Table 1. Summary of the areas of agreement among the Science Work Group about macrophytes in the Delta. The list was developed by members after review and discussion of the white paper.

Issue #	Topic	Agreement	Comment
1	Macrophyte species	*Egeria densa* (brazilian waterweed) and *Eichhornia crassipes* (water hyacinth) are widely distributed, dominant, non-native macrophytes in the delta. *Ludwigia* spp. (water primrose) is another invasive aquatic weed that has increased in biomass and distribution and may be causing water quality problems.	Are there other species that should be included because of their potential to cause problems?
2	Water quality impacts	*E. densa, E. crassipes, and Ludwigia* spp. can grow to become dense colonies. At high biomass the colonies deplete dissolved oxygen, impede navigation, obstruct agricultural intake pipes and provide mosquito breeding habitat.	Are there other impairments we want to specifically call out? Diurnal pH shifts, larval fish predation?
3	Trends in biomass & distribution	*E. densa, E. crassipes, and Ludwigia* spp. have increased in abundance since the middle of the last century in the Delta. Insufficient information exists to determine whether their distribution and biomass continues to increase annually.	
4	Drivers	Six physical factors have been identified that likely influence the abundance and distribution of *E. densa* and *E. crassipes*. They are light, temperature, salinity, flow, nutrients and chemical/mechanical control efforts. Less is known about the factors controlling *Ludwigia* spp. populations.	I omitted DIC and interspecies interactions. Is this OK?
5	Control	Present chemical and mechanical controls are useful for reducing the annual size of macrophyte colonies but are not successful in controlling inter-annual abundance.	
6	Nutrient Management	It is unlikely that nutrient management alone will be sufficient to control the abundance and distribution of macrophytes. It is uncertain whether sufficient nutrient reductions can be achieved to have a significant effect on the problem in the Delta.	Are we comfortable saying this now without additional research?

Table 2. Summary of information gaps identified by the Macrophyte Science Work Group for the Delta after review and discussion of the white paper. Issues 1 to 6 might best be addressed by a combination of monitoring and special studies. The two efforts should be closely coordinated to simultaneously address multiple issues at the same time.

Issues #	Management Question	Knowledge Gap	Recommendation
1	Have all macrophyte species causing water quality problems in the Delta been identified?	Yes, but no comprehensive monitoring program exists to identify new invasive species before they become a problem.	Implement a comprehensive multi-year monitoring program to detect new aquatic species before they become widespread and conduct studies to evaluate whether early control is feasible and desirable.
2	Is the abundance and distribution of *E. crassipes* and *E. densa* increasing in different Delta habitats?	Uncertain as no comprehensive monitoring program exists that measures change in biomass and distribution on a reoccurring annual basis.	A comprehensive multi-year monitoring program needs to be implemented to determine changes in seasonal and annual biomass of all dominant species of macrophytes in the Delta.
3	What is the overall effect of macrophytes on aquatic life, including threatened and endangered fish species in the Delta?	Dense macrophyte beds reduce dissolved oxygen beneath them restricting the distribution of aquatic organisms. Intermediate bed densities are hypothesized to be beneficial to larval fish by providing refuge from predators and increased planktonic and epiphytic food resources while maintaining higher dissolved oxygen levels.	It is neither possible nor desirable to eliminate all macrophytes from the Delta. Studies should be carried out to determine fish usage as a function of macrophyte species and bed density. The results of these studies could serve as a target for macrophyte control efforts at restoration sites and in other important fish habitats.
4	What factors limit the growth and maximum size of macrophyte beds on both a seasonal and inter-annual basis? Are any of these factors controllable?	Most of the primary drivers controlling macrophyte production and distribution are known. Less information is available about their relative importance in different delta habitats and which factors are most important on a seasonal and inter-annual basis.	At representative Delta locations simultaneously measure both instantaneous and annual production rates while monitoring changes in primary drivers to identify factors responsible for controlling seasonal, annual and inter-annual net production. Coordinate these studies with those for issue # 5 below.

Table 2. (Continued)

Issues #	Management Question	Knowledge Gap	Recommendation
5	Can nutrient management reduce the abundance of macrophyte species?	Limited information exists on nutrient concentrations that control macrophyte growth rates. *E. crassipes* obtains its nutrients from the water column and maximum growth will be a function of some, as of yet, unknown ambient nutrient concentration. *E. densa* and *Ludwigia* spp may be more difficult to control with an ambient nutrient management program as both species are rooted and may acquire nutrients from both the water column and sediment.	Conduct field experiments to determine nutrient concentrations in and outside macrophyte beds. Couple these experimental results with laboratory and field mesocosm work to identify both the limiting nutrient and its optimal concentration range for maximum growth. Use the information to determine whether production can be constrained by only reducing ambient water concentrations. Evaluate whether the results are robust in different Delta habitats.
6	Can the efficacy of mechanical & herbicide control practices be improved with a better understanding of both nutrient dynamics in and nutrient requirements of macrophyte beds in the Delta?	What is the fate of material left on-site after control actions? Does mineralization foster an enhanced regeneration of macrophytes in areas with long residence time and low nutrient concentrations?	Conduct experiments to determine the fate of organic material left onsite after control measures have been implemented by comparing nutrient dynamics and macrophyte regrowth in beds with and without removal of harvested material. Couple these studies with those conducted for Issue # 5 above.
7	Can biogeochemical models help evaluate the relative importance of different macrophyte drivers, test management scenarios & evaluate the redirected negative effects of nutrient management?	Ecosystem water quality models are not available for the Delta although a Modeling Science Work Group is being formed to make recommendations on model development. The proposed model should include nutrient and macrophyte sub models.	Develop an ecosystem model that includes both a nutrient and macrophyte sub model. Macrophyte monitoring and modeling should be closely coordinated with model development to provide model coefficients and inform model calibration and validation efforts. Conversely, modelers should attempt to develop models that will inform critical questions posed by macrophyte researchers.