Applied Ecology of *Myriophyllum spicatum* in Fall River

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Introduction

Eurasian watermilfoil (*Myriophyllum spicatum*) is one of the most invasive aquatic weeds in California. It is currently a problem in 44 states and Canada. Although typically a problem in lentic (still water) habitats, reports of its occurrence in flowing systems (lotic) throughout the west have become more frequent. In lotic systems, its growth contributes to increased flooding. We are investigating the occurrence, phenology, and growth status of Eurasian watermilfoil with the hope of applying this information to its management in Fall River, CA (Photo 1 and 2). We are mapping its distribution in Fall River and comparing sediment and plant characteristics from invaded and uninvaded areas to determine potential limitations to its spread. Total nonstructural carbohydrates (TNC) in plant tissues are being measured to identify periods when reserves are lowest. This information will be essential for timing mechanical harvesting operations.

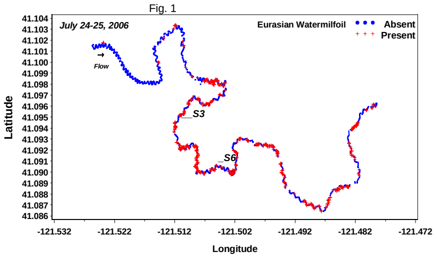
Above, Photos 1, 2: Fall River is located in Shasta County CA, approximately 100 km east of Redding.

Materials and Methods

Mapping of the distribution was conducted in the summer of 2006 using a GPS linked camera and a viewing cone. These images were later analyzed for species presence and the results were used to construct a distribution map (Fig. 1). An upstream limit of the distribution of the watermilfoil population was determined. In 2005 and 2006 several sediment samples were collected from the river and used to pot *ex situ* nutrient addition experiments using cuttings collected from a single location in the river. These experiments were used to assess whether available nitrogen (N) or phosphorous (P) content within the sediment would affect the distribution of the watermilfoil population. Critical levels of tissue N and P of 1.3% and 0.13% respectively were published by Gerloff (Gerloff, 1966). After 6 weeks the experiment was harvested and measured for dry weight response, tissue N, and tissue P (Figs. 2, 3, 4, 5, 6, 7, 8, and 9).

In 2005 and 2006 whole plant samples were collected from sites designated DM, W2, RR, and W1 within the river and used to determine biomass allocation and TNC content of the root crowns (Figs. 10, 11, 12, 13, 14, and 15). A similar study was conducted in experimental ponds in Texas by John Madsen (Madsen, 1997).

Fig. 1



Left, Fig. 1: Distribution map of watermilfoil at the upstream limit of distribution on the river. Sediments for sites S3 and S6 were collected from infested locations on this map. Sediments from sites S2 and S7 were collected from un-infested locations upstream.

Right: Image of watermilfoil on the riverbed as seen through the viewing cone while mapping the plant's distribution.

Results

Tissue N content was well above the critical value of 1.3% for all sites. Tissue P content was below the critical value of 0.13% for the 2 uninfested soils. However dry weight response to nutrient addition suggested that upstream sediment N or P content does not limit watermilfoil growth and therefore may not limit the distribution of the population (Figs. 2, 3, 4, 5, 6, 7, 8, and 9). The experiment was repeated in 2006 and is still being analyzed.

Root TNC were analyzed during the 2005 and 2006 growing seasons. Watermilfoil exhibited a distinct flowering timing during the summer and fall followed by a die back to root crowns in the fall and winter. Information from the analysis suggested a minimum root TNC, which coincided with the onset and peak of flower dry weight and onset of seasonal regrowth (Figs. 10, 11, 12, 13, 14, and 15). Results from 2007 are still being analyzed.

-Gerloff, G.C. and P.H. Krombholz. 1966. Tissue analysis as a measure of nutrient availability for the growth of angiosperm aquatic plants. Limnology and Oceanography 11: 529-537.
-Madsen, John D. 1997. Seasonal biomass and carbohydrate allocation in a southern population of Eurasian Watermilfoil. Journal of Aquatic Plant Management 35: 15-21.
-Ralph, Peter J. and Rolf Gademann. 2005. Rapid light curves: A powerful tool to assess photosynthetic activity. Aquatic Botany 82: 222-237.

