ow to evaluate environmental risks of exotic biologi control agents: the OECD & ERBIC experience

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Kiel, November 2004

w to evaluate environmental risks of exotic bc agen

Biological control for sustainable pest management, but….

Is risk assessment by regulation of imports a solution?

How to evaluate environmental risk?

Host-range testing as focal point of environmental risk assessment?

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ogical control for sustainable pest management, bu

ological control often said to be:

- Environmentally safest form of pest management
- Most cost-effective form of pest management
- Most durable form of pest management (once good, always good)
- Highest success rate per tested "active ingredient"

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wever, during past decades increasing criticism from environmentalists:

- Mistakes occur frequently, and …
- If something goes wrong, repair is difficult/impossible

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If something goes wrong……….

ian ladybird beetle *Harmonia axyridis* recent release in Euro

aded Holland, dispersed very quickly and established

perience in North America:

ry polyphagous, reduction of other ladybird beetles, and atta
of many non-targets

ssive invasion of houses in fall

hen prey is gone, goes to fruit
 sugar (grapes > bad wine)

Recorded risk of biological control agents

nce 1888: > 6000 introductions of exotic agents worldwid

> 1500 (25%) established

> 525 (9%) success (35% of established)

(in chemical control 0.003% success)

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Recorded risk of biological control agents

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> 700 species of biocontrol agents involved in (

80 % parasitoids

18 % predators

2 % pathogens

> 150 species used in commercial Inundative B

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Biocat (CABI) data analysed (5300 cases): < 100 non-target effects listed, but often information is lacking

Recorded risk of biological control agents

Biocat analysis (Lynch et al., 2001):

< 8% of classical biocontrol introductions have non-target effects

< 1.4% with mortalilty effect of > 40% (= population reductio

Non-target effects often caused by natural enemies that establish, but do not lead to control of target…

Poor agent choice: poor effectiveness, poor host-range testing, higher risk of non-target effects

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risk assessment by regulation of imports a solution

registration of parasitoids and predators until recently

ry few mistakes

t as biocontrol is now also applied by non-professionals: mo
risk, so better guidance needed

creasing number of countries develop ruling (25 out of >200)

Ruling delayed introduction of agents, but did not result in
lower number of introductions (FAO, CABI 2004)

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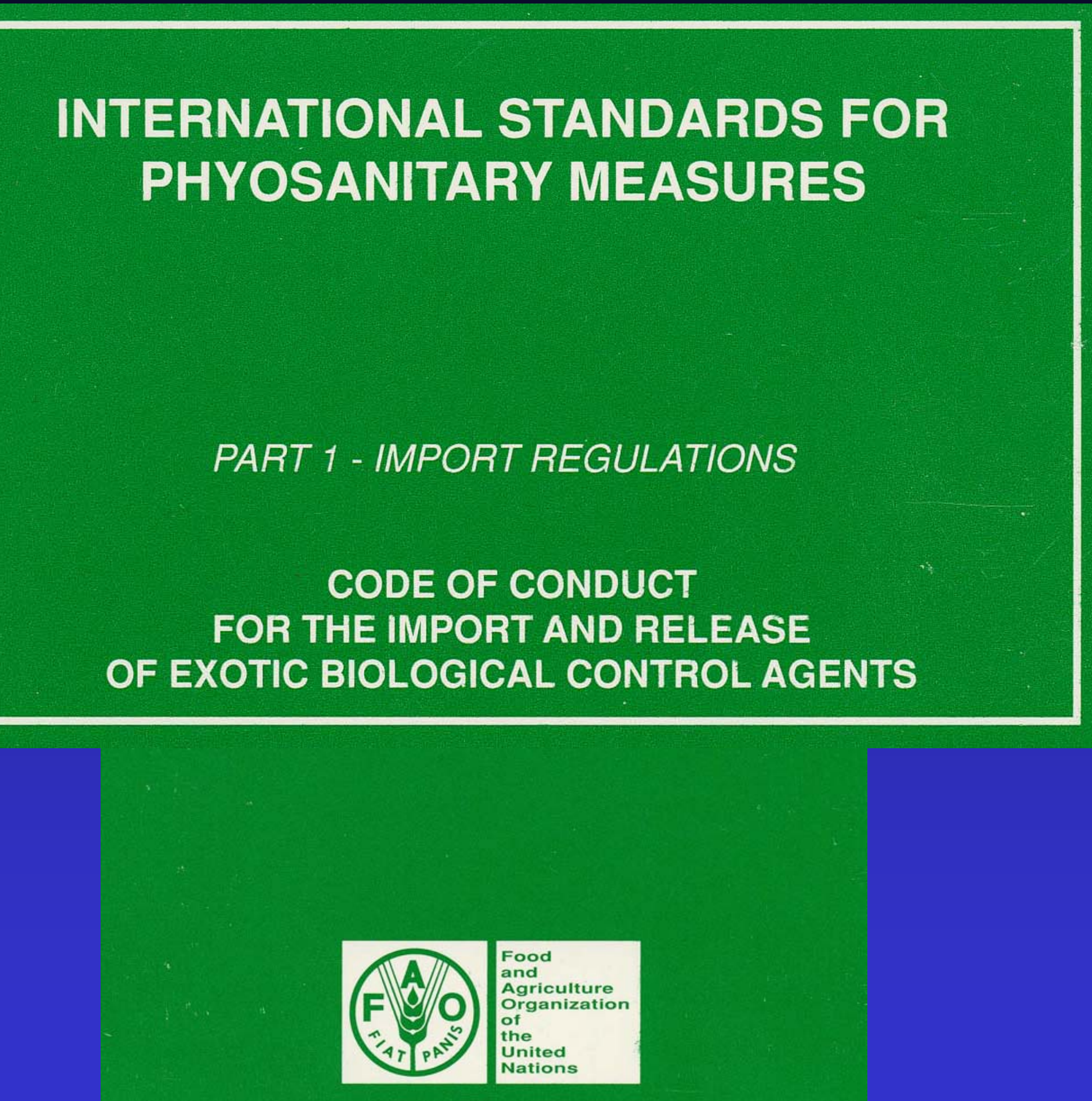
Examples of "old" guidelines / regulations



