The Discussion Forum on development of IAS management tools and guidance began on 1 May 2019 with a discussion of Cost-Benefit Analysis. By the end of the month, it received 136 contributions from around the world, providing commentary and examples of the use of this and related methods. The discussion was structured into a number of threads asking for views and evidence on different aspects of this issue. This report summarises the contributions received by 31 May 2019 (09:00 GMT)

- **Remit of the Discussion - Decision making in the marine environment**

Contributions were received from a number of contributors highlighting the problems faced when managing species in the marine environment. In particular they emphasised the need to focus on prevention; to ensure discussion adequately considered both terrestrial and marine environments and the need for methods to support prevention as a management approach. This was supported.

- **What do we mean by analysis of costs and benefits?**

Contributors highlighted a range of different methods to analyse the costs and benefits associated with invasive alien species, or which are used to support decision making and include the consideration of costs and benefits. In the context of the discussion, these included:

- Cost-benefit analysis - using purely monetary values to assess both the costs and benefits of a species or management action.
- Cost-effectiveness analysis, contrasting the costs of implementing a programme with the benefits measured in non-economic terms, for example the number of a threatened species saved.
- Multi-criteria methods – assessing a wide range of different criteria, often measured in different currencies to prioritise amongst a variety of different available options. For example including the public acceptability, humaneness and wider environmental impacts of management proposals alongside economic costs.
- Risk assessment – a formal process, typically based on a combination of available evidence and expert opinion, which assesses the probabilities that a species will enter, establish, spread and cause impacts in an area.
- Risk management – a process of assessing the feasibility and effectiveness of management. In some circumstances this may also be called Impact Management.
- Risk Analysis – a term referring to the combined use of risk identification, risk assessment, risk management and associated risk communication.

What are the costs and benefits associated with invasive alien species and their management?

A table describing the different costs and benefits associated with invasive alien species and their management was offered, describing the main currencies in which each was typically measured.

Cost or benefit	Currency of measurement
Cost of species presence	
• Impact of species on human wellbeing	social
• Impact of species on wider biodiversity	biodiversity
• Impact of species on the environment	environmental
• Impact of species on economic activity	economic
Benefit of species presence	
• Economic value of use of new species	economic
• Addition of new species to local biodiversity	biodiversity
• Positive effects of new species on other species (including biological control)	environmental
• Beneficial effect of new species on human wellbeing	social
• Beneficial effect of new species on the environment	environmental
• Improved global conservation status of the introduced species	biodiversity
Cost of management	
• Restriction in trade	economic
• Costs of regulation	economic
• Costs of interception/inspection	economic
• Welfare impact of management (vertebrates)	animal welfare
• Costs of surveillance	economic
• Costs of removal	economic
• Costs of maintaining contingency capability	economic
• Social acceptability of management	social
• Wider environmental impacts of management	environmental
Benefit of management	
• Reduced risk of future invasion and associated costs	multiple
• Reduced current impacts	multiple
• Reduced future impacts	multiple

Contributions highlighted a number of points related to these costs and benefits

- The lack of available information on which to base an assessment of economic costs in many regions.
- Most analyses and decisions only consider a small proportion of the costs and benefits described in this list.
- The importance of including non-economic measures such as biodiversity and public acceptability in decision making.
- Difficulties in defining costs and benefits for species occurring both in the wild and in domestic production, highlighting the problems associated with aquaculture.
- The need to include environmental as well as economic impacts in decision making.

- The need to consider prevention as well as the management of species once they have established
- That similar categories may be applied to pathways as well as species, of relevance to pre-border control and prevention.

What Decisions are Informed by These Analyses?

A variety of different types of decision were described in posts or attached papers. The choice of appropriate methods varied between each. These included:

- Demonstrating economic impact, often required to illustrate the importance of an issue or the need to manage.
- Showing a net economic benefit of management - often required to gain support for a management action.
- Optimising a management approach – determining the most cost-effective may to implement a programme – with examples provided in relation to surveillance or inspection.
- Prioritisation – choosing from a wide range of options (species, management alternatives) to best direct cost-effective management.

Availability of Databases

Contributors highlighted the availability of existing databases and initiatives which can inform a number of these costs and benefits. These include:

- Impact of species on wider biodiversity and the environment - existing EICAT initiative (Hawkins et al 2015) and GISS (Nentwig et al 2016)
- Impact of species on human wellbeing – existing SEICAT initative (Bacher et al 2017)
- Species Risk assessments – a range of regional and national programmes and databases were identified. (Risk Assessments, Belgium, EU, UK)
- Cost of Eradication. A range of studies and databases describe the costs of successful eradications worldwide. (Brockerhoff et al 2010, Gardener et al 2010, Holmes et al 2015, 2016, Howald et al 2007, martins et al 2006, Rejmanek and Pitcairn 2002, Robertson et al 2017, Gerda website)

Linked to these databases, suggestions were made for new datasets to be established or existing ones improved.

- Risk Assessment - There is scope to collate these and make them more readily available, but the need for standardised metadata and quality control was highlighted (Roy et al 2018)
- Impacts of Species - a suggestion to extend the field "IsInvasive" in the GRIIS checklists (Pagad et al 2018). Here, the notion between current and potential impact becomes important. Currently the process is to provide evidence of impact to flag it as invasive = when it's already too late to act. Perhaps it's more proactive to include potential impact in these checklists.
- Wider data on the costs of management – a need for more standardised information on the practical costs of management, including prevention and ongoing management.

