Recent Invasion, Current Status and Invasion Pathway of European Common Reed, *Phragmites australis* subspecies *australis*, in the Southern Ottawa District

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Catling, Paul M., and Susan Carbyn. 2006. Recent invasion, current status and invasion pathway of European Common Reed, *Phragmites australis* subspecies *australis,* in the southern Ottawa district. Canadian Field-Naturalist 120(3): 207–312.

A survey of populations of native North American Common Reed (*Phragmites australis* subsp. *americanus*) and the introduced invasive alien, European Common Reed (*Phragmites australis* subsp. *australis*) was conducted in four eastern Ontario townships in 2003. The historical status of the two taxa in the region was evaluated through reference to herbarium specimens collected over the past century. The introduced subspecies appears to have entered the district in the 1970s and subsequently assumed dominance but was not recognized as an alien until 2003. It is now widespread in the four townships where ninety-five populations were recorded during the 2003 survey. Of these, 25 were referable to the native subspecies which was localized and 70 were referable to the introduced subspecies which was widespread. The native subspecies occurs in natural wetlands and also spreads to roadsides, but the introduced subspecies is much more strongly associated with roads, where the rhizomes extend onto gravel shoulders and are broken and transported by construction equipment, graders, ploughs, mowers, and in the treads of many kinds of vehicles. Sensitive wetlands should have buffer zones exceeding 1000 m to prevent colonization of subsp. *australis*. Monitoring of the two subspecies will be essential to the protection of native biodiversity, since early detection of the alien subspecies in a sensitive wetland will offer the best opportunity for control.

Key Words: North American Common Reed, *Phragmites australis* subsp. *americanus,* European Common Reed, *Phragmites australis* subsp. *australis*, invasion pathway, alien, invasive species, Ottawa, Canada.

One of the most productive plants in temperate regions, Common Reed, *Phragmites australis* (Cav.) Trin. *ex* Steud. has economic and agricultural values and is under-exploited (Small and Catling 2001). Domestication and introduction of non-native races however, pose some potential risks to both agriculture and environment. It is a major pest of irrigation and flood control channels in some parts of the world and, being able to grow in water 2 m deep or on dry ground, it is not readily controlled by drawdown.

It was only recently realized that both native and introduced races existed in North America (Catling et al. 2003). The native plants have been designated subspecies *americanus* Saltonstall, P. M. Peterson & Soreng (Saltonstall et al. 2004) and the introduced plants identified as subspecies *australis* (Catling 2006, 2007, Catling et al. 2007). It is believed that the introduced subspecies *australis* originated from southern Europe. It has been recently recognized as a major threat to North American biodiversity (Chambers et al. 1999; Meyerson et al. 2000; Catling et al. 2003; Robichaud and Catling 2003; Catling 2005). In a recent survey of the St. Lawrence River wetlands it was found to have a greater impact on native plant diversity than most other invasive aliens including Purple Loosestrife, *Lythrum salicaria,* (Lavoie et al. 2003). The subspecies *australis* is currently spreading in Canada from areas of concentration in southern Ontario and southern Quebec and has only recently been reported from western Canada (Martin 2003; Schueler et al. 2003) and the maritime provinces (Catling et al. 2004).

In eastern Ontario the alien subspecies *australis* was first recognized in 2003, but it apparently invaded the area a few decades earlier. Local botanists noticed the rapid spread of dense stands of *Phragmites* beginning in the 1970s and the rapid change from the status of a locally rare plant (Dore 1959) created suspicion about the possibility of an introduced race. Preliminary observations suggested that it spread into the region along roads very recently and became widespread. Here we analyse its apparent recent spread into the region along roads by providing information on its history of invasion, current status and invasion pathway in the southern part of the Ottawa district based on identification of herbarium specimens and a current survey of populations in four adjacent townships. This work will also provide benchmark data for analysis of future changes in status of native and introduced subspecies, thus contributing information needed to predict rate of spread and impact.