FAO code of cond

- Very, very gene
- But is being revised present and more speci

Others:

Very general:

USA, CABI

Very specific:

Australia, Ne Zealand

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How to evaluate environmental risk?

th OECD group we studied all existing guidelines/regulations
(30) and came to following design:

Characterization of natural enemy (taxonomy, biology)

Human health risks (limited info asked)

Environmental risk assessment (lot of info asked, but depen

Efficacy (limited info: significant reduction in pest populatio

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How to evaluate environmental risk?

n OECD working group we developed a general framework risk assessment (Anonymous, 2004 via www.oecd.org)

OECD Environment, Health and Safety

Series on Pesticides

No. 21

Guidance for Information Requirements for
ation of Invertebrates as Biological Control Agents (IBCAs)

History and work of OECD group

- nada-OECD proposed to develop guideline for regulation of macro's
- CD was working already on guideline for microbials and pheromones (botanical insecticides?)
- CD idea for macro's was explained to ERBIC group during meeting in UK, February 1999
- tially no biologists in OECD working group; only regulators, made some of us decide to take part, so regulation would be based also on science and biocontrol practical experience
- st, biocontrol industry was not involved, later representative of IBMA and ANBP took part in meetings: 10 WG meetings
- llaboration not always optimal, but hard work of biocontrol scientist and industry representatives resulted in many adaptations: see it as work in progress

How to evaluate environmental risk?

a European Commission funded
oject (ERBIC) we developed ideas
a quantitative environmental risk
sessment

BioControl **48:** 3–38, 2003.

RUM

**vironmental risk assessment of exotic natural
emies used in inundative biological control**

VAN LENTEREN[1], D. BABENDREIER[2], F. BIGLER[2], G. BURGIO[3],
M.T. HOKKANEN[4], S. KUSKE[2], A.J.M. LOOMANS[1],
IENZLER-HOKKANEN[4], P.C.J. VAN RIJN[5], M.B. THOMAS[5],
G. TOMMASINI[6] and Q.-Q. ZENG[4]

RBIC = Evaluating Environmental Risks of Biologica Control Introductions into Europe: activities

ojectives:

- determine positive and negative effects of biological p control for agriculture, the environment and biodiversity

- develop methods to assess the potential risk of import a release of biocontrol agents

- draft guidelines to ensure that biological control agents wh are to be introduced are environmentally safe

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RBIC = Evaluating Environmental Risks of Biologica Control Introductions into Europe: activities

achieve objectives, specific case studies of four syste were done:

