The impacts of riparian tree removal on water shading in the Sacramento-San Joaquin River Delta using Lidar data analysis

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The presence of trees may be destabilizing the levees along the Sacramento-San Joaquin River Delta, and the removal of levee trees is a possible scenario undergoing discussion to strengthen the levees. One unintended consequence of tree removal may be a significant decrease in riparian shading, which can lead to a subsequent increase in water temperature. Increased water temperature can lead to changes in fish habitat, behavior, and overall health, shifts in species, changes in metabolic and decomposition rates, and different water chemistry. We modeled the relative change in incident solar radiation on channels in the Sacramento-San Joaquin River Delta under the current conditions and under a hypothesized treeless Delta. We used classified, 1m Lidar data of the Delta, acquired by the Airborne 1 Corporation during late January to February 2007, as the base dataset to examine both of these scenarios. The first return dataset provided the current structural conditions, and the bare earth layer provided the treeless scenario. We ran a solar irradiation model (r.sun) to calculate daily irradiation for summer months on a per-pixel (1m) basis. r.sun calculates daily irradiation using both slope/aspect information as well as occlusion by adjacent objects via a ray-tracing algorithm. Our results estimate as much as a 10% increase in solar radiation across the Delta should the trees be removed, a change that may result in significant increases in water temperature and changes in critical habitat.

Key Words - *lidar; riparian shading; remote sensing; water temperature; radiation*

Theme: Ecosystem Management-Remote Sensing Cluster

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POSTER ABSTRACTS: Ecosystem Management - Remote Sensing Cluster

Applications of airborne remote sensing in the Sacramento-San Joaquin River Delta

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Comprehensive monitoring of the Sacramento-San Joaquin River Delta is a critical component of ecosystem management and decision support. Monitoring is greatly facilitated by remote sensing technologies that provide synoptic data acquired rapidly across large areas. Airborne remote sensing missions can be flown on-demand to maximize monitoring outcomes. Hyperspectral imaging and light detection and ranging (LiDAR) are readily available, state-of-the-science airborne remote sensing technologies that have provided extensive datasets of the Delta, and have been used successfully in a number of management applications. Hyperspectral imagery has been used to create maps of aquatic vegetation distribution. These maps have been used to monitor the result of large-scale herbicide application to exotic Brazilian waterweed, and to study community composition changes in floating aquatic vegetation subsequent to successful control of exotic water hyacinth. The maps were also used to understand the hydrodynamic controls on submerged plant presence. LiDAR data has been used to identify individual tree crown sizes on every levee of the Delta, many of which are currently being considered for removal to meet federal levee standards. LiDAR first and last returns were used to model levee tree removal and the consequent increase in solar radiation incident on Delta waterways.

Key Words - *Remote sensing; management; hyperspectral; LiDAR*

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Using remote-sensing products to identify velocity thresholds on submerged aquatic vegetation cover in the Sacramento-San Joaquin Delta

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In the Sacramento-San Joaquin River Delta, submerged aquatic vegetation (SAV) alters river hydrodynamics, affecting the transport and fate of sediments, nutrients, and even other vegetation. Establishment and persistence of submerged plants are, in theory, limited by water velocity. Identifying the threshold at which velocities impact submerged plant cover is a critical component in parameterizing spatially distributed models of submerged plant cover and identifying potential niche space. There are velocity thresholds critical to plant cover identified in the literature, however, most are determined experimentally in hydraulic flumes, vary widely depending on methodology, and likely difficult to scale up to the ecosystem level, natural environment. Here, we used submerged aquatic vegetation distribution maps derived from airborne hyperspectral imagery to extract submerged plant cover in a 1 km buffer around velocity monitoring stations deployed throughout the Delta. Since water velocity constrains, but does not necessarily promote, establishment and persistence, we developed and applied an algorithm in which we iterated through different velocity thresholds, performing a t-test at each velocity to determine the significance of the separation in SAV cover above and below each threshold. The velocity position which yielded the most significant separation, then, was determined to be the velocity threshold on SAV establishment and persistence, and the p-value was the significance of this threshold. This analysis resulted in the detection of a significant velocity threshold, the position of which can be used to parameterize spatially distributed models of submerged aquatic plant cover.

