (GECI), Ensenada, Baja California, Mexico. luciana.luna@islas.org.mx

The California and Baja California islands offer our two countries—US and Mexico—a fertile and common ground to collaborate. The environmental restoration of these islands,

some of our most valuable ecosystems in terms of biodiversity, natural resources and sovereignty, demands focused actions based on a strategic and long-term vision, scientifically defined priorities and options that are technically and economically feasible. While latitude somehow tends to distinguish and separate our islands, the marine waters that embrace them—the cross-border California Current—brings them together. The commonalities include the overall marine environment, and more specifically the seabirds, the pinnipeds, and the terrestrial vegetation. Beyond political borders, the common geography and our shared efforts reintegrate the bonds between our natural insular territories. For close to one century, the US and Mexico have collaborated to conserve these special islands, and more so during the last two decades. The eradication of invasive vertebrates on our islands—backed in some cases in Mexico by bi-national funds—has resulted in a dramatic improvement of the plant communities and ecological functions of these ecosystems, Guadalupe Island being perhaps the best example on the Mexican side. Thanks to recent simultaneous eradication and systematic monitoring projects on the region's islands, we have mutually benefited from the practical experiences on the two countries. Strengthening a more systematic knowledge exchange between conservation practitoners from both the US and Mexico, and investing together in our "common house," we can envision that the unique California and Baja California islands will be fully recovered in the coming two decades, offering a valuable story of international success based on dialogue and consensual collaboration.

The future of invasive species research. Jennifer L. Funk. Schmid College of Science and Technology, Chapman University, Orange, CA USA. jlfunk@chapman.edu

In recent decades, the field of Invasion Biology has moved beyond case studies of single invasive species to identify holistic frameworks explaining patterns of spread and how invasive species affect a range of ecological processes. By considering invasive species in the context of evolutionary, physiological, community and ecosystem processes, invasion biology research has enriched the fields of ecology and evolutionary biology and contributed to the development of management tools. However, predicting invasions, understanding their drivers, and evaluating their impacts remain key challenges for academics and practitioners in the field of invasion biology. This talk will highlight key directions for invasive species research including functional trait approaches for identifying potential invaders and restoring invaded systems, soil-plant feedbacks, epigenetic variation and adaptation of invasive species to climate change, and the ecological impacts of invasive species.

The future of invasive plant tools and techniques. Morgan Ball, Wildlands Conservation Science.

As aerial survey technologies progress to produce geospatial datasets with ever-improving resolution, land managers run the risk of data overload. Data management tools will have to catch up. These tools will need to not only prioritize management on a local and regional scale, they will need to be used to track treatment success and help to discern effective past management efforts. This "analytical feedback loop" is necessary to effectively decide how budgets are allocated in order to achieve the greatest return on investment.

The future of invasive plant management goals and successes. John Randall, The Nature Conservancy, San Diego, CA. jrandall@tnc.org.

As Cal-IPC approaches its 25th anniversary it is a good time to consider how invasive plant management and prevention have changed in the past quarter century. Invasive species garner more attention from agencies, NGOs, and the media now than they did in the early 1990s, but this may have peaked prior to the recession and in recent years public and private funding for invasive species have declined. In addition, some academic and other voices opposing efforts against invasive species have been raised. Some of this may be the result of our own lack of success in actually eliminating certain populations –or in at least shrinking them to the point that they can be easily managed - even after great expenditures of time and money. This is a good time, therefore, to again review what we have learned from projects that have failed or been less than completely successful, and to take a clear-eyed view of the invaders and invasions that we do not have the technology, resources, or public will to prevent or control over the long-term. Our best path forward may be to invest in research on potential new prevention and control methods, and on how to learn to live with some invaders and invasions while promoting the native species (or productive agricultural crops) that we are managing for.

Poster Abstracts

Integrated management project of mesquite in Oman. Saud Al Farsi * and Rshid Al Shidi. Directorate General of Agriculture & Livestock Research, Ministry of Agriculture & Fisheries, Sultanate of Oman, saud1717@yahoo.com

Mesquite trees have presently invaded in Oman environment after almost four decades of their introduction as ornamental tree plants on the roadsides, landscapes and other areas as pasture tree. Recently, this tree has become as an environmental problem as it has occupied pastures, urban & abandoned land and valleys. In 2014, Ministry of Agriculture & Fisheries adopted a national project entitled “Integrated Management Project of Mesquite”. The main goals of this project was to formulate a national plan in controlling mesquite trees in terms of stopping the spread of mesquite trees in the most affect areas by using Geographical Information System “GIS” and Remote sensing “RS” techniques which also help for detecting and surveillance of mesquite trees in Oman.

The project team members started to draw the path of the project and the 1st step was towards conducting field experiments in four sites. In each site, nine practices were implemented as follows: fork the mesquite tree from 50 cm depth and clean the place from any falling seeds and young plants, cut the stem of the mesquite tree on ground level and spray immediately by herbicide, cut the stem of the mesquite tree on ground level and spray immediately by diesel,

cut the stem of the mesquite tree on ground level and spray immediately by vehicle oil, spray whole green canopy of the small mesquite tree, injecting the herbicide into the stem of the mesquite tree, ring cutting of the mesquite tree stem and spray immediately by herbicide, peel off the mesquite tree stem and spray immediately by herbicide and spray the mesquite tree stem by herbicide only. In the 2nd step of the project, a field survey has been conducted to detect the most affected areas and zones. Then the fork practice of the mesquite trees from a depth of 50 cm was carried out in the selected zones. The work is in progress. In future, an Integrated Management Program of Mesquite in Oman will be established.

