Landcare Research
Manaaki Whenua

To release or not to release? Insights provided by a new risk index for weed biocontrol agents



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Perennial issues with host-range testing

No-choice laboratory starvation tests determine the *fundamenta*l host-range of candidate agents with ~100% reliability

BUT not all fundamental hosts are suitable *field* hosts

No-choice scenarios can give spurious results…

‘Type I Errors’ or **false positives**

Systems that produce false positives are not ideal!

Example: *Longitarsus jacobaeae* in NZ

No-choice larval starvation tests: NZ native *Senecio wairauensis* is a fundamental host[1]

No evidence of non-target attack in the field since 1983 release[2]

Reliance on no-choice tests would have needlessly prevented a highly successful programme

[1]Syrett 1985. NZ J. Zool. 12: 335-340
[2]Paynter *et al.* 2004. *NZ Plant Prot. 57:102-107*

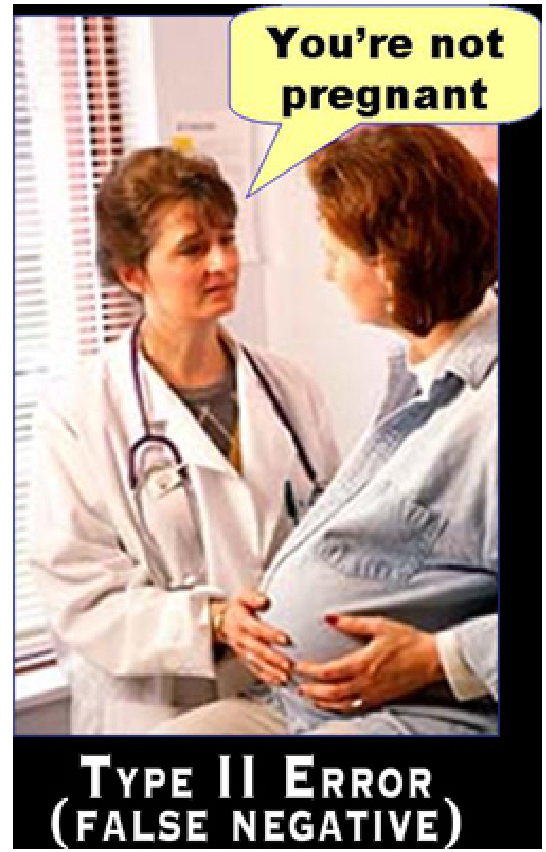
Cage choice oviposition tests

Developed to eliminate false positives (assumed to be “more natural” & more likely to reflect true acceptability of a potential host plant)

BUT: if an agent ignores lower-ranked plant spp. in the presence of the target plant[1]…

[1]e.g. Marohasy, J. (1998) *Biocontrol News & Information,* **19,** 13N-20N.

You might get a big surprise!



False negative example: Broom seed beetle *Bruchidius villosus* in NZ

Unexpected attack on tagasaste *Cytisus proliferus*

Choice tests: all oviposition occurred on target broom *C. scoparius*[1]

Tagasaste begins flowering before broom & beetles emerging early from hibernation experience a no-choice situation

Retrospective testing: *B. villosus* accepts tagasaste in no-choice scenarios!

[1] Haines *et al.* 2004. *Proc. XI Int.Symp Biological Control Weeds* pp. 271–276

Open field tests/large field cages

Considered most reliable tests

BUT tests are done overseas & are costly to set up & logistic problems are common e.g.

- Permission to grow key NZ test plants denied by some countries
- Can be hard to grow some plants overseas (e.g. many NZ *Clematis* spp. & tagasaste don't thrive in the UK)

Gorse soft shoot moth was released in NZ after large field cage tests in Hawaii indicated low risk to tagasaste

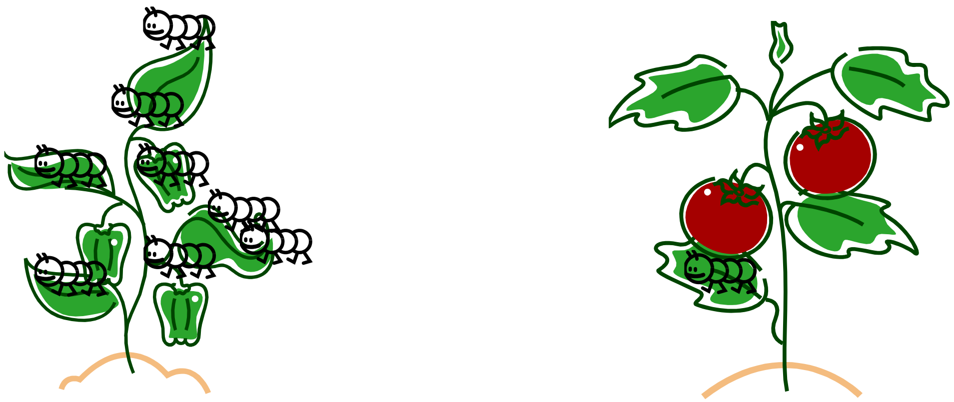
Hill *et al.* (1995) Biocontrol, Science, Technology 5, 3-10.

