Guidance for evaluating the costs of invasive species and their control

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GUIDANCE FOR EVALUATING THE COSTS OF INVASIVE SPECIES AND THEIR CONTROL

Abstract

Invasive alien species cause different types of costs and often need to be controlled. Given several available control measures, choosing the most profitable one is not straightforward, especially if one has no training in economic methodologies. This paper introduces a guidance to assist in economic evaluation of control measures. The first section sets out the basic information on the species, its impact, as well as on the methods available for its control. The second section deals with the actual assessment, first defining alternative scenarios, followed by a cost and benefit assessment, and a comparison of different scenarios.

Keywords: invasive species, control, guidance, cost benefit analysis

Introduction

Invasive alien species cause different types of costs, and some degree of control is often necessary. However, there are often several alternative control measures available, and choosing the most profitable one is not straightforward. This paper introduces a guidance that has been developed to assist in the economic evaluation of control measures (Heikkilä and Kettunen 2014). In practice, the guidance presents the evaluation process step by step. It is illustrated using examples from different evaluations that have taken place. The guidance is intended to be used as a memory list of important aspects and to aid the thinking process. It is aimed to support public administration and the evaluation work by individuals who may not be trained in economics.

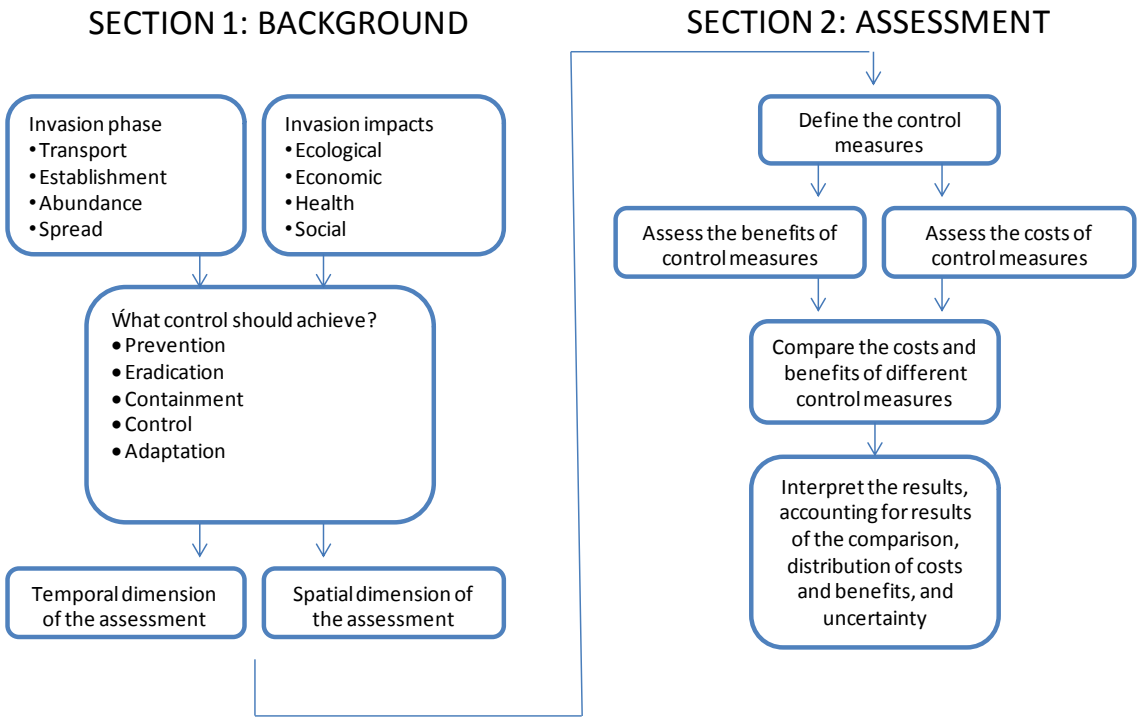

Figure 1. The structure of the evaluation procedure.

The first section in the guidance is the background phase, which provides the basic information on the species, its impact, as well as available knowledge on the methods available for its control. Once the basic information is dealt with, the guidance proceeds to the actual assessment, where the alternative scenarios are first defined, followed by an assessment of the benefits and costs, and a comparison of different scenarios against each other. The guidance will walk through these steps, step by step (Figure 1). This paper introduces the main aspects of the guidance.

