Integrated, Adaptive Management of Aquatic Weeds: The USDA-ARS Delta Region Areawide Aquatic Weed Project (DRAAWP). Patrick J. Moran[1*], Paul D. Pratt[1], David L. Bubenheim[2], Christopher Potter[2], Sharon P. Lawler[3], Karen C. Jetter[4], Edward J. Hard[5], Beckye Stanton[6], [1]U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS), Exotic and Invasive Weeds Research Unit (EIWRU), 800 Buchanan St., Albany, CA 94710, USA, [2]National Aeronautics and Space Administration (NASA), Ames Research Center, Moffett Field, CA, USA, [3]University of California-Davis, Department of Entomology and Nematology, Davis, CA, USA, [4]University of California-Davis, Department of Agricultural and Natural Resource Economics, Agricultural Issues Center, Davis, CA, USA, [5]Division of Boating and Waterways, California Department of Parks and Recreation, Sacramento, CA, USA, [6]Sacramento-San Joaquin Delta Conservancy, Sacramento, CA, USA. *Corresponding author (Patrick.Moran@ars.usda.gov)

The Sacramento-San Joaquin Delta is the critical nexus of California's scarce water supply. The Delta provides part or all of the drinking water for 25 million people and irrigates 4 million acres of cropland producing $25 billion annually. The Delta is also home to one of the state's largest recreational boating industries and supports large-scale commercial navigation for import/export shipments. Finally, the Delta provides habitat for threatened and endangered fish and a wide range of plant and animal life. Invasions by aquatic weeds, especially water hyacinth (*Eichhornia crassipes*), Brazilian waterweed (*Egeria densa*), and the shoreline giant grass invader known as arundo (*Arundo donax*), have required annual expenditures of over $5 million per year to control, but continue to exert damaging impacts by impeding water conveyance to agricultural, industrial and domestic users, obstructing recreational and commercial navigation, altering water quality, and degrading natural habitats in the Delta. The USDA-Agricultural Research Service initiated support for a new Delta Region Areawide Aquatic Weed Project (DRAAWP) in 2014. The project is using new tools to detect and control invasive aquatic weeds, and is bringing agencies involved in aquatic weed control and management of water resources together to share knowledge and leverage resources to implement integrated, adaptive management. Under the strategic direction of the implementation component of the project, selecting focus impact areas for increased chemical and mechanical control treatments, water hyacinth peak annual coverage in the Delta has been reduced markedly since 2014, as detected using satellite images. New chemical and mechanical control regimes are being tested at key sites that are most critical for water conveyance and navigation. One new biocontrol agent, a planthopper, is being released, and mechanisms to improve efficacy of two previously released weevil species are being investigated. Decision support tools for water hyacinth control are being developed by incorporating new information on water hyacinth responses to altered environments and impacts on growth, new remote-sensing derived knowledge of the seasonal distribution of this aquatic weed, and interagency dialogue to identify the sites that are most critical for water resource management. Brazilian water weed control has improved over two-fold with no increase in the amount of chemicals used, as a result of an improved application regimen. Chemical and bio-chemical integrated control of arundo is being implemented. Two biological control agents that are new to this region are being released, a pilot project with herbicide treatment is underway, and new inter-agency dialogue is being used to facilitate site access. Under an assessment component of the

DRAAWP, new control tools are being evaluated in field plots, and new techniques are being used to evaluate operational field efficacy. A bio-economic model is measuring the costs/damage associated with the aquatic weeds and will be used to estimate the benefits of successful management. Under the research component of the project, studies in tanks and in the field have shown positive associations between decaying water hyacinth and larval mosquito populations. Other studies are determining key factors that determine aquatic weed growth, modeling the effects of agricultural land use on water quality, and examining the impact of water hyacinth and its management on dissolved water oxygen. Under an outreach component, a website has been launched, and regular meetings are keeping stakeholders informed. The overall goal of the DRAAWP is to bring about improved management of numerous aquatic weeds in the Delta through scientific knowledge and improved inter-agency cooperation.