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The Re-growth Capacity of Sago Pondweed Following Mechanical Cutting

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INTRODUCTION

Due to biomass production by aquatic macrophytes, increased flow resistance is realized in summer, and removal of vegetation becomes necessary to prevent flooding as a consequence of the higher water levels. A method often used to remove submerged macrophytes is cutting of the stems just above the sediment. By cutting macrophytes in this way, the hydraulic interconnectivity between wetlands and rivers is reduced (Scholz and Trepel 2004). This generally results in lower water levels and less risk of upstream flooding but increases the risk of downstream flooding (Trepel et al. 2003). To compensate for this risk, cutting between 50 to 70 percent of the macrophyte population can be considered in order to regulate water flow, but the rate of re-growth determines if a second removal of macrophytes is necessary.

In general, this cutting is done with equipment that is limited to shallow depths (Livermore and Koegel 1979, Cooke et al. 1986). In this manner, only the upper parts of the vegetation are removed and the efficiency is low due to potential rapid re-growth (Strange et al. 1975, Perkins and Sytsma 1987, Wilson and Carpenter 1997). Cutting plants just above the sediment is more successful to control macrophyte re-growth than cutting plants higher along their shoots (Livermore and Koegel 1979, Cooke et al. 1986).

Re-growth of aquatic plant species after cutting can be affected by seasonality. Sago pondweed (*Stuckenia pectinatus* (L.) Boerner) has a pseudo-annual life form, which means adult plants die during autumn and produce asexual propagules (tubers) that hibernate in the sediments (Hangelbroek et al. 2002). These tubers are the only vegetation structures that survive in shallow waters of temperate regions (Lapirov and Petukhova 1985) and removal of these structures would reduce future growth. For example waterfowl herbivory on aboveground biomass, which can be compared with vegetation cutting, will have little effect on the future productivity when senescing parts are eaten in autumn, but foraging on overwintering structures like tubers during early spring will remove the future growth potential of the plant (Kiørboe 1980).

The re-growth of aquatic plants is also species dependent and a trade-off between regeneration/dispersion abilities and establishment/colonization abilities exist (Barrat-Segretain et al. 1998). Most aquatic vegetation propagates by vegetative means (Sculthorpe 1967, Barrat-Segretain 1996), which means re-growth in cut plots will occur through stolons, rhizomes, turions, unspecialized fragments and the remaining stem biomass. *Sparganium emersum* for example may be able to re-grow faster then sago pondweed because its basal meristems, in contrast with the apical meristems of sago pondweed, are left intact after cutting (Sand-Jensen et al. 1989).

The aim of this study was to investigate the re-growth capacity of sago pondweed at different cutting periods. This species was chosen because it is fast growing and drastically influences the flow conditions of a river (Losee and Wetzel 1993, Sand-Jensen 1998). It is a cosmopolitan species that occurs circumboreally to about 70°N (Hulten 1968) and is also found in South Africa, South America, South Eurasia, and New Zealand (Kantrud 1990).

MATERIALS AND METHODS

This study was conducted on the Wamp, a lowland river in the Nete-catchment (Belgium). Pastures and arable fields determine the surrounding land use. The river is, at the point where the experiments were carried out, 8 m wide and at normal weather conditions the water depth ranges between 30 and 70 cm.

The aquatic vegetation is dominated by sago pondweed, *Sagittaria sagittifolia* and *Potamogeton natans*. On this river the vegetation typically appears in April and reaches its highest biomass between July and August (unpublished data). To prevent economic damage from flooding, aquatic vegetation is mechanically cut when flooding threatens the adjacent land. In general this means that vegetation is cut once a year between July and September.

To estimate the re-growth capacity at different cutting periods 4 treatment months were chosen (May, July, August and September).

