CENTRE FOR EVIDENCE-BASED CONSERVATION

SYSTEMATIC REVIEW No. 21

ARE JAPANESE KNOTWEED (*FALLOPIA JAPONICA*) CONTROL AND ERADICATION INTERVENTIONS EFFECTIVE?

REVIEW REPORT

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COVER SHEET

Title	**Are Japanese knotweed (*Fallopia japonica*) control and eradication interventions effective?**
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SYSTEMATIC REVIEW SUMMARY

Background

Japanese knotweed (*Fallopia japonica*) is an invasive plant listed as one of the IUCN's top 100 invasive species of global concern. It is a vigorously competitive plant that regenerates readily, and is difficult to control. Japanese knotweed control and eradication is undertaken using a wide suite of mechanical and chemical techniques. Many statutory and non-statutory agencies publish guidelines detailing the effectiveness of various methods, but a critical appraisal of empirical evidence regarding the effectiveness of different control and eradication methods has not previously been undertaken. The need to evaluate control and eradication methods under a variety of circumstances and time periods has been identified by UK stakeholders, but has global relevance.

Objectives

To systematically collate and synthesise published and unpublished evidence in order to address the question:

> "Are Japanese knotweed (*Fallopia japonica*) control and eradication interventions effective?"

The secondary objective was:

> "To investigate whether effectiveness of control and eradication treatments for Japanese knotweed is influenced by the following factors:
>
> 1. Environmental and geographical factors;
> 2. Operational level variables; and
> 3. Hybridisation and species variety."

Search strategy

Electronic searching was completed using the following databases, catalogues and web-engines: Agricola, CAB Abstracts, Digital Dissertations Online, Index to Theses Online, ISI Web of Knowledge (including ISI Web of Science and ISI Proceedings searches), JSTOR, Science Direct, Scirus (all journal sources), Scopus, AllTheWeb, Dogpile, Google Scholar, Scirus (all web sources), Blackwell Synergy, ConservationEvidence.com, Copac, Directory of Open Access Journals, English Nature's "Wildlink" library catalogue, Elsevier, European Nature Information System database V2 (EUNIS), iSpecies, and SpringerLink. Publication searches on 49 statutory and non-statutory organisation websites were conducted. Specialist searching was completed on 14 invasive species websites. Bibliographies of articles accepted into the review, traditional literature reviews, and relevant literature lists were searched for additional articles. Personal contact with researchers was used to retrieve further data.

Selection criteria

Any studies in any habitat that examined the impact on abundance of any management intervention used to control or eradicate any subspecies, variety or

hybrid of Japanese knotweed were included. Appropriate spatial or temporal controls were a prerequisite for studies to be included in quantitative analysis. Studies of biological control were not included as no data are yet available on effectiveness.

Data collection and analysis

The inclusion criteria were met by 74 articles, and these included information for Japanese knotweed and the hybrids Bohemian knotweed (*F. x bohemica*) and back-crossed *F. japonica* var. 'Crimson Beauty'. Multivariate synthesis was used to identify broad patterns in the effectiveness of all management interventions, using data extracted from 64 of the included articles only. Data suitable for meta-analyses were extractable from only 11 articles. Meta-analyses were used to examine the following six management techniques only (due to lack of suitable data on any other techniques): the herbicides glyphosate and imazapyr used alone and in combination, cutting applied alone, cutting followed by filling the stem with glyphosate herbicide, and cutting followed by spraying regrowth with glyphosate.

Main results

All six interventions investigated by meta-analysis produced statistically significant decreases in knotweed abundance in the short-term, except for cutting used alone. However, the ecological significance of the impacts of these treatments is uncertain, and there is no robust evidence available regarding their long-term effectiveness. Uncertainty is exacerbated by the small number of individual effect sizes, the limitations of the pooled studies (particularly confounded baselines and short timescales), and the high heterogeneity among included studies. The meta-analyses demonstrate that existing available evidence is insufficient to derive generic evidence-based management guidance for these particular techniques. These conclusions are supported by multivariate analysis of lower quality data from a wider range of sources. Variation in effectiveness was evident both within and between treatments, but this variation could not be linked to any ecological or intervention-related variables.

Timing of control influences the effectiveness of glyphosate application, with application later in the year appearing to have a more significant effect on knotweed abundance. However, the effect is no longer significant when considered alongside the duration of control. This relationship should be treated cautiously, as it could be confounded by one of the many variables that differed between the included studies.

No conclusive evidence was found for differences in effectiveness of management techniques due to taxonomic variation.

Conclusions

Available evidence suggests that applications of the following six control methodologies will not eradicate Japanese or hybrid knotweed in the short-term: the herbicides glyphosate and imazapyr used alone and in combination, cutting applied alone, cutting followed by filling the stem with glyphosate herbicide, and cutting followed by spraying regrowth with glyphosate. The review highlights a lack of readily-available, long-term, robust, controlled experiments assessing the effects of

the full range of management techniques used against Japanese and hybrid knotweed. As such, it emphasises important deficiencies within the current body of evidence. The authors of this review are aware of control methods in use other than the six methods analysed in this review. However, as some monitoring results are not made readily available, the effectiveness of the full range of control and eradication methods currently implemented cannot be tested. Readers must therefore put the evidence presented here into a broader context of poor data accessibility.

This review recommends further research into methods used to control and eradicate Japanese knotweed. This research should focus on long-term collection of monitoring data, adequate replication, and investigation of the impacts of treatments on rhizomes. A large, well-replicated experiment or monitoring programme examined over a long time period could be used to test a range of different factors that may influence Japanese knotweed control and eradication. It is recommended that collaboration between stakeholder groups across and between countries be used to achieve a multi-site aspect to this research. Considering the substantial amount of money that is already invested in knotweed control, it would be worthwhile to provide funding for developing more effective ways of managing the problem under different circumstances.