Final Report for MSU
Award ID: G245-06-W0094 (awarded 2006)

White Sweetclover in Alaska: Can this invasive affect the floodplain vegetative community?

UAF PI: Tricia Wurtz (Advisor)/Blaine Spellman
MSU PI: Jon Wraith

Date: 8/28/2007

Title - White Sweetclover in Alaska: Can this invasive affect the floodplain vegetative community?

Investigators: Dr. Tricia L. Wurtz
USDA Forest Service
Pacific Northwest Research Station
Fairbanks, AK

Blaine T. Spellman
University of Alaska Fairbanks
Fairbanks, AK

Introduction

Research conducted outside Alaska has shown that invasive plant species can drastically affect plant communities and ecosystem function (Mack et al., 2000; Levine et al., 2003). Due to a harsh climate and small human population, Alaska has historically had few invasive species. However, between the years of 1963 and 2006, plant inventories indicated that the number of non-native species in Alaska increased by 46% (Carlson and Shephard, 2007). Unfortunately, there is currently little information regarding the interactions of invasive and native species within arctic and sub-arctic ecosystems. This study represents a first step toward understanding the ecological impacts of invasive plant species within Alaska.

Only recently has an invasive plant species, white sweetclover (*Melilotus alba*), established extensive and dense populations within floodplain habitats of Alaska. On sites without sweetclover, early-successional glacial floodplain habitats in Alaska are sparsely vegetated with isolated patches of shrubs and herbaceous vegetation (Chapin et al., 2006). On at least three river floodplains, these open habitats have begun to be filled with sweetclover. Sweetclover was documented as the most abundant non-native species along the Nenana, Stikine, and Matanuska Rivers (J. Conn, unpublished data) and is located along several rivers of south-central and interior Alaska (Wurtz et al., 2005).

While non-native plants can potentially displace either adults or seedlings, we focused on the ability of sweetclover to impact the recruitment of native species. We hypothesized that shading from sweetclover could physiologically stress and kill seedlings of native species that are accustomed to an open-light environment. The hypotheses are important questions because reduced seedling recruitment can directly impact plant populations and community structure (Seabloom et al., 2003; Yurkonis et al., 2005).

To test these hypotheses, we conducted both greenhouse and field experiments. In the greenhouse experiment, we grew common floodplain seedlings for three months under shade-cloth that was representative of sweetclover shading. We determined the physiological response of these native seedlings to varying intensities of shading. In the field experiment, we established treatment plots within patches of sweetclover along the Nenana (64°13'N, 149°16'W) and Healy Rivers (63°51’N, 148°53’W). Within these plots, sweetclover was either removed or left intact and native seedling establishment and survival was tracked throughout the 2006 growing season. From these data, we determined whether plots with sweetclover experienced higher mortality of native seedlings compared to plots where sweetclover was removed.

Results

Shading by sweetclover along the Healy River obstructed 1 to 94% of the available photosynthetically active radiation (PAR) (Fig. 1). This range suggests that the five shade levels we used in the greenhouse were representative of actual sweetclover shading conditions in the field (Fig. 1). We found no trend regarding the relationship between native seedling mortality and shade treatment in our greenhouse study, because few of the native seedlings died during the experiment. However, increased shading led to decreased final biomass production for each species (Fig. 2). When comparing the control to high shading treatment, the final biomass was reduced by 76, 89, 88, 82, and 50% for the native species *Hedysarum alpinum*, *Hedysarum mackenzii*, *Chamerion latifolium*, *Salix alaxensis*, and *Alnus tenuifolia* respectively. Furthermore, as shading increased, root:shoot biomass became skewed towards shoot production for all species except *A. tenuifolia* (Fig. 2). The reduction of overall biomass and skewed root:shoot are factors indicative of shade stress (Grime 1979).

The level of shading that caused physiological stress differed among native species. *A. tenuifolia* is tolerant of moderate-high shading, while the other tested species are not (Fig. 3). *A. tenuifolia* did not express decreases to final biomass until the highest level of shading (85% obstructed PAR) (Fig. 3). Conversely, for all other species, final biomass began to decrease after medium-low or medium shading (40-62% obstructed PAR) (Fig. 2). Therefore, four of the five tested species can be physiologically stressed when sweetclover exceeds 40% cover, while *A. tenuifolia* will not be stressed until sweetclover has greater then 70% cover (Fig. 1).