Methods

A recent study of plants of *Phragmites australis sensu lato* in eastern Ontario suggested that plants with lower glumes exceeding 4.2 mm long were referable to the native subspecies *americanus* (Robichaud and Cat-

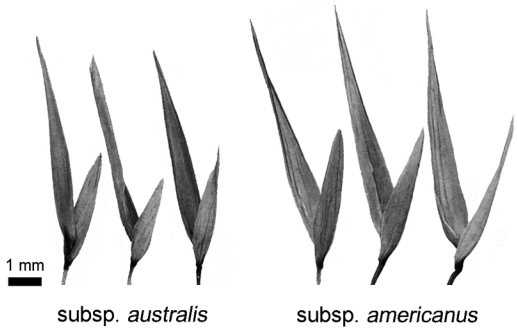

FIGURE 1. Glumes of *Phragmites australis*. The smaller on the right of each attached pair is the lower glume, whereas the longer glume on the left of each pair is the upper glume. The subspecies *australis* on the left has shorter lower glumes as represented by three examples from an inflorescence of a specimen from Dundas County (*Catling and Robichaud*, 10 Oct. 2002, DAO). On the right are three pairs from an inflorescence of subspecies *americanus* from Leeds and Grenville County (*Catling and Kostiuk,* 30 Aug. 2003, DAO) showing its characteristically longer lower glumes.

ling 2003). More recent work based on correlation with basal stem color and date of collection (Saltonstall et al. 2004; Catling and Mitrow *in press*) has supported the separation using 4.2 mm for length of longer glumes, this separation being correct (i.e. correlated with other diagnostic features) 97.3% of the time (Figure 1). Most recently (Catling 2006) the following key has been recommended for distinguishing the two subspecies:

Basal internodes red or reddish-purple; longer lower glumes 3.8-7 mm long . . . . . subspecies *americanus*

Basal internodes pale yellow; longer lower glumes 2.6-4.2 (4.8) mm long . . . . . subspecies *australis*

For the study reported here undertaken in 2003, we used a length of 4.2 mm or more to identify the native subspecies *americanus* and 4.1 mm or less to identify the introduced subspecies *australis* in a survey of four adjacent geographic townships (Figure 2): Russell (45.2833ºN, 75.2833ºW), Osgoode (45.2333ºN, 75.5000ºW), North Gower (45.1500ºN, 75.6833ºW) and Marlborough (45.0666ºN, 75.8166ºW). Hybrid-like or intermediate clones were not observed during this study but several were located subsequently in townships to the north.

The survey was conducted in May 2003 at which time the persistent flowering stalks of the previous year were readily visible on the landscape and the persisting inflorescences were not so damaged as to prevent measurement of first glume lengths. The survey included driving all roads in each township, checking known locations and searching larger open wetlands in Rideau Township on foot. All small wetlands visible from roads were examined with binoculars. Location of populations was recorded with GPS and size of patches and number of flowering stalks and distance from road were also recorded. Populations were defined as less than 500 m apart or 500 m in length. A voucher inflorescence from one of the tallest flowering stems was collected from each population and from these vouchers the length of the longest first glume of 25 examined was recorded. Voucher specimens for some the collections were deposited in the AAFC [Agriculture and Agri-Food Canada] vascular plant collection (acronym DAO ["Department of Agriculture, Ottawa"]). All flowering culms within individual stands were similar and were assumed to represent single clones.

Collections in Canadian herbaria from Ottawa area and Carleton and Prescott counties were identified to race (using criteria described above) in order to determine status of the two subspecies in the region in the past. The historical information was compared to maps of the occurrence of the native and introduced

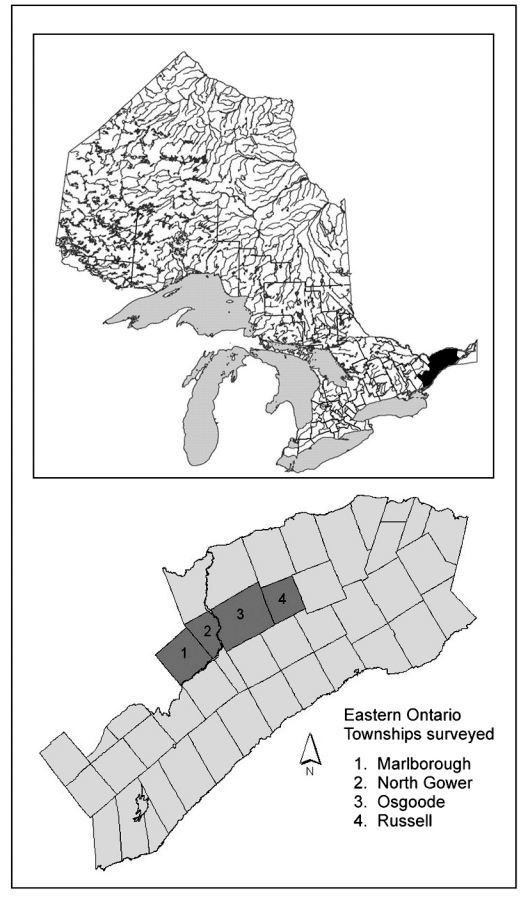

FIGURE 2. Location of four adjacent townships in eastern Ontario where native and introduced subspecies of *Phragmites australis* were surveyed and mapped in May 2003. Inset map above shows eastern Ontario and Great Lakes with Eastern Ontario region shown in black.

