Introduction

The adverse impacts of extensive stands of invasive common buckthorn (*Rhamnus cathartica*) on terrestrial plant communities across a watershed are widely recognized and well documented. It is known to decrease the abundance and diversity of native forest understory species and reduce regeneration of native forest trees. In contrast, potential impacts of this aggressive invasive species on aquatic systems and water quality in general are less clear. This white paper is intended to address this issue, and to question as to why a Watershed District should be involved with buckthorn control efforts.

General Impacts of Buckthorn at the Watershed Level

The aggressive nature of invasive species as they exploit a niche and become established is due to the lack of limiters such as pests and disease that keep populations of these same species in balance within their natural range. Absent these limitations a newly introduced plant can quickly become established to the point of domination, out competing and displacing native plants. This is true in the case of both terrestrial and aquatic invasive species.

Buckthorn, an invasive species of short-stature tree native to Europe has become well-established within Washington County, MN, and throughout the upper Midwest. It is often found in near-continuous stands in the understory of forest canopies dominated by oak (Quercus spp.), exploiting this niche because it is moderate shade tolerant, while producing deep shade below on the forest floor. It also is an aggressive competitor in riparian forests, forest edges, and old agriculture fields reverting to forest cover. Buckthorn is a prodigious seed producer, and its seed remains viable in the soil for as long as five years. It also has allelopathic properties which suppress competing vegetation (Seltzner 2003).

Buckthorn leafs out earlier in the spring and retains its leaves longer into the fall than most native tree species. By breaking bud earlier in the year and holding onto leaves later, it can take advantage of a longer period of growing than native plants. This gives buckthorn access to more resources and create competitive advantage. Deep shade for longer periods of time suppresses the grown of native understory plant cover. As a result buckthorn is known to decrease the abundance and diversity of native forest understory species, reduce regeneration of native trees, and alter forest ecosystems (Knight et al. 2007).

The leaves of buckthorn contain as much as five times more nitrogen and are also known to decay much more rapidity that leaves of other forest trees. The rapid and near complete decomposition of buckthorn leaves on the forest floor result in extensive areas of unprotected bare ground beneath stands of buckthorn.

Buckthorn and European earthworms are each recognized as invasive species in Washington County that are having a negative effect on native understory plants and soils. There is increasing evidence that these two invasive species have a facilitative relationship and may occur in greater abundance together than either would on its own (Knight et al. 2007; Madritch & Lindroth 2009; Roth 2015). Their combined impact includes a reduction in leaf litter, reduction in soil organic matter, and changes soil nutrient cycling.

Forest cover and associated soils are known to slow and filter the movement of water though a watershed. An adverse impact of buckthorn on natural forests throughout a watershed may also adversely affect water quality.

Direct Impact of Buckthorn on Water Quality in Riparian Zones

The loss of native understory plants and changes in forests in general can have an adverse effect on water quality within a watershed by increasing runoff areas from bare soils which can increase erosion and sediment loads carried into water courses. Buckthorn can tolerate higher levels of soil moisture and occurs on relatively wet sites such the margins of wetlands and in riparian forests corridors (Stuart and Graves 2004). The adverse effects of buckthorn can be more severe when buckthorn infests areas in proximity to watercourses:

1. Bare soil beneath stands of buckthorn growing in riparian areas subject to seasonal flooding can increase erosion and sediment loads directly into streams (Larkin, D. 2014). The loss of leaf litter and an increase in the amount of bare ground can increase further with the presence on worms that also prefer moist soils.

2. Buckthorn growing on wet sites is known to produce fruit sooner and bear more and larger fruit than similar individuals on upland sites (Gourley 1985). These seeds, carried along with sediments, can be the source of a new invasion, spreading the infestation further downstream and throughout the watershed. Controlling invasive plants reduces the amount of seed available for new or expanded infestation and is recognized as one of the most effective means of suppressing invasive plant pressure. (Eschtruth and Battles 2009; Warren et al. 2012).

3. The largest source of energy and nutrient contributions to small headwater streams comes from the terrestrial riparian environment, predominantly in the form of plant materials. Native trees commonly found in riparian forest (ash spp., elm spp.) typically loose their leaves in September and October. Buckthorn leaf drop can be as late as November, and rate of decomposition of buckthorn leaves is much more rapid (5-7X) than that of other riparian tree species (Heneghan et al 2002; Frenud et.al. 2013). The delay in leaf fall into streams, the high leave of nitrogen in buckthorn leaves, and their rapid decay can result in a late yet exaggerated pulse of energy and nutrients into the aquatic ecosystem, potentially altering food webs.

Conclusion

The dominance of buckthorn infestations across watersheds have the potential to generally affect water quality by altering forest structure and creating extensive areas of bare soil which can increase the volume and intensity of runoff following rain and snow melt. This can lead to soil erosion and increase sediment load in runoff water that reaches water courses. These potential impacts increase with slope steepness. The impact of buckthorn growing in proximity to water features can have a direct effect on water quality in a manner similar to that described at the watershed level. In addition, the presence of buckthorn in riparian areas may facilitate further spread of this invasive plant and adversely affect water quality.

The potential impacts of buckthorn on water quality establish the basis for a watershed district to support efforts to control this invasive terrestrial invasive plant.

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