DRAAWP Progress Report–Aquatic Plant Growth, Herbicides, and Outreach-January 2018

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Aquatic Plant Growth

Waterhyacinth regulation by water temperature. Replicated trials of an experiment following growth of waterhyacinth (*Eichhornia crassipes*) at four water temperatures (15C, 20C, 25C, and 30C) over the course of six weeks were completed during 2017 (Figure 1). Waterhyacinth was harvested from one square within the tank each week over the course of six weeks. The biomass increase was similar at 25C and 30C, but greater than growth in tanks at either 15C or 20C (Figure 2). Relative growth rate was calculated for both trials, with growth rate increasing with temperature (Figure 2). The wide variability in relative growth rate for each week of the trial is due in part to the effect of crowding.

One trial of a similar experiment for South American spongeplant (Limnobium laevigatum) was completed during 2017, with the second trial to be completed early in 2018. Two trials are planned for a similar experiment examining the effect of water temperature on the growth of the submersed plant Brazilian egeria (*Egeria densa*).

Phenology of Aquatic Plants

Waterhyacinth phenology. The abundance of waterhyacinth (*Eichhornia crassipes*) has been measured at three sites each month in the Sacramento/San Joaquin Delta since May 2015 (Figure 3, left). At each site, temperature-recording sensors were deployed. Each month, twelve biomass samples are collected using a 0.1 m^2 quadrat (Figure 3, right). Waterhyacinth maximum biomass was similar all three years (2015, 2016, and 2017), with biomass reaching almost 3,000 gDW/m^2 each year at the Lambert Road site. Growth begins each year at all site in the March to April timeframe, and declines in late fall. Some of this material in late fall may break off and drift, aiding in the spread of waterhyacinth to new locations.

Similar studies have been performed for the submersed invasive species curlyleaf pondweed (*Potamogeton crispus*) and Brazilian egeria (*Egeria densa*). For all three species, plant material will be analyzed for carbohydrate and nitrogen content.

Herbicide Trials

Waterhyacinth herbicide trials. In 2017, the effectiveness of using combinations of herbicides was examined in a field trial. While systemic herbicides have predominated in the past, it often will require 8 weeks after treatment or more for plants to die and disperse. Some research suggests that adding a contact herbicide might speed the process without loss of efficacy. Waterhyacinth rosettes were placed in 44 1m x 1m quadrats floating in open water, which constitute treatment plots (Figure 5). Four weeks after initiation, the plots were treated with carfentrazone (Stingray, 8 oz/acre), flumioxazin (Clipper, 9 oz/acre), imazamox (Clearcast, 32 oz/acre) and glyphosate (RoundUp Custom, 48 oz/acre) or combinations of carfentrazone + imazamox, carfentrazone + glyphosate, flumioxazin + imazamox, or flumioxazin + glyphosate. All treatments were at a spray volume of 100 gal/acre, and included Agridex as a surfactant at 48 oz/acre. The two contact herbicides alone (carfentrazone and flumioxazin) did not significantly reduce waterhyacinth biomass (Figure 5). Imazamox and glyphosate used alone significantly reduced waterhyacinth biomass. While the combinations were all effective, they were not significantly better than either imazamox or glyphosate used without a contact herbicide tank mix.

For 2018, further field trials will focus on control of waterprimrose (*Ludwigia* sp.). In addition, a mesocosm trial of available aquatic herbicides on Brazilian egeria is planned.

Outreach

Outreach activities disseminate information from the project to users both locally and globally. The main outreach vehicle is the DRAAWP webpage, found at http://ucanr.edu/sites/DRAAWP/. The webpage provides an overview of the DRAAWP project, subproject descriptions, and highlights products. The webpage also provides basic information about aquatic plants in the Delta and aquatic weed control techniques. As part of the webpage and outreach, investigators are scheduled to contribute blog postings so that a blog entry is released at two-week intervals.

In addition to the above, a symposium is planned for the Western Aquatic Plant Management Society annual meeting in March 2018 (www.wapms.org). A stakeholder meeting is also in the planning stage for the summer of 2018.

Key Products:

Publications:

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. Contr. 111:13-22.

Madsen JD, Wersal RM. 2017. Proper survey methods for research of aquatic plant ecology and management. Journal of Aquatic Plant Management, 56s:90-96.

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 Watershed Science, 15:4, Art. 5.

Turnage G, Madsen JD. 2017. Curlyleaf pondweed (*Potamogeton crispus*) control using copper-ethylenediamine alone and in combination with endothall. Journal of Aquatic Plant Management 55:116-119.

Wersal RM, Madsen JD. 2017. Designing and using phenological studies to define management strategies for aquatic plants. Journal of Aquatic Plant Management, 56s:83-89.

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.
Delta Regional Areawide Aquatic Weed Project, University of California Division of Agriculture and Natural Resources. http://ucanr.edu/sites/DRAAWP/

Figure 1. (Left) Experimental setup of four rows of tanks in a USDA Aquatic Weed Research Lab greenhouse. Each row is temperature-controlled at a preset temperature, with four tanks per row. (Right) Four weeks into one experiment, growth is quite apparently different between the row set at 25C (left) and the row set at 15C (right).

