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Overview of Vol.6, No.2 - Invasive Species of Wetlands

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The world's native sedge meadows, potholes, marshes, peatlands, sloughs and swamps are rich and dynamic ecosystems, known collectively as wetlands. The complex nature of wetlands is evident in the number of classification systems that have been developed to organize them. Characterized by their distinct hydrology, vital soil structure, varying salinity levels, and diversity of vegetation, wetlands serve unique purposes under many names. These vital areas are as far-reaching as they are diverse. From the salt marshes of the Baltic coast to the sedge meadows of the Mississippi River Delta of the United States, wetlands are extensive.

Wetland systems are becoming more and more rare due to advancing development pressures. Consequently, restorationists have devoted time and energy towards wetland restorations in order to re-establish their diverse habitats and distinct function as nutrient sinks. The art of restoring wetlands relies on the management of invasive species before and after the installation of a project. The management issues that arise during these wetland restoration projects are as varied as the wetland system itself. The four papers in this section of Restoration and Reclamation Review offer evaluations of techniques for managing various invasive species: *Typha angustifolia, Elytrigia repens, Phragmites australis,* and *Melaleuca quinquenervia*. These species raid different wetland systems in several parts of the globe. And due to their varying biology and inherent nature, the techniques used to control them also range across a large spectrum. Within these papers emerge crucial issues that span the realm of budding problems in the field of wetland restoration today. The purpose of this overview is to identify the restoration issues raised in these papers and discuss them as they pertain to the management techniques of the afore mentioned invasive species. This discussion will concern the following emergent issues: spreading techniques and their effects on control, introgression and hybridization, geographic behavior, and variety of wetland type.

The inherent biology and spreading behavior of a species often dictate its degree of invasiveness. Special morphological adaptations have enabled many invasive species to expand across landscapes where species lacking these traits become threatened. All four papers in this section explore this issue in their discussions of species invasions and the direct consequences in management approaches. Ina Timling, for example, discusses *E. repens* and its ability to spread prolifically through rhizomes that renew from buds at the base of its shoots. Many new branches can develop from one parent plant, increasing its ability to expand its population. These rhizomes also have allelopathic properties, which may inhibit the germination of other native plant seeds. Timling therefore proposes a management technique that directly combats *E. repens* at the rhizome stage. Grazing and cutting are proposed control measures since removing foliage will cause a carbohydrate loss in the rhizomes.

Similarly, Keith Fredrick discusses *P. australis*' ability to spread through rhizome extension. This often results in large pure stands consisting of clones of a few individuals. In addition, *P. australis* may also live for long periods of time. Ultimately, due to its aggressive spreading behavior, Fredrick proposes the need for a combination of herbicide application and cutting to truly eradicate the plant.

M. quinquenervia, as explained by Elizabeth Weaver, also has a biological advantage over other species. Its ability to produce new shoots from epicormic buds and to form sprouts from the roots of cut trees helps to advance its negative impacts on native systems. A prolific seed producer, *M. quinquenervia* may release seeds following disturbance to their vascular connections, implicating control measures. Weaver thus proposes girdling the mature tree and applying herbicide directly to the tree's cambium or to the

stump of a cut tree to prevent coppicing. These control measures are therefore aimed directly at the sprouting behavior of the tree.

Lastly, Stefanie Miklovic identifies *T. angustifolia*'s ability to expand its population through biological means. Besides being a prolific seed producer, *T. angustifolia* can also produce large rhizomes, which can lead to quick formation of dense stands. An oxygen-diffusion pathway allows rhizomes to receive oxygen from the atmosphere, surviving anaerobic conditions in the sediment. Miklovic proposes flooding as a specific way to control *T. angustifolia* by blocking the diffusion pathway, leading to the anaerobic respiration, the production of ethanol, and eventually possible death. All of the papers in this section identify spreading behavior as an important advantage over other species. As one can see, these special adaptive traits have serious implications on control techniques. For that reason, the first step in managing invasive species should be to identify the aggressive biological traits of the specific species in order to minimize their impacts on a wetland restoration site.

Introgression has provided certain species with the ability to expand through genetic mixing. Two papers touch on this complex topic as it pertains to species advancement in wetlands: *T. angustifolia* (Miklovic) and *P. australis* (Fredrick). Introgression involves the repeated hybridization between two species of the same genus, wherein one taxa is native to that region and the other is new to it. Miklovic discusses the significance of introgression in *T. angustifolia* as it corresponds to increased competitive ability. When the range of *T. angustifolia* overlaps with *T. latifolia* (common native cattail), hybridization may occur to form *T. x glauca*. This newly formed species is stronger, having gained the invasive character of *T. angustifolia* as well as the advantages of *T. latifolia*. It may now survive in an expanded environment, causing harm to the native species and former natural habitat. This production of a new variant inevitably causes complications with identification and, in turn, management.

P. australis is also capable of hybridizing with other taxa in sedge meadows of North America. Fredrick describes in his paper how the presence of different genetic populations could explain the varying behavior and performance of *P. australis* in different geographic regions of North America. Some populations in the U.S. are threatened by the aggressive behavior of *P. australis*, whereas others have few problems and have remained stable. The presence of distinct genotypes within a region could have caused a more aggressive genotype to flourish. This issue should cause alarm in the restoration field due to its grave implications on management possibilities. Oftentimes the native parent plant is also harmed by a control technique that would combat the new genotype. A biocontrol agent for example, would not differentiate between *P. australis* or *T. angustifolia* and their native counterparts. Using a foliar herbicide spray and looking for problem species at an early age are possibly the only control options.