Resisting re-establishment of invasive plant species in fuels-reduction areas. Joseph Algiers, Jr. National Park Service, Santa Monica Mountains National Recreation Area, CA. joseph_algiers@nps.gov

Invasive species pose a large threat to native vegetation. Billions of dollars are spent annually on efforts to control invasive species in agricultural and natural settings. Studies have revealed multiple benefits from removing invasives. However, there have been no studies that have evaluated the outcomes of these strategies in fuels-reduction areas, at least not in southern California. I investigated efforts to control three invasive plant species (*Carduus pycnocephalus* Italian thistle, *Centaurea solstitialis* yellow star thistle, and *Foeniculum vulgare* sweet fennel) at three sites in the Santa Monica Mountains National Recreation Area. In all three cases, weed control efforts initially reduced the cover of invasive species targeted for eradication. Native cover was evaluated at one site, but it showed no differences in any year following treatment. Following eradication of Italian thistle in a fuels-reduction area, I planted disturbance-adapted native plants belonging to three life-history strategies (annuals, herbaceous perennials, and perennial grasses). I evaluated the ability of these natives to resist re-establishment of the invasive thistle. Unfortunately, this experiment was done during a drought. As replacement vegetation, perennial grass and herbaceous perennial cover was low and native annuals did not recruit. Italian thistle showed little difference in cover regardless of which native plant life-history strategy it occurred with. However, several months following planting, thistle grown with perennial grasses were smaller than thistle grown in plots that had been designated to receive annual plants (annuals that never grew). Although perennial grasses did not reduce the cover of thistle, they did reduce its size. Further research on the use of native species to prevent re-establishment of invasive species may help guide resource management strategies in fuels-reduction areas.

Susceptibility of invasive blackberry species to rust disease by *Phragmidium violaceum* in Oregon. William L. Bruckart, III*, and Jami L. Michael; USDA, ARS, FDWSRU; 1301 Ditto Ave.; Ft. Detrick, MD 21702. William.bruckart@ars.usda.gov

Five species of invasive blackberry have been deemed established along the West Coast of the United States (U.S.) based on molecular characteristics. *Phragmidium violaceum*, a candidate rust disease for biological control of invasive blackberry already deployed in Australia, was discovered in Oregon in 2005. Anecdotal observations were that the disease had eliminated some blackberry thickets in Oregon at that time, but the plant persists and not all individuals in populations that remain are diseased. A field investigation was made to determine the present status of *P. violaceum* on invasive blackberry in Oregon. This involved

making field observations and collections of plants and the fungus. Artificial inoculation of blackberry accessions was also initiated using an Elk River, OR isolate increased on a Lincoln City, OR blackberry accession. In 2010, additional plant samples were collected from 30 field sites for greenhouse inoculations, and clones were easily separated on the basis of susceptibility to disease. Morphological identification of plant accessions was determined on the basis of field data and substantiated during return visits to the various sites in 2013 and 2014 when blackberry was in flower. This enabled correlating *Rubus* species with susceptibility to *P. violaceum*. The most common species of invasive blackberry along the Pacific coast of the U.S., *R. armeniacus*, is not susceptible to the rust disease. Another species, possibly *R. praecox* (published as "*R. anglocandicans*"), was commonly diseased both in the field and in greenhouse tests. Also susceptible were *R. laciniatus* and *R. vestitus*, although the latter species has not yet been tested artificially in this study. This basic understanding of the introduced blackberry complex in the U.S. and susceptibility of species within the complex to *P. violaceum* is a critical first step in developing biological control or other strategies for management of invasive *Rubus*.

Eradicating weeds in Sierra meadows for climate change resilience. Elizabeth Brusati*, Doug Johnson, and Dana Morawitz. Cal-IPC, Berkeley, CA. edbrusati@cal-ipc.org

Sierra Nevada meadows are key habitats for wildlife. They are also important for water storage and carbon sequestration. These functions will become even more critical as California's climate changes. In recent years, Cal-IPC has worked with local partners to identify high-priority invasive plants in the Sierra Nevada. Cal-IPC has undertaken a project to eradicate invasive plants in and around several Sierra meadows in partnership with Sierra Nevada organizations and with funding from the Wildlife Conservation Society's Climate Adaptation Fund. Targeted species include Scotch thistle, Canada thistle, spotted knapweed, rush skeletonweed, perennial pepperweed, and yellow starthistle. Sites include Bear Valley (PG&E, treatment by the Placer County Agriculture Department), riparian meadows along the Truckee River (treatment conducted by private contractor through a non-profit group); meadows in the Smithneck State Wildlife Area near Sierra Valley (treatment by the California Conservation Corps); and a suite of wet meadows in the Tahoe Basin and Hope Valley (treatment by the El Dorado/Alpine Counties Dept. of Agriculture). The project demonstrates approaches to meadow conservation in the Sierra. For each site, weed locations are uploaded to Calflora, work is documented with photos, and a long-term eradication workplan will be put in place. Future efforts will aim to engage local citizens in maintaining these efforts. The project also includes developing suggestions for land managers on actions that improve climate resilience in montane meadows. This poster will report on two seasons of field work.

A plant risk evaluation (PRE) tool for assessing the invasive potential of ornamental plants. Christiana Conser[1], Lizbeth Seebacher[2], David W. Fujino[3], Sarah Reichard[4], Joseph M. DiTomaso[1]* Christopher Crawford (presenter), ccrawford@suscon.org. [1] Department of Plant Sciences, University of California Davis, Davis, California,[2] Washington State Department of Ecology, Lacey, WA,[3] University of California Center for Urban Horticulture, Davis, CA, [4] University of Washington Botanical Gardens,