Fig. 2

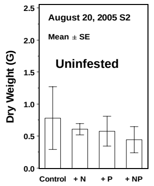


Fig. 3

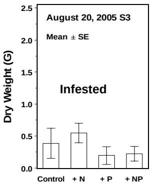


Fig. 4

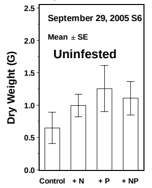


Fig. 5

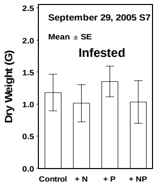


Fig. 6

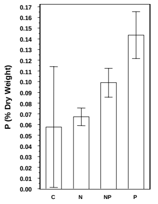


Fig. 7

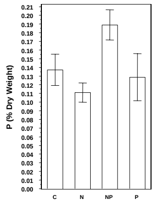


Fig. 8

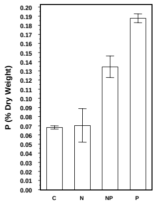
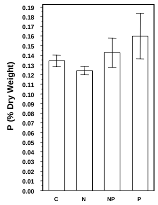


Fig. 9



Above, Figs. 2, 3, 4, 5, 6, 7, 8, 9: Dry weight and tissue phosphorous response to nutrient addition. Sediments from S2 and S7 were collected upstream at sites where watermilfoil was not present and sediments from S3 and S6 were collected from downstream sites infested with watermilfoil. Dry weight response from all sites showed no difference in growth in soils from infested and un-infested locations in the river. Tissue nitrogen (graphs not shown) content was well above the critical level for all subjects. Tissue phosphorous content was below the critical level of 0.13 % in the soils from un-infested sites indicating suboptimal phosphorous levels. Watermilfoil distribution within the river does not appear to be limited by sediment N or P content. We postulate that watermilfoil had not yet been exposed to the upstream regions, but would be capable of establishing once introduced to these sites.

Fig. 10 Total Nonstructural Carbohydrates (TNC) in root crowns for sites DM and W2 in 2005

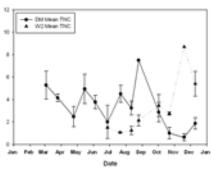


Fig. 11 Above ground mass of *Myriophyllum spicatum* per m^2 at sites DM and W2 in 2005

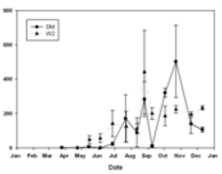


Fig. 12 Floral mass per individual for sites DM and W2 in 2005

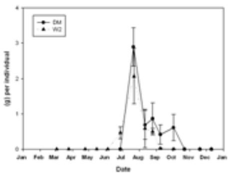


Fig. 13 Total Nonstructural Carbohydrates (TNC) in root crowns for sites DM, W2, RR, W1 in 2006

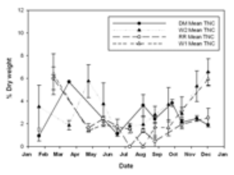


Fig. 14 Above ground mass of Myriphyllum spicatum per m^2 at sites DM, W2, RR, W1 in 2006

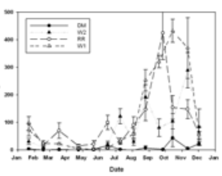
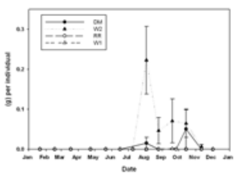


Fig. 15 Floral mass per individual for site DM, W2, RR, W1 in 2006



Above, Figs. 10, 11, 12, 13, 14, 15: Root TNC had a seasonal minimum which coincided with the onset and peak peak of flower dry weight and onset of seasonal regrowth for watermilfoil. The primary minimum for populations in Texas was determined to occur during spring regrowth and a secondary minimum was detected in autumn possibly due to warm water induced reduction of growth (Madsen, 1997). On Fall River a secondary autumn minimum of TNC occurs only at site DM. These results indicated that the TNC behave differently at different locations within the river. Optimal timing of control treatments may vary with location.

Conclusions

- Sediment N and P content does not appear to affect the distribution of watermilfoil along the course of the river.
- The present upstream limit can potentially move further upstream.
- The minimum root TNC generally occurs between June and August as the growing season begins.
- Control strategies should not discount the necessity to control upstream of the present population's distribution and timing of control strategies will have to be adapted according to location along the river.

Acknowledgements

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Left: Build up of watermilfoil debris on a downstream bridge. October 02, 2005.

Right: Watermilfoil cultivated ex situ *for nutrient addition experiments. March 31, 2005.*