Exotic / endemic host specific *Encarsia* parasitoids

Exotic / endemic generalist *Trichogramma* parasitoids

Exotic / endemic generalist *Orius* predators

Exotic / endemic generalist entomopathogens: fungi nematodes

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RBIC = Evaluating Environmental Risks of Biologica Control Introductions into Europe: activities

th results of case studies we (ERBIC) defined ecolog context and the selection of appropriate non-target species

- Host-specificity testing
- Natural enemy establishment capability
- Natural enemy dispersal capability
- Direct effects on the non targets
- Indirect effects on the non targets

sk assessment methodology

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How to evaluate environmental risk?

ntify environmental risks of introducing exotic natural enem
by determining:

non-target host range
establishment in non-target habitat
dispersal to non-target habitat
direct effects on non-target organisms
ndirect effects on non-target organisms

Host range of exotic is focal point of environmental risk assessment

If natural enemy is very target host specific: risk low

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t range testing as focal point of environmental risk

nsiderations when developing host range testing:

st range tests aim to demonstrate if a natural enemy can fee kill, develop or reproduce on a non-target species under natural conditions

owledge of biology and behaviour of the natural enemy in its natural environment is essential when designing host range tests.

ten utterly simple set-ups ignoring biology and resulting in rrelevant results (over estimation of host range)

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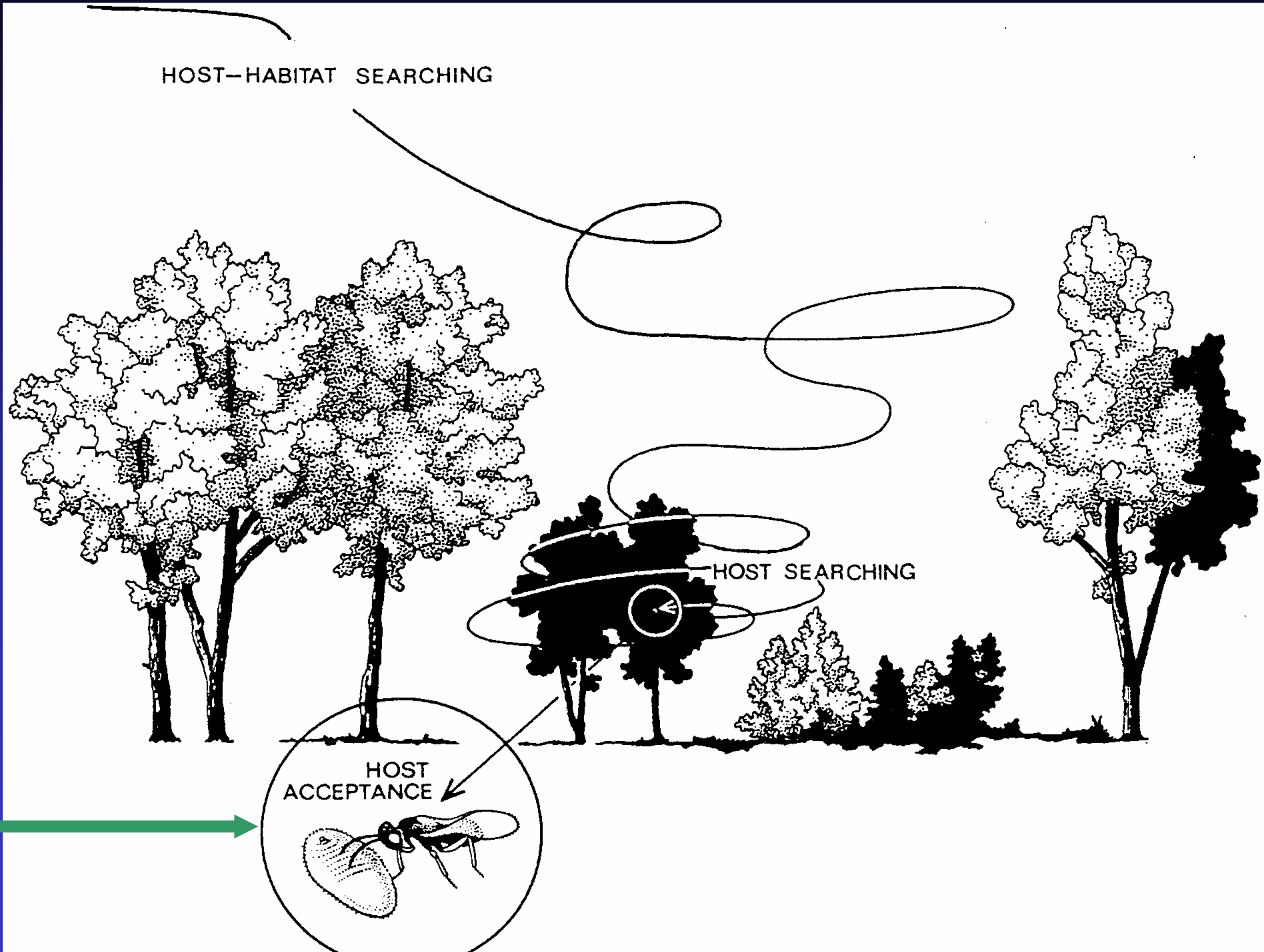
now natural enemy behaviour in natural environme