Examples of the use of cost and benefit analysis to support IAS management.

Examples were provided of the use of cost-benefit analyses to support decision making from a number of regions including the Caribbean (Daigneault et al 2014), Africa (Wise 2007), Europe (Reyns et al 2018) and Australia (Nordblom et al 2001).

Examples of cost-effectiveness analyses, used to assess or optimise the effectiveness of management approaches were also highlighted. (Blignaut et al 2007, Keller et al 2008, Merel et al 2008, Epanchin-Niell 2017, Kraaij et al 2017)

As well as providing links to existing databases, papers describing the methods and standards for risk assessment were provided (Roy et al 2018).

Examples of the use of multi-criteria methods to assess risk management were provided (Booy et al 2017, Zengeya 2017)

Studies were also provided that assessed the social consequences of management (Creed et al 2017), prioritsation by local communities (Shrestha et al 2019) and the conflicts that can arise (Branco et al 2014)

Studies also described the costs of species presence (Mwebazi et al 2010, Bradshaw et al 2016, Hoffman and Broadhurst 2016, Economic Impacts websites, Pratt et al 2017).

Descriptions of national approaches to support decision making

A number of countries provided detailed links and descriptions of their national processes to assess and prioritise the management of alien species.

In Australia they have been undertaking successful environmental IAS management for more than 70 years and no longer explicitly apply a classic cost-benefit approach because of the difficulty of valuing the economic benefits to environmental assets for most activities. They have therefore moved to "cost-effectiveness analysis" which looks at collective assessment of the relative effectiveness of a range of different actions at achieving the desired environmental outcome. They have found this much more effective in community co-development and costing of management plans around specific SMART management goals. (Carwadine et al 2012). A detailed account of the different elements of the Australian processes and their sequence was provided in post #1378

For the UK, links were provided to their risk analysis framework, which includes risk assessment and risk management methods, to assess the risks and priorities for management of different species. A paper describing the use of a multi-criteria method applied to species risk management and prioritisation was provided (Booy et al 2017). A detailed account of the different elements of this was provided in post #1376.

The World Organisation for Animal Health (OIE) provided their document ‘Guidelines for assessing the risk of non-native animals becoming invasive’ in post #1380

Cuba provided detailed a description of their process for identifying, assessing, prioritising and managing risks in posts #1410 and #1411

Lastly, the Australians provided a shortened account of the key elements of their recommended process that may be of particular use for those countries developing new processes (post #1387). In summary this included:

- Firstly, know what you have within your borders, prioritize these using Risk Assessment based on actual and potential impacts, then apply the post-border risk management approach to the top ranked species to define actions incorporating CBA, Cost effectiveness analysis and feasibility analysis based on what information is available to species focused response programs.
- Second step is to identify over the horizon threats from alien (non-indigenous) species that are proposed for deliberate introduction (e.g. for trade) or species likely to hitchhike with trade. For key high impact threats which have a high risk of accidental/deliberate entry, a full quantitative risk assessment is best.
- Third, pathway risk analysis. Identify which species we are concerned about that we don't have and that have the highest likelihood of establishment. Then define where these pests and diseases are most likely to come from. This then rolls into an Risk Analysis for shipping and associated containers coming from those countries to target inspection efforts.

This summary approach received support from a number of posts.

In addition, a number of countries gave more general descriptions of their processes and needs. These included reference to Early et al (2016) which described national capabilities worldwide and highlighted the needs for enhanced capabilities in many developing economies. A number of posts also highlighted the need for regional cooperation and information sharing to enhance the identification and management of risks.

For South Africa, a paper by van Wilgren (2012) described their use of CBA to guide the choice and management of species for management, one of the most extensive examples of the use of CBA. They also provided materials describing the species level approaches and a paper was provided which used a multi-criteria scoring approach to review the benefits and negative impacts of species currently listed in their Alien and Invasive Species Regulations.

Norway described how they conducted Cost-Effectiveness analysis of mitigation measures as they often lack benefit estimates. Government guidelines for CBA (and CEA) from the Norwegian Ministry of Finance as well as the ecosystem service approach and environmental valuation methods and benefit transfer techniques are increasingly being used as an additional decision tool in environmental management. An account of this was provided in post #1384.

In Mexico a preliminary exercise was conducted for the years 2007 to 2012, to find out what would be the cost for the private sector that imports EEI, if the imports of certain exotic species were prohibited through regulation. Also, the benefits of regulating imports of IAS were quantified; the avoided costs were quantified for damages and impacts and for control and eradication. To do this, the costs of control, eradication and economic damages were taken as reference, in which a number of countries have incurred as a consequence of the introduction of IAS of algae, plants, aquatic invertebrates, terrestrial invertebrates, fish and vertebrates.

In Belgium impact assessments have been performed for a number of species, and more detailed full risk assessment for a limited set of species (http://ias.biodiversity.be/species/risk), some of which have been used to justify inclusion of species on the EU List. (Risk Assessments Belgium)

In Ecuador, a risk assessment system is being developed for exotic species and a tool for cost-benefit analysis is important to help decision-making regarding the management of these species.

The European Union have been undertaking risk assessments to support the Listing of Species of Union Concern. (Risk Assessment EU).

From China, the issue of how to apply methods at different scales was raised. A number of papers were provided giving examples of priority threat management approaches that may be useful in this context (Firn et al 2013, Reyes et al 2016).

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