DRAAWP Progress Report-Biological Control of Aquatic Weeds-January 2018

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DRAAWP Agencies Involved: USDA-ARS-EIWRU; Division of Boating and Waterways-CA Dept. of Parks and Recreation; University of California-Davis, Dept. of Plant Sciences; Sacramento-San Joaquin Delta Conservancy; Contra Costa County Mosquito Control District; San Joaquin County Mosquito Control District; California Dept. of Food and Agriculture-Pest Exclusion.

Water Hyacinth

Re-introduction of previously-released biocontrol agents: As described in the "Control Approaches-Biological Control" page of the DRAAWP website, three insects, known as "biocontrol agents", targeting floating water hyacinth were first released in the Delta in the early 1980s. Two leaf-feeding and stem-boring weevil species and one stem-boring moth were released (Figure 1). These insects were originally discovered by the USDA-ARS in water hyacinth's native range in South America, and have since been released worldwide where water hyacinth is invasive. A two-year survey revealed that the one weevil species that is still present in the Delta varies in density from near 0 in winter and early spring to an average of 5 to 6 weevils per plant in late summer (as many as 39 on one plant) (Figure 2), but is unable to keep up with the rapid growth of water hyacinth. The other weevil species is not present except in isolated populations near Modesto on the Tuolumne River (Figure 2). DNA studies are confirming the identity of the weevils. Working in the laboratory, DRAAWP researchers studying collections of this 'other' weevil species from around the world have determined that a collection from Australia produced twice as many offspring over a longer time period under simulated Delta weather conditions than the population currently in California. Studies to verify that this weevil feeds only on water hyacinth are underway and will support a permit application to release the Australian collection in the Delta. Permits are pending to re-release a third biocontrol agent, the stem-boring moth (Figure 1), from cold-hardy U.S populations. Releases of these agents will be implemented in the context of adaptive, integrated management of water hyacinth throughout the Delta.

Introduction of a new biocontrol agent: The "Projects-New Biocontrol Agents" section of the DRAAWP webpage provides information about the water hyacinth planthopper, which, like the other agents, is native to South America, has been widely released in the U.S., and feeds on plant juices. An initial release outside of the Delta near Sacramento led to local establishment (Figure 2). To integrate biocontrol with chemical control, tests have been conducted by P. Moran to determine if herbicides used for control (glyphosate, 2,4-D, imazamox), an additive used to improve control, and one other herbicide (penoxsulam) and additive proposed for use, are toxic when planthoppers are placed on dipped water hyacinth leaves. Results of three tests so far indicate no toxicity. Future studies will examine the effect of spraying planthoppers feeding on whole plants in colonies. In additional studies that are required by regulatory agencies before widespread releases of the planthopper (and also the second weevil species) in the Delta, planthoppers and weevils were fed to tank colonies of Federally-endangered Delta smelt, and also rainbow trout, as a stand-in for endangered or threatened Chinook salmon and steelhead. These studies involved a collaboration with the Univ. of Calif School of Veterinary Medicine,

Center for Aquatic Biology and Aquaculture. Studies conducted over 96 hours than rainbow trout feed on the biocontrol agents, but there was no difference in fish mortality of either species over 96 hours. Longer studies, ie 7 to 10 days, are still needed to determine if there are any chronic effects. In the meantime, releases of the planthopper are continuing outside of the Delta. A total of 26,000 planthoppers were released in 2016 and 8,200 in 2017. The Contra Costa and San Joaquin Mosquito Vector Control Districts, and the California Dept. of Food and Agriculture, provide indoor or outdoor rearing tanks for the planthopper.

Integration of biocontrol into adaptive management plan. Biocontrol of water hyacinth with the planthopper, weevils, and moth was included as a key control strategy in a five-year Biological Assessment (BA) addressing multiple control methods targeting eight aquatic weed species. The BA was submitted by USDA-ARS and the Division of Boating and Waterways-CA Parks for regulatory review in October 2017, with implementation expected in the spring of 2018.