n



RBIC = Evaluating Environmental Risks of Biologica Control Introductions into Europe: activities

th the ERBIC group we published (among others….100 other publications….) a proposal for a quantifiable environmental risk assessment

uld present it here, but we are revising it and later this morn you will hear more about it (Loomans)

Host range testing: interpretation of results

st difficult groups for interpretation of host range data:
more pronounced oligophagous = slightly polyphagous
biological control agents

t feeling, modeling, theory and experience all indicate that :
these are not very efficient natural enemies, and
may also show more severe non-target effects when compar
to strongly polyphagous and monophagous species

n-target effects of this group of natural enemies needs to be
studied with high priority

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One or more non-targets are attacked, what next?

pending on kind and number of non-target species attacked
cision to not introduce OR to continue with risk assessment

r classical biocontrol agents estimate:
direct and indirect non-target effects

r inundative biocontrol agents estimate:
establishment in and dispersal to non-target habitat
direct and indirect effects on non-target organisms

ese estimates will - in relation to negative effects of other control methods - lead to conclusion (but): go / no go

What next?

by this group>>

vironmental
pact of
ertebrates for
ological Control
Arthropods:
thods and Risk
sessment

pear June 2005

WPRS 2004:

mmission on
rmonisation of
gulation of
CAs (Bigler)

Who has documented example of host shift, or change in host range??

For information and reprints

Joop.vanLenteren@wur.nl

Become member of IOBC-Europe!!!

www.iobc-wprs.org

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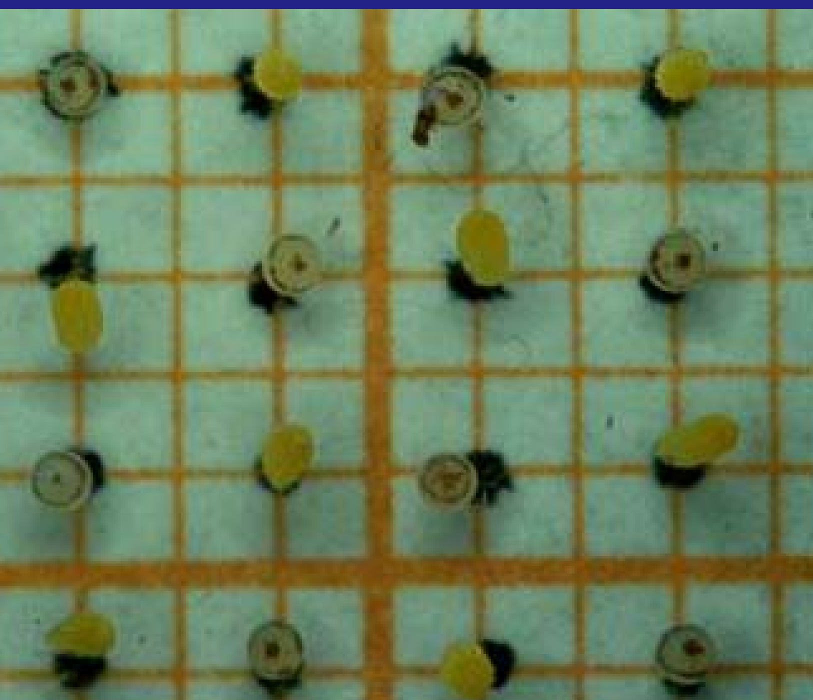
Considerations when developing host range testing

Know natural enemy foraging behaviour

Host habitat searching, host searching and host acceptance

one phase is skipped, more hosts might be accepted than in natural situation >> irrelevant results



Considerations when developing host range testing

Know natural enemy foraging behaviour in its environment

Quality and (history of) rearing conditions of the host plant, host and natural enemy

If not good or not specified: irrelevant results

Genetic changes

Changes always occur while rearing in lab.: irrelevant results

Unnatural hosts, artificial diets

Change in responses of natural enemies: irrelevant results

Host or natural enemy infection with pathogens

Change in response to hosts: irrelevant results

Considerations when developing host range testing

Behavioural variation in natural enemies: know it's origin!!