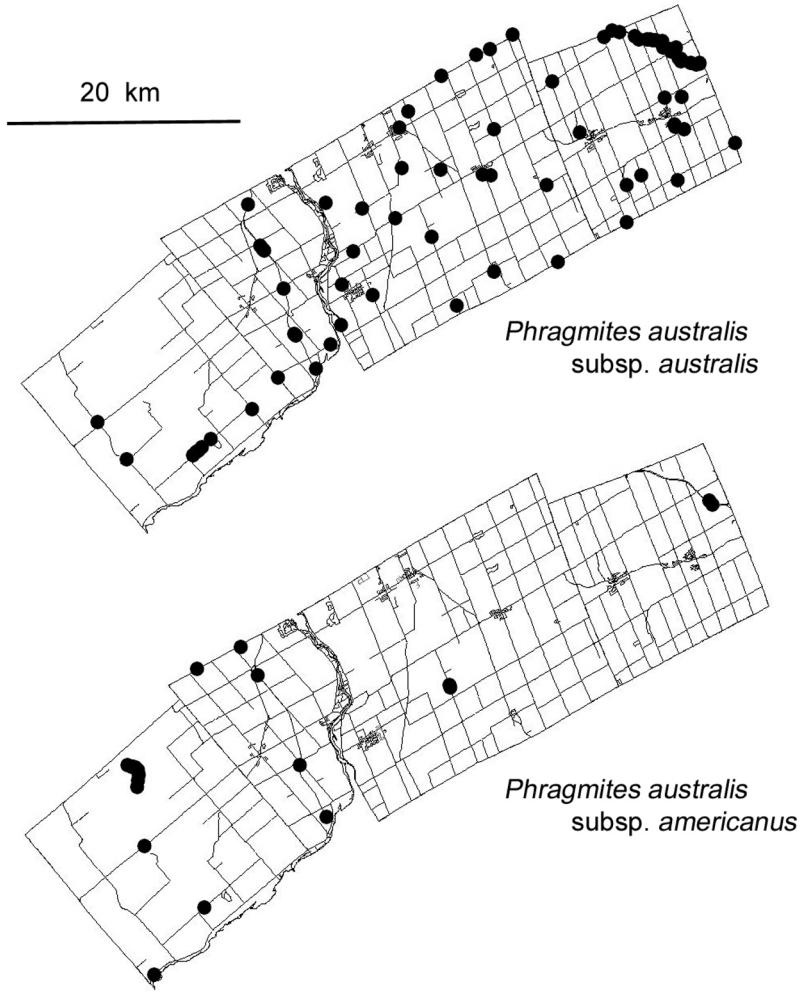

FIGURE 3. Distribution of native and introduced subspecies of Common Reed *Phragmites australis* in four eastern Ontario townships based on a survey in May 2003. Aove, introduced Eurasian subspecies *australis*. Below, native North American subspecies *americanus*.

subspecies in the four townships based on the results of the 2003 survey.

The relationship to roads was analysed by comparing the distribution of both subspecies by plotting on township maps showing roads using histograms showing frequency of various distances from roads. In order to further elucidate the history of spread, the size of patches was compared on major and minor roads, all at least 20 years old, in Russell township.

Results

History of Invasion

In Canadian herbaria there are 45 specimens of *Phragmites australis* collected in the southern portion of the Ottawa district (Ottawa-Carleton Regional Municipality and Prescott-Russell counties). Of these, 21 collected prior to 1970 are referable to the native subspecies. The earliest collection of the introduced subspecies was in 1976 at Manotick (*Hanes*, DAO). Of the 24 specimens collected after 1970, only five are referable to the native subspecies, the remainder having the relatively short first glumes of the introduced subspecies. Thus the introduced subspecies appears to have entered the district in the 1970s and subsequently assumed dominance but was not recognized as an alien until 2003 (Catling et al. 2003).