How can a species be rare in one country and problematic in another one? The variability in species performance may extend beyond different geographic regions throughout the world. In some cases, the species may be native in both countries, and in other cases, the species is native in one country and not in the other. The issue of geographic behavior surfaces in the discussions of two species, *M. quinquenervia* (Weaver) and *P. australis* (Fredrick). An exploration of the similarities and differences between the two species will be helpful in understanding this complex issue.

M. quinquenervia is native to Australia's east coast. Weaver explains that due to increasing agricultural and urban development of these coastal wetlands, *M. quinquenervia* is considered threatened in Australia. In the Florida Everglades, however, it is a non-native species and has taken on a changed appearance and altered behavior, establishing denser stands and encroaching on edges of mangrove swamps. Similarly, according to Fredrick, *P. australis* is becoming increasingly rare in Europe. Due to its ability to prevent bank erosion and its high productivity, preservation and research attempts are being made to protect it. Conversely, in the sedge meadows of the Mississippi River Valley and along the east

coast of the United States, *P. australis* is much more aggressive than it is in Europe. *P. australis* is native to some regions of N. America, and in parts of the western United States it is not considered invasive. This raises interesting questions about native and non-native species, and their invasive character.

Not all non-native plants will be invasive, and not all invasive species are non-native. But given the right conditions and removal of barriers, a species will capitalize on a landscape. As discussed earlier, *P. australis* may have the advantage of hybridizing with other taxa, creating a more invasive species. In the case of *M. quinquenervia*, perhaps it has expanded because of lack of herbivores in its new region. As Weaver explains in her paper, the biological control agents that feed on it in Europe do not exist in the same magnitude in the Everglades. Consequently, it has successfully taken advantage of the limited barriers, and thus, has expanded.

Another topic in the field of wetland restoration today involves analysis of wetland communities and how their structure, function, and history have lent to the growth of certain invasive species. The type of wetland system and its history may have measurable effects on what kind of invasive species inhabits it, as well as what management techniques are appropriate to use to control it. Certain invasive species are able to flourish in distinctive environments where they may out-compete more vulnerable native species that are intolerant of disturbances in these systems. Due to the diversity in wetland systems, there are many possibilities for species invasions. In order to shed light on this important issue, it is useful to delve into the cavities of wetland types to uncover their value as determinants of species variability, disturbance, and control.

E. repens (Timling) invades the salt marshes along the coast of the Baltic Sea. These are small ecosystems in Europe and contain many rare and protected species. Due to the distinct hydrology of the salt marshes, as well as the salinity of the waters, *E. repens* has been able to expand successfully throughout this region. *E. repens* has a high salt tolerance, and therefore can withstand the high concentrations in the Baltic marshes. However, knowing the natural history of the salt marshes is helpful in determining management techniques for *E. repens*. Since inundation and extensive grazing historically formed the marshes, Timling proposes a grazing solution for eradicating *E. repens*. And since grazing will cause a carbohydrate loss from the rhizomes, the effects of *E. repens* may be lessened.

The distinctive character of the Florida Everglades also has a direct effect on the control of *M. quinquenervia* (Weaver). A unique system made up mostly of freshwater marshes, the Everglades offer habitat for many different plant communities. Due to its geographic location, a hot spot between civilization and the Gulf of Mexico, it has become subject to altered hydrology and a changed ecosystem. These disturbances create pathways for invasive species, like *M. quinquenervia*. Weaver proposes further study into how the alteration of the water regime has affected the invasion of *M. quinquenervia*, and how restoration of the water regime will affect the present *M. quinquenervia* population. Given the natural history of the site and the disturbances it has absorbed, it is important to consider the hydrology of the site in order to make decisions about management techniques.

T. angustifolia (Miklovic) is another example of a species whose control over a distinctive wetland type has affected the various management techniques necessary to control it. The glacial marshes of North America provide a unique habitat with calcareous, basic soils and varying salinity levels. Miklovic discusses the ability of *T. angusifolia* to flourish in brackish waters, thereby gaining a competitive advantage in this system. Its tolerance of highly saline waters, coupled with its ability to hybridize with *T. latifolia*, has created substantial consequences for management of *T. angustifolia* in glacial marshes.

The issues addressed in the four papers of this section are important for understanding wetland restorations, and how they are impacted by invasive species. All of the papers shed light on techniques

for controlling species invasions and, more importantly, reveal subjects of great concern in the growing field of wetland restoration. Due to the wide variety of wetland types, the diverse number of species that inhabit them, as well as the many human disturbances that impinge on them, it is no wonder that wetland restoration projects have varied and site-specific goals. There is not one answer for control of the diverse and perplexing invasive species throughout the world. The only way to unearth the solution for minimizing the injurious effects of species invasion is to develop themes of commonality. Drawing similarities between precedents and new invasions and studying the historical processes of the individual wetland will help determine answers for control. The nature of the site and the character of the invasive species itself directly influence the possible control measures. And once these determinants are understood and the invasive species are at bay, the wetland systems that offer such rich habitats and diverse appeal will emerge again.