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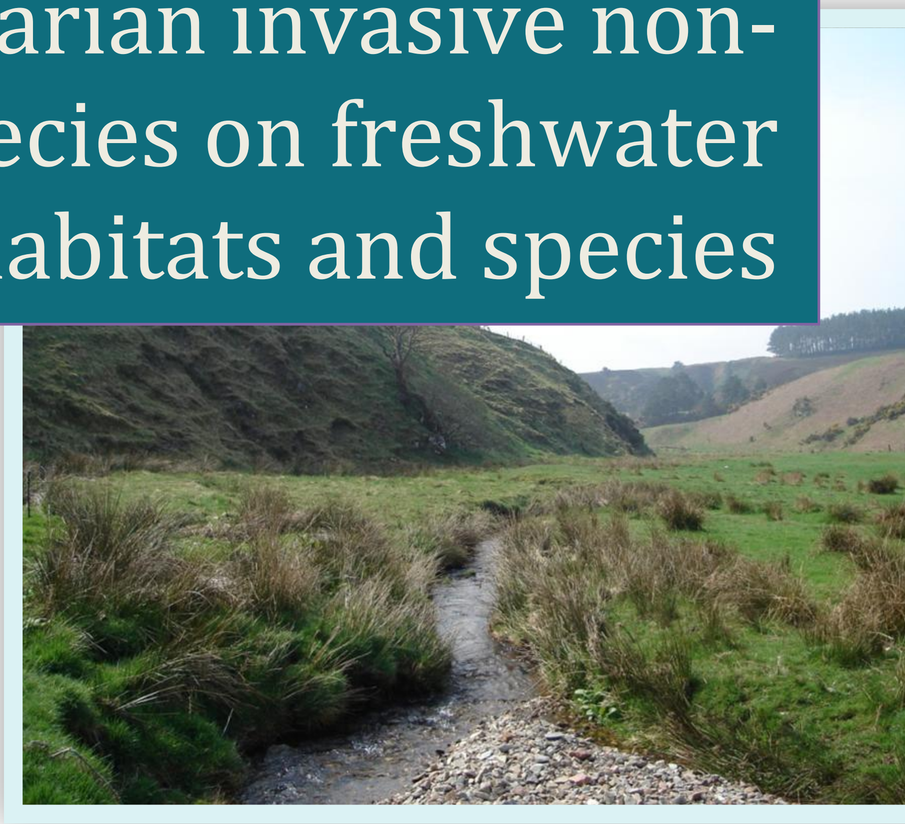
Impact of riparian invasive non-native plant species on freshwater habitats and species



Final Report

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Executive Summary

Background to research

The four species, Rhododendron (*Rhododendron ponticum* and its hybrids), Japanese Knotweed (*Fallopia japonica*), Himalayan Balsam (*Impatiens grandulifera*), and Giant Hogweed (*Heracleum mantegazzianum*) have become major plant invaders along streams and rivers in the UK.
This report summarises the documented impacts of these riparian alien species on aquatic habitats and species. These species are invasive non-native species in other parts of Europe and North America and evidence is drawn from across these ranges.

Objective of research

To summarise documented impacts of riparian invasive non-native plant species Rhododendron (Rhododendron ponticum and its hybrids), Japanese Knotweed (Fallopia japonica), Himalayan Balsam (Impatiens grandulifera), and Giant Hogweed (Heracleum mantegazzianum) have on freshwater habitats and species?

Key findings

1. There is little quantitative evidence on the level or significance of impacts of non-native riparian plants on freshwater habitats and species, particularly over long time periods.

2. Rhododendron appears to have direct impact on the aquatic system by suppressing algal growth, providing poor quality litter, decomposing slowly and altering invertebrate abundance and assemblage structure.

3. Japanese Knotweed may have slower leaf decomposition and alter macro-invertebrate assemblages. Fungal species richness on Japanese Knotweed leaves is higher but spore production is lower. Sites invaded by Japanese Knotweed have a higher number of rare species.