Present Status

Ninety-five populations were recorded in the four townships during the 2003 survey. Of these, 25 were referable to the native subspecies and 70 were referable to the introduced subspecies. Both subspecies

FIGURE 4. Patch of pale stems of *P. australis* subsp. *australis* on gravel portion of a roadside and extending in a large clone in the adjacent ditch and swamp. Highway 417, Russell Township, May 2003.

occurred in all four townships, but the native subspecies was much more localized, with most populations in a single wetland (Figure 2).

Invasion Pathway

As seen in the distribution maps (e.g. Figure 3) there is a strong association of the introduced subspecies with roads (Figure 4). This is confirmed in the histogram (Figure 5) where the vast majority of the populations of the introduced subspecies are within 100 m of a road. In fact 52% were in the roadside gravel (Figure 4) and 84% were within 3 m of the boundary between vegetation and gravel shoulder. Populations of the native subspecies occurred at greater distances from a road (Figure 5) with 36% on the shoulder and 60% within 3 m. Although occurrence of the native subspecies on roadsides was much less, it is clearly spreading from natural habitats to roadsides. Since both subspecies may come into close contact on roadsides, there is an opportunity for the subspecies to hybridize. The introduced subspecies was most frequent in the eastern townships that have the most roads (Figure 3). The native subspecies was most frequent in the far western township which has the least extensive road network and the most extensive natural wetlands.

Major concentrations of the introduced subspecies occurred along Highway 417 (upper right in Figure 3), the busiest and oldest major highway in the region, and the largest patches in Russell township occurred along this road, suggesting that this is one of the places where it first entered the region (Figures 3 and 6). The association of the introduced subspecies with roads suggested spread by dispersal of rhizomes by road vehicles rather than wind-blown seed which would have resulted in more occurrences at greater distances from roads. The tough rhizomes extend into the gravel shoulders and even onto the asphalt (Figure 4). They are readily broken and transported by ploughs, graders and in the tire treads of many kinds of vehicles (personal observation). This mechanism of dispersal is believed to be largely responsible for the rapid spread and present strong association with roads.

There is a possibility that spread along roads is facilitated by relatively high sodium salt (NaCl) concentrations, as noted for many other vascular plants spreading along roadsides (e.g. Catling and McKay 1980, 1981; Reznicek and Catling 1987). Salt concentrations may reduce competition by eliminating other species, thus promoting salt-tolerant species. Although the alien subspecies may be tolerant of relatively high salt concentrations, reliance on salty habitats is probably much less than for other rapidly spreading roadside plants such as *Carex praegracilis* (e.g., Reznicek and Catling 1987). Some patches of the alien subspecies of Common Reed do occur at great distances from roads and some roadside patches extend up to 100 m from roads beyond the influence of sodium salt.

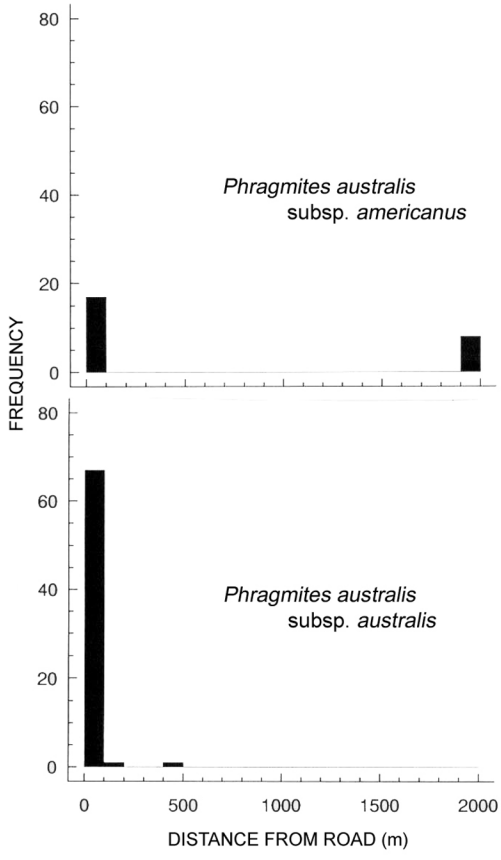

FIGURE 5. Histograms showing frequency of distances from major and minor roads of native and introduced subspecies of *australis* in four eastern Ontario townships.