During each month 7 plots of 0.0225 m^2 were harvested by manually cutting the vegetation at the river bottom by using scissors. The plots of the same treatment were taken on a row that was longitudinally orientated with the river. The other plots were placed adjacent to the first row and all within the same monospecific sago pondweed patch. To ensure that exactly the same plots were re-harvested later in the vegetation season an iron grid was placed at the river bottom with the same dimensions as the harvested plots. The harvested vegetation was rinsed and dried at 75°C during 48 hours to obtain dry weight values.

For the first cutting treatment (28th of May) one vegetation plot was re-harvested on 6 July. Further in the growing season another vegetation plot was re-harvested each month until December. Thus in total 6 of the 7 plots were re-harvested. For the other treatment cuttings the same sampling frequency was maintained with one plot that was re-harvested each month after the cutting (Figure 1).

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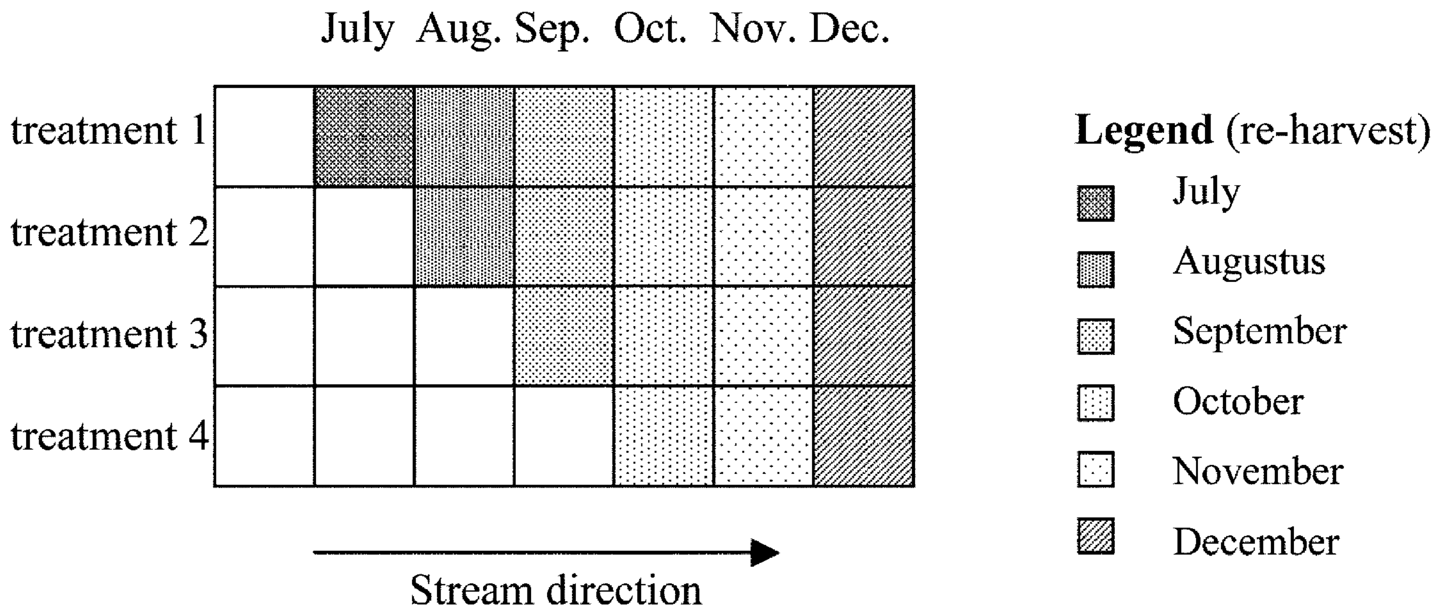

Figure 1. Grid pattern used to monitor the re-growth of *Stuckenia pectinatus* (L) Boerner. The filled squares represent the months were the vegetation was re-harvested after a period of growth.