Arundo

Releases of two new agents. The "Projects-New Biocontrol Agents" page of the DRAAWP web page describes the arundo shoot tip-galling wasp *Tetramesa romana* and the root- and stem-feeding arundo armored scale *Rhizaspidiotus donacis*, which were collected originally in arundo's native range in Mediterranean Spain and released in Texas and Mexico, with demonstrated impact. Releases of about 3300 arundo wasps in the western and central Delta in 2015-2016 were guided by a satellite image-guided mapping project completed by the Sacramento-San Joaquin Delta Conservancy (SSJDC) (Figure 3), which allowed USDA-ARS to prioritize sites and develop contacts with landowners for site access. The arundo armored scale was released by first rearing the scales on arundo 'microplants' in a greenhouse for 6 months, then planting the microplants at field sites, and this technique was successful, as the next generation of scale offspring migrated from the microplants to the mature arundo at the sites. In 2017, integrated biological, chemical and mechanical control of arundo was initiated in the western Delta. At a state park (Figure 3) and two other sites, arundo plots (4 m^2) were 'topped' at 1 m height (about 3 ft tall) with a hedger, then allowed to regrow for four weeks. 120 arundo wasps were then released into each plot (total of 1800 released in 2017). The biocontrol release plots were marked with buffers, and the SSJDC then sprayed glyphosate + imazapyr onto the rest of the arundo at the State Park site (Figure 3). Microplants with the arundo armored scale will be added to the plots in 2018. A plot of arundo was planted at the CDFA facility in Sacramento in 2017 and was infested with the wasp and armored scale for rearing for future field releases.

Key Products:

Publications:

Moran PJ, Pitcairn MJ, Villegas B. 2016. First establishment of the planthopper, *Megamelus scutellaris* Berg, 1883 (Hemiptera: Delphacidae), released for biological control of water hyacinth in California. Pan-Pacific Entomol. 92:32-43.

Hopper JV, Pratt PD, McCue KF, Pitcairn MJ, Moran PJ, Madsen JD. 2017. Spatial and temporal variation of biological control agents associated with *Eichhornia crassipes* in the Sacramento-San Joaquin River Delta, California. Biol. Cont. 111:13-22.

Ta J, Anderson LWJ, Christman MA, Khanna S, Kratville D, Madsen JD, Moran PJ, Viers JH. 2017. Invasive aquatic vegetation management in the Sacramento-San Joaquin River Delta: status and recommendations. San Francisco Estuary and Water Sci. 15:4, Art. 5.

Models or Other Technology Transfer:

Aquatic Invasive Plant Control Program (AIPCP) Biological Assessment. Authored by the USDA-ARS and the Division of Boating and Waterways-CA Department of Parks and Recreation, summarizing the DRAAWP-influenced, integrated, adaptive management plan for controlling aquatic weeds in the Delta. Submitted on 10/13/2017 to the U.S. Fish and Wildlife Service and the NOAA-National Marine Fisheries Service.

Permit application for arundo biocontrol to CA Department of Parks and Recreation. Permit granted May 2017. Summarized plan for arundo biocontrol and integration with mechanical and chemical control. Permit granted by CA Parks represented the first time that this agency has permitted intentional release of weed biocontrol agent on its lands in the Delta region.