Another option – using quantitative data

Performance on test & target plants in laboratory tests has long been quantified e.g.

- HCF Newton (1933)[1] presented % survival of *Longitarsus* beetles on ragwort & a range of test plants

Usually assumed that **relative performance** is a predictor of risk of non-target attack.



[1]Newton, H. C. F. (1933). Bull. Ent. Res. 24: 511-20

Key question

- Is there a threshold relative performance level below which non-target attack is unlikely to occur

- Potential relevance:
  - May help regulators (EPA) assess risk, safeguarding environmental safety of weed biocontrol AND
  - avoid unnecessarily rejecting safe agents (improving cost-effectiveness of weed biocontrol for stakeholders)

- This presentation investigates this hypothesis using data from NZ biocontrol programmes…

Methods

- Reviewed host-range test data & compiled database of plant spp. growing in NZ (native & exotic) that supported development in starvation tests
- Calculated relative performance scores by dividing performance (e.g. % survival) on each test plant by the same measure on the target weed
- Conducted surveys/consulted literature to identify which of these fundamental hosts are field hosts in NZ
- Logistic regressions explored relationships between binary variable non-target attack (y/n) & relative performance

Relative performance measures investigated

Quantitative laboratory testing data often reported for:

1. Larval survival in no-choice starvation tests
2. Oviposition (choice & no-choice tests)

Non-target attack

Attack categorised[1]:

- **no attack:** no signs of attack despite presence of the biocontrol agent in the immediate vicinity
- **spill-over:** incidental feeding on non-targets resulting from spill-over effects from high agent abundance or development on non-target plants only in the presence of the target
- **full utilisation:** population persistence in the absence of the target plant

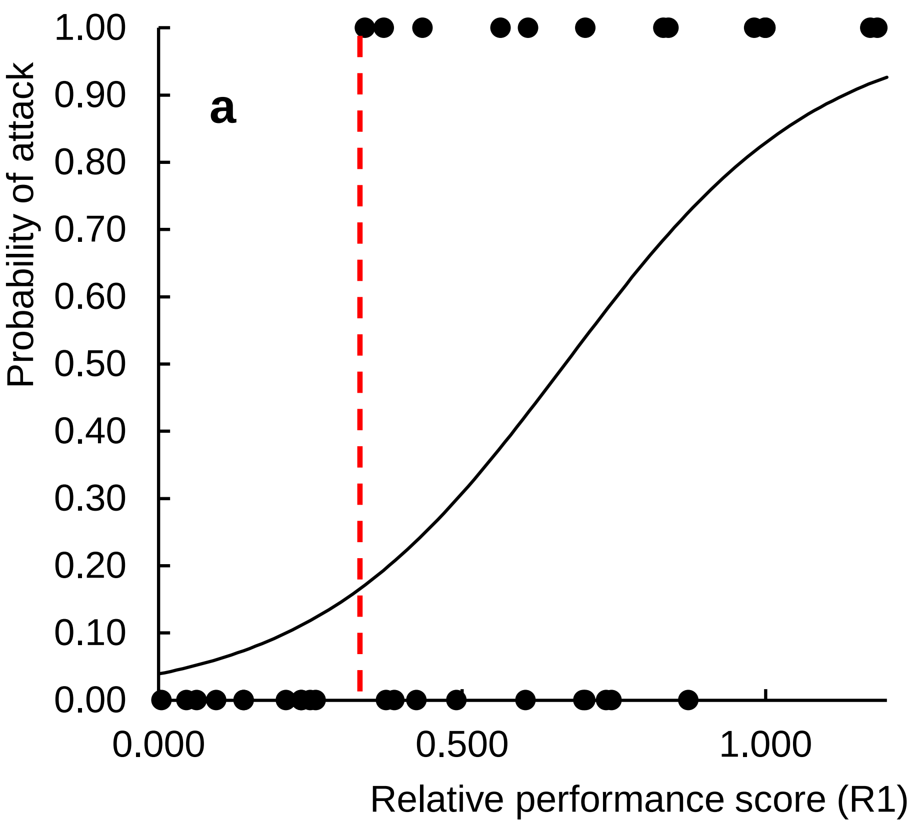
[1]Sheppard A., et al. (2005). *Biological Control,* **35,** 215-226.