For the sweetclover removal field experiment, plots dominated with adult and juvenile sweetclover had an average of 23 and 24 percent survival of establishing native seedlings (Fig. 4). In plots where sweetclover was removed, leaving only native vegetation or no vegetation, there was an average of 43 and 44 percent survival of establishing native seedlings (Fig. 4). Therefore, native seedlings had lower survivorship in plots that had sweetclover compared to plots where sweetclover was removed (Fig. 4).

Discussion

We determined that sweetclover patches can shade a substantial proportion of PAR along early successional floodplain surfaces. Furthermore, the amount of shading that occurs under sweetclover can physiologically stress each of our tested species. We conclude that sweetclover represents a barrier to the recruitment of common floodplain species through its ability to obstruct light to establishing seedlings. Differences in shade tolerance among species may allow the least-stressed plants to benefit in the presence of sweetclover. Since *A. tenuifolia* would not be hindered until growing under extremely dense sweetclover, the recruitment of *A. tenuifolia* (or species with similar shade tolerance) may increase in the presence of this invasive. Consequently, the composition of native vegetation within invaded floodplain habitats may shift towards the most shade tolerant species.

Native seedlings had a higher proportion of mortality in the presence of sweetclover. The species composition of this cohort of seedlings is currently unknown and is a priority of research during the summer of 2007. The observed differences between removal treatments might exist due to a single species' inability to tolerate the competitive environment in plots with sweetclover. Still, the data suggest that sweetclover impacts the recruitment rate of native seedlings, which may have long-term effects on individual plant populations and the overall composition of this plant community (Tilman 1997; Yurkonis 2005).

Our data suggest that sweetclover has the ability and may already be altering Alaskan floodplain plant communities. Our research represents a first step towards understanding the complicated interactions between invasive species and floodplain vegetation of Alaska.

Publications

As of the submission of our grant report, there are currently no peer-reviewed publications that have resulted from the funded research. Spellman is working on completing his Masters degree, and we hope to publish at least one, and possibly two, papers from the funded research. The first paper is already in manuscript form and is entitled "Competition for light by invasive sweetclover represents a barrier to the recruitment of native riparian plants of Alaska". The second paper will focus on the removal experiment and a separate competition experiment between native legumes and sweetclover.

Literature Cited

Carlson, M. L., and Shephard, M., 2007: The spread of invasive exotic plants in Alaska: is establishment of exotics accelerating? *In*, Harrington, T. B., and Reichard, S. H. (eds.), *Meeting the Challenge: Invasive Plants in Pacific Northwestern Ecosystems*, PNW-GTR-694. Portland, Oregon: USDA, Forest Service, PNW Research Station.

Chapin III, F. S., Viereck, L. A., Adams, P. C., Van Cleve, K., Fastie, C. L., Ott, R. A., Mann, D., Johnstone, J. F., 2006: Successional processes in the Alaskan boreal forest. *In*, Chapin III, F. S., Oswood, M. W., Van Cleve, K., Viereck, L. A., Verbyla, D. L. (eds.), *Alaska's Changing Boreal Forest*. New York: Oxford University Press.

Conn, J. S., Beattie, K. L., Shephard, M. A., Carlson, M. L., Lapina, I., Hebert, M., Gronquist, R., Densmore, R., Rasy, M., (in review): Alaska Melilotus invasions: distribution, origin, and susceptibility of plant communities. *Arctic, Alpine, and Antarctic Research*.

Grime, J. P., 1979: *Plant Strategies and Vegetation Processes*. New York: John Wiley and Sons.

Mack, R. N., Simberloff, D., Lonsdale, M., Evans, H., Clout, M., and Bazzaz, F., 2000: Biotic invasion: causes, epidemiology, global consequences and control. *Issues in Ecology,* 5: 1-19.