1.0 INTRODUCTION

This report summarises the documented impacts of riparian alien plant species on aquatic habitats and species. There is growing interest surrounding the idea that invasive non-native riparian plants may exert substantial effects on stream habitats and species by altering both in-stream processes and terrestrial-aquatic linkages. These changes can influence community structure by altering productivity and nutrient cycling[1,26,27] which can ultimately compromise ecosystem functioning[9,10,14]. Impacts on stream habitats and species may be direct (e.g. providing poor quality litter), or indirect (e.g. through displacement of native vegetation). The magnitude of impact can depend on factors such as invading plant attributes[9], extent of invasion[17], characteristics of the system being invaded[9] and climate[4].

2.0 DIRECT EFFECTS

Riparian vegetation influences streams through shading and inputs of organic matter[20]. Shading can suppress algal growth by reducing the light available for photosynthesis[13,20] and inputs of organic matter provide a source of nutrients and energy that drives many in-stream ecosystem processes[12].

2.1 Shade effect and algal growth

Streams bordered by Rhododendron show evidence of far lower algal production than streams bordered by either deciduous woodland or grassland[14]. This is attributed to the dense shade cast by Rhododendron[14]. As Japanese Knotweed also casts deep shade[14] a similar effect may be expected. This has serious implications for consumer production (i.e. invertebrates). Algal resources, having lower carbon-to-nutrient ratios than leaf litter, are assimilated far more efficiently[7]. Moreover, in this study the lack of good quality leaf litter in the stream increased the grazing pressure on the limited algal resource[14].

2.2 Allochthonous inputs

This material comprises organic matter in the form of leaves, woody debris and terrestrial invertebrates.

2.2.1 Leaf litter quality and quantity

The presence of invasive non-native plants changes the composition of riparian litter which affects the performance of aquatic decomposers such as fungi and detritivorous invertebrates by modifying the quality and quantity of detritus[4,8,11]. Invasive non-native plants are generally assumed to have poor litter quality compared to native species[14,15]. Poor quality can be defined in terms of a) having low palatability (due to tannins and polyphenols), and b) a high carbon-to-nitrogen ratio (C:N)[9]. Both are associated with slower rates of nutrient release through decomposition[26]. The C:N ratio of senesced Japanese Knotweed leaves was found to be 38-58 % higher than dominant native riparian species[26]. Analysis also showed that 75 % of the foliar nitrogen from senescing Japanese Knotweed leaves was reabsorbed prior to litter fall, in contrast to native species which reabsorb only 3 -5 %[26]. Therefore, leaf litter from Japanese Knotweed contributes less nitrogen to riparian soils and the wider aquatic environment compared to its native counter-parts[26].

Inconsistent effects have been detected in the decomposition rates of non-native invasive riparian vegetation. One study reported a slower rate of decomposition of Japanese Knotweed compared to other non-woody plants. However, the rates were comparable to those of several native riparian tree and shrub species (e.g. *Salix* sp.)[9]. No difference was found in the decomposition rate of leaves from native species compared to those of Japanese Knotweed in a stream in Idaho, USA[5]. However, a further study, using submerged leaf packs, found the breakdown of Japanese Knotweed to be higher than native oak in one invaded stream but not in another. The different responses were attributed to the extent of Knotweed invasion and the resident detritivorous assemblage. Decomposition was faster where there was more extensive invasion and large invertebrate shredders (e.g. caddis flies, Trichoptera spp.) were present. Leaf pack decomposition rates were slower still in non-invaded streams[17].

Aquatic invertebrates prefer to feed on native species such as Alder and Oak rather than Rhododendron which results in the slower decomposition of Rhododendron leaves[14,15]. In addition it has also been shown that the presence of Rhododendron reduces the decomposition rates of native alder leaves[14]. This was believed to be due to Rhododendron-induced changes in the detritivore community[14]. Surprisingly, these studies do not measure leaf toughness which would presumably be higher for Rhododendron.

2.2.2 Effect on aquatic macroinvertebrates

Aquatic macro-invertebrate assemblages differ depending on whether non-native riparian plants are present or absent[14,17]. Rhododendron-bordered streams have been compared to those bordered by pasture and deciduous woodland. Pasture-bordered streams were dominated by shredder-grazer consumers, those bordered by deciduous woodland were dominated by primary consumers (e.g. shredders such as Limnephilidae caddis flies, grazers and collectors), whilst Rhododendron-bordered streams were intermediate between the two[14]. In particular, shredder abundance (e.g. stoneflies (Plecoptera) & *Gammarus* sp.) was lower in Rhododendron-bordered streams[14]. However, a better comparison could be made by comparing Rhododendron with vegetation which was structurally similar such as native scrub.