Results

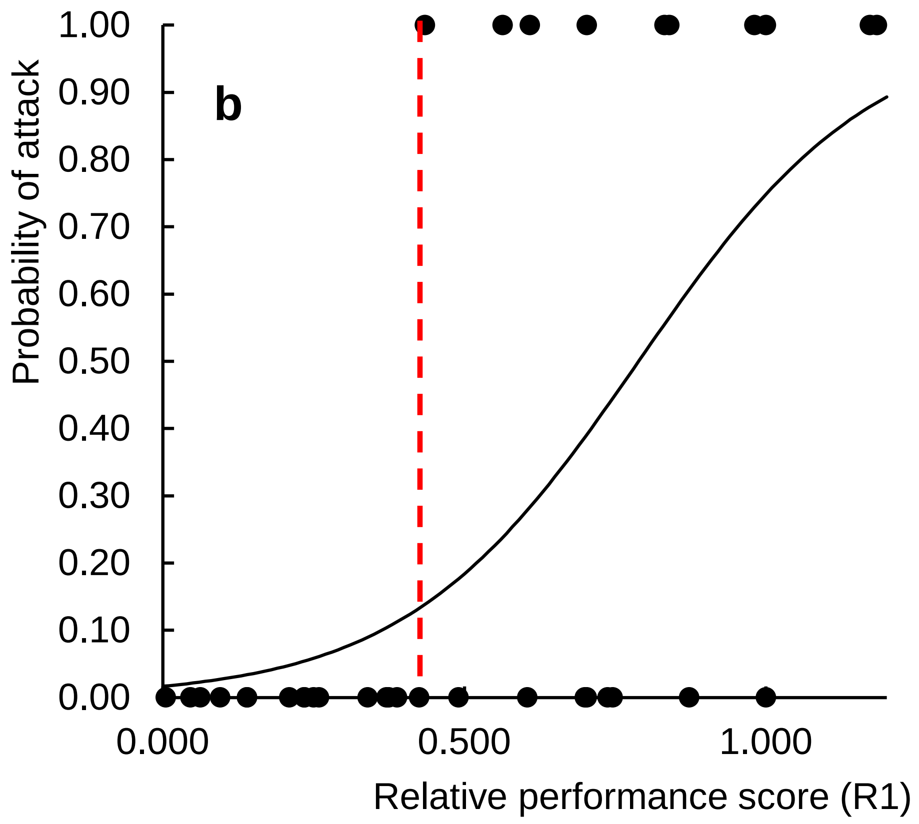
- Data collected for 23 agent spp. released in NZ
- 38 potential agent/host plant combinations
- Data quality sometimes questionable (often not reported if differences in survival or oviposition were statistically significant)
- No cases of serious non-target attack on native plants or crops - most examples are feeding on other introduced plant spp. that are related to the target weeds

No-choice starvation tests (R1)

All attack(including spill-over)