Seabloom, E. W., Borer, E. T., Boucher, V. L., Burton, R. S., Cottingham, K. L., Goldswasser, L., Gram, W. K., Kendall, B. E., and Micheli, F., 2003: Competition, seed limitation, disturbance, and reestablishment of California native annual forbs. *Ecological Applications*, 13: 575-592.

Tilman, D., 1997: Community invasibility, recruitment limitation, and grassland biodiversity. *Ecology,* 78: 81-92.

Wurtz, T. L., Spellman, B. T., Macander, M., and Harris, N., 2005: *Melilotus alba* on Alaska's roads and river networks: towards an ecological risk assessment. 6th Annual Statewide Noxious and Invasive Plants Management Workshop. Fairbanks: Center for Noxious and Invasive Pest Management.

Yurkonis, K. A., Meiners, S. J., and Wachholder, B. E., 2005: Invasion impacts diversity through altered community dynamics. *Journal of Ecology,* 93: 1053-1061.

Products

Funded data was presented at the following conferences:

Spellman, B.T. and T. L. Wurtz. 2007. Poster. Competition between white sweetclover and riparian vegetation in Interior Alaska. 60th Annual Meeting of the Western Society of Weed Science. Portland, Oregon, March 13-15 (abstract published in conference proceedings).

Spellman, B.T. and T.L. Wurtz. 2006. Poster. Competition for light between invasive sweetclover and establishing native plants of interior Alaska riparian ecosystems. 7th Annual Statewide Noxious and Invasive Plants Management Workshop. Anchorage, Alaska, October 25-26.

Spellman, B.T. and T.L. Wurtz. 2006. Poster. Competition for light between invasive sweetclover and establishing native plants of interior Alaska riparian ecosystems. LTER All Scientists Meeting. September 20-23. Estes Park, Colorado.

Long-Term Goals and Continued Progress of Research

This experiments described in this report were conducted both in 2006 and 2007. At this writing, the 2007 field work is still in progress. We hope to disseminate the findings to Alaskan land managers at the 8th Annual Statewide Noxious and Invasive Plants Management Workshop in Fairbanks in November, 2007, and to the broader public in the form of peer-reviewed manuscripts.

Benefits of Seed Money

The funding provided from the seed grant was vital to the quality and completion of the research. The funds were used to hire field assistants, who helped in the set-up, maintenance, and data collection of the sweetclover removal experiment. Without their help, the removal experiment would have never taken place.

Advancing this Research

First, a future project might compare invaded floodplain habitats to similar, yet non-invaded river habitats, thus providing observational evidence about the potential impact(s) of sweetclover to native plant communities. Second, the impact of sweetclover on floodplain nitrogen dynamics should be addressed in future research. Finally, and most importantly, the public needs to be informed about the potential outcomes of plant invasion. Teaming with local elementary and high school teachers could inform the youth of Alaska about the impacts of non-native species. Lesson plans for primary education need to be developed in Alaska and could benefit from our projects findings.

Budget

Proposal Budget			
Field Season 1 – (May through August 2006)			
Personnel	Hourly rate	Total Hours	Cost to Project
Field Assistant	9.50	200	2069.00
Field Season 2 – (May through August 2007)			
Personnel	Hourly Rate	Total Hours	Cost to Project
Field Assistant	9.50	245	2431.00
Indirect Funds			
Institutional Overhead			450.00
		Total Proposed Amount	4950.00