Key Words - *Remote sensing; SAV; water velocity*

Theme: Ecosystem Management-Remote Sensing Cluster

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Object based tree crown detection and size prediction with LIDAR imagery

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With current concerns over the affects of destabilization of levees in the San Joaquin-Sacramento Bay Delta due to tree root incursion, we performed an assessment of the size and distribution of trees using tree crown detection algorithms applied to LIDAR data collected across the entirety of the legal Delta. Using local maximum heights as seeds, we applied a region growing algorithm to the LIDAR imagery to derive candidate tree crowns. We assumed that tree crowns would decrease in height from the peak to the edge. False positives were removed using object based techniques such as shape, size, and spectral characteristics of the tree crowns. Using these techniques, we were able to calculate the crown area and number of individuals trees along levees In the Delta.

Key Words - *remote sensing; lidar; trees*

Theme: Ecosystem Management-Remote Sensing Cluster

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Preliminary results from change detection of floating aquatic species in the Sacramento-San Joaquin Delta

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The Sacramento-San Joaquin Delta is one of the most heavily invaded estuaries in the Unites States. Water hyacinth is a major invasive plant species colonizing the Delta that has, along with other invasive species, negatively impacted the health and hampered the recreational and commercial uses of the estuarine ecosystem. Hyperspectral HyMap imagery at 3 m resolution was acquired over the Delta from 2004 to 2008 and classified into six main target classes: water, submerged aquatic plants, water hyacinth (*Eichornia crassipes*), pennywort (*Hydrocotyle umbellata*), water primrose (*Ludwigia* spp.) and 'other' which included soil, dry vegetation, emergent and riparian plants. Post-classification change detection analysis of the five images was done at 30 m spatial resolution particularly looking at declining and growing regions of water hyacinth. The results of this study highlight the biotic and abiotic characteristics of these regions. This study also concludes that areas cleared of water hyacinth through management are most frequently colonized by submerged vegetation. On the other hand, areas with submerged vegetation are the most likely to be invaded by water hyacinth. Further investigation of these patterns should yield important information on the future of water hyacinth colonization.

Key Words - *invasive species; water hyacinth; change detection*

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Use of hyperspectral remote sensing to evaluate efficacy of aquatic plant management

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Invasive aquatic plant species negatively affect biodiversity, fluvial dynamics, water quality, and water storage. In California's Sacramento-San Joaquin River Delta, one submersed species – *Egeria densa* – and one floating species – *Eichhornia crassipes* – are actively managed to maintain navigable waterways. We monitored the spatial and temporal dynamics of these species and their communities using airborne hyperspectral data and assessed the effect of herbicide treatments used to manage these species from 2003 to 2007. Each year in the early summer, 12% of the surface area of the Delta was occupied by submersed aquatic plant species and 2-3% by floating invasive plant species. Since 2003, the coverage of submersed aquatic plant species expanded about 500 ha, whereas the coverage of *E. crassipes* was reduced. Although local treatments have reduced the coverage of submersed aquatic plants, Delta-wide cover has not been significantly reduced. In contrast, the spread of water hyacinth either has been constant or decreased over time. These results show that (1) the objectives of the *Egeria densa* Control Program (EDCP) have been hindered until 2007 by restrictions imposed on timing of herbicide applications, (2) repeated herbicide treatment of water hyacinth has resulted in the control of the spread of this species, which also seems to have facilitated the spread of water primrose and pennywort. These results suggest that management of the Delta aquatic macrophytes may benefit by an ecosystem-level implementation of an Integrated Delta Vegetation Management and Monitoring Program, rather than targeting only two problematic species.

Key Words - *Remote sensing; management; hyperspectral; egeria; water hyacinth*

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