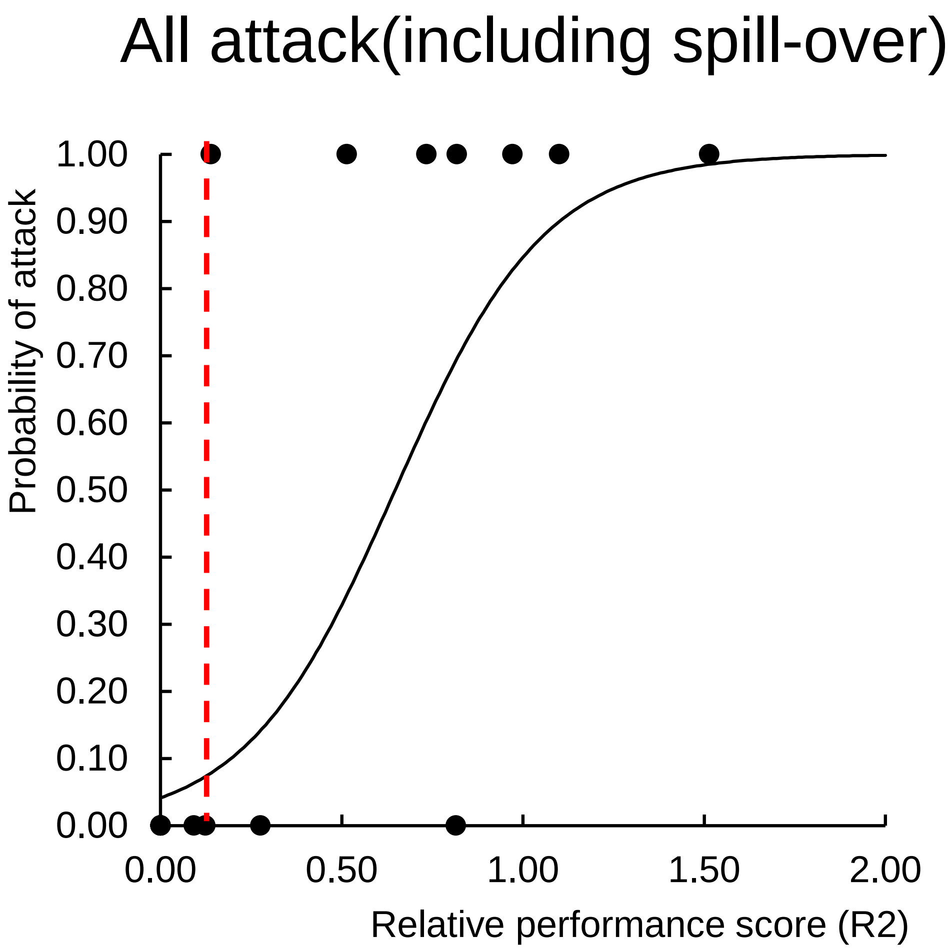
Full utilisation only

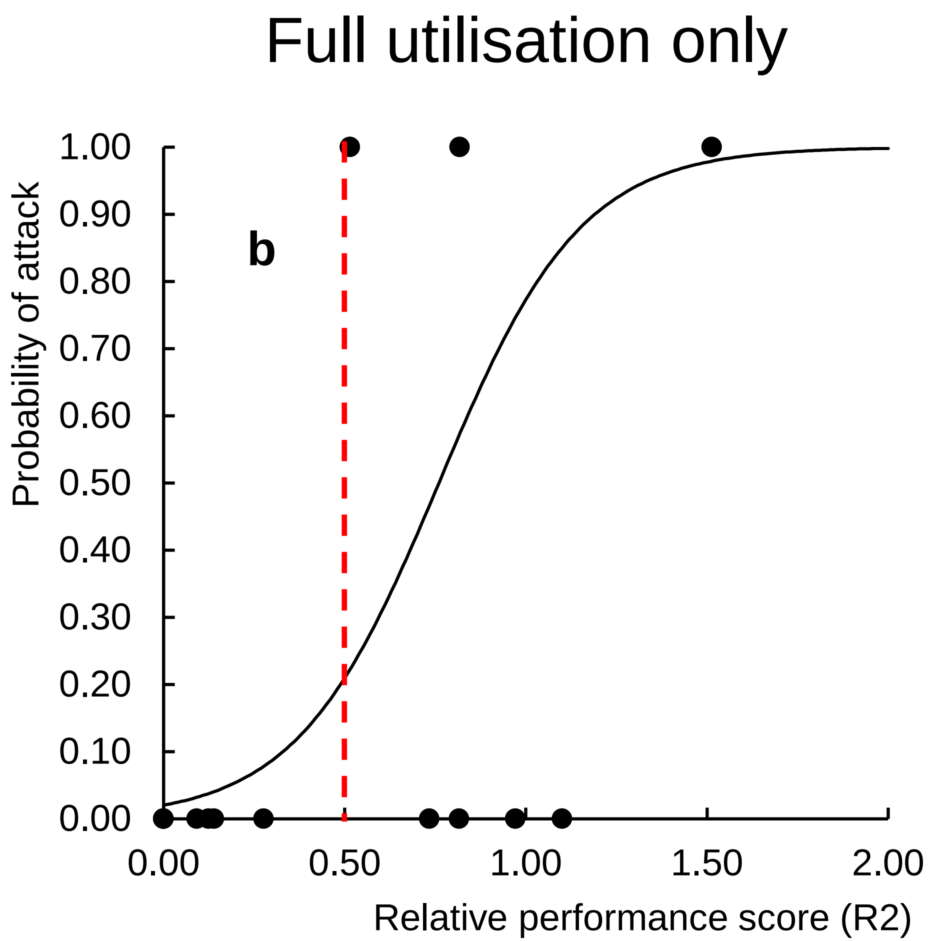


X^2 *P* < 0.001; lowest score where non-target attack occurred =~0.34

X^2 *P* < 0.001; lowest score for full utilisation =~0.44

No-choice oviposition tests score (R2)