Figures & Tables

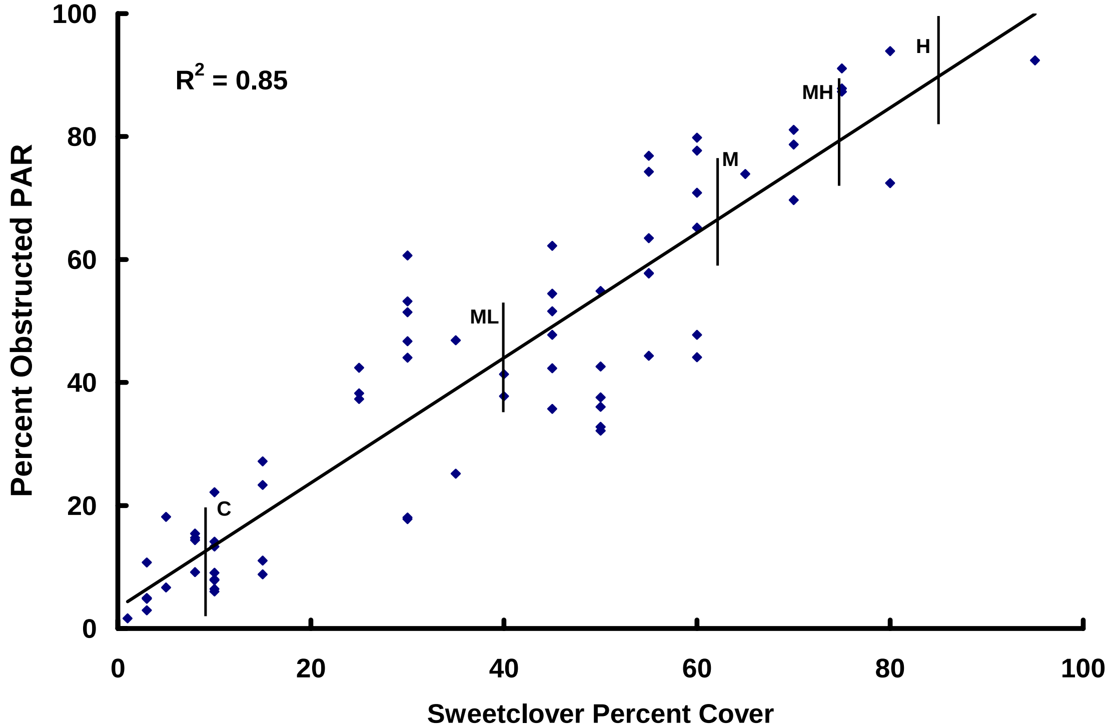

Figure 1. The percentage of obstructed light under sweetclover patches in relation to the percent cover of sweetclover visually estimated along the Healy River floodplain in Alaska. Vertical bars indicate the shading treatments used in the native seedling glasshouse experiment: control (C), medium-low (ML), medium (M), medium-high (MH), and high (H) shading.