- Genetically fixed or phenotypiccally plastic behaviour (learn
- Physiological condition of natural enemy (food etc.)

Test in relevant multitrophic perspective

- All relevant stimuli should be present (often stimuli poor situations are used..)
- Host sufficiently long on host plant to produce herbivore induced synomones

Always work with:

- Positive controls (exposure of target host with natural enem tells whether natural enemy is in good condition
- Negative controls (exposure of hosts without natural enemy) tells whether hosts/ host plants are in good condition

Considerations when developing host range testing

Choice of relevant non-target species: difficult / important

Related species, species in similar habitat, and species of conservation concern

Insect biocontrol specialists that testing of up to 10 non-target species is realistic

Be aware of confusing effects of test design

Overestimated host ranges

- non-host attacked in absence of natural host
- non-host attacked in close proximity to natural host

Underestimated host ranges

- valid, but less preferred host neglected in presence of preferred host

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Host range testing scheme

Small arena no-choice black-box test: > No > Low hazard, stop testin

are non-target species attacked?

Yes ⟶ many > > High hazard, stop testi

↓ few

Small arena no-choice behavioural test

Host range testing scheme

Small arena no-choice black-box test: > No > Low hazard, stop testi
are non-target species attacked?

Yes → many > > High hazard, stop testi

↓ few

Small arena no-choice (sequent.) behav. test:> No, or low rate, > Low hazard, stop testi
are non-target species attacked?

Yes, at constant fixed rate → many > High hazard, stop testi

↓ few

Host range testing scheme

Small arena no-choice black-box test: > No > Low hazard, stop testi
are non-target species attacked?
Yes → many > > High hazard, stop testi
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Small arena no-choice (sequent.) behav. test:> No, or low rate, > Low hazard, stop testi
are non-target species attacked?
Yes, at constant fixed rate → many > High hazard, stop testi
↓ few

Large arena no-choice behavioural test: > No, or low rate > Low hazard , stop testi
are non-target species attacked?
Yes, at constant fixed rate → many > High hazard, stop testi
↓ few

Large arena whole plant choice test: > No, or low rate > Low ha
are non-arget species attacked? and no switch in preference stop tes
Yes, easy or switch in preference → Stop testing > High ha
↓ In rare cases

Field test
are non-target species attacked? > No > Low ha

1. Risk identification and evaluation

ntify risks of introducing exotic natural enemy
establishment in non-target habitat
dispersal to non-target habitat
non-target host range
direct effects on non-target organisms
ndirect effects on non-target organisms

termine likelihood of each of the risks

termine magnitude of each of the risks

ery limited information for biocontrol risk assessments!!)

Risk assessment

velopment of criteria to evaluate likelihood of risks:

Establishment:

Dispersal:

Non-target host range: 0, 1-3, 4-10, 11-30, > 30 species

Direct effects: very unlikely, unlikely, possible, likely, very lik

ndirect effects:

Risk assessment

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Establishment:

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Direct effects: very unlikely, unlikely, possible, likely, very lik

ndirect effects:

velopment of criteria to evaluate magnitude of risks:

Establishment:

Dispersal:

Non-target host range: species, genus, family, order, none

Direct and Indirect effects:

1. Risk identification and evaluation

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udgement can be made concerning risk of release

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ample for non-target host range

elihood: host range: 0, 1-3, 4-10, 11-30, > 30 species

Numerical value 1 2 3 4 5

gnitude: host range: species, genus, family, order, none

Numerical value 1 2 3 4 5

sk index non target host range: 5 x 2 = 10

1. Risk identification and evaluation

ximum risk index per criterion: 5 (likelihood) x 5 (magnitude)

ximum risk index for all criteria (dispersal, establishment, ho
ange, direct and indirect effects) : 25 + 25 + 25 + 25 + 25 = 12

applied this method of determining risk to a number of natu
nemies

Risk indices for biocontrol agents