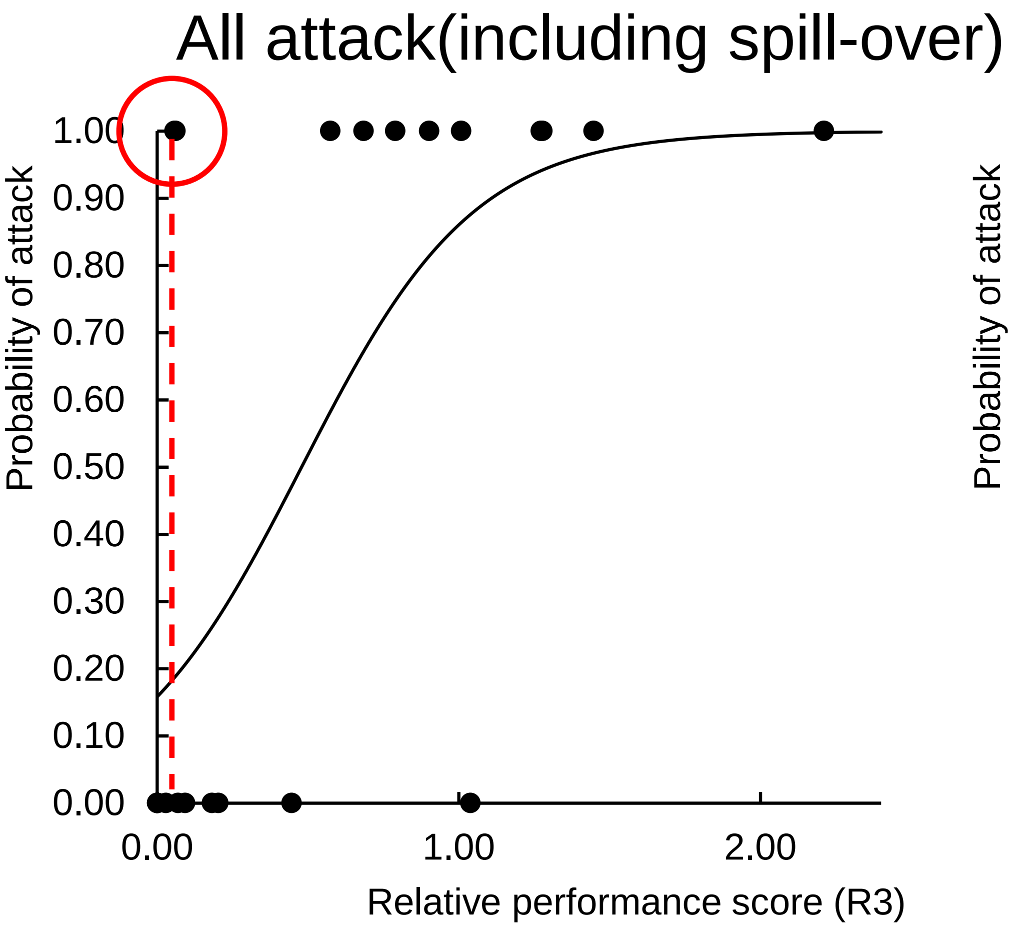


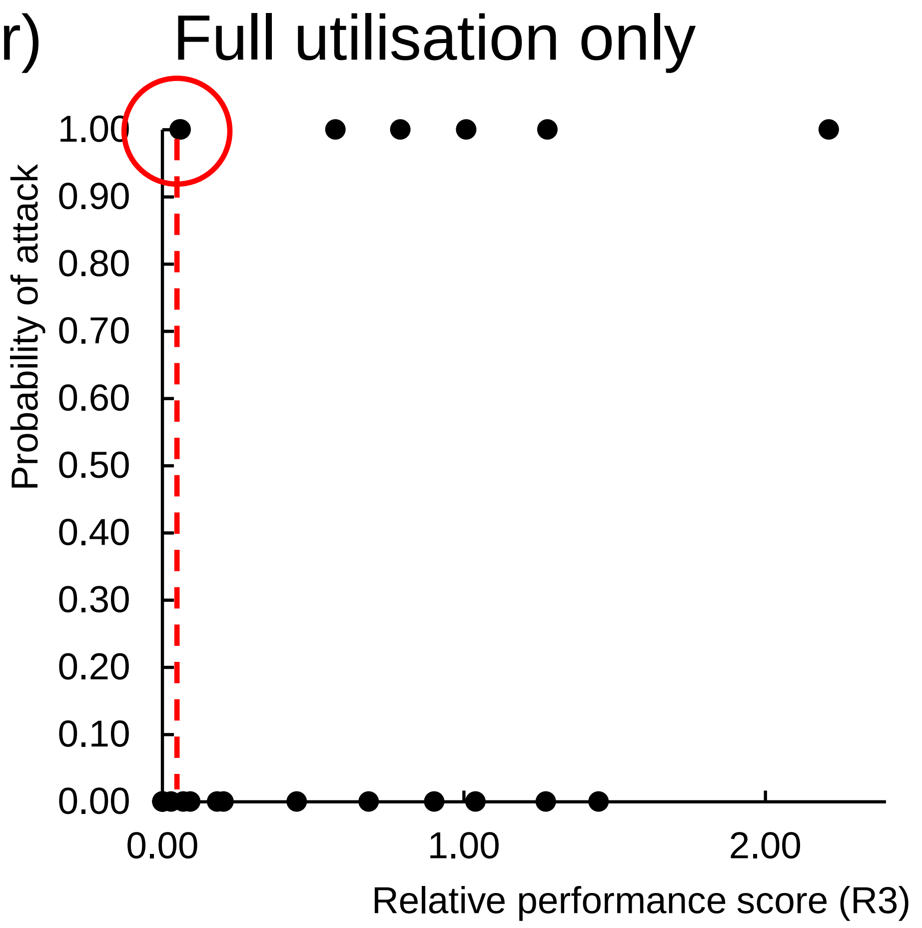


X^2 $P < 0.001$; but lowest score where non-target attack occurred only 0.14

X^2 $P < 0.01$; lowest score for field use = 0.51 (caveat: few examples)

Choice oviposition scores (R4)





X^2 *P* < 0.001; but lowest score where non-target attack occurred only 0.06!