Section 1 – background information

1. Identify the phase of the invasion

Invasion takes place in phases, and between the various phases there may be lag periods. The identification of the phase of the invasion helps to determine what is achievable through control and what kinds of methods may be available. The earlier the invasion phase, the better are the chances for prevention or rapid eradication. If the invasion is already in the spread phase, containment, control and adaptation become available as potential control strategies. In some cases, the eradication of a widespread species is impossible. This is the case, for example, with many marine alien species or plant species whose seeds remain in the soil for a long time. Determining the invasion phase thus helps in establishing the ecological, technological and economic realities related to control.

2. Describe the impacts of the invasion

In the second step the impacts of the invasion are assessed on a general level by answering the following questions: 1) What types of impacts are caused and what is their magnitude if the invasion continues as at present or expands further; and 2) What type of costs and in what magnitude are incurred due to efforts to prevent or stop the invasion. At this stage the costs need not be evaluated in monetary terms, but it is good to reflect on their order of magnitude. The scale used can be, for example: no, small, medium, large, and very large impacts. The aim is to determine the kinds of impacts that the species may cause. Economic, ecological, health and social impacts should all be considered. Examples from existing literature are provided in the guidance.

3. Define what is to be achieved through control

In the next step it is to be defined what we would like to achieve through control. Several types of actions may be included – for instance both prevention and adaptation may be included as potential control strategies. However, realism should be used to narrow down the objectives to a set of strategies that are technologically and economically considered at least moderately feasible. The available objectives include for instance prevention, eradication, containment, control and adaptation. When defining the control objectives, it is worth considering the invasion phase (step 1) and the types of costs (step 2), but also the impact of the following factors: the risk factors that contribute to the likelihood of the spread; potential transport pathways; whether the species affects production or is purely an environmental pest; production structure, including professional and hobby producers; chances for a coordinated control action; history of the species; and legislation.

4. Specify the temporal dimension of the assessment

Some of the investments are one-off events, for instance establishing an internet portal for monitoring invasive species. Mostly, however, the costs occur every year, and often depend on the population size of the species (for instance sampling and analysis). Most of the costs change over time, meaning that the time period of the assessment matters. A very short term assessment of, for instance, eradication is likely to miss the largest benefits of eradication: the avoided future damage costs. In many control cases, the costs of control are immediate whereas the benefits may occur much later. It is therefore essential to consider the time frame of the assessment carefully. When the costs and benefits occur in different periods of time, also the changing value of money needs to be accounted for. The guidance therefore also explains the concept of discounting.

5. Specify the spatial dimension of the assessment and the agents included

In addition to the temporal dimension it is useful to define the geographical area in which the effects are to be examined. It needs to be established whether the assessment is local, regional or nationwide. It should also be determined what type of assessment is necessary. If there are large cross-sectoral impacts involved, it is important to look at the effects on the whole economy, for instance through a computable general equilibrium model. If, on the other hand, impacts are limited to one sector or cross-sectoral impacts are fairly small, a partial equilibrium model or partial budgeting may be used. It is also essential to determine the agents that are taken into consideration. The guidance lists different actors that are related to invasive species to provide some help in defining the relevant agents.

Section 2 – evaluation of the control measures

Section 1 dealt with the background information. Once the above issues have been established, it is possible to move on to the actual assessment.

6. Define the control measures

Define the control measures (i.e., scenarios) that will be assessed. Control measures (scenarios) refer to a variety of alternative development paths. In this context, this means listing the potential control methods (already considered in a preliminary fashion in Section 1), and then narrowing those down to a few realistic alternatives whose costs and benefits are to be assessed. Also a baseline scenario should be defined. This could be for instance the current state of affairs or a business-as-usual scenario.

Control measures can include different control strategies (for example prevention and adaptation), different control methods (for example, mechanical, chemical and biological control) or different degrees of the same control method (for example, how much of a chemical pesticide is applied per hectare or which substance is to be used). Between the various control measures there may also be temporal and spatial variations: for example, in the initial phase of the programme the control may be massive and is later relaxed, or control actions may be targeted in some key areas.

The complex part is that in relation to all different scenarios it is necessary to evaluate the impact of control on the growth and spread of the invasive species. This may be done using different growth and spread models or forecasts, or expert opinion if models are unavailable.

7. Assess the costs and benefits of the control measures

Once the control measures have been defined, the costs and benefits of each measure should be assessed. The costs of control should include both the monetary costs (for example, administration, employment costs, control substances, equipment, and accessories), as well as the costs through time and effort of "unpaid workers" such as the producers. In addition, one should consider any other costs of the control measure, such as the potential external environmental or health impacts of the use of chemical pesticides.