Two studies comparing aquatic invertebrates on Japanese Knotweed litter with those on native plant leaf litter found no significant difference in the abundance of invertebrate shredders or total invertebrates[3,5]. Conversely, another example reported that extensive Japanese Knotweed invasion led to a greater number of large invertebrate shredders (e.g. Trichoptera)[17].

Reduced species richness in benthic shredders has been linked with slower litter decomposition rates[9]. This effect may be exacerbated for species with very low palatability such as Rhododendron[16]. Furthermore, many benthic shredders feed on leaf litter from specific plant species[4]. Therefore, from an ecosystem perspective, a reduction in detritivore richness and a change in assemblage structure driven by non-native invasive riparian vegetation could compromise ecosystem functioning[9].

2.2.3 Effect on aquatic fungi

Aquatic fungi are important for leaf decomposition but the effect of invasive non-native riparian plant species is inconsistent. Fungal biomass was found to be higher on native oak at one site but higher on Japanese Knotweed leaves at another site whilst spore production was higher on oak leaves than on Japanese Knotweed[17]. Fungal species richness was higher on Japanese Knotweed than on oak leaves at three out of four sites[17]. However, a higher number of rare fungal species were recorded at a site invaded by Japanese Knotweed compared to an un-invaded site irrespective of the leaf species used by the fungi[17].

2.2.4 Provision of other organic matter

In addition to leaf litter, terrestrial invertebrates living and feeding on the riparian vegetation can form an important component of the diet of benthic invertebrates and fish. The number of invertebrates found on these four invasive plant species is lower than native alternatives. Thirty-one species are associated with Rhododendron[16] compared to common riparian trees such as Alder and Birch which have in excess of two hundred species[2].

2.3 Terrestrial adult invertebrates

Riparian vegetation provides food and shelter for emerged adults with aquatic larvae. Invasive plant species may at times fulfil this role. For example, Himalayan Balsam is a good source of pollen, a food source for some stoneflies[20]. However, negative effects can occur. Green Frogs (*Rama clamitans*) have shown reduced foraging success due to low arthropod abundance where there has been invasion by Japanese Knotweed[18] and it is reasonable to hypothesise that the same might apply for native UK amphibians.

3.0 INDIRECT EFFECTS

3.1 Displacement of native vegetation

Cover and species richness of native and non-native riparian plants is inversely correlated[25,26], due to invasive non-native plant species out-competing native species[24]. Rhododendron prevents germination of other tree species and suppresses vascular plants, bryophytes[19,21], and grasses[22] whilst Himalayan Balsam has strongly negative allelopathic effects[23]. This displacement negatively affects bank stability, hydrology, nutrient loading, microhabitat conditions and the aquatic biota of adjacent water systems[26]. Effects may be more pronounced when the species in question invades graminoid-dominated habitats because of marked differences in plant traits such as phosphorus uptake[23].

3.2 Stream bank stability

Displacement of native vegetation with plants which die back annually (Japanese Knotweed, Himalayan Balsam, Giant Hogweed) exposes bare soils, contributing to bank instability and increased bank erosion[6,26]. Displaced soil particles can settle in the slow flowing areas of a stream or river creating ideal conditions for aquatic plant growth and thus altering the vegetation within the channel[6]. Furthermore, silt can clog the gaps between the gravel on the river bed rendering it unsuitable for salmon spawning[6].

3.3 Nutrient cycling

Japanese Knotweed has the potential to influence nutrient cycling through re-absorption of high levels of nitrogen (see section 2.2.1)[26].

4.0 CONCLUSION

The documented impacts of these invasive non-native species on aquatic habitats and species are relatively few and often contradictory. Rhododendron appears to have direct impact by suppressing algal growth, providing poor quality litter, decomposing slowly and altering invertebrate abundance and assemblage structure. However, these impacts are largely based on one study. Japanese Knotweed has an effect on fungal species, rare fungal species and spore production. It may have slower leaf decomposition and alter macro-invertebrate assemblages but this depends on the extent of invasion and the comparisons used. Impacts of Himalayan Balsam and Giant Hogweed can, at present, only be inferred.

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