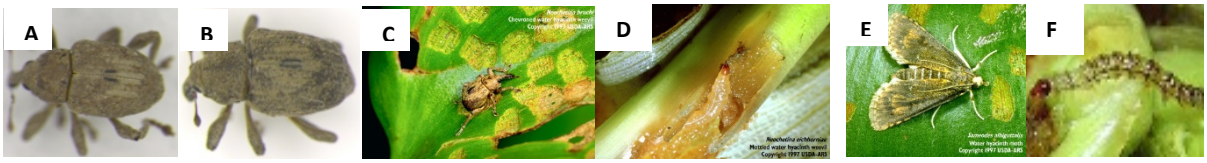

Figure 1: Three biocontrol agents of water hyacinth from its South American native range that were previously released in the Delta, now being re-visited by the DRAAWP. **A**, The water hyacinth weevil *Neochetina bruchi*, which is still widespread and sometimes abundant in the Delta, but not exerting enough impact on water hyacinth. **B**, The other water hyacinth weevil, *Neochetina eichhorniae*, which did not establish in the Delta but may be present in the San Joaquin River watershed. Lab research has determined that a collection of this weevil released in Australia is better-adapted to cool winter conditions in the Delta than the U.S. collection previously released, and so the Australian weevil could establish large populations. **C**, Damage caused by adult water hyacinth weevils to leaves. **D**, Weevil larvae bore through leaves to the central growing tip or 'crown' of the plant. **E**, The water hyacinth moth *Niphograpta albiguttalis*, which did not establish in the Delta. Efforts are underway to re-release this moth collected from areas of the southeastern U.S. with a similar cool winter climate. Photos A, B by Julie Hopper, USDA-ARS and Delta Stewardship Council. Photos C-F by U.S. Army Corps of Engineers, Aquatic Plant Control Research Program.

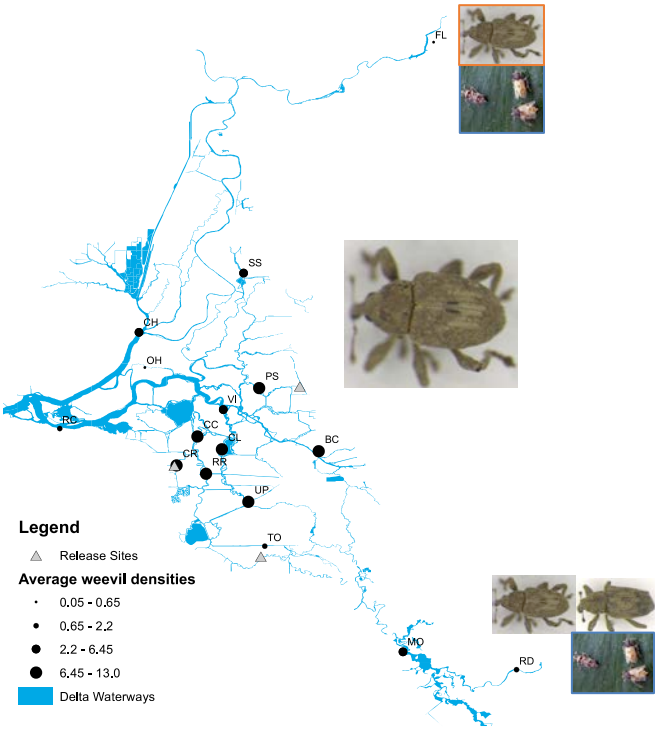

Figure 2: Survey of water hyacinth biocontrol agent populations in the Delta and surrounding areas conducted by P. Pratt and J. Hopper of the USDA-ARS. One species of the water hyacinth weevil, *N. bruchi*, is present throughout the Delta and tributaries sampled from east of Sacramento south to Modesto. Densities vary widely between sites and over time. The other weevil species, *N. eichhorniae*, is present only in isolated populations south of the Delta, near Modesto and along the Tuolumne River. A newly-released agent, the water hyacinth planthopper, *M. scutellaris*, is present near Sacramento and Modesto, outside of the Delta. Map and weevil photos by J. Hopper, USDA-ARS.