In addition to the costs of the different control measures, also their benefits should be evaluated. These are often more difficult to evaluate and less certain than the costs. The benefits are most commonly those costs that are avoided when the population of the invasive species is either prevented, eradicated, restricted or contained in some way. Additionally the control measures may produce side benefits, for instance control of some other harmful species. For example, ballast water treatment can simultaneously target multiple potential invasive species. The guidance provides examples on methods and measures that have been used in the published studies. There are several methods developed in the field of environmental economics to assess for instance recreational and other environmental values, using both revealed and stated preference methods. Similarly, in the field of health economics several methods exist for assessing the human health impacts, including for instance Cost of Illness and Quality Adjusted Life Years -methods. These methods are briefly introduced in the guidance. Their application may be time-consuming and therefore it should be carefully considered whether the impacts are so large that they should be quantitatively assessed and monetised, or whether qualitative inclusion is sufficient (step 2).

8. Evaluate the control measures

Once the costs and benefits have been estimated for each control measure, they should be compared against each other. The guidance defines and illustrates the notions of net benefits and benefit-cost ratios that can be used to compare the control methods. The net benefit of the measure can be calculated by subtracting the total discounted costs from the total discounted benefits. The total benefits of the measure are those costs that are avoided by choosing the control measure in question – often these avoided costs are the total discounted costs of the baseline scenario (e.g. business-as-usual scenario). If the figure is positive, it means that the measure will produce net benefits compared to the baseline scenario.

The benefit-cost ratio (BCR) describes how large the benefits of the measure are compared to its costs. It is obtained by dividing the total discounted benefits of the control measure by its total discounted costs. If the ratio is greater than one, it means that the measure yields higher benefits than costs. For example, the BCR-figure 1.50 means that the control measure provides benefits that are 1.5 times greater than the costs.

The measures can be compared by comparing their net benefits. The measure that has the greatest net benefit produces the highest benefits to the society that invests in it. Comparison of the net benefits is a simple concept that is easy to communicate to people. A simple analysis of the net benefit is often not enough, however, when the resources are limited. The measure that produces the greatest net benefits may also require most resources to accomplish. Those resources may for instance not be available or could be better invested elsewhere. In such a case, it is justified to examine the benefit-cost ratio.

When comparing the benefit-cost ratios of the control measures, it does not matter how large net benefits the control measures produce. Instead, the comparison answers the question: "Which control measure provides the highest rate of return for the invested resources?" In other words, how high the benefits are compared to the costs incurred. High benefit-cost ratio,

however, might mean a small net benefit in absolute terms. Another disadvantage is that if the benefits and costs are very small or uncertain in magnitude, the ratio becomes unstable and its interpretation difficult. Often it is sensible to use both net benefits and benefit-cost ratio to compare the alternatives.

The impact estimates are often not measured in monetary terms. However, the control measures may still be compared. In this case, one must define (and possibly weight) the criteria on basis of which the measures are compared. Some of these criteria may include data measured in monetary terms (for example, the cost of the measure). Other data types may be, for example, quantitative non-monetised data, binary data (yes/no), semi-quantitative data (e.g. on a scale of 1 to 5) or qualitative data. Different multi-criteria analysis methods can then be used to compare the alternatives.

9. Interpret the results

Even when the comparison of the relative costs and benefits of the control measures has been carried out, there are remaining issues that should be considered. First of all, the expert should interpret the results obtained in the comparison. The numbers and the assessment themselves do not provide a decision or suggest a way of action. The results should be interpreted in a holistic fashion. Second, the division of costs and benefits should be assessed. Who incurs the costs and who reaps the benefits is a question of not only equity. Any successful policy should take into account the incentives and disincentives of different agents, and the distribution of the costs affects those incentives and disincentives. The distribution also affects the legitimacy and public acceptance of any policies or control measures. Finally, the uncertainty related to the issue should be evaluated. If the assessment results are based on a numerical model, a sensitivity analysis or some other type of uncertainty analysis (e.g. Monte Carlo simulation) should be undertaken. Also best case and worst case scenarios can be assessed in addition to the most likely scenario.

Summary

The framework presented in the guidance helps in taking into account most of the important issues when evaluating the economic impacts of invasive species control measures. The guidance is not meant to be followed blindly – the species and event specific issues always need to be considered. The guidance is, however, a backbone and a memory list of questions that should be considered when the control assessments are made. It is also important to document the assessment thoroughly and provide a transparent view of the calculations undertaken. Such practice makes the assessor vulnerable to critique, but it is the only way of advancing the field and making more reliable and useful economic cost assessments of invasive species control.

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