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Weed Risk Assessment (WRA) methods for evaluating invasiveness in plants have evolved rapidly in the last two decades. Many WRA tools exist, but none were specifically designed to screen ornamental plants prior to being released into the environment. To be accepted as a tool to evaluate ornamental plants for the nursery industry, it is critical that a WRA tool accurately predicts non-invasiveness without falsely categorizing them as invasive. We developed a new Plant Risk Evaluation (PRE) tool for ornamental plants. The 19 questions in the final PRE tool were narrowed down from 56 original questions from existing WRA tools. We evaluated the 56 WRA questions by screening 21 known invasive and 14 known non-invasive ornamental plants. After statistically comparing the predictability of each question and the frequency the question could be answered for both invasive and non-invasive species, we eliminated questions that provided no predictive power, were irrelevant in our current model, or could not be answered reliably at a high enough percentage. We also combined many similar questions. The final 19 remaining PRE questions were further tested for accuracy using 56 additional known invasive plants and 36 known non-invasive ornamental species. The resulting evaluation demonstrated that when "needs further evaluation" classifications were not included, the accuracy of the model was 100% for both predicting invasiveness and non-invasiveness. When "needs further evaluation" classifications were included as either false positive or false negative, the model was still 93% accurate in predicting invasiveness and 97% accurate in predicting non-invasiveness, with an overall accuracy of 95%. We conclude that the PRE tool should not only provide growers with a method to accurately screen their current stock and potential new introductions, but also increase the probability of the tool being accepted for use by the industry as the basis for a nursery certification program. Access online at PLoS ONE.

Phenological and population responses of the invasive pioneer tree, *Bellucia pentamera* (Melastomataceae) to selective logging disturbance at Gunung Palung National Park, Indonesia. Christopher Dillis*[1], Cam Webb[2], Andrew Marshall[3], and Marcel Rejmanek[1]. [1]Graduate Group in Ecology at UC-Davis, One Shields Avenue, Davis, CA; [2]Arnold Arboretum at Harvard University, 25 Arborway, Boston, MA; [3]Department of Anthropology at the University of Michigan, 500 S State St, Ann Arbor, MI. *cdillis@ucdavis.edu

Gunung Palung National Park in Indonesia is currently an invasion front of the Neotropical pioneer tree, *Bellucia pentamera*, which has begun to establish in the last 10-20 years. Due to a period of intense selective logging that occurred outside the research station between 2000 and 2002 there is a sharp boundary between disturbed and undisturbed habitat in close proximity.

We compared 70 plots in the disturbed area to those in the undisturbed research station, recording the presence of treefalls and evidence of prior selective logging activity. Sampled *B. pentamera* individuals were divided into four age classes: seedlings, saplings, juveniles, and adults to provide a rough estimate of population dynamics. Monthly phenology was recorded for 12 months for individuals in both disturbed and undisturbed habitats to explore differences in fruiting frequency. These data were also used to make comparisons with native trees (in undisturbed

habitat only) using phenology data that have been collected for other ongoing projects.

Plots with previous logging had significantly more *B. pentamera* individuals across all age classes than sites with treefalls alone, suggesting an important difference in the nature of these two types of disturbances. No individuals were found in plots without either logging activity or natural treefalls. Phenology data suggest that *B. pentamera* is significantly more prolific in its fruit output than even the most frequently available native alternatives. *B. pentamera* produces ripe fruit at a much higher frequency (75%) than the most frequently fruiting natives (*Pternandra* spp.: 33% and *Cyathocalyx* spp.:29%). *B. pentamera* also produces fruit much more frequently in disturbed areas (80% of fruiting months) than in undisturbed areas (60%).

Our results suggest that without facilitation by selective logging, *B. pentamera* may well still have become naturalized, but may not have necessarily produced the significant invasion currently realized at Gunung Palung National Park.

The interaction of nitrogen and topography on the physiology of *Stipa pulchra*. Robert Fitch* and Erin Questad. California State Polytechnic University, Pomona, CA. rlfitch@outlook.com

Increased nitrogen deposition has been shown to favor invasive plant species; therefore, it is critical to know which areas have increased nitrogen because these areas will be at a greater risk of invasion and will require more management than other areas. Anecdotal evidence suggests that invasion of annual grasses occurs more abundantly in valleys and lowlands and less abundantly on the steeper slopes where native species, such as *Stipa pulchra*, appear to be more prevalent. A possible explanation for this pattern is the fact that nitrogen strongly covaries with water; therefore, during rainfall events, water carries nitrogen off the slopes in runoff where it collects in the valleys/lowlands.

The objectives of this study were to 1) analyze the differences in soil moisture and soil nitrogen created by a topographical gradient and 2) to determine the areas within the topographical gradient that are the most suitable for the native perennial bunch grass, *Stipa pulchra*. To test these hypotheses, plots were established along three different topographical positions within four canyons in the Voorhis Ecological Reserve, part of the Cal Poly, Pomona campus. Three nitrogen treatments (ambient, addition, and removal) were replicated and five individuals of *Stipa pulchra* were planted in each plot with all invasive species continually being removed while allowing native species to persist.

Soil nitrogen and soil moisture were highest in the lowest topographical positions and were lowest in the steepest positions, suggesting that topography effects the soil nitrogen content at small spatial scales due to covariance with water and soil movement. The leaf water potential of *Stipa* in the lowest topographic position was sometimes lower and sometimes higher than other positions, suggesting that there may be shifting limitations on plant water status in low-lying areas. Nitrogen did not have an effect on plant growth or measures of plant performance during the first four months of the study. Further research will be conducted analyzing soil temperature and solar radiation along the same topographical gradient.