RESULTS AND DISCUSSION

The average dry weight of *S. pectinatus* in these experiments reached a peak in August of 293 g m^{-2} (Figure 2), which is comparable with biomass reported for other water bodies (Collier et al. 1999, Madsen and Adams 1988, Peltre et al. 1993). After August the biomass declined towards 13 g m^{-2} in September. This fast decline of *S. pectinatus* is in agreement with the exponential decline that Sand-Jensen et al. (1989) detected from September onwards. When the vegetation was removed at the end of May, dry weight values of 101 g m^{-2} were reached five weeks later. These values lie within the range of the unharvested treatment. This period is comparable with a three to six week recovery of Eurasian milfoil (*Myriophyllum spicatum*), a species that also grows rapidly under high nutrient loads (Rawls 1975, Cooke et al. 1990, Crowell et al. 1994). Others however found that Eurasian milfoil never reached pre-harvested biomasses when harvested in July (Kimbel and Carpenter 1981).

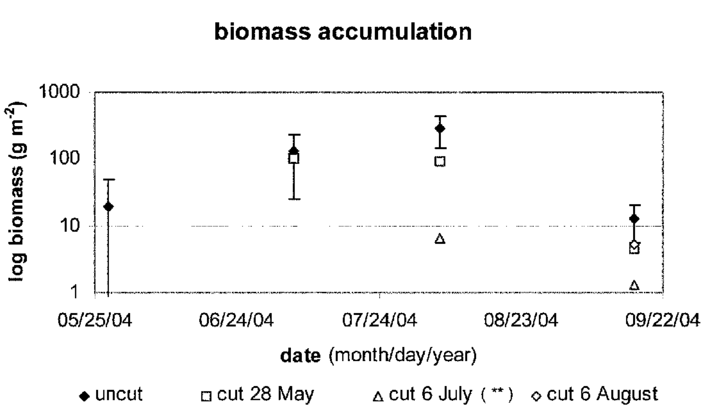

Figure 2. Growth and re-growth after harvesting of *Stuckenia pectinatus*. The bars represent the standard deviation of the 7 harvested plots. (**) Indicate significant differences (p = 0.05) between the uncut situation and the cut situation based on a Wilcoxon rank test.

Our experiments show the same effect when *S. pectinatus* is harvested at the beginning of July. The biomass only reached 6 g m^{-2} after five weeks of growth. In September a further decrease of the biomass towards 1 g m^{-2} was observed.

From these results it is clear that mowing early in the season does not effectively reduce the biomass in the long-term. Barrat-Segretain et al. (1996) stated that the time of disturbance could influence the capacity of a plant species to regenerate. *Potamogeton pusillus* for example does not regenerate from fragments when disturbance occurred in spring but regenerated when the disturbance took place later in the season (Barrat-Segretain *et al.* 1996, Kadono 1984).

Removal of sago pondweed, in order to prevent high water levels, is less effective in May/June when compared with removal in July. If removal of aquatic vegetation takes place too early in the season, fast growing species will re-grow and result in the same biomass later in the season.

Re-growth is also dependent on the competition between species. Sago pondweed will emerge faster than *Chara aspera* and has a lower temperature threshold (Van den Berg et al. 1998). In these experiments the competition between species was negligible because of the absence of other species in the plots.

This study showed that cutting early in the vegetation season could result in the same biomass later in the season compared with the un-cut situation. Nevertheless, in some instances, early plant growth may start to impede water flow and this will require that management be implemented earlier in the season. This could imply that a second removal is necessary or a combination of management techniques has to be used because shading, cutting and low doses of herbicides (diquat) also has shown to be effective in reducing growth (Filizadeh and Murphy 2002). In areas with long growing seasons a third cutting could be necessary (Weisser and Howard-Williams 1982).

Removal of too much aquatic vegetation however can negatively impact invertebrate numbers, (Kaenel et al. 1998, Monahan and Caffrey 1996) and management goals should be balanced between allowing adequate water flow and providing habitat for fish and invertebrates. In this river system the optimal date of cutting, to obtain reduced re-growth potential of sago pondweed later in the season, is removal of the vegetation in July. Earlier cuttings may be required, but rapid re-growth will likely require an additional cutting. Additional data should be gathered for other species and rivers with a higher species diversity to determine the optimal time of mowing.

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