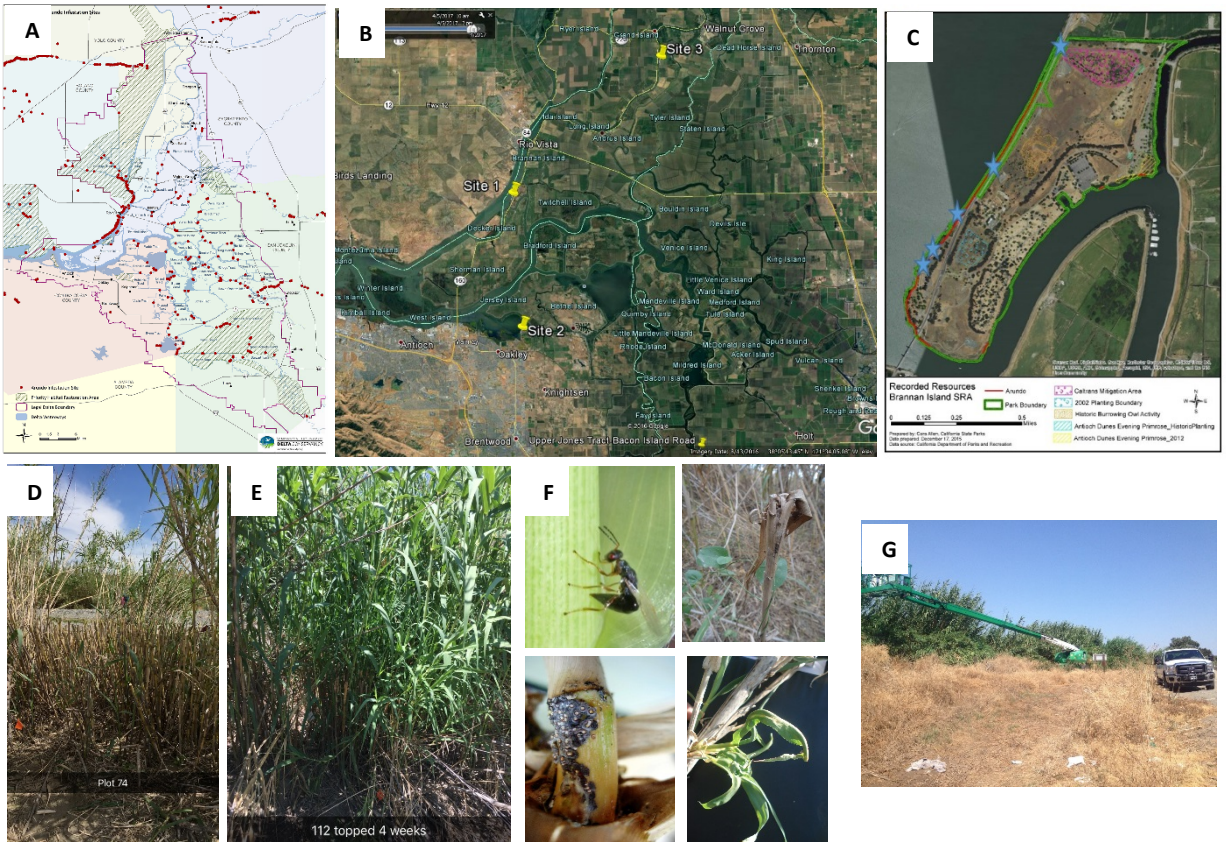

Figure 3: Biological and integrated control of arundo in the Delta. **A**, DRAAWP-funded mapping project completed in 2016 by the Sacramento-San Joaquin Delta Conservancy (SSJDC) to pinpoint arundo populations in the Delta. B, Three sites selected for arundo biocontrol in the western Delta based on accessibility and robust arundo populations. **C.** Brannan Island State Recreation Area along the Sacramento River. Stars indicate biocontrol release plots. Red line indicates arundo population targeted for chemical control. **D**, Integrated biological-mechanical control plots with arundo topped at 1 m height. **E**, Vigorous arundo regrowth after topping, onto which the arundo wasp was released in 2017. **F**, Arundo biocontrol agents and their damage; top two panels show the arundo wasp *T. romana*; bottom two panels show the arundo armored scale *R. donacis*. **G**, Aerial boom spraying of arundo at the State Rec Area by the SSJDC, September 2017.