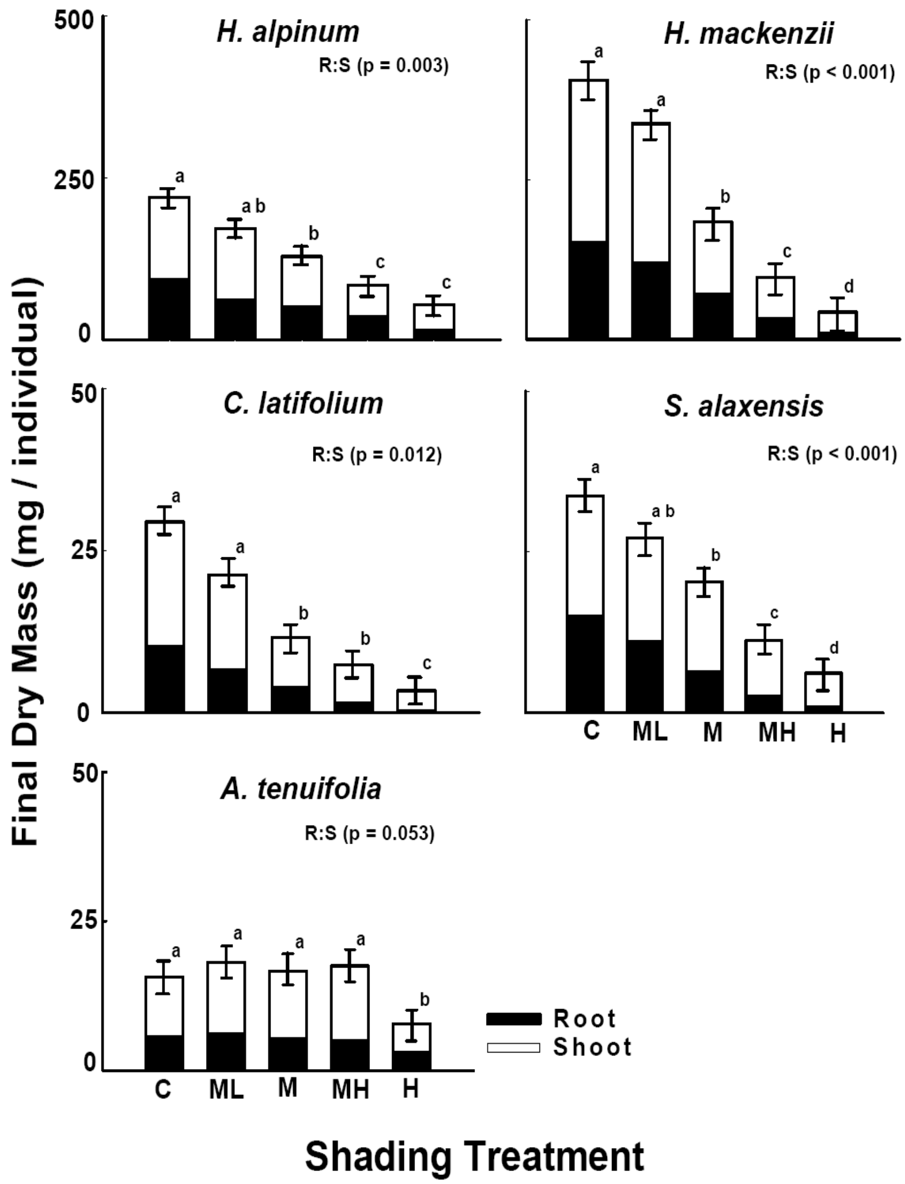

Figure 2. Final dry mass (mean ± s.e) of five common floodplains species grown under five levels of shading; final dry mass of species with the same lowercase letter are not significantly different ($p > 0.05$). Shading treatments are control (C), medium-low (ML), medium (M), medium-high (MH), and high (H).

