The value of information in invasive species management

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OBJECTIVE

- Invasive species exact a growing toll on ecosystems and cause substantial economic losses.
- Invasive species management is hindered by the uncertainty inherent to the invasion process, or the population dynamics of the species.
- Research provides one venue for acquiring information, subsequently lessening uncertainty. However, allocating resources to research detracts from other key management activities.
- We assess the value of information (VOI), or the value of reducing uncertainty, in invasive species management. VOI can help identify the areas which yield higher returns from research investments.

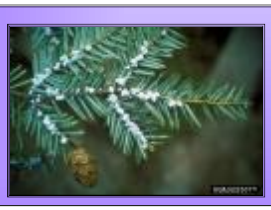
Boll Weevil (left), Asian Longhorned Beetle (right)
Pictures from Alton N. Sparks, Jr., University of Georgia, Bugwood.org; USDA APHIS, Plant Health website

MODEL

- We analyze the VOI in the model from Haight et al. (2007) which evaluates detection strategies for invasive species from the perspective of a government agency manager monitoring a land parcel.
- The manager chooses the search rate, *s*, to minimize the expected discounted cost of management, *E(MC)* (figure on left), as a function of several parameters (table on left).
- One measure of the value of reducing uncertainty is the expected value of perfect information (EVPI) which represents the potential gain from acquiring full knowledge about a parameter.
- Assume the species' growth rate, g_i, has several potential values, $i = 1,\ldots,n$, depending on the state of the world and each state has some probability of occuring, $p(g_i)$. The manager chooses from a number of search intensities, $j = 1,\ldots,m$, and faces management costs, $MC(s_{ij})$, The EVPI is the following:

$$\min_j \sum_{i=1}^{n} MC(s_{ij})\, p(g_i) \Big] - \sum_{i=1}^{n} \Big[\min_j MC(s_{ij})\, p(g_i) \Big]$$

which is the difference between the optimal expected management costs and the expected management costs under perfect information.



Hemlock Woolly Adelgid (left and center), Coffee Berry Beetle (right)
Pictures from USDA Forest Service, Northeastern Area, Photo Gallery; CT Agricultural Experiment Station Archives, CT Agricultural Experiment Station, Bugwood.org; Eric Erbe, USDA Agr. Res. Svc., Bugwood.org

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REFERENCES Haight, R.G., S.V. Mehta, F. R. Homans, and R. C. Venette. 2007. Optimal Search Strategies for Detecting Invasive Species. Working paper.

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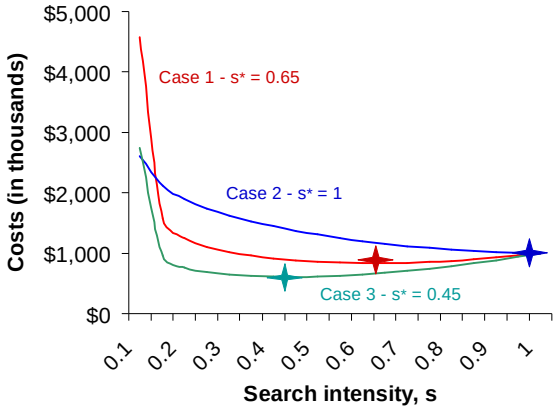
Expected management costs for invasive species cases



Expected management costs: This figure plots the expected management costs over the search intensity, *s*, for each case in the table below. The optimal search intensity, *s**, (denoted by the star), is the search rate that minimizes the expected costs.

Cactus Moth (left), Emerald Ash Borer (right)
Pictures from Dale Habeck, Bugwood.org; David Cappaert, Michigan State University, Bugwood.org

Parameter values for cases representing different invasive species

Cases / Parameters	Case 1	Case 2	Case 3
Search costs (`000s)	100	100	100
Eradication costs (`000s)	500	500	300
Arrival rate	0.22	0.4	0.22
Expectation of growth rate	0.11	0.11	0.11
Discount rate	0.1	0.1	0.1
Optimal search intensity	0.65	1	0.45
Expected value of perfect information	3.7	0	6.0

Invasive species cases: Case 1 is a species with high eradication costs and a moderate arrival rate. Case 2 is a similar species but with a higher arrival rate. Case 3 represents a species with moderate eradication costs and a moderate arrival rate. Those cases with EVPI > 0 could benefit from research focusing on the growth rate.

DISCUSSION

- Biological parameters, particularly the growth rate, tend to have a higher value of information than the economic parameters based on this model.
- However, the EVPI varies depending on the characteristics of the species. Species with high arrival or growth rates (Case 2) do not necessarily gain from additional research focusing on the biological parameters. Targetted research for species with relatively lower biological parameters (Cases 1 and 3) could yield potential gains for the land manager.
- Future research should build upon this information to identify the optimal resources to allocate to research vis-à-vis other management activities.