X^2 *P* > 0.05 – not significant!

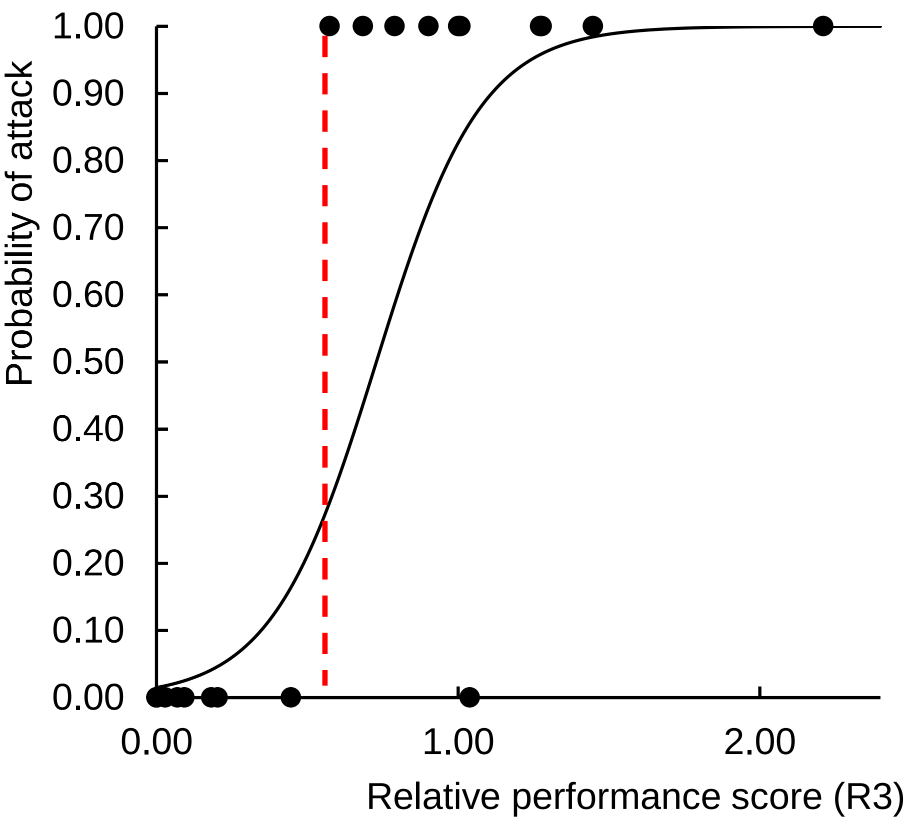
Choice tests, continued…

- Low 'false negative' scores both seed-feeders (*B. villosus* & *Cydia succedana*)
- Choice tests inappropriate for seed-feeders: asynchrony between phenology of agent & target weed reproduction in NZ[1] results in no-choice scenarios in the field