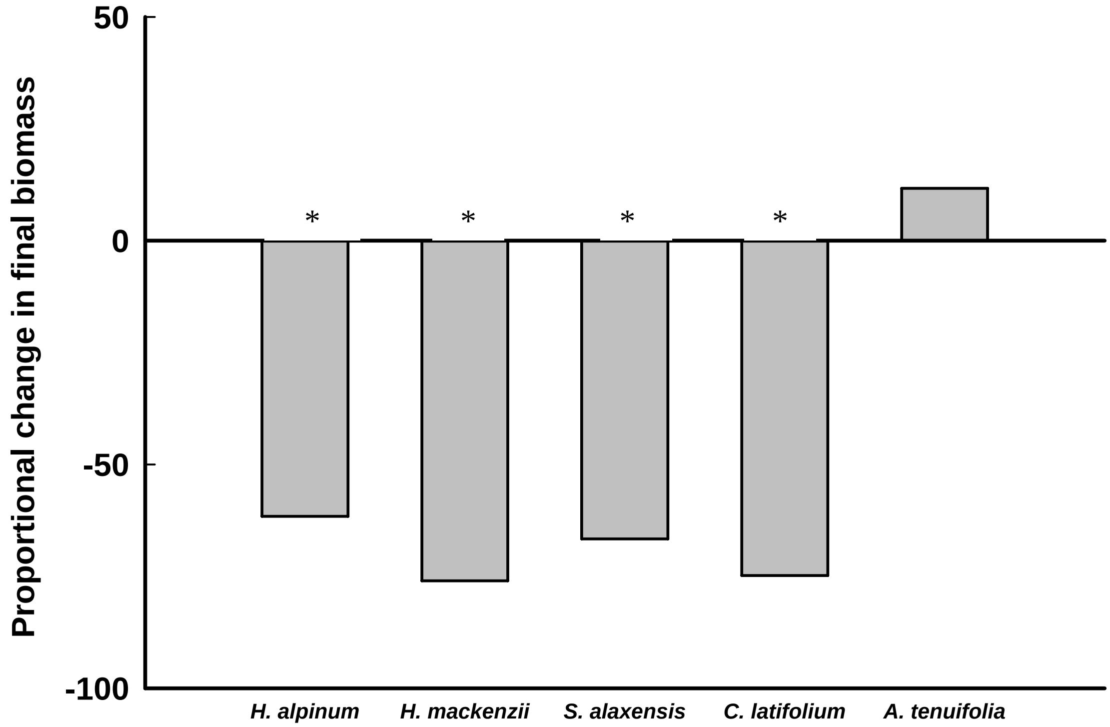

Figure 3. The relative difference between final biomass of each tested species under the control (C) and medium-high (MH) shade treatments. An asterisk indicates difference ($p < 0.05$) between the two treatments. Proportional change in biomass was calculated as: (MH / C - 1) * 100.

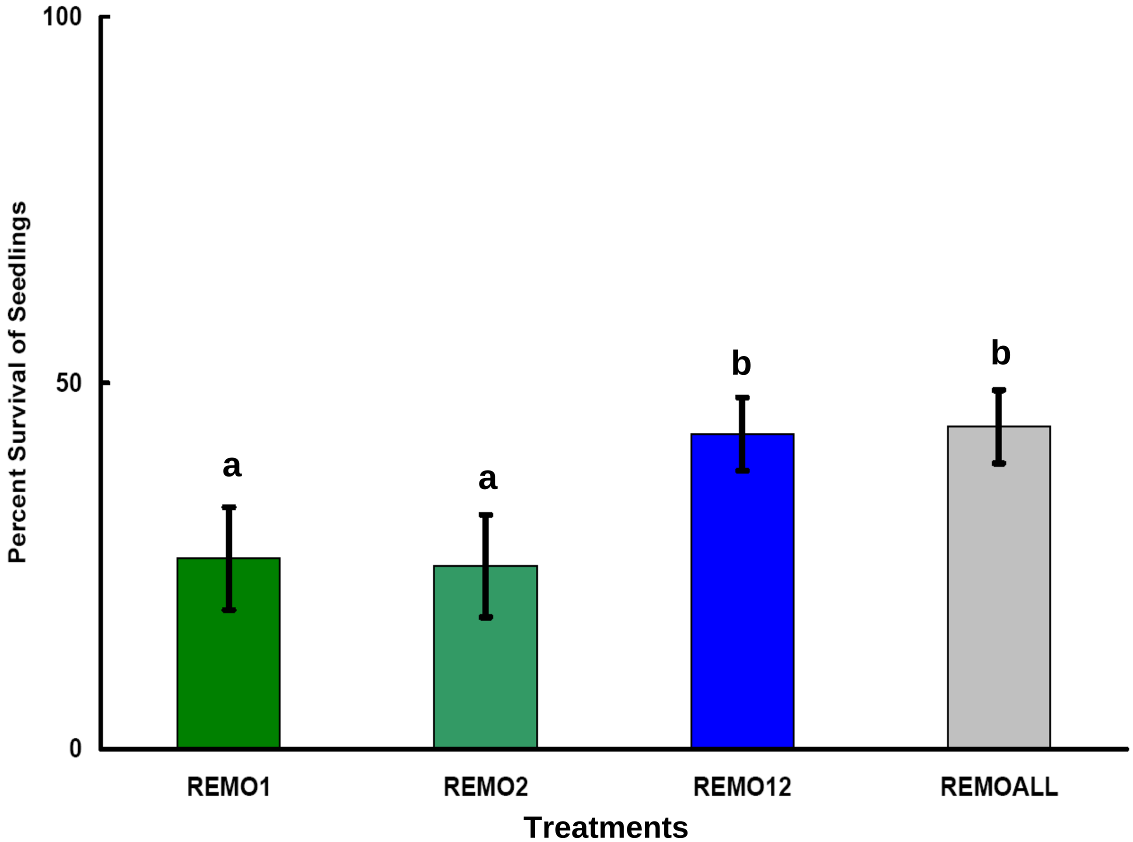

Figure 4. Mean percent survival (± SE) of native seedlings within four sweetclover removal treatments. REMO1 = adult sweetclover + native vegetation intact, REMO2 = juvenile sweetclover + native vegetation intact, REMO12 = native vegetation intact, REMOALL = all vegetation removed.