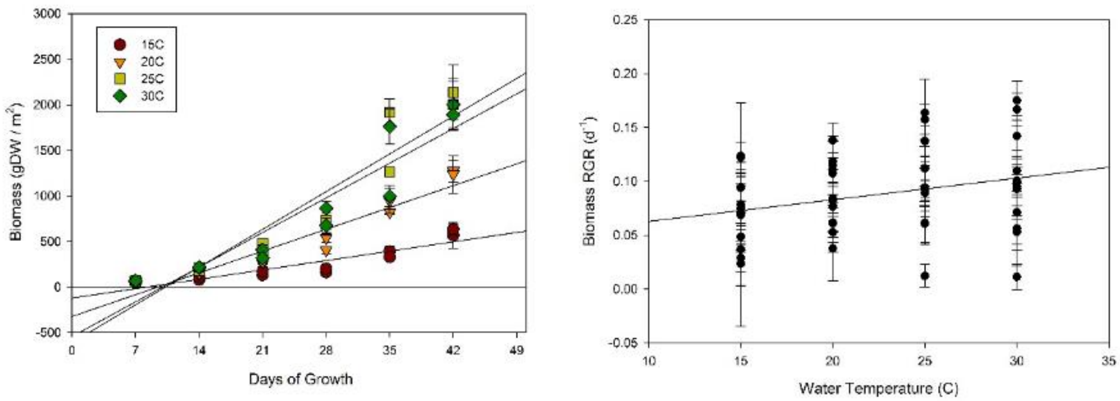

Figure 2 (Left) Mean biomass (gDW/m^2) versus days of growth for waterhyacinth grown at four temperatures for six weeks. Growth at 25 and 20C were similar, but greater than for 15 and 20C. (Right) Waterhyacinth biomass relative growth rate (d^{-1}) increases across temperature during the course of the experiment.

Figure 3. (Left) A map of waterhyacinth sampling locations in the Sacramento / San Joaquin Delta. Lambert Road, Becky's Bridge, and Whiskey Slough are indicated. Trapper Slough was sampled for only a few months, and replaced with Becky's Bridge. (Right) Sampling waterhyacinth using a 0.1 m^2 quadrat.

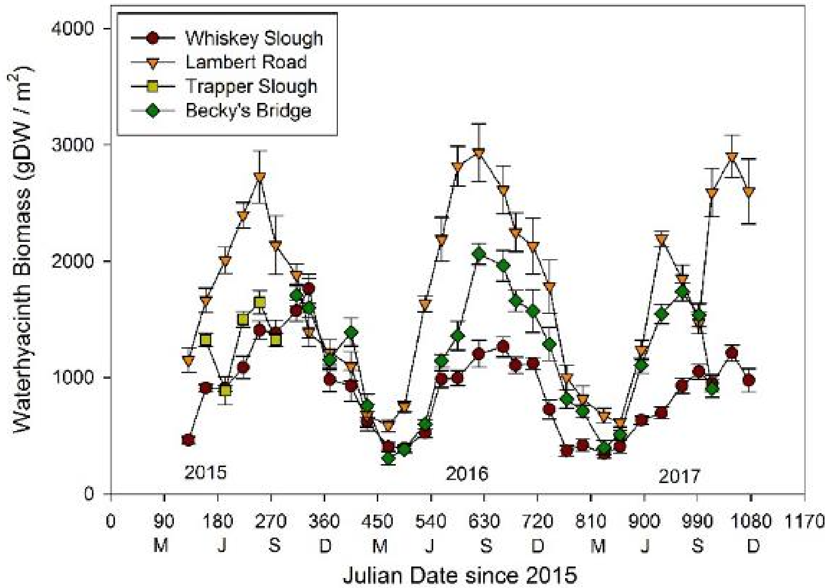

Figure 4. Waterhyacinth total biomass for sites sampled monthly in the Sacramento / San Joaquin River Delta. Three sites each month were sampled from Mary 2015 through December 2017, but Trapper Slough was replaced with Becky's Bridge during the first year.

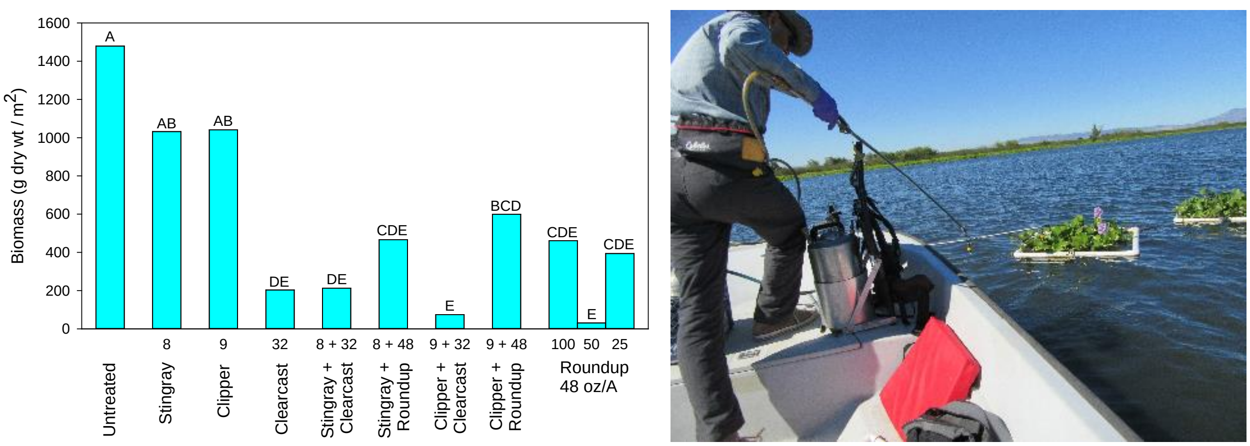

Figure 5. (Right) Applying herbicides to test quadrats. (Left) Biomass of waterhyacinth plants in as an average of four applications per treatment collected eight weeks after treatment.