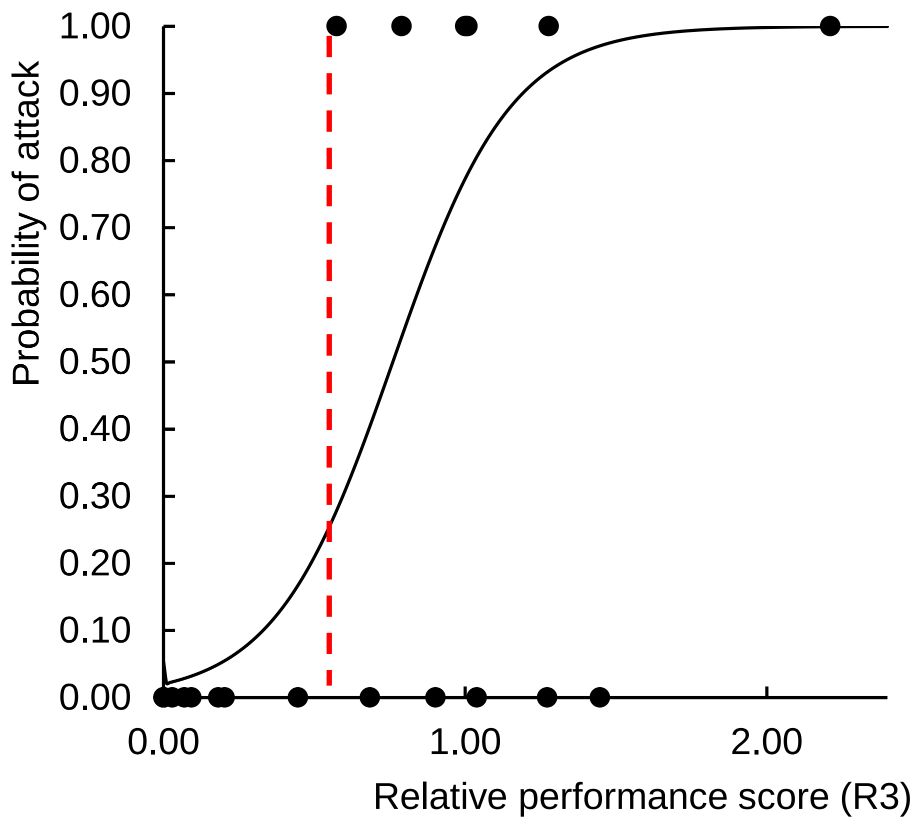
[1]Paynter Q., et al. (2008). *Biological Control,* **46,** 453-462

Choice oviposition scores minus seed-feeders (R4)

All attack(including spill-over)



Full utilisation only



X^2 $P < 0.01$; lowest score where non-target attack occurred 0.57

Ditto!