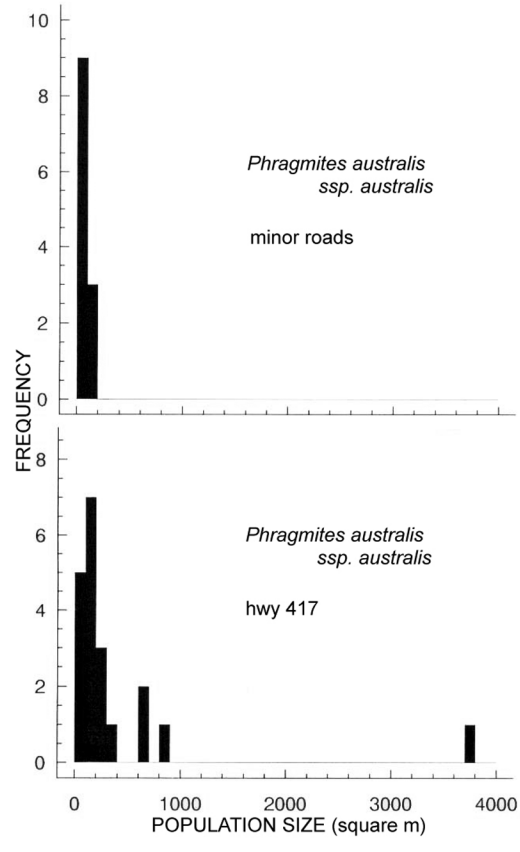

FIGURE 6. Histograms showing frequency of clone sizes of the introduced *Phragmites australis* subspecies *australis* in relation to major and minor roads in Russell Township.

Further evidence for a lack of strong dependence on sodium salt is the observation that the alien subspecies of Common Reed occurred along many minor and gravel roads that do not receive applications of deicing salt.

The introduced subspecies has colonized two natural wetlands in the study area without spreading from a roadside. One of these stands is 500 m from a road along a pond shore used extensively as a staging area by waterfowl. This colonization may have been the result of transport of rhizomes by the waterfowl, which occurs with many aquatic plants, but is unusual. Once in a wetland system the rhizomes are likely to be transported further by aquatic mammals and birds for building habitations, platforms and nests. Successful germination of wind-dispersed seed is also a possibility, but strong association with roads suggests that it happens infrequently. Both native and introduced populations produce apparently viable seed with quantities varying between poplulations (personal observation, Catling). As alien Common Reed increases on the landscape the frequency of unusual dispersal mechanisms is likely to increase, and spread through wetlands may increase substantially.

Future Spread

Considering that it is being spread by road vehicles along corridors of essentially continuous habitat, including new and disturbed habitats, the rate of spread can be anticipated to be rapid. *Carex praegracilis* W. Boott is believed to have spread the same way throughout much of eastern North America from the midwest in only 30 years (e.g., Reznicek et al. 1976; Reznicek and Catling 1987). Since the introduced subspecies of *Phragmites australis* has apparently spread from roadsides to distances of up to 500 m from roads (Figure 5), it appears that it is not confined to the near road environment. Although it seems less likely that the introduced subspecies will invade sensitive wetlands through introduction by waterfowl, the chances will increase as it becomes more abundant. There are also

opportunities for spread into isolated wetlands through transport along tracks of off-road vehicles including motorcycles, ATVs and snowmobiles.

The introduced subspecies has extensively spread into both saline and non-saline wetlands and along both dry and wet roadsides in parts of the United States. Within another 10-20 years it is expected to line many major roadways in eastern Canada and it will have entered many wetlands from adjacent or nearby roads. As it spreads it is most likely to become established first along major roads, providing an early warning of future impact on the nearby landscape.

The introduction of invasive aliens into wetlands by roads provides another reason to have extensive buffer zones around wetlands with high protection priority. Considering that the vegetative spread of *P. australis* can be very rapid, and mammals and birds transport rhizome fragments over substantial distances for nesting, buffers exceeding 1000 m are desirable. Monitoring of the two subspecies will be essential to the protection of native biodiversity, since early detection of the introduced subspecies in a sensitive wetland will offer the best opportunity for control.

Acknowledgments

J. Cayouette, W. J. Cody and F. W. Schueler provided useful comments.

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Received 26 April 2005
Accepted 17 February 2007