The effects of nitrogen deposition and plant invasion on litter decomposition. Eliza Hernández[1]*, Erin Questad[1], and Katherine Suding[2]. [1]Biological Sciences Department,

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Litter decomposition is a foundational ecological service in that it plays a key role in biomass production, nutrient cycling, and biodiversity conservation. The process of decomposers (e.g. bacteria, fungi, etc.) breaking down plant litter is essential to providing available nutrients in the soil for plant growth and productivity. The economic value of decomposition in the United States is an estimated $500 million a year. As a consequence of anthropogenic global change, litter decomposition may be significantly altered. Nitrogen deposition, a process accelerated by human activities, has been found to significantly increase, decrease, or have no effect on litter decomposition rates. Such varied findings call for further research on nitrogen enrichment as it pertains to litter decomposition. Additionally, increased nitrogen levels are thought to perpetuate the spread of invasive plant species, which in turn can alter decomposition rates by changing the type and quality of litter found in plant communities. In this study, litter decomposition rates were compared between an invasive grass, *Bromus hordeaceus*, and a California native grass, *Stipa pulchra*, under ambient and elevated nitrogen conditions. Preliminary results indicate higher decomposition rates in both grass species under elevated nitrogen conditions. Furthermore, *B. hordeaceus* had lower decomposition rates than *S. pulchra* in both nitrogen treatments, which illustrates how anthropogenic change alters the quality and quantity of litter in invaded plant communities.

Multi-benefit weed control: the San Joaquin River Invasive Species Management and Jobs Creation Project. Jeff Holt[1] Trevor Meadows[1], Heyo Tjarks[1], Julie Rentner[1], Sharon Weaver[2], Jake Salimbene[2] Andrew Rayburn*[1]. [1]River Partners, 912 11th St. Suite LL2, Modesto, CA. [2]San Joaquin River Parkway and Conservation Trust, 11605 Old Friant Rd, Fresno, CA. arayburn@riverpartners.org

The San Joaquin River Restoration Program (SJRRP) funded the San Joaquin River Invasive Species Management and Jobs Creation Project to manage and monitor invasive species along the 150-mile river stretch slated for higher flows, and to provide jobs in a region of chronically high unemployment. River Partners and the San Joaquin River Parkway & Conservation Trust have divided the five river reaches to tackle this landscape-scale project. Initial project phases focused on planning, permitting, and landowner negotiations for site access. Invasive species mapping began in 2011, and >5000 acres of the SJRRP Area have been mapped to date including the San Luis and Merced NWRs, Great Valley Grasslands State Park, Hatfield State Recreation Area, Riverbottom Park, Scout Island, Sycamore Island, Spano River West, Van Buren Unit and five private inholdings. Focal invasives include giant reed (*Arundo donax*), red sesbania (*Sesbania punicea*), salt cedar (*Tamarix* sp.), perennial pepperweed (*Lepidium latifolium*), edible fig (*Ficus carica*), Himalayan blackberry (*Rubus armeniacus*), yellow starthistle (*Centaurea solstitialis*), and tree tobacco (*Nicotiana glauca*). Using baseline spatial data, field mapping, and additional data from partners, we have balanced multiple factors to prioritize invasive species treatment. Annual treatments began in 2012 and have continued through 2015. Mechanical, chemical and grazing methods employed have been developed through experience, research, and

additional consultation. Over 780 acres of invasives have been treated, including >590 acres of *L. latifolium*, 160 acres of *S. punicea*, 25 acres of *A. donax*, and smaller extents of other species. Treatment effectiveness continues to be assessed via monitoring in 2015. Seed of competitive native grasses has also been broadcast in some areas to prevent invasive species recolonization. The project has provided jobs for permanent staff, interns, agricultural laborers, and hundreds of Conservation Corpsmembers whom have received job training related to riparian restoration and invasive species control.

Assessing spatio-temporal changes of invasive Algerian sea lavender (*Limonium ramosissimum*) in San Francisco Bay wetlands. Kerstin Kalchmayr*, Barbara Holzman, Ellen Hines and Katharyn Boyer. San Francisco State University, Department of Geography and the Environment/Department of Biology 1600 Holloway Avenue San Francisco, CA 94132. kerstink@mail.sfsu.edu

In 2006 the non-native Algerian sea lavender (*Limonium ramosissimum* ssp. *provincial*) – LIRA was discovered growing in San Francisco Bay wetlands. This discovery prompted early research to describe the species' life history and behavioral traits to help inform eradication strategies. These early studies provided essential baseline information on LIRA's ability to invade and impact San Francisco Bay salt marshes. However, as these studies were conducted over a short-term period they provided a limited view into the ecological behavior of the species whose effects can change dramatically over time and can potentially impact management plans. The present study investigates the spatio-temporal changes of LIRA in SF Bay wetlands over the last seven years by assessing current Bay-wide spatial distribution of LIRA populations and evaluating LIRA's impacts on species composition and soil properties. From 2008-2010 twenty LIRA populations around San Francisco Bay were surveyed and mapped. To determine how these populations have changed in their abundance and distribution, these populations were resurveyed and remapped in 2015. Additionally, mensurate surveys at three wetland sites in the west-central San Francisco Bay were undertaken. At these sites existing survey plots established in 2008 were used to assess current LIRA and co-occurring halophyte percent cover. Soil core samples were similarly collected and analyzed from each survey plot. Initial studies have shown LIRA to be an invasive species that grows well in the upper marsh zone negatively impacting native species. Over the seven year time frame it is likely that LIRA has increased in abundance and distribution in this region further displacing native floral species and impacting soil properties such as moisture and salinity. Results from this study can therefore be helpful to inform priority eradication programs and can further fine-tune control strategies.