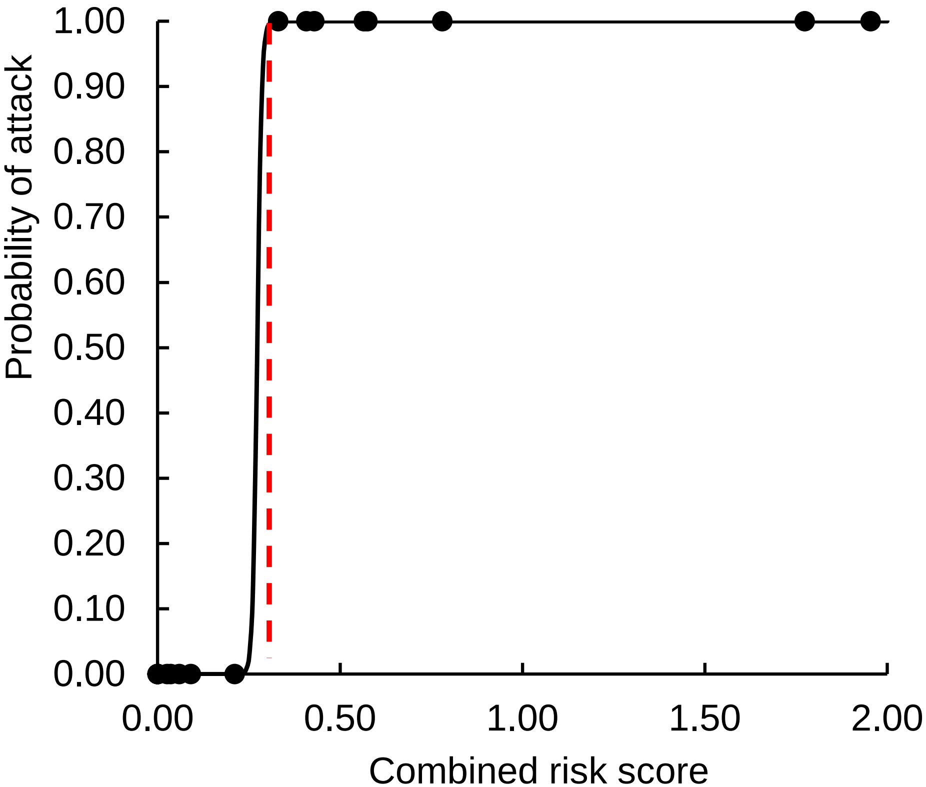
Combining risk measures

- Concept pioneered by Wan & Harris (1997)[1] & used more recently by Olckers & Borea (2009)[2]
- Host suitability is influenced by multiple factors (suitability for oviposition, larval development etc.) & risk is a product of these factors
- e.g. if the oviposition relative performance score = 0.1 & larval starvation test relative performance score = 0.5; then the 'combined' relative performance on that test plant is 0.1 X 0.50 = 0.05

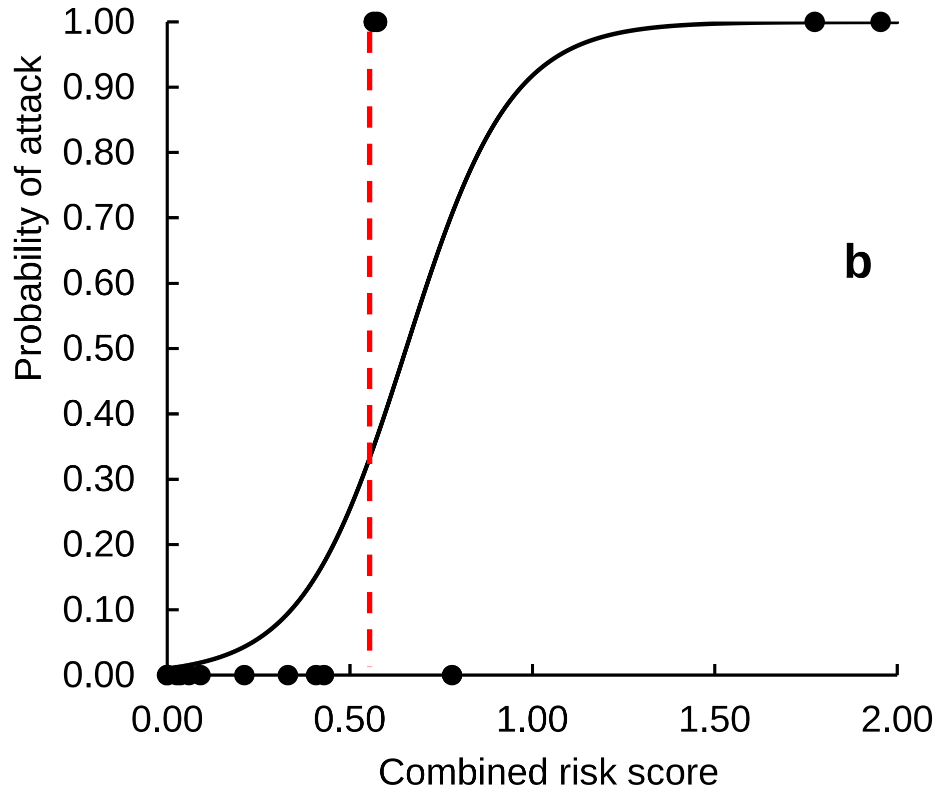
[1]Wan F-H & Harris, P (1997) Biocontrol, Science & Technology 7, 299-308
[2]Olckers, T. & Borea, C. K. (2009) *Biocontrol,* **54,** 143-154

Combined no-choice starvation (R1) x no-choice oviposition (R2) scores

All attack(including spill-over)



Full utilisation only



X^2 P < 0.001; lowest score where non-target attack occurred = 0.33

X^2 P = 0.01; lowest score for field utilisation = 0.57; caveat – few examples

Conclusions

- Quantitative laboratory testing data can help predict risk of non-target attack
- Combining no-choice starvation & oviposition scores resulted in a clear-cut threshold score, below which non-target attack did not occur
- Quantitative choice-test data did not display a threshold score (risk of false negatives)
- BUT potential for refining choice-test analysis by excluding certain agent types (e.g. flower/seed-feeders) for which choice testing is inappropriate
- More (& better) data required to refine predictive ability - & there is plenty more data from overseas programmes

Acknowledgements

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