Rapid root responses of native and invasive California plants exposed to a post-drought precipitation pulse. Joanne Kim* and Jennifer Funk. Schmid College of Science and Technology, Chapman University, Orange, CA USA. Joannesuahkim93@yahoo.com

Precipitation events in southern California can vary in quantity and are predicted to become less frequent over time. Native and invasive plants may have different strategies to tolerate semi-arid environments to maximize survival. - Roots are a critical component of nutrient and water uptake; thus, understanding the rapid response of root systems to precipitation pulses

could provide insight into how plants maximize resource uptake in these systems. In this study, we measured short-term root and above-ground growth for two invasive (*Avena barbata* and *Medicago polymorpha*) and three native (*Encelia california, Salvia apiana,* and *S. columbariae*) plant seedlings in response to a post-drought water pulse. We detected increased above-ground growth across all 5 species after the precipitation pulse. However, rates of root elongation and new root tip appearances varied between species. The two invasive species differed substantially, exhibiting the highest (*M. polymorpha*) and lowest (*A. barbata*) rates of new root tip appearance. In response to the pulse, *M. polymorpha* (annual forb) rapidly increased in both new root tip appearance and relative root elongation within 2 days, while *A. barbata* showed relatively little response. Two native shrubs (*E. californica* and *S. apiana*) increased root tip appearance and root elongation within first 2 days. However, root growth was not as rapid as in *M. polymorpha*. Furthermore, annual forb *S. columbariae* differed from a closely related species *S. apiana* with little change in these traits over 2 days, but substantial increase over 1 week. While all 5 species differed in root response to a precipitation pulse, growth strategy appeared to be independent of origin. This variation could be critical to explaining performance and fitness differences among restoration species and should be explored across a wider range of species.

Seedbank-mediated coexistence of invasive annual grasses and native annual forbs under a changing climate. Marina LaForgia, UC Davis, Davis, Ca. mlaforgia@ucdavis.edu.

Local scale species diversity is important for essential ecosystem functioning and has been linked to resistance to invasion. Although exotic annual grasses dominate California grasslands, the majority of species diversity in these communities comes from native annual forbs. Native forb populations are able to persist with exotic grasses by forming long-term seedbanks that buffer population decline during unfavorable years while exotic annual grasses exhibit much lower seed dormancy and germinate nearly all of their annually produced seed each fall. It is this differential seed dormancy that currently maintains the coexistence of forbs and grasses. How climate change will affect seedbank-mediated coexistence remains unknown. Climates are projected to become more variable through higher frequencies of both intense rainfall and extreme droughts, while the mean tendency is toward a drier climate in the western United States. Over the past 15 years in my study site, a California annual grassland, precipitation during the important winter growth period has decreased substantially, extreme climatic events have occurred (e.g. the 2013-2014 drought), and native annual forb diversity has declined significantly. A critical question is whether seed bank storage is still maintaining species coexistence, so that aboveground native forbs will recover in favorable years. Alternatively, either increased rainfall variability, or decreased mean rainfall favorability may undermine the capacity of seed banks to buffer environmental variation. To answer this question, I have 15 years of aboveground plant cover data from an annual grassland in northern California and two years of belowground seedbank composition from before and after the recent extreme drought. With these data, I am testing whether species that are declining in abundance aboveground, namely native forbs, are being lost from the system rather than persisting via seed dormancy.

GrassApp, a tool that helps landowners facing grass invasion. Dorothy Y. Maguire [1,3], Stephen Novak [1], Massimo Cristofaro [2], and René FH Sforza [3]. [1] Department of Biological Sciences, Boise State University, Boise, ID. , [2] BBCA, Rome, Italy, [3] USDA-ARS, European Biological Control Laboratory, Montferrier-sur-Lez, France. maguire.dory@gmail.com

In recent decades, invasive alien grass species have become a considerable problem in rangelands of western America (NA). Cheatgrass, several Bromus species, medusahead and more recently ventenata now dominate native plant communities, displacing the native flora, and reducing hay and cattle production. The extent of spread of these invasive grasses has caused extensive environmental and economic damage throughout Washington, Idaho, and Oregon, and more recently, California. The severity of damage caused by these species is being increasingly recognized as problematic, but tools for learning about the proper management, as well as proper identification and reporting of the spread of these species are difficult for the public to access. We are using multidisciplinary approach by combining research on the spread and management strategies for these species, with outreach and stakeholder engagement, to ensure that the latest research is made available, and easily accessible to the general public. Our objective was therefore to develop an interactive and easy-to-use website, and mobile browser to help individuals who are at risk of being negatively affected by these plants learn about the most common invasions in the western U.S., and the research that is being done to slow them down. More specifically, "Invasive Grass Mapper" allows scientists, managers, stakeholders, and the general public to use their smart phones to accurately identify and report, the presence and location of invasive species on their land. Discussion forums hosted by experts, and photos help ensure that the identifications, and information collected are accurate. By serving as a hub for scientific discussion on invasive grasses, this website can facilitate communication between researchers, managers, and the communities being impacted by these aggressive grasses. The data generated by this site can in turn help scientists track the spread of these species, discover new populations, thereby helping to inform management strategies.

Chemically cleaning your boots: the use of disinfectants to reduce the dispersal of invasive weed seeds. Christopher McDonald*[1], Zach Principe[2]. [1]University of California Cooperative Extension, 777 E. Rialto Ave, San Bernardino CA, 92415. cjmcdonald@ucanr.edu. [2]The Nature Conservancy, 402 West Broadway, Suite 1350, San Diego, CA 92101, zprincipe@tnc.org.

Numerous seeds have structures, including barbs, hooks and spines, which assist with dispersal by adhering to passing animals. These species with epizoochorous dispersal have been unintentionally and widely dispersed to novel locations and in some cases have altered native plant communities in their new range. Best management practices (BMP) require persons entering a weed infestation to clean their equipment and clothing before entering a site, and when leaving a site to prevent the infestation of sites visited as seeds may fall off during work. The process of decontaminating clothing or boots is time consuming and even after a careful manual cleaning seeds can become lodged in small nooks and cracks of equipment, clothes and boots. Practical means of killing weed seeds in the field are desirable and would fit BMP standards. Selecting a treatment method is difficult; chemicals must

not injure a person through accidental contact, and yet must be portable and survive adverse field conditions. Several different methods of seed sterilization were tested in this study, including treatment with Lysol and rubbing alcohol. Preliminary results of these methods indicate poor performance of some of these treatments on some common weed species in southern California. Given the fact that these chemicals do not perform well, other methods of decontamination will need to be considered.

Livestock grazing and landscape diversity in California vernal pools. Julia Michaels, UC Davis, CA. jmichaels@ucdavis.edu

Vernal pools are seasonal wetlands that are inundated in the winter and dry during the summer. The exotic species that currently dominate California grasslands are poorly adapted to seasonality in the pool basins and are mostly limited to pool edges, resulting in 'islands' of habitat within invaded grassland that support a suite of over 200 species of native flora. Vernal pools are characterized by low within-pool diversity and exceptionally high between-pool diversity. Often, two adjacent pools of similar shape and size can be unique in their species assemblages, due to their unique combination of hydrology, chemistry, and topography.

Currently, vernal pools are threatened by conversion of ranches to development, with conservation dependent on maintaining the economic viability of ranches. No studies have looked at the effects of grazing on between-pool (beta) diversity, which is the most prevalent form of diversity in these systems. Local disturbances and selective grazing in some upland ecosystems have been shown to enhance diversity at local sites, while homogenizing diversity between these sites. To address this question, I have compared species assemblages in vernal pools that have been grazed continuously and in pools that have been fenced off from livestock since 1970s at a site in Sacramento County. I paired 15 grazed and 15 ungrazed pools, and established nine vegetation quadrats per pool (30 pools, 270 quadrats total). During peak flowering season, I sampled these quadrats for grasses and forbs, and calculated richness, cover and abundance, for both individual species and for native vs. exotic species. I am currently using PermANOVA and PermDISP statistical software to compare beta diversity between the grazed and ungrazed pools

Identifying emerging invasive plants for early eradication on the San Mateo County coast. Dana Morawitz*, Doug Johnson, and Elizabeth Brusati. Cal-IPC, Berkeley, CA. *dfmorawitz@cal-ipc.org

Identifying and removing new invasive plants before they become widespread is a cost-effective strategy that prevents ecological impacts. As in most areas, invasive plant management on the San Mateo County coast has mostly focused on high-profile species, including Cape-ivy, European beach grass, pampasgrass, Hardinggrass, and Canary Island St. Johnswort. Working on less well-established invasive plants, for which eradication remains feasible, has been promoted by Cal-IPC and the Bay Area Early Detection Network (BAEDN). In previous years BAEDN had identified several isolated populations of known weeds in the region as strategic targets. As a next step, Cal-IPC and the region's land managers wanted to better understand the potential future threat from emerging weeds. With support from the US Fish & Wildlife Service's Coastal Program, Cal-IPC analyzed non-native plant species already naturalized in the region to determine

which presented the highest risk of causing environmental harm in the future. The project used three complementary tools: the Calflora database to determine non-native plants that were not widespread in the region; expert interviews to check on distribution and perceived risk; and the Plant Risk Evaluation (PRE) criteria system from UC Davis to predict risk based on life history factors. Using these tools, we identified 9 species as potential early-eradication targets and 11 species as surveillance targets. Local partners, including the San Mateo County Resource Conservation District (RCD), will collect additional information on distribution of each species, and public landowners will undertake control efforts to learn about the efficacy of different approaches.

Do native and invasive species share similar carbon capture strategies? Monica Nguyen* and Jennifer L. Funk. Schmid College of Science and Technology, Chapman University, Orange, CA, USA. *nguyen.an.monica@gmail.com

Growing evidence suggests that across species, several key leaf traits (e.g., foliar nitrogen (N), photosynthetic rate (A)) are strongly related, forming a single leaf economics spectrum (LES) of slow to rapid carbon capture, with native and invasive species occupying the "slow" and "fast return" ends of this spectrum, respectively. These inferences are based on the assumption that relationships underlying the LES are constrained across biomes and life forms, allowing simple measurements (e.g., N) to be used to infer a suite of related leaf attributes. Alternatively, if the slopes and positions of native and invasive species within these relationships are not supported in all communities, understanding ecological strategies of invaders may prove more complex. Looking for evidence of consistency in trait relationships among co-occurring native and invasive species, we examined relationships among four leaf traits (A, specific leaf area, foliar N and phosphorous) from sites across five Mediterranean climate ecosystems differing in resource availability. We performed standardized major axis regression for each possible trait combination within and across sites, testing for slope homogeneity and shifts in elevation or along a common slope between native and invasive species. When sites were pooled, the data suggest native and invasive species have similar carbon capture strategies (i.e., similar slopes), with invasive species occupying the faster return end of the LES. When analyzed regionally, however, differences emerge. Unlike South Africa and Western Australia, native and invasive species in California and Spain, despite common slopes, were not separated along those slopes. Regional differences may be driven by life form. Species sampled in South Africa and Western Australia were distinct (woody natives, herbaceous invaders), while species in California and Spain were more comparable. Our context-dependent results suggest using LES relationships to infer broad functional differences between native and invasive species must be approached with caution.

Pre-release impact assessment of the leaf-mining moth (*Digitivalva delaireae*), a potential biological control agent for Cape-ivy (*Delairea odorata*). Angelica M. Reddy*, Christopher N. Mehelis, and Patrick J. Moran. USDA-Agricultural Research Service (ARS), Exotic and Invasive Weeds Research Unit, Albany, CA. Angelica.Reddy@ars.usda.gov

Pre-release efficacy assessments of potential biological control agents are a must in any biological control program to demonstrate that the potential agent will adversely affect key

growth parameters of the target weed. This information can also be used to prioritize agent selection based on likely efficacy. The leaf-mining moth (*Digitivalva delaireae*) is a potential agent for the invasive vine Cape-ivy (*Delairea odorata*) in western North America, where two morphological varieties (stipulate and exstipulate) of Cape-ivy occur. Two laboratory experiments were conducted to assess (1) the oviposition preference of *D. delaireae* for either of the two varieties and (2) its impact on plant performance using low and high densities of the moth on both varieties. There was no difference between the two varieties in the proportion of leaves oviposited on or damaged by *D. delaireae*. Similarly, the effect of *D. delaireae* herbivory on plant performance was not influenced by Cape-ivy variety. Independent of moth density treatment (low or high), herbivory by *D. delaireae* resulted in an overall reduction in plant growth and biomass accumulation, and Cape-ivy was unable to compensate for *D. delaireae* damage: mean relative growth rate, main stem length increment, dry shoot biomass, and leaf mass fraction were reduced 22%, 27%, 22%, and 17% in plants exposed to one generation of *D. delaireae* herbivory compared to unexposed plants. These results indicate that once released, *D. delaireae* has the potential to negatively affect stem growth, biomass accumulation and rate of stand expansion of Cape-ivy in the field.

River Partners and the California Conservation Corps – a win-win partnership for job creation, invasive species removal, and multi-benefit habitat restoration. Dave Roberts*[1], Stephen Sheppard[2], Ruben Reynoso[3], Trevor Meadows[2], Jeff Holt[2], Sara Weaver[4], and Andrew P. Rayburn[3]. [1]River Partners, San Diego Bay National Wildlife Refuge, 1080 Gunpowder Point Drive, Chula Vista, CA 91910. [2]River Partners, 912 11th St. Suite LL2, Modesto, CA 95354. [3]River Partners, 580 Vallombrosa Ave., Chico, CA. [4]California Conservation Corps, 401 West 34th Street, San Diego, CA 91950. droberts@riverpartners.org.

Large-scale invasive species removal and habitat restoration projects are critical for recovery of special-status species and enhancement of valuable ecosystem services, but are often extremely labor-intensive endeavors. In California, many of these projects are implemented in regions characterized by chronic unemployment that often disproportionately affects youth seeking to transition into the workforce. As a result, these projects offer unique opportunities to employ, train and empower young women and men working for the California Conservation Corps (CCC) and Regional Conservation Corps (RCC) to better themselves while engaging in hands-on conservation. Over the past 5 years, River Partners, the CCC, and various RCCs have developed successful state-wide partnerships to create hundreds of skilled jobs in local communities while successfully implementing cost-effective, large-scale invasive species removal and habitat restoration projects. For example, corpsmembers have been trained on the use of hand labor and heavy equipment to treat invasive species including giant reed (*Arundo donax*), red sesbania (*Sesbania punicea*), salt cedar (*Tamarix* spp.), perennial pepperweed (*Lepidium latifolium*), edible fig (*Ficus carica*), Himalayan blackberry (*Rubus armeniacus*), yellow starthistle (*Centaurea solstitialis*), and tree tobacco (*Nicotiana glauca*). Corpsmembers have also helped install water-efficient irrigation systems, plant native species from seed, cuttings, and potted stock, support volunteer and outreach events, and remove

trash and other debris from restoration sites. An overview of these activities and partnerships will be presented, with examples drawn from a diverse range of invasive species control and habitat restoration projects in Southern California, the San Joaquin Valley, and the Sacramento Valley. The job creation and training benefits of these projects will be emphasized, in addition to the important roles that CCC corpsmembers play in on-the-ground project implementation.

Soil-mediated impacts of the invasive grass *Ehrharta erecta* on a forest understory community. Annika Rose-Person*, Courtenay Ray, and Ingrid M. Parker**.** University of California, Santa Cruz, CA. anrosepe@ucsc.edu

Understanding the complex ways that invasive plant species impact native ecosystems is crucial to the restoration of native habitats. Invasive plants can have soil-mediated impacts on native biodiversity through both biotic and abiotic mechanisms. Here we strive to identify the soil-mediated effects of *Ehrharta erecta,* an invasive, perennial grass that is prevalent at UC Santa Cruz and in a diversity of habitats across California. Previous work has suggested that *E. erecta* may suppress colonization by arbuscular mycorrhizal fungi, which can be important plant mutualists. We will condition soil by growing *E. erecta* in pots for four months, along with pots of control soil, and then remove *E. erecta* seedlings and sterilize half of these soils of all biota. We will test the nitrogen and phosphorous levels of all soil types (*E. erecta*-conditioned, sterile *E. erecta*-conditioned, control, and sterile control) to determine the extent of *E. erecta*'s impacts on soil nutrient levels. We will then plant the four soils with natives commonly seen in habitats invaded by *E. erecta*: *Clinopodium douglasii*, *Rubus ursinis,* and *Stachys bullata*, as well as *E. erecta* itself. We will use two-way ANOVA to test for the effects of *E. erecta* conditioning and sterilization on plant growth rate and arbuscular mycorrhizal fungi colonization for each of the three native species and *E. erecta.* By investigating the interaction between soil conditioning and sterilization, we will determine whether the impacts of the invader are primarily abiotic, by altering nutrient levels, or biotic, by altering microbial associates. By determining how *E. erecta* impacts native plant species, we will be better equipped to understand why some species may be better competitors against *E. erecta*, and to restore invaded habitats. This research will give us tools to manage this important environmental weed in California.

Ecological and economic implications of invasive giant reed (*Arundo donax*) control for the Santa Clara River watershed. Marc Steele*, Ian Bell, Eliza Berry, Zach McKelvey, and Brooke Prentice-Dekker, Bren School of Environmental Science & Management, University of California, Santa Barbara, Santa Barbara, CA. msteele@bren.ucsb.edu

The Santa Clara River (SCR) watershed is an important terrestrial and aquatic ecosystem in Ventura and Los Angeles Counties. Currently it is threatened by the invasion of the giant reed, *Arundo donax*, which perpetuates fires, degrades habitat, uses large amount of water, and increases severity of flood events. While efforts are underway to eradicate the invasive reed, it is difficult for government agencies, researchers, and NGOs to access funds for arundo removal given the expense of removal and the weed's persistence in returning. This project analyzes the costs and benefits of arundo removal under three groups of management scenarios relative to a baseline, business-as-usual, approach. The first scenario

considers the adoption of a contingency plan by agencies operating in the SCR watershed. This represents an immediate arundo control response after an episodic fire or flood event, which can have several critical implications for management costs. The second scenario promotes a more comprehensive and collaborative removal effort by agencies in developing priority areas, while the third scenario combines the approaches seen in both the first and second. Case studies are used to develop cost structures for various agency types (i.e. government, NGO) and modeled across the watershed. Primary benefits of arundo removal are assessed as avoided damages and reduced impacts from fire and flood events at variable levels of overall reed cover in the watershed. Flood impacts are evaluated using a 2D MIKEFLOOD model and fire impacts using a combination of FARSITE and HFire models. A cost-benefit analysis is then used to understand the effectiveness and financial incentives across varying management strategies. Our results aim to support future efforts for enhanced arundo removal and provide a more efficient framework for managing the invasive reed in riparian habitats.

Results of velvetgrass (*Holcus lanatus*) control in the Kern Canyon wilderness of Sequoia National Park. Rich Thiel*, Athena Demetry, Mathias Herriges, Christine Davis, Brian Werner, Sequoia and Kings Canyon National Parks, Three Rivers, CA. richard_thiel@nps.gov

The Kern Canyon is the least developed and the most naturally-functioning watershed in Sequoia and Kings Canyon National Parks, and visitors to the Kern experience among the most intact wilderness character in this region. Velvetgrass (*Holcus lanatus*) is one of only nine non-native plant species known in the Kern Canyon and has been present in relatively few (yet often dense) patches. Velvetgrass was detected very recently in 2006 in the Kern Canyon. It is extremely invasive in montane meadows, forming pure stands that displace native meadow vegetation. In 2006 velvetgrass occupied 83 separate patches (13.5 gross acres) dispersed along approximately 16 river miles of the Kern River 20 miles or more from any road. In 2009 we initiated a 3-year pilot control project to investigate the efficacy of several different control methods, eventually settling on a combination of a single glyphosate herbicide treatment followed by several years of hand-pulling with large work crews (> 10 people) working to exhaust the seed bank. Velvetgrass percent cover and stem counts have been recorded annually. A cooperative agreement with adjacent Sequoia National Forest has allowed crews to treat dense populations further down canyon. This presentation goes beyond evaluation of the different control methods to display the results of using the control method that was ultimately determined to be the most effective. Results in 2014 indicated all of the individual infestations had very significant declines in stem counts and in invaded area compared to the first year of control efforts. Approximately 70% of the infestations are fully controlled, and there has been no further spread into the park since initial discovery in 2006. These results will provide managers with useful information for managing velvetgrass infestations. Results will be updated with 2015 field season data and also assessed against the current drought conditions in California

Successful habitat restoration of a native thistle following jubata grass control. Don Thomas. San Francisco Public Utilities Commission. dethomas@sfwater.org

Fountain thistle (*Cirsium fontinale* var. *fontinale*) is a federally endangered native thistle that grows in serpentine seeps and in seasonally wet serpentine grassland. This habitat has been invaded by jubata grass (*Cortaderia jubata*) and other invasive plants. This study describes the successful recovery of two serpentine seep populations through passive revegetation following control of jubata grass.

One fountain thistle population, located in the Peninsula Watershed of the San Francisco Public Utilities Commission, had been mostly displaced from its serpentine seep habitat by the invasion of jubata grass. The jubata grass was removed by cutting the stalks with a chain saw and treating cut stems with glyphosate. The recovery of this population was studied over time using a transect study. A central east-west trending line transect was placed through the population. Expansion of the population was measured by running 5-ft. wide perpendicular belt transects along this transect in both north and south directions. It was found that between 2010 and 2015 the fountain thistle population expanded to fill almost all of the available habitat, indicating successful recovery. Between 2010 and 2014 the population expanded southward at an average annual rate of 6.2 ft./yr. and northward at an average rate of 3.9 ft./yr. However, between 2014 and 2015 the rate had decreased to 1.4 ft./yr. southward and 1.9 ft./yr. northward, as the population began to reach the limits of the habitat available for re-colonization.

The second population, located on Caltrans property, had also been heavily invaded by jubata grass. After the application of glyphosate to control the jubata grass, the site has been worked on twice annually by volunteers of the California Native Plant Society to remove any new invasive plants. From fewer than 100 plants, this population has also expanded rapidly to a few thousand and has re-occupied the available habitat.

Importance of effective public outreach for invasive vegetation removal projects in the Santa Ana River floodplain, Riverside County, CA. Melissa Tu[1], Hayley Lovan[2], Dan Herlihy[3], Sloane Seferyn[3], and Richard Stolpe[4]. [1]Atkins North America, San Diego, CA. [2] USACE Los Angeles District, CA. [3]UltraSystems, Inc., Irvine, CA. [4]Cardno, Inc., Solana Beach, CA. Melissa.tu@atkinsglobal.com

The U.S. Army Corps of Engineers (USACE) contracted with UltraSystems to remove non-native invasive plant species from the Santa Ana River floodplain to mitigate USACE flood control impacts. A unique aspect of the project was the removal of immense stands of invasive giant reed (*Arundo donax*) that traditionally provided shade and scenic trails for the equestrian community.

Prior to the current project, some of the local community was not aware of invasive vegetation removal processes and goals. Some individuals did not support the project and stood in front of dangerous removal equipment and destroyed native restoration plantings.

For the current project, the USACE funded an early public outreach program so that UltraSystems and its subcontractors, Cardno and Nature's Image, could hold more public meetings to explain the long-term benefits to the community when re-establishing native habitats. To accommodate community and equestrian concerns raised at the meetings, certain trails were avoided or maintained; trail closures were coordinated and minimized; and scientific and safety information was disseminated. As a result, many community members became project advocates, and invasive vegetation removal and habitat restoration has